17th Czech and Slovak Conference on Magnetism

Book of Abstracts

June 3 – 7, 2019
Košice, Slovakia

17th Czech and Slovak Conference on Magnetism

Organized by

Faculty of Science
Pavol Jozef Šafárik University in Košice

Institute of Experimental Physics
Slovak Academy of Sciences, Košice

in cooperation with

Slovak Physical Society

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Editors: Pavol Sovák, Ivan Škorvánek,
Martin Orendáč, Jozef Marcin and Marián Reiffers

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Scope of the Conference

The objective of the conference is to offer the opportunity for the Slovak and Czech scientists and guests from other countries working in the field of basic and applied magnetism to present their recent results and to exchange ideas and technical information.

Technical Content

The programme of the conference covers the following areas:

1. Theoretical problems of magnetically ordered materials, magnetization processes
2. Amorphous, nanocrystalline and other soft magnetic materials
3. Magnetic materials for energy applications (permanent magnets, magnetocaloric materials, motors, transformers, ….)
4. Magnetic thin films and surfaces, spintronics, particles and nanostructures
5. Low-dimensional magnetic materials, molecular magnets and ferrofluids
6. Rare-earth and 5f-systems
7. Strongly correlated electron systems, superconducting materials
8. Multifunctional magnetic materials (multiferroic, magnetoelastic, shape memory, …)
9. Other magnetic materials and applications not included in 1-8

Each session comprises both oral (invited and contributed talks) and poster presentations.

Conference Language

The official language of the conference is English.

Proceedings

The Proceedings of the Conference will be published in Acta Physica Polonica A. It is an open access peer-reviewed scientific journal, indexed in the Web of Science™ (Science Citation Index, Science Citation Index Expanded, Current Contents - Physical, Chemical & Earth Sciences) and Scopus®.

Conference Date and Location

The conference sessions will take place in the lecture halls of Faculty of Medicine Pavol Jozef Šafárik University in Košice, during June 3-7, 2019.

CSMAG'19 Conference Secretariat

Institute of Physics, P. J. Šafárik University
Park Angelinum 9
041 54 Košice, Slovakia
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P R O G R A M M E

Programme at a Glance

Monday June 3	Tuesday June 4	Wednesday June 5	Thursday June 6	Friday June 7
	9:00 – 10:30 Session 4	9:00 – 10:30 Session 5	9:00 – 10:30 Session 8	9:00 – 10:30 Session 7
10:00 Registration	10:30 – 11:00 Coffee break	10:30 – 11:00 Coffee break	10:30 – 11:00 Coffee break	10:30 – 11:00 Coffee break
	11:00 – 12:45 Session 3	11:00 – 12:45 Session 5	11:00 – 12:45 Session 3	11:00 – 12:30 Session 7 & 1
	12:45 – 14:00 Lunch break	12:45 – 14:00 Lunch break	12:45 – 14:00 Lunch break	12:30 Closing
13:45 – 16:00 Opening Session	14:00 – 16:00 Session 6	14:00 – 16:00 Session 9	14:00 – 16:00 Session 4	
16:00 – 16:30 Coffee break	16:00 – 16:30 Coffee break	16:00 – 16:30 Coffee break	16:00 – 16:30 Coffee break	
16:30 – 18:30 Session 2	16:30 – 18:30 Session 1	16:30 – 18:00 Poster Sessions P2, P3, P4, P5	16:30 – 18:00 Poster Sessions P1, P6, P7, P8, P9	
18:30 Welcome drink		19:00 Concert	19:00 Barbecue	

Conference Sessions

1. **Theoretical problems of magnetically ordered materials, magnetization processes**
2. **Amorphous, nanocrystalline and other soft magnetic materials**
3. **Magnetic materials for energy applications (permanent magnets, magnetocaloric materials, motors, transformers, ...)**
4. **Magnetic thin films and surfaces, spintronics, particles and nanostructures**
5. **Low-dimensional magnetic materials, molecular magnets and ferrofluids**
6. **Rare-earth and 5f-systems**
7. **Strongly correlated electron systems, superconducting materials**
8. **Multifunctional magnetic materials (multiferroic, magnetoelastic, shape memory, ...)**
9. **Applications and other magnetic materials not included in 1-8**

MONDAY, JUNE 3

10:00 Registration

13:45

OPENING SESSION

Pavol Sovák, Co-Chair

P. J. Šafárik University, Institute of Physics, Košice, Slovakia

Ivan Škorvánek, Co-Chair

Institute of Experimental Physics SAS, Košice, Slovakia

14:00 I-01 (invited)

MAGNETIC PROPERTIES OF SPINEL FERRITE BASED NANOPARTICLE SYSTEMS

D. Fiorani, K. N. Trohidou, M. Vasilakaki, N. Ntallis, R. Mathieu, R. Zysler, G. Lavorato, E. Winkler, R. Zysler, E. Agostinelli and D. Peddis

14:30 I-02 (invited)

CHALLENGES FOR MAGNETIC MATERIALS IN VEHICLE ELECTRIFICATION

M. A. Willard, S. Lan, B. Dong, A. Martone, P. Wang and M. Daniil

15:00 I-03 (invited)

OVERVIEW THE WAYS FOR ENHANCING THE COERCIVITY OF HOT DEFORMED NdFeB MAGNETS

Y. I. Lee, P. H. Liao, Y. J. Wong, H. W. Chang, *W. C. Chang* and C. C. Shaw

15:30 I-04 (invited)

THE DOMAIN WALL VELOCITY PLATEAU: CASE OF THE DZYALOSHINSKII DOMAIN WALLS

A. Thiaville, V. Krizakova, N. Rougemaille, J. Vogel, D. de Souza Chaves and S. Pizzini

16:00 Coffee break

MONDAY, JUNE 3

AMORPHOUS, NANOCRYSTALLINE AND OTHER SOFT MAGNETIC MATERIALS

Lajos K. Varga, Chair
Wigner Research Center for Physics of Hungarian Academy of Sciences, Budapest, Hungary

16:30 **I-05 (invited)**
1D AND 2D LOSS CHARACTERIZATION SYSTEMS: OPTIMAL DESIGN, MEASUREMENT METHODS AND RESULTS
O. de la Barrière, C. Appino, C. Ragusa, F. Fiorillo, M. LoBue and F. Mazaleyrat

17:00 **I-06 (invited)**
ASSESSMENT OF SOFT MAGNETIC MATERIALS WIDEBAND PROPERTIES FOR A SUSTAINABLE USE OF ENERGY
E. Ferrara

17:30 **O2-01**
TEMPERATURE EVOLUTION OF MAGNETIC STRUCTURE IN Fe-Co-Si-B-Mo-P METALLIC GLASS BY MÖSSBAUER SPECTROMETRY
M. Miglierini, M. Cesnek and J. Dekan

17:45 **O2-02**
INFLUENCE OF SUBSTITUTION ON THE STRUCTURE AND MAGNETIC PROPERTIES OF RAPIDLY QUENCHED $Fe_{86}B_{14}$ ALLOY
L. Hawelek, P. Wlodarczyk, M. Polak, P. Zackiewicz and A. Kolano-Burian

18:00 **O2-03**
FORC STUDY OF MAGNETIZATION REVERSAL AND INTERLAYER INTERACTIONS IN RAPIDLY QUENCHED Fe/Co- BASED BILAYER RIBBONS
B. Kunca, I. Maťko, P. Švec and I. Škorvánek

18:15 **O2-04**
GMI EFFECT IN AMORPHOUS RIBBONS AND POSSIBILITY OF ITS APLICATION IN NULL-DETECTOR MAGNETIC FIELD SENSOR
P. Gazda, M. Nowicki and R. Szewczyk

18:30 **Welcome drink**

TUESDAY, JUNE 4

MAGNETIC THIN FILMS AND SURFACES, SPINTRONICS, PARTICLES AND NANOSTRUCTURES

Onofre Rojas, Chair
Physics Department, Federal University of Lavras, Lavras, Brazil

09:00 **I-07 (invited)**
APPROACHES TO EQUIP GRAPHENE WITH MAGNETIC FEATURES: FROM SUBSTITUTION AND EDGE ENGINEERING TO SP^3 FUNCTIONALIZATION
J. Tuček, P. Blonski, M. Otyepka and R. Zbořil

09:30 **O4-01**
LOCAL SURFACE EFFECTS IN FERRITE NANOSPHERES
D. Zákutná, D. Honecker and S. Disch

09:45 **O4-02**
CuMnAs: CONDUCTIVITY AND ANISOTROPIC MAGNETORESISTANCE
K. Vyborny, J. Volny, D. Wagenknecht and K. Uhlirova

10:00 **O4-03**
MAGNETIC STATES OF FERROMAGNETIC/NON-MAGNETIC MULTILAYER DOTS
I. Vetrova, J. Šoltýs, M. Mruczkiewicz, T. Ščepka and V. Cambel

10:15 **O4-04**
SPIN HALL EFFECT IN RANDOM PLATINUM-BASED ALLOYS FROM AN AB INITIO THEORY
I. Turek, J. Kudrnovsky and V. Drchal

10:30 **Coffee break**

TUESDAY, JUNE 4

MAGNETIC MATERIALS FOR ENERGY APPLICATIONS (PERMANENT MAGNETS, MAGNETOCALORIC MATERIALS, MOTORS, TRANSFORMERS, ...)

Horia Chiriac, Chair

National Institute of Research and Development for Technical Physics, Iasi, Romania

11:00 **I-08 (invited)**
STRESS-INDUCED MAGNETIC ANISOTROPY ENABLING ENGINEERING OF MAGNETIC SOFTNESS AND DOMAIN WALL DYNAMICS OF Fe-RICH AMORPHOUS MICROWIRES
A. Zhukov, P. Corte-Leon, L. Gonzalez-Legarreta, M. Ipatov, J. M. Blanco and V. Zhukova

11:30 **O3-01**
SHAPED CRYSTAL GROWTH OF Fe-Ga AND Fe-Al ALLOY PLATES BY THE MICRO PULLING DOWN METHOD
K. Kamada, R. Murakami, M. Arakawa, T. Minamitani, T. Ueno, Y. Shoji, A. Yamaji, M. Yoshino, S. Kurosawa, Y. Yokota, Y. Ohashi and A. Yoshikawa

11:45 **O3-02**
OPTIMIZATION OF THE MAGNETIC PROPERTIES OF HARD MAGNETIC Hf-Co-B ALLOYS BY STRUCTURAL MODIFICATIONS
A. Musiał, Z. Śniadecki, N. Pierunek, Yu. Ivanisenko, A. Kilmametov, D. Wang, M. H. Fawey and B. Idzikowski

12:00 **O3-03**
INTRINSIC MAGNETIC PROPERTIES OF THE $L1_0$ MnAl AND FeNi
S. Arapan, P. Nieves and D. Legut

12:15 **O3-04**
COMPARISON THE EFFICIENCY OF LASER CUTTING AND ELECTRICAL DISCHARGE MACHINING DIRECTED TO SHAPING OF GLASSY TAPES PRODUCING ELECTRICAL ROTOR-ELEMENTS
S. Balla and A. Lovas

12:30 **O3-05**
EFFECT OF REFINED SURFACE DOMAIN WALLS ON THE CORE LOSSES COMPONENTS IN GO SILICON STEEL AT DIFFERENT FREQUENCIES
I. Petryshynets, F. Kováč, J. Füzer, P. Kollár, V. Puchý and M. Podobová

12:45 **Lunch break**

TUESDAY, JUNE 4

RARE-EARTH AND 5f-SYSTEMS

Konrad Siemensmeyer, Chair
Helmholtz Zentrum Berlin, Berlin, Germany

14:00 **I-09 (invited)**
VIBRON STATES IN CERIUM INTERMETALLICS - REALITY?
P. Javorský, M. Klicpera, P. Doležal, M. Boehm, S. Rols, M. M. Koza, D. T. Adroja, T. Guidi, K. Vlášková and H. Mutka

14:30 **I-10 (invited)**
MAGNETIC POLARIZATION OF AMERICIUM GROUND STATE IN $AmFe_2$
N. Magnani, R. Caciuffo, F. Wilhelm, E. Colineau, R. Eloirdi, J.-C. Griveau, *J. Rusz*, P. M. Oppeneer, A. Rogalev and G. H. Lander

15:00 **O6-01**
TWO-ION MAGNETIC ANISOTROPY IN U-COMPOUNDS: U_2Ni_2Sn
S. Maskova, A. V. Andreev, H. Nakotte, K. Kothapalli and L. Havela

15:15 **O6-02**
PRELIMINARY RESISTIVITY RESULTS ON U_2Ni_2Sn SINGLE CRYSTALS
I. Halevy, A. Kolomiets, S. Mašková, A. V. Andreev and L. Havela

15:30 **O6-03**
MAGNETIC STATES IN $UCo_{1-x}Rh_xGe$ SYSTEM
J. Pospíšil, Y. Haga, A. Miyake, P. Prochek, S. Kambe, N. Tateiwa, Y. Tokunaga, M. Tokunaga and E. Yamamoto

15:45 **O6-04**
A SPIN-GLASS GROUND-STATE IN AN $Er_2Zr_2O_7$ SINGLE CRYSTAL
M. Klicpera, K. Vlášková, R. H. Colman and P. Proschek

16:00 **Coffee break**

TUESDAY, JUNE 4

THEORETICAL PROBLEMS OF MAGNETICALLY ORDERED MATERIALS, MAGNETIZATION PROCESSES

Ilja Turek, Chair

Institute of Physics of Materials, Czech Academy of Sciences, Brno, Czech Republic

16:30 **I-11 (invited)**
PROXIMITY EFFECTS IN GRAPHENE VAN DER WAALS HETEROSTRUCTURES
M. Gmitra

17:00 **O1-01**
PECULIARITIES OF THE ENERGY SPECTRA AND MAGNETIC PROPERTIES OF 1D HEISENBERG SPIN MODELS FOR POLYMERIC COMPLEXES OF TRANSITION METALS AND HYPOTHETICAL GRAPHENE BASED NANOMAGNETS
V. O. Cheranovskii, V. V. Slavin, A. L. Tchougréeff and R. Dronskowski

17:15 **O1-02**
ULTRAFAST MAGNETIZATION AND LATTICE DYNAMICS BEYOND THE THREE TEMPERATURE MODEL
K. Carva, P. Baláž, P. Maldonado and P. M. Oppeneer

17:30 **O1-03**
FREE ENERGY LANDSCAPE PROFILES OF MAGNETIC NANODOTS WITH DIFFERENT TYPE OF SPATIAL ASYMMETRY
J. Tóbik

17:45 **O7-06**
THERMODYNAMIC PROPERTIES OF SUPERCONDUCTING STATE IN DOPED GRAPHENE BILAYER
K. M. Skoczylas, A. P. Durajski and R. Sczęśniak

18:00 **O1-05**
TENSOR-NETWORK STUDY OF QUANTUM SPIN SYSTEM ON HYPERBOLIC LATTICE GEOMETRIES
M. Daniška and *A. Gendiar*

18:15 **O1-06**
SPIN-1/2 HEISENBERG DIAMOND AND OCTAHEDRAL CHAINS IN A MAGNETIC FIELD AS A STATISTICAL-MECHANICAL PROBLEM OF HARD-CORE MONOMERS AND DIMERS
J. Strečka, T. Verkholyak, O. Derzhko, K. Karľová and J. Richter

WEDNESDAY, JUNE 5

LOW-DIMENSIONAL MAGNETIC MATERIALS, MOLECULAR MAGNETS AND FERROFLUIDS

Alžbeta Orendáčová, Chair
P. J. Šafárik University, Institute of Physics, Košice, Slovakia

09:00 **I-12 (invited)**
HIGH SPIN CYCLES: TOPPING THE SPIN RECORD FOR A SINGLE MOLECULE VERGING ON QUANTUM CRITICALITY
J. Schnack

09:30 **O5-01**
PHASE BOUNDARY RESIDUAL ENTROPY AND FINITE TEMPERATURE PSEUDO-TRANSITION FOR ONE-DIMENSIONAL MODELS
O. Rojas

09:45 **O5-02**
RING-SHAPED MAGNETIC MOLECULES WITH COMPETING INTERACTIONS: COEXISTENCE OF FRUSTRATION AND BIPARTITENESS
W. Florek, G. Kamieniarz and M. Antkowiak

10:00 **O5-03**
TUNING THE THERMAL ENTANGLEMENT IN A ISING-XXZ DIAMOND CHAIN WITH TWO IMPURITIES
I. M. Carvalho, O. Rojas, *S. M. de Souza* and M. Rojas

10:15 **O5-04**
TUNING OF PHYSICAL PROPERTIES OF $Fe_7(PO_4)_6$ BY SODIUM INTERCALATION
O. Volkova, E. Kozlyakova, L. Shvanskaya and A. Vasiliev

10:30 **Coffee break**

WEDNESDAY, JUNE 5

LOW-DIMENSIONAL MAGNETIC MATERIALS, MOLECULAR MAGNETS AND FERROFLUIDS

Olga Volkova, Chair
Lomonosov Moscow State University, Moscow, Russia

11:00 I-13 (invited)
INTERCHAIN MEAN-FIELD THEORY FOR THE BIMETALLIC FERROMAGNETIC SPIN-CHAIN COMPOUND $MnNi(NO_2)_4(en)_2$ (en = ETHYLENEDIAMINE)
A. Honecker, M. Tiwari, S. Süllow, M. Bleckmann, R. Feyerherm and W. Brenig

11:30 O5-05
QUANTUM ENTANGLEMENT IN SPIN-1/2 MOLECULAR NANOMAGNETS WITH TRIANGLE-BASED GEOMETRY
K. Szałowski and P. Kowalewska

11:45 O5-06
MULTIFUNCTIONAL MOLECULAR MAGNETS BASED ON OCTACYANOMETALLATES: MAGNETOCALORIC EFFECT
M. Fitta, R. Pełka and M. Bałanda

12:00 O5-07
EFFECT OF THE INTERLAYER SPECIES AND INTERACTIONS ON MAGNETIC BEHAVIOUR OF Co(II)-CONTAINING LAYERED DOUBLE HYDROXIDES
A. N. Salak, D. E. L. Vieira, E. L. Fertman, A. V. Fedorchenko, V. A. Desnenko, Yu. G. Pashkevich, R. Yu. Babkin, E. Čižmár, A. Feher and J. M. Vieira

12:15 O5-08
LOW-DIMENSIONAL FERROMAGNETISM IN SODIUM NICKEL PHOSPHATES $Na_5Ni_2(PO_4)_3$ (H_2O) AND $Na_6Ni_2(PO_4)_3OH$
O. V. Maximova, L. V. Shvanskaya, *A. N. Vasiliev*, K. Molla, B. Rahaman and T. Saha-Dasgupta

12:30 O5-09
COMPARISON OF STRUCTURAL PROCESSES IN MAGNETIC FLUIDS BASED ON TRANSFORMER OILS
J. Kúdelčík, Š. Hardoň, P. Bury, M. Timko and P. Kopčanský

12:45 Lunch break

WEDNESDAY, JUNE 5

APPLICATIONS AND OTHER MAGNETIC MATERIALS NOT INCLUDED IN 1-8

Rastislav Varga, Chair

P. J. Šafárik University, Institute of Physics, Košice, Slovakia

14:00 **I-14 (invited)**
PROGRESS IN THE DEVELOPMENT OF JILES-ATHERTON MODEL OF MAGNETIC HYSTERESIS LOOP OF MODERN MAGNETIC MATERIALS – A REVIEW
R. Szewczyk

14:30 **O9-01**
TUNING ELECTRONIC PHASE SEPARATION IN $CaFe_3O_5$ BY DOPING
B. V. Hakala, K. H. Hong and J. P. Attfield

14:45 **O9-02**
THE FINITE ELEMENTS MODEL OF ACTIVE COMPENSATION OF EARTH MAGNETIC FIELD AND MAGNETIC ENVIRONMENTAL NOISES IN MAGNETIC ATOMIC SENSORS
K. Peczalski and A. Ostaszewska-Liżewska

15:00 **O9-03**
MAGNETIC-FIELD-INDUCED TRANSITIONS IN BISMUTH
B. Camargo, P. Gierlowski, M. Sawicki and K. Gas

15:15 **O9-04**
DYNAMIC HYSTERESIS MODELING FOR MAGNETIC SHAPE MEMORY ALLOY ACTUATOR VIA A PI-SIGMA NEURAL NETWORK WITH A MODIFIED BACKLASH-LIKE OPERATOR
W. Pan, R. Xu, Y. Yu, C. Zhang and *M. Zhou*

15:30 **O9-05**
MONITORING OF THERMAL DAMAGE AFTER DEPOSITION OF COATINGS VIA BARKHAUSEN NOISE TECHNIQUE
M. Čilliková, J. Uríček, *M. Neslušan*, V. Ballo and A. Mičietová

15:45 **O9-06**
Withdrawn

16:00 **Coffee break**

WEDNESDAY, JUNE 5

16:30 Poster Sessions – P2, P3, P4, P5

19:00 Concert

THURSDAY, JUNE 6

MULTIFUNCTIONAL MAGNETIC MATERIALS
(MULTIFERROIC, MAGNETOELASTIC, SHAPE MEMORY, ...)
Kei Kamada, Chair
Tohoku University, Sendai, Japan

09:00 I-15 (invited)
Fe BASED NANOPARTICLES FOR BIOMEDICAL AND ENVIRONMENTAL APPLICATIONS
C. Gómez-Polo and L. Cervera

09:30 O8-01
TUNABLE EXCHANGE BIAS IN THE MULTIFERROIC $BiFe_{0.5}Sc_{0.5}O_3$ PEROVSKITE
E. L. Fertman, A. V. Fedorchenko, V. A. Desnenko, V. V. Shvartsman, D. C. Lupascu, S. Salamon, H. Wende, D. D. Khalyavin, A. I. Vaisburd, N. M. Olekhnovich, A. V. Pushkarev, Yu. V. Radyush and A. N. Salak

09:45 O8-02
EFFECT OF DRIVE SIGNAL AND TEMPERATURE ON HYSTERESIS OF MAGNETICAL SHAPE MEMORY ALLOY-BASED ACTUATOR
M. Zhou, Y. Yu, C. Zhang and S. Wang

10:00 O8-04
MICROSTRUCTURAL AND MAGNETIC PROPERTIES OF SORBENTS BASED ON CERIUM DIOXIDE
J. Luňáček, O. Životský, Y. Jirásková, P. Janoš and J. Buršík

10:15 O6-05
ROTATING MAGNETOCALORIC EFFECT IN FRUSTRATED TmB_4
S. Gabáni, Mat. Orendáč, K. Flachbart, E. Gažo, G. Pristáš, N. Shitsevalova, K. Siemensmeyer

10:30 Coffee break

THURSDAY, JUNE 6

MAGNETIC MATERIALS FOR ENERGY APPLICATIONS (PERMANENT MAGNETS, MAGNETOCALORIC MATERIALS, MOTORS, TRANSFORMERS, ...)

Vinh Hung Tran, Chair
Institute of Low Temperature and Structure Research, Polish Academy of Sciences, Wroclaw, Poland

11:00 **I-16 (invited)**
MOLECULAR MAGNETOCOOLING
M. Evangelisti, G. Lorusso, E. Palacios, O. Roubeau and E. Natividad

11:30 **O3-06**
DIRECT STUDIES OF THE MAGNETOCALORIC EFFECT IN CYCLIC MAGNETIC FIELDS IN $Ni_{50}Mn_{37-x}Al_xSn_{13}$ RIBBONS SAMPLES
A. G. Gamzatov, A. M. Aliev, A. B. Batdalov, Sh. K. Khizriev, N. H. Yen, N. H. Dan and S. C. Yu

11:45 **O3-07**
MAGNETIC INDUCED MARTENSITIC TRANSITION IN HEUSLER ALLOYS IN HIGH MAGNETIC FIELD
E. Dilmieva, Yu. Koshkidko, V. Koledov, A. Kamantsev and V. Shavrov

12:00 **O3-08**
CRYSTAL STRUCTURE AND MAGNETOCALORIC EFFECT IN $La_xAg_{1-x}MnO_3$ NANOPARTICLES
M. Zentková, M. Mihalik, M. Mihalik jr., M. Kovalik, M. Vavra and J. Briančin

12:15 **O3-09**
MAGNETIC-FIELD DEPENDENCE OF MAGNETOCALORIC EFFECT IN Gd UNDER DIFFERENT THERMODYNAMIC CONDITIONS
A. Kamantsev, V. Koledov and V. Shavrov

12:30 **O3-10**
HIGH THERMOELECTRIC POTENTIAL OF NANOGRAINED $CuFeS_2$
J. Hejtmánek, P. Levinský, L. Kubíčková, Č. Drašar, J. Navrátil, E. Dutková and P. Baláž

12:45 **Lunch break**

THURSDAY, JUNE 6

MAGNETIC THIN FILMS AND SURFACES, SPINTRONICS, PARTICLES AND NANOSTRUCTURES

Vladimír Cambel, Chair
Institute of Electrical Engineering,
Slovak Academy of Sciences, Bratislava, Slovakia

14:00 **I-17 (invited)**
SURFACE SPIN DISORDER IN FE/FEXOY CORE-SHELL NANOPARTICLES AND ITS INFLUENCE ON THE MACROSCOPIC BEHAVIOR
M. Lostun, M. Porcescu, M. Grigoraș, G. Ababei, G. Stoian and *N. Lupu*

14:30 **I-18 (invited)**
TWO-DIMENSIONAL MAGNETIC VAN DER WAALS MATERIALS: WHAT DOES THE FUTURE HOLD?
M.-H. Phan

15:00 **O4-05**
SPIN WAVE EDGE STATES IN ARRAY OF MAGNETIC RINGS
M. Mruczkiewicz

15:15 **O4-06**
LASER-INDUCED SPIN CURRENTS AND SPIN TRANSFER TORQUE IN NONCOLLINEAR MAGNETIC STRUCTURES
P. Baláž, K. Carva, U. Ritzmann, M. Zwierzycki, P. Maldonado and P. M. Oppeneer

15:30 **O4-07**
SKYRMION CONFINEMENT AND CONTROLLED MOTION IN MAGNONIC ANTIDOT LATTICES
J. Feilhauer, S. Saha, J. Tóbik, M. Zelent, K. Bublikov, L. J. Heyderman and M. Mruczkiewicz

15:45 **O4-08**
MAGNETOFERRITIN-INDUCED TRANSVERSE RELAXIVITY ENHANCEMENT IN MRI
O. Strbak, L. Balejcikova, M. Mihalikova, P. Kopcansky and D. Dobrota

16:00 **Coffee break**

16:30 **Poster Sessions – P1, P6, P7, P8, P9**

19:00 **Barbecue**

FRIDAY, JUNE 7

STRONGLY CORRELATED ELECTRON SYSTEMS, SUPERCONDUCTING MATERIALS

Pavol Szabó, Chair
Institute of Experimental Physics SAS, Košice, Slovakia

09:00 **I-19 (invited)**
SPIN-ORBIT COUPLING INDUCED WEYL POINTS IN A TWO-ELECTRON DOUBLE QUANTUM DOT
Z. Scherubl, A. Palyi, G. Frank, I. Lukacs, J. Nygard, G. Zarand and *Sz. Csonka*

09:30 **O7-01**
POSSIBLE TWO-GAP SUPERCONDUCTIVITY IN Mo_8Ga_{41} ADDRESSED BY THERMODYNAMIC AND SPECTROSCOPIC MEASUREMENTS
Z. Pribulová, M. Marcin, J. Kačmarčík, P. Szabó, M. Kopčík, V. Vaňo, C. Marcenat, V. Yu. Verchenko, A. V. Shevelkov and P. Samuely

09:45 **O7-02**
DFT CALCULATIONS ON THE MÖSSBAUER PARAMETERS OF THE NONCENTROSYMMETRIC Th_7Fe_3 SUPERCONDUCTOR
V. H. Tran and M. Sahakyan

10:00 **O7-03**
EXPLORING KONDO LATTICES WITH TWO INEQUIVALENT Ce-SITES
J. Fikaček, J. Pospíšil, M. Hrůzová Kratochvílová, J. Valenta, J. Fikaček, P. Opletal, S. Kambe and *J. Custers*

10:15 **O7-04**
ANTIFFEROMAGNETIC DOME AND QUANTUM PHASE TRANSITIONS IN HEAVY FERMION SYSTEM $Yb_2Pd_2In_{1-x}Sn_x$
G. Lamura, I. Onuorah, P. Bonfà, S. Sanna, Z. Shermadini, R. Khasanov, J.-C. Orain, C. Baines, I. Curlik, A. Dzubinska, G. Pristas, *M. Reiffers*, F. Gastaldo, M. Giovannini, A. Martinelli, C. Ritter, E. Bauer, R. De Renzi and T. Shiroka

10:30 **Coffee break**

FRIDAY, JUNE 7

STRONGLY CORRELATED ELECTRON SYSTEMS, SUPERCONDUCTING MATERIALS & THEORETICAL PROBLEMS OF MAGNETICALLY ORDERED MATERIALS, MAGNETIZATION PROCESSES

Itzhak Halevy, Chair
NRCN, Be'er Sheva, Israel

11:00 **O7-05**
SUPERCONDUCTING FERROMAGNETIC NANODIAMOND
T. Samuely, G. Zhang, O. Onufriienko, A. Volodin, N. Iwahara, L. F. Chibotaru, V. V. Moshchalkov, P. Szabó and P. Samuely

11:15 **O7-07**
FIELD DEPENDENT DENSITY OF STATES OBSERVED ABOVE THE UPPER CRITICAL MAGNETIC FIELD IN STRONGLY DISORDERED MoC THIN FILMS
P. Szabó, M. Kopčík, T. Samuely, J. Kačmarčík, M. Žemlička, M. Grajcar and P. Samuely

11:30 **O7-08**
RESPONSE OF CRITICAL CURRENTS TO NEUTRON IRRADIATION OF REBaCuO TAPES IN LOW AND HIGH MAGNETIC FIELDS
M. Jirsa, M. Rameš, P. Svora, I. Ďuran and L. Viererbl

11:45 **O7-09**
MAGNETIC PHASE DIAGRAM OF Ca-DOPED $EuFe_2As_2$ COMPOUNDS
L. M. Tran, M. Babij, L. Korosec, T. Shang, Z. Bukowski and T. Shiroka

12:00 **O1-07**
NONENQUILIBRIUM CHARGE TRANSPORT THROUGH LAYERED FALICOV-KIMBALL SYSTEM WITH METALLIC LEADS
M. Žonda, R. Smorka and M. Thoss

12:15 **O1-08**
OVERCOMING LIMITATIONS OF THE ALLOY ANALOGY MODEL FOR AB INITIO TREATMENT OF FINITE TEMPERATURES
D. Legut, D. Wagenknecht, K. Carva and I. Turek

FRIDAY, JUNE 7

12:30	**CLOSING** Mark W. Meisel, Chair *Department of Physics, University of Florida, Gainesville, USA*

POSTER SESSIONS

WEDNESDAY, JUNE 5

16:30 – 18:00

- **P2** **AMORPHOUS, NANOCRYSTALLINE AND OTHER SOFT MAGNETIC MATERIALS**
- **P3** **MAGNETIC MATERIALS FOR ENERGY APPLICATIONS (PERMANENT MAGNETS, MAGNETOCALORIC MATERIALS, MOTORS, TRANSFORMERS, ...)**
- **P4** **MAGNETIC THIN FILMS AND SURFACES, SPINTRONICS, PARTICLES AND NANOSTRUCTURES**
- **P5** **LOW-DIMENSIONAL MAGNETIC MATERIALS, MOLECULAR MAGNETS AND FERROFLUIDS**

THURSDAY, JUNE 6

16:30 – 18:00

- **P1** **THEORETICAL PROBLEMS OF MAGNETICALLY ORDERED MATERIALS, MAGNETIZATION PROCESSES**
- **P6** **RARE-EARTH AND 5f-SYSTEMS**
- **P7** **STRONGLY CORRELATED ELECTRON SYSTEMS, SUPERCONDUCTING MATERIALS**
- **P8** **MULTIFUNCTIONAL MAGNETIC MATERIALS (MULTIFERROIC, MAGNETOELASTIC, SHAPE MEMORY, ...)**
- **P9** **APPLICATIONS AND OTHER MAGNETIC MATERIALS NOT INCLUDED IN 1-8**

POSTERS - WEDNESDAY, JUNE 5

P2 AMORPHOUS, NANOCRYSTALLINE AND OTHER SOFT MAGNETIC MATERIALS

P2-01 **MANIPULATION OF THE DOMAIN WALL SHAPE IN THIN MAGNETIC WIRE BY CURRENT ANNEALING**
O. Váhovský, K. Richter, A. Thiaville and R. Varga

P2-02 **MAGNETIC PROPERTIES OF NANOCRYSTALLINE ALLOYS AFTER ELECTRONS IRRADIATION OF PRECURSOR**
J. Sitek, *J. Dekan*, D. Holková, B. Butvinová and P. Butvin

P2-03 **PERMEABILITY, PERMITTIVITY AND EM-WAVE ABSORPTION PROPERTIES OF POLYMER COMPOSITES FILLED WITH MnZn FERRITE AND CARBON BLACK**
R. Dosoudil, K. Lisý and J. Kruželák

P2-04 **SUBSTITUTED LITHIUM FERRITE UTILIZED AS MAGNETICALLY ACTIVE FILLER FOR THE COMPOSITES WITH ACRYLONITRYLE BUTADIENE RUBBER MATRIX**
M. Ušáková, E. Ušák, R. Dosoudil and *M. Šoka*

P2-05 **STRUCTURAL AND MAGNETIC STUDY OF Fe-Al_{20}-(Ti, Nb) ALLOYS**
Y. Jirásková, N. Pizúrová, M. Friák and D. Janičkovič

P2-06 **INVESTIGATION OF LOCAL AND GLOBAL STRESS STATE AND THE DEGRADATION IN METGLAS TAPES CAUSED BY THE LASER CUTTING**
A. Szabo

P2-07 **MORPHOLOGICAL AND STRUCTURAL STUDY OF HEAT-AFFECTED ZONE INDUCED BY LASER CUTTING OF GLASSSY METAL TAPES**
D. Koti, L. Novak and A. Cziraki

P2-08 **MAGNETIC RESPONSE OF AMORPHOUS AND NANOCRYSTALLINE FeSn(P)B RIBBONS TO ELECTRON IRRADIATION**
B. Butvinová, P. Butvin, I. Janotová, D. Janičkovič, J. Sitek, J. Dekan, D. Holková and I. Maťko

P2-09 **IRREVERSIBLE PERMEABILITY OF Fe-BASED SOFT MAGNETIC COMPOSITES**
Z. Birčáková, P. Kollár, J. Füzer, R. Bureš and M. Fáberová

P2-10 **INFLUENCE OF FERRITE AND RESIN CONTENT ON INNER DEMAGNETIZING FIELDS OF Fe-BASED COMPOSITE MATERIALS WITH FERRITE-RESIN INSULATION**
F. Onderko, Z. Birčáková, P. Kollár, J. Füzer, M. Strečková, J. Szabó, R. Bureš and M. Fáberová

P2-11 **NEUTRON IRRADIATION EFFECTS ON METALLIC GLASSES STUDIED BY MÖSSBAUER SPECTROMETRY AND DIFFRACTION OF SYNCHROTRON RADIATION**
M. Cesnek, M. Stefanik, M. Miglierini, J. Bednarcik and O. Milkovic

P2-12 **GLASS-COATED MICROWIRES FOR TEMPERATURE SENSORS**
E. Komova, L. Galdun, T. Ryba and R. Varga

P2-13 **MAGNETIC PROPERTIES OF $LiFeSi_2O_6$ PREPARED BY MECHANOCHEMICAL/THERMAL PROCESS USING DIFFERENT Fe(III) SOURCES**
O. Skurikhina, R. Tarasenko, V. Tkáč, M. Orendáč, R. Witte, M. Fabián, M. Kaňuchová, M. Senna, V. Šepelák, E. Tóthová

P2-14 **DOMAIN WALL DYNAMICS OF WIRES IN PERPENDICULAR MAGNETIC FIELD**
L. Fečová, K. Richter and R. Varga

P2-15 **RAPID CRYSTALLIZATION OF METALLIC GLASSES STUDIED BY IN-SITU XRD FLASH-ANNEALING**
J. Bednarčík, K. Kosiba, S. Pauly and A. Rothkirch

P2-16 **THE PREPARATION OF Co-BASED HEUSLER ALLOYS BY TAYLOR-ULITOVSKY TECHNIQUE IN THE FORM OF GLASS-COATED MICROWIRES**
T. Ryba, L. Galdun, Z. Vargova, V. M. Prida and R. Varga

P2-17 **AXIAL DOMAIN WALL DIMENSION IN BISTABLE GLASS-COATED MICROWIRE**
M. Kladivová, J. Ziman and P. Duranka

P2-18 **REAL STRUCTURE INVESTIGATION IN SOFT METALLIC GLASSY TAPES USING GLOW DISCHARGE OPTICAL EMISSION SPECTROSCOPY**
K. Bán and A. Lovas

P2-19 **THE EFFECT OF FEMTOSECOND LASER IMPULSES FOR METALLIC GLASS MAGNETIC PROPERTIES DURING LASER CUTTING PROCESSES**
Z. Weltsch

P2-20 **DIRECT (XRD) AND INDIRECT STRUCTURAL ANALYSIS OF HEAT AFFECTED ZONE AFTER LASER CUTTING AT FINEMET AND METGLAS ALLOYS**
M. Nagy, K. Bán and Á. Cziráki

P2-21 **DIRECT (SEM) AND INDIRECT STRUCTURAL ANALYSIS OF HEAT AFFECTED ZONE AFTER LASER CUTTING AT FINEMET AND METGLAS ALLOYS**
K. Bán, M. Nagy and Zs. Fogarassy

P2-22 **WETTABILITY CHANGING OF FINEMET SUBSTRATES USING HIGH-ENERGY FEMTOSECOND LASER IMPULSES**
M. Berczeli

P2-23 **MAGNETOELASTIC ANISOTROPY IN GLASS-COATED MICROWIRES STUDIED USING SAMR METHOD**
P. Duranka, J. Ziman, J. Onufer and S. Kardoš

P2-24 **GLASS-COATED MICROWIRES FOR ENGINEERING APPLICATION**
A. Spegarova, R. Sabol, J. Gamcova, L. Galdun, T. Ryba, R. Jurc, L. Hvizdos, R. Varga

P2-25 **THE FREQUENCY DEPENDENCE OF SWITCHING FIELD OF MAGNETIC MICROWIRE**
J. Gamcova, L. Galdun, T. Ryba, R. Sabol, R. Jurc, A. Spegarova, L. Hvizdos, R. Varga

P2-26 **ENGINEERING OF MAGNETIC PROPERTIES OF Co- RICH MICROWIRES BY POST-PROCESSING**
L. Gonzalez-Legarreta, *V. Zhukova*, P. Corte-Leon, M. Ipatov, J. M. Blanco and A. Zhukov

P2-27 **PREPARATION AND CHARACTERIZATION OF Fe BASED SOFT MAGNETIC COMPOSITES COATED BY SiO_2 LAYER PREPARED BY STÖBER METHOD**
P. Slovenský, A. Zeleňáková, *P. Kollár*, J. Füzer, M. Jakubčin and M. Fáberová

P2-28 **CHARACTERIZATION OF STRUCTURE AND MAGNETIC PROPERTIES OF WARM COMPACTED Ni-Fe-Mo SOFT MAGNETIC ALLOY**
P. Slovenský, P. Kollár, M. Fáberová, R. Bureš, M. Jakubčin and J. Füzer

P2-29 **STUDY OF REVERSIBLE AND IRREVERSIBLE MAGNETIZATION PROCESSES PROPORTIONS OF Fe-MgO SOFT MAGNETIC COMPOSITES**
M. Jakubčin, Z. Birčáková, P. Kollár, J. Füzer, R. Bureš and M. Fáberová

P2-30 **INFLUENCE OF MECHANICAL STRESS ON MAGNETIZATION REVERSAL IN RAYLEIGH REGION IN AMORPHOUS FINEMET**
J. Kováč and L. Novák

P2-31 **THE EFFECT OF SILICON SUBSTITUTION FOR BORON ON THE STRUCTURAL AND MAGNETIC PROPIERTIES OF MELT-SPUN $Fe_{79.3}Co_2Cu_{0.5}Mo_{0.2}Si_xB_{18-x}$ (x = 5-9) ALLOYS**
M. Polak, L. Hawelek, P. Wlodarczyk, P. Zackiewicz and A. Kolano-Burian

P2-32 **SOFT MAGNETIC COMPOSITES PREPARED BY 3D LASER PRINTING**
B. Kocsis, I. Fekete, I. Zsoldos and L. K. Varga

P2-33 **MAGNETIC FIELD SENSORS WITH REDUCED TEMPERATURE DEPENDENCE**
R. Jurc, L. Galdun, T. Ryba, R. Sabol and R. Varga

P2-34 **ANHYSTERETIC MAGNETIZATION FOR NiFeMo SOFT MAGNETIC COMPACTED POWDER**
D. Olekšáková, P. Kollár, M. Jakubčin, Z. Birčáková, P. Slovenský and J. Füzer

P2-35 **STRUCTURAL AND MAGNETIC CHARACTERISTICS OF $Fe_{73.5}Cu_1Nb_3Si_{13.5}B_9$ GLASS-COATED NANOWIRES**
T.-A. Óvári, G. Ababei, S. Corodeanu, H. Chiriac and N. Lupu

P2-36 **CURRENT DRIVEN MAGNETIC SWITCHING AND DOMAIN WALL VELOCITY IN TWISTED GLASS-COATED MICROWIRES FOR SENSOR APPLICATIONS**
S. Corodeanu, *H. Chiriac*, N. Lupu and T.-A. Óvári

P2-37 **EFFECTS OF IRON DEFICIENCY ON MAGNETIC PROPERTIES OF NiZn FERRITES**
J. Sláma, M. Šoka, M. Ušáková and E. Ušák

P2-38 **EFFECTS OF MAGNETIC ANNEALING ON THE GMI EFFECT IN Co-RICH NANOCRYSTALLINE HITPERM ALLOYS**
F. Andrejka, T. Eggers, J. Marcin, P. Švec, M.-H. Phan and I. Škorvánek

P3 MAGNETIC MATERIALS FOR ENERGY APPLICATIONS (PERMANENT MAGNETS, MAGNETOCALORIC MATERIALS, MOTORS, TRANSFORMERS, ...)

P3-01 **Withdrawn**

P3-02 **MAGNETOCALORIC AND THERMOPHYSICAL PROPERTIES OF $LaFe_{11.2-x}Co_{0.7}Mn_xSi_{1.1}$ COMPOUNDS**
A. M. Aliev, A. G. Gamzatov, *N. Z. Abdulkadirova* and P. Gębara

P3-03 **FABRICATION AND MAGNETOCALORIC CHARACTERIZATION OF GLASS-COATED Ni_2FeGa MICROWIRES**
P. J. Ibarra-Gaytán, L. Frolova, L. Galdun, T. Ryba, O. Milkovic, P. Diko, V. Kavecansky, J. L. Sánchez Llamazares, Z. Vargova and R. Varga

P3-04 **MAGNETIC CHARACTERIZATION OF $Ni_{50}Fe_{19}Ga_{27}Co_4$ GLASS COATED MICROWIRE**
M. Hennel, P. J. Ibarra-Gaytán, T. Ryba, J. Kováč, L. Galdun and R. Varga

P3-05 **INFLUENCE OF HIGH PRESSURE OXYGENATION ON THE STRUCTURE AND MAGNETIC PROPERTIES OF La-Ca-Sr-Mn-O PEROVSKITE CERAMIC MATERIAL**
K. Zmorayova, V. Antal, V. Kavecansky, J. Kováč, M. Kanuchova and P. Diko

P3-06 **NANOFLUID BASED ON A NEW GENERATION TRANSFORMER OIL: SYNTHESIS AND FLOW PROPERTIES**
K. Paulovičová, J. Tóthová, M. Rajňák, M. Timko, P. Kopčanský and V. Lisý

P3-07 **THERMAL STABILITY AND MAGNETIC CHARACTERIZATION OF $Gd_{54}Co_{37}Ni_9$ METALLIC GLASS**
Yu. Katuna, M. Lisnichuk, K. Saksl, V. Girman, M. Fejerčák, E. Čižmár, A. Kluikov, Z. Molčanová, V. Vorobiov and P. Sovák

P3-08 **MAGNETIC AND STRUCTURAL CHARACTERIZATION OF Gd-BASED METALLIC GLASSES**
M. Lisnichuk, Yu. Katuna, K. Saksl, M. Fejerčák, M. Šulikova, Š. Michalik, E. Čižmár, A. Kluikov, V. Girman, V. Vorobiov and P. Sovák

P3-09 **LOW-TEMPERATURE HEAT CAPACITY MEASUREMENTS IN Gd -BASED NANOCOMPOSITES**
A. Berkutova, A. Zeleňáková, P. Hrubovčák, O. Kapusta, R. Tarasenko and V. Zeleňák

P3-10 **THE EFFECT OF TEMPERATURE ON MAGNETIZATION CURVES NEAR CURIE POINT IN LaFeCoSi**
P. Gębara, R. Gozdur and K. Chwastek

P3-11 **EFFECT OF THE TEMPERATURE ON THE MAGNETIC AND ENERGETIC PROPERTIES OF SOFT MAGNETIC COMPOSITE MATERIALS**
E. Pošković, L. Ferraris, *R. Bidulsky* and M. Actis Grande

P3-12 **MAGNETOTHERMAL PROPERTIES OF FePt THIN FILM ALLOYS**
S. Vorobiov, O. Tkach, V. Latyshev, E. Čižmár, M. Orendáč and V. Komanický

P3-13 **THE INFLUENCE OF FIBER LASER SCRIBING ON MAGNETIC DOMAINS STRUCTURES AND MAGNETIC PROPERTIES OF NO ELECTRICAL STEEL SHEETS**
V. Puchý, I. Petryshynets, F. Kováč, L. Falat, M. Podobová, J. Füzer, J. Mrázek and S. Vytykáčová

P3-14 **EFFECT OF MILLING ENVIRONMENT ON MICROSTRUCTURE AND MAGNETIC PROPERTIES OF NdFeB NANOPARTICLES**
M. Grigoras, M. Lostun, T. Roman, G. Stoian, G Ababei, H. Chiriac and N. Lupu

P3-15 **MULTIPARAMETER OPTIMIZATION OF MECHANICAL CUTTING PROCESS OF GRAIN ORIENTED SILICON STEEL**
S. Gontarz, R. Patyk, Ł. Bohdal and D. Jackiewicz

P4 MAGNETIC THIN FILMS AND SURFACES, SPINTRONICS, PARTICLES AND NANOSTRUCTURES

P4-01 **TRANSPORT PROPERTIES OF ANTIFERROMAGNETIC CuMnAs ALLOY**
F. Máca, J. Kudrnovský, V. Drchal, K. Carva, P. Baláž and I. Turek

P4-02 **MAGNETO-STRUCTURAL PROPERTIES AND SPIN POLARIZATION OF Co_2MnSn HEUSLER MELT-SPUN RIBBON**
L. Galdun, T. Ryba, V. Haskova, P. Szabo and R. Varga

P4-03 **IRON-BASED CORE-SHELL NANOPARTICLES PRECIPITATED FROM COPPER-IRON ALLOY**
O. Milkovic, M. Cesnek, J. Gamcová, T. Kmjec and J. Kohout

P4-04 **STRUCTURAL AND MAGNETIC PROPERTIES OF MECHANICALLY ALLOYED $Fe_{50}Co_{50}$ SYSTEMS**
K. Brzózka, T. Szumiata, B. Górka, D. Olekšáková and P. Kollár

P4-05 **LOCAL MATERIAL CHARACTERIZATION OF TOPOLOGICAL-INSULATOR/FERROMAGNET THIN FILM HETEROSTRUCTURES USING REAL- AND K-SPACE IMAGING IN PHOTOEMISSION ELECTRON MICROSCOPY**
M. Vondráček, V. Tkáč, J. Kopeček, M. Vališka, L. Fekete, V. Holý, G. Springholz, V. Sechovský and *J. Honolka*

P4-06 **MAGNETIC ANISOTROPIES IN ANTIFERROMAGNETIC TRANSITION-METAL DIFLUORIDES**
C. A. Corrêa and *K. Výborný*

P4-07 **MODELLING OF STRUCTURAL AND MAGNETIC PROPERTIES OF NANOCOMPOSITES FOR MAGNETOCALORIC AND BIOMEDICAL APPLICATIONS**
P. Hrubovčák, N. Kučerka, A. Zeleňáková and V. Zeleňák

P4-08 **Withdrawn**

P4-09 **MAGNETIC Fe_3O_4 NANOPARTICLES COATED BY POROUS SiO_2: CORE@SHELL NANOSYSTEMS FOR BIOMEDICAL APPLICATIONS**
J. Szűcsová, A. Zeleňáková, O. Kapusta and V. Zeleňák

P4-10 **MICROMAGNETIC SIMULATION OF THERMAL GENERATION OF SPIN WAVES USING MUMAX3**
J. Woźny, R. Gozdur, B. Guzowski and Ł. Bernacki

P4-11 **INFLUENCE OF SINGLE SUBSTITUTION ON MAGNETIC PROPERTIES OF NOVEL Y_2FeSi HEUSLER ALLOY**
K. Gruszka and K. Bednarska

P4-12 **ASYMMETRIC BUBBLE EXPANSION IN THIN FERROMAGNETIC LAYERS**
K. Richter, O. Vahovsky, L. Fecova and R. Varga

P4-13 **AB-INITIO CALCULATIONS OF LAYERED TOPOLOGICAL INSULATORS UNDER CHEMICAL AND STRUCTURAL DISORDER**
J. Šebesta, P. Baláž and K. Carva

P4-14 **THE MAGNETITE NANOPARICLES: DIVALENT IRON CONTENT FROM IN-FIELD MÖSSBAUER SPECTROSCOPY**
J. Kohout, D. Kubániová, L. Kubíčková, T. Kmječ, K. Závěta, N. I. Chistyakova and O. Kaman

P4-15 **PROPERTIES OF LSMO/YBCO INTERFACE**
V. Štrbík, N. Gál, M. Sojková, Š. Chromik, M. Španková and M. Talacko

P4-16 **STRUCTURAL CHARACTERIZATION OF EPITAXIAL LSMO THIN FILMS GROWN ON LSAT SUBSTRATES**
M. Španková, E. Dobročka, V. Štrbík, Š. Chromik, N. Gál, N. Nedelko, A. Ślawska-Waniewska and P. Gierlowski

P4-17 **EXCHANGE BIAS IN Co/CoO COMPOSITE POWDER FABRICATED BY HIGH-ENERGY BALL MILLING COMBINED WITH ANNEALING**
V. H. Ky, *N. T. Hieu*, D. K. Tung, L. T. H. Phong, D. H. Manh, J. Kováč, B. Kunca and I. Škorvánek

P4-18 **INVESTIGATIONS OF A $Ni_{2.00}Mn_{1.16}Ga_{0.84}$ SINGLE CRYSTAL AND $Rh_2Mn_5Bi_4$ THIN FILMS USING A VARIABLE TEMPERATURE MAGNETO OPTICAL SETUP**
J. Fikáček, S. Cichoň, O. Heczko, V. Kopecký, J. Lančok and J. Honolka

P4-19 **OBSERVATION OF THE SHARP VERWEY TRANSITION IN Fe/Fe_3O_4 NANOCOMPOSITES PREPARED BY A COMBINED HIGH ENERGY BALL MILLING AND ANNEALING METHOD**
L. T. H. Phong, D. H. Manh, N. V. Dang, M.-H. Phan, N. X. Phuc, J. Kováč and I. Škorvánek

P4-20 **HIGH TEMPERATURE MEMORY EFFECTS IN MAGNETIC NANOPARTICLES**
M. Perovic, M. Boskovic, V. Kusigerski, T. Barudzija, Z. Jaglicic, J. Blanusa, V. Spasojevic, N. Pizurova, O. Schneeweiss, M. Zentkova and M. Mihalik

P4-21 **PHONON-ASSISTED TRANSPORT THROUGH CAPACITIVELY COUPLED AHARONOV-BOHM INTERFEROMETERS**
P. Florków and S. Lipiński

P4-22 **PREPARATION AND CHARACTERIZATION OF $La_xAg_{1-x}MnO_3$ MAGNETIC SUSPENSIONS FOR SOFT HYPERTHERMIA**
M. Kovalik, M. Vavra, M. Zentková, M. Mihalik, M. Kubovčíková, M. Mihalik jr. and J. Briančin

P4-23 **Withdrawn**

P4-24 **STUDY OF THE DYNAMIC BEHAVIOR OF VORTICES DEPENDING ON THE CURVATURE OF CONFINEMENT**
K. Bublikov, M. Mruczkiewicz, J. Tóbik, J. Feilhauer and V. Cambel

P4-25 **VALENCE BAND OF MANGANESE TELLURIDE**
K. Vyborny and P. E. de Faria Jr.

P5 LOW-DIMENSIONAL MAGNETIC MATERIALS, MOLECULAR MAGNETS AND FERROFLUIDS

P5-01 **DIELECTRIC BREAKDOWN DRIVEN BY MAGNETIC FIELD IN GRADUALLY AGED FERROFLUID**
J. Kurimský, M. Rajňák, R. Cimbala, I. Kolcunová, B. Dolník, J. Džmura, J. Petráš, J. Zbojovský, P. Bartko, M. Ivančák, M. Timko and P. Kopčanský

P5-02 **SMALL ANGLE X-RAY SCATTERING STUDY OF MAGNETIC NANOFLUID EXPOSED TO ELECTRIC FIELD**
M. Rajnak, V. M. Garamus, M. Timko, P. Kopcansky, K. Paulovicova, J. Kurimsky, B. Dolnik and R. Cimbala

P5-03 **HUBBARD DIMER WITH ELASTIC INTERACTIONS. STUDIES OF THERMAL EXPANSION, MAGNETOSTRICTION AND ELECTROSTRICTION**
T. Balcerzak and *K. Szałowski*

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J. Petráš, J. Džmura, J. Kurimský, R. Cimbala, I. Kolcunová, B. Dolník and J. Zbojovský

A B S T R A C T S

INVITED TALKS

I-01

MAGNETIC PROPERTIES OF SPINEL FERRITE BASED NANOPARTICLE SYSTEMS

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The investigation of the magnetic properties of spinel ferrite nanoparticles deserves a special interest, as the spinel structure allows tuning the anisotropy and the saturation magnetization by the control (through the chemical composition, preparation method and particle size) of the cation distribution between the tetrahedral and octahedral sublattices.

In this work we present a study of the magnetic properties of two types of spinel ferrite based nanoparticles:

a) core/shell particles ($CoO/Zn_xCo_{1-x}Fe_2O_4$), in order to investigate the effect of the interface coupling between two magnetic phases with different anisotropy

b) nanoparticle powders system ($MnFe_2O_4$), in order to investigate the effect of strong interparticle interactions.

$\underline{CoO/Zn_xCo_{1-x}Fe_2O_4}$. The core diameter is 4 nm and the shell thickness is 2 nm, as shown by TEM images. In $CoO/CoFe_2O_4$, the core/shell interface exchange coupling produces a strong increase of anisotropy, but Exchange Bias (EB) is not observed, due to the high anisotropy of $CoFe_2O_4$. The Zn substitution, occupying the tetrahedral sites, produces a decrease of anisotropy, as shown by the decrease of Hc and of the thermal stability, shown by the decrease of the blocking temperature. EB is observed, due to the change of the ratio between the anisotropy energy of the antiferromagnetic phase and the interface exchange coupling energy. The Exchange Field decreases with increasing the Zn content [1].

$\underline{MnFe_2O_4}$ The investigation of the static and dynamical properties of a powder of 2nm particles shows a typical superspin glass behaviour with a freezing temperature of 45 K. The ZFC/FC curves, thermoremanent and isothermal remanent magnetization and memory curves are recorded according to the specific cooling protocols of spin glasses. Monte Carlo simulations replicate very well the experimental findings. Coating of particles with albumin does not change the freezing temperature, indicating that the strength of dipolar interactions is not affected, but leads to higher irreversibility temperature in the ZFC/FC curves and to a decrease of magnetization and anisotropy. The results are well reproduced by a model (DFT calculations and Monte Carlo simulations) describing a new clustering effect induced by the coating, the albumin surrounding groups of exchange coupled clusters [2].

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I-02
CHALLENGES FOR MAGNETIC MATERIALS IN VEHICLE ELECTRIFICATION

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A fundamental transformation of the transportation sector in the United States is underway. In parallel with advances in renewable energy resources for power generation, the rising use of electric and hybrid vehicles is reshaping the future of transportation [1]. Similar efforts are moving forward for more-electric ships, aircraft, and other military technologies. Due to their prevalence, magnetic materials play an important role in improving the efficiency and performance of devices in electric power generation, conditioning, and conversion. However, additional challenges exist for magnets used in transportation applications, where enhanced reliability, power density, and overall energy capacity are increasingly important. This talk will focus on hard and soft magnetic materials, with an emphasis on their design and optimization for future power electronics and electric drives for vehicles[2]. Specifically, the impact of hard magnetic materials on electric motor/generator technologies and of soft magnetic materials on electricity generation/conversion technologies will be presented. The structure-property relationships that allow these advanced materials to provide greater performance will be discussed in terms of and their potential impact on future power electronics and electric drives for vehicles [3].

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I-03

OVERVIEW THE WAYS FOR ENHANCING THE COERCIVITY OF HOT DEFORMED NdFeB MAGNETS

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The improvement of intrinsic coercivity ($_iH_c$) of the magnets is crucial in the motor applications at higher temperature. For hot deformed heavy rare-earth (HRE) free Nd-Fe-B magnets, $_iH_c$ is as high as 15 kOe due to their nanoscale microstructure. The coercivity can be further enhanced by adding Dy or Tb to the alloys or by grain boundary diffusion with low-melting alloys due to the decoupled 2:14:1 grains, resulted from the isolation of magnetic grains by nonmagnetic boundary phase. In this presentation, several cheaper ways for improving the coercivity of hot-deformed NdFeB magnets, mainly made from commercial MQU-F powders, will be introduced. At first, mixing another commercial Dy-containing MQU-G powders into MQU-F powders could enhance the coercivityof the hot-deformed magnets from 15.1 to 22.1 kOe. The increment of magnetocrystalline anisotropy field for $R_2Fe_{14}B$ with Dy substitution leads to coercivity enhancement. Secondly, doping 2 wt%$R_{70}Cu_{30}$ alloy powders [R=Dy, Dy + Nd, mischmetal (MM)] into the hot-deformed NdFeB magnets is also effective in enhancing the coercivity to 19–19.5 kOe, originated from different mechanisms. $Dy_{70}Cu_{30}$-doped magnets and $(Nd_{0.5}Dy_{0.5})_{70}Cu_{30}$-doped magnets show an almost identical enhancement of coercivity of about 4.4 kOe. Importantly, the latter magnet shows a beneficial effect of reducing the usage of Dy from 1.6 to 0.8 wt%. Most interestingly, Dy-free $MM_{70}Cu_{30}$-doped magnet ($MM=Pr_{71}Nd_{27}Ce_2$) can also exhibit a comparable coercivity increment of about 4 kOe and yet still persist high magnetic energy product. The microstructure analysis shows that the entrance of Pr into 2:14:1 phase, grain refinement, modified grain shape, and Ce-containing grain boundary layer play crucial roles in its coercivity enhancement. Finally, hot deformed NdFeB magnets doped with $Tb_{80}Ga_{20}$ alloy powders followed by annealing at 700 °C, $_iH_c$ can be further enhanced to 24.0 kOe with attractive $(BH)_{max}$ of 37.5 MGOe.

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I-04

THE DOMAIN WALL VELOCITY PLATEAU: CASE OF THE DZYALOSHINSKII DOMAIN WALLS

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We studied field-driven domain wall (DW) velocities in asymmetric multilayer stacks with perpendicular magnetic anisotropy and large Dzyaloshinskii-Moriya interaction (DMI), both experimentally and by micromagnetic simulations.

Using magneto-optical Kerr microscopy under nanosecond and intense pulse fields, we show that DWs in these films can propagate at velocities up to hundreds of m/s [1] and that, instead of the expected decrease of velocity after the Walker field [2], a long plateau with constant velocity is observed, before breakdown. Both the maximum speed and the length of the velocity plateau strongly depend on the values of the spontaneous magnetization and the DMI strength of the different stacks, as well as on their magnetic anisotropy. Compared to previous observations of the velocity plateau, a specific feature is that the value of the plateau velocity is close to the maximum value (Walker velocity).

Micromagnetic simulations reproduce these features in sufficiently wide strips, even for perfect samples so that these features are intrinsic to the DW dynamics. Analyzing in detail the structure of the moving walls, the key role of so-called 2π vertical Bloch lines is revealed. Based on the “corrugated domain wall motion” model of J. Slonczewski [3], that applies to the DW dynamics in the region of negative differential mobility, a physical model to explain this plateau is proposed.

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I-05

1D AND 2D LOSS CHARACTERIZATION SYSTEMS: OPTIMAL DESIGN, MEASUREMENT METHODS AND RESULTS

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Accurate measurements of magnetic losses are of paramount importance for the design of efficient electrical machines. The standard measurement method, based on the use of the Epstein frame, ensures good reproducibility of the results, as verified by a number of international comparisons 0. However, the so-determined loss figures might be appreciably different from the "true" loss values, the ones one can obtain by accurate local measurements of field and induction 0. At the same time, the test samples require tedious preparation, including relief of cutting stresses. On the other hand, no standards are today available for the measurement of the loss under bi-dimensional induction, ubiquitous in electrical machines, although research effort have been devoted to circular induction measurements (for example, cross-shaped magnetizers 0 and systems with hexagonally shaped samples 0). At INRIM, a characterization setup based on a circular sample in the center of a three-phase machine was developed 0. Induction values up to 1.85 T could be reached, with maximum frequency around a few hundred Hz. These limiting values of induction and frequency had to be overcome, in order to meet the conditions of modern electrical machine cores, often saturated and working at kilohertz frequencies. In this communication, present-day developments in alternating and two-dimensional measurements of magnetic losses will be discussed, with emphasis on recent activity by SATIE/INRIM/Politecnico di Torino aimed at overcoming the previous limits. Two main points will be addressed: 1) *Alternating fields*. The Single Sheet Tester will be specifically discussed, for its ability to provide accurate results without incurring in the drawbacks of the Epstein method. The measurement repeatability, in terms of loss values and apparent power, is, however, not always fully satisfying, because of the non-negligible reluctance of the yoke-sample junctions and the loss in the yoke. A novel approach, addressed in 0, by which the drop of the potential occurring in different parts of the magnetic circuit is automatically compensated by means of a feedback system will be highlighted. 2) *Two-dimensional magnetization*. We will focus on the realization of setups based on circular samples and three-phase magnetizers. One of them has been optimized to reach the kilohertz range, while a second one has been designed to approach the sample saturation. Both fieldmetric and thermometric loss measurement methods have been applied. Results for rotating and alternating inductions in non-oriented Iron-Silicon laminations up to the saturation are provided, together with results obtained up to the kHz range in steel sheets and Soft Magnetic Composites.

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I-06

ASSESSMENT OF SOFT MAGNETIC MATERIALS WIDEBAND PROPERTIES FOR A SUSTAINABLE USE OF ENERGY

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Fundamental and applied investigations on Soft Magnetic Materials (SMMs) have brought major breakthroughs in the many implementations of electromagnetism since the XIX century. Research on SMMs continues to be active and exciting, as they remain crucial in the conversion, storage, and distribution of energy and information [1]. Advanced preparation and characterization techniques are continuously developed, in order to tailor structural and magnetic properties and understand the underlying physical behaviors. The urgency of reducing worldwide energy consumption, addressed by intergovernmental agencies as the IPCC [2], relies to a good extent on higher efficiency of the electrical machines and in power electronics. Researchers are thus faced with the ambitious goal of optimizing the electromagnetic devices, by developing, for example, SMMs with high saturation magnetization and low losses, a feat requiring the assessment of their properties upon a broad range of operating conditions. There actually is an irreversible trend towards increasingly high working frequencies of magnetic cores, frequently associated with complex exciting regimes (e.g., non-sinusoidal induction, two-dimensional fields), which require improved measuring methods and novel theoretical approaches. An outline of such problems and of the experimental and theoretical methodologies developed in recent times for a general assessment of the phenomenology of different soft magnetic materials will be provided in this communication [3].

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I-07

APPROACHES TO EQUIP GRAPHENE WITH MAGNETIC FEATURES: FROM SUBSTITUTION AND EDGE ENGINEERING TO SP^3 FUNCTIONALIZATION

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Graphene has captured an immense interest of the scientific community since its isolation in 2004. Besides its unique features such as high electrical conductivity and surface area, graphene exhibits a long spin lifetime and limited hyperfine interactions, favoring thus its potential applications in the field of spintronics and biomedicine, provided it can be made magnetic. However, pristine graphene is diamagnetic in nature. Thus, various strategies have been suggested to equip graphene with sustainable magnetic properties. If defects are introduced in the graphene structure, magnetic moments emerge; these defects include local topology perturbations, vacancies, non-carbon atoms in the graphene lattice, adatoms, mixed sp^2-sp^3 hybridization, and edges. However, in order to establish a magnetic ordering within graphene, a communication medium must be sufficiently strong to maintain the interaction pathways among defect-induced magnetic moments.

In the present contribution, strategies to imprint magnetism in graphene will be introduced, assessing critically their advantages and drawbacks with respect to the recent theoretical and experimental advancement in the quest for “magnetic” graphene. More specifically, we will focus on the issue of doping the graphene lattice with non-carbon atoms [1,2] and edge engineering [3] and we will discuss the emergence of magnetic features highlighting the role of the chemical nature and electronic character of the doping element, doping concentration, doping-induced magnetic configurations and size and edge aspects. We will introduce a new derivative of graphene, i.e., hydroxofluorographene, as an example of sp^3-functionalized platform to show magnetic ordering sustainable up to room temperature as a function of F/OH ratio [4]. Finally, future challenges in the field of “magnetic graphenes” will be highlighted.

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I-08

STRESS-INDUCED MAGNETIC ANISOTROPY ENABLING ENGINEERING OF MAGNETIC SOFTNESS AND DOMAIN WALL DYNAMICS OF Fe-RICH AMORPHOUS MICROWIRES

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Thin magnetically soft amorphous wires are extremely demanded by developing industries [1,2]. Less expensive Fe-rich microwires are preferable for the applications. But amorphous Fe-rich materials exhibit rather high magnetostriction coefficient and consequently present quite low GMI effect [1].

The most common method for magnetic softness optimization is the annealing. From previous studies of Co-rich amorphous materials it is known that stress annealing can considerably affect the magnetic properties of amorphous materials [1].

Consequently, the purpose of this paper is to present our recent experimental results on influence of stress- annealing on magnetic properties and GMI effect of Fe- and Fe-Co based glass-coated microwires.

We observed that Fe-rich microwires annealed under stress at appropriate annealing conditions (time and temperature) can present low coercivity, considerable magnetic softening and enhanced GMI effect. Coercivity, remanent magnetization, magnetic anisotropy field and hence GMI-ratio values depends on temperature and time of stress-annealing, stress applied during the annealing [2].

For interpretation of observed changes of hysteresis loops after stress annealing we considered internal stresses relaxation and different mechanisms of stress-induced anisotropy.

Observed versatile properties of stress annealed glass-coated microwires with enhanced soft magnetic properties and GMI ratio make them suitable for technological sensing applications.

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I-09

VIBRON STATES IN CERIUM INTERMETALLICS - REALITY?

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The nature of electronic correlations has attracted great scientific interest for many decades. The observation of an additional magnetic excitation that originates in a strong magneto-elastic coupling and cannot be explained on the basis of standard crystal-field model represents an unexpected, intriguing phenomenon, so far observed only in few cerium-based intermetallic compounds. The ground state multiplet of Ce^{3+} ions in crystalline solids is split due to crystal field (CF) into three doublets, in the case of a cubic symmetry into one doublet and one quartet. Surprisingly, the inelastic neutron spectra in cubic $CeAl_2$ revealed two excitations from the ground state, while one would expect just one peak bounded with excitation from the doublet ground state Γ7 to excited quartet Γ8 [1]. The physical model describing such unusual observation was introduced by Thalmeier and Fulde [2] on the basis of a strong magnetoelastic interaction between the CF excitations and phonons which leads to a formation of a new quantum state - vibron quasi-bound state. The additional magnetic peak in the neutron energy spectra, considered as a manifestation of this vibron state, was also observed in tetragonal $CePd2Al_2$ and $CeCuAl_3$. Here, we present results of our inelastic neutron scattering experiments on compounds from the $CePd_2(Al,Ga)_2$ and $Ce(CuAl)_4$ series. Some of the new results evoke an idea that - beyond the original approach based on the theory of the magnetoelastic interaction leading to a formation of the quantum vibron states – there could be an alternative explanation of the observed features: local atomic site disorder in the studied materials. Such explanation is corroborated mainly by precise structural studies including also NMR measurements.

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I-10

MAGNETIC POLARIZATION OF AMERICIUM GROUND STATE IN $AmFe_2$

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Americium in its trivalent state has a nonmagnetic ground state J=0, which is a result of cancellation of nonzero orbital and spin moments of opposite signs. When embedded into a ferromagnetic matrix, its large molecular field influences the magnetism of the americium. Using density functional theory (DFT) calculations and x-ray magnetic circular dichroism (XMCD) experiments we study the magnetic state of americium in $AmFe_2$, where Fe atoms carry a large spin moment. Since americium is in J=0 state, it allows to directly measure the magnetic dipole moment from experiments [1]. Comparing the DFT+U calculations with magnetic moments obtained using XMCD sum rules [2,3], we find the closest match for a U value of 1eV in combination with the around mean field double-counting correction [4].

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I-11

PROXIMITY EFFECTS IN GRAPHENE VAN DER WAALS HETEROSTRUCTURES

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Electronic structure of bare graphene, tiny band gap and spin-orbit coupling, limits its applications as an efficient spin channel. Novel 2d semiconductors or magnetic semiconductors involved in vertical van der Waals heterostructures allow graphene to borrow some of their specific properties. The emergent proximity effects as enhanced spin-orbit or exchange coupling offer new perspectives for graphene spintronics [1]. Graphene on transition-metal dichalcogenides exhibits proximity spin-orbit effects opening new venues for optospintronics [2], and provides route for exploring robust helical edge states [3, 4]. Bilayer graphene on transition metal dichalcogenides is even more appealing as the spin properties of the proximitized bilayer graphene can be turned on and off by gate voltage, creating a platform for spin-orbit valves and spin transistors [5]. Magnetic proximity effects in bilayer graphene on semiconducting ferromagnets are predicted to yield field effect magnetism [6], which opens a potential for a whole new class of phenomena and device concepts. Particular attention attracts a class of transition-metal dichalcogenides exhibiting metal-insulator transition with different charge density wave phases. In such a case a fascinating finding is observed namely that induced proximity effects in graphene are significantly influenced by the presence of the commensurate charge density wave.

In the talk our theoretical results for the electronic band structures of graphene on different 2d material substrates will be reviewed and discussed in terms of recent experimental observations. We discuss the orbital, spin-orbital and magnetic proximity effects which can be efficiently described by phenomenological symmetry-based Hamiltonians allowing to extract simplified theoretical picture of the induced proximity effects in graphene.

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I-12

HIGH SPIN CYCLES: TOPPING THE SPIN RECORD FOR A SINGLE MOLECULE VERGING ON QUANTUM CRITICALITY

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Theory has predicted a number of interesting quantum critical points for one-dimensional magnetic systems. At such points the ground state and thus low-temperature properties of a material change drastically upon variation of an appropriate external parameter. Competing exchange interactions constitute one possibility to drive a magnetic system into criticality. But since one cannot design the size of exchange interactions at will, it remains open whether certain fascinating systems can ever be realized in the lab.

Here we report on the chemical synthesis of a mixed 3d/4f coordination cluster that turns out to be very close to a quantum critical point. It also shows a ground state spin of S=60, one of the largest ever observed. [Fe10Gd10(Me-tea)10(Me-teaH)10(NO3)10] ·20MeCN forms a nano-ring system of alternating gadolinium and iron ions with a nearest neighbour coupling and a frustrating next-nearest neighbour coupling between adjacent iron ions only. Such spin systems are termed delta (or saw- tooth) chains. They exhibit a variety of frustration effects, among them giant magnetization jumps as well as macroscopic degeneracies of the ground state with profound caloric consequences [1].

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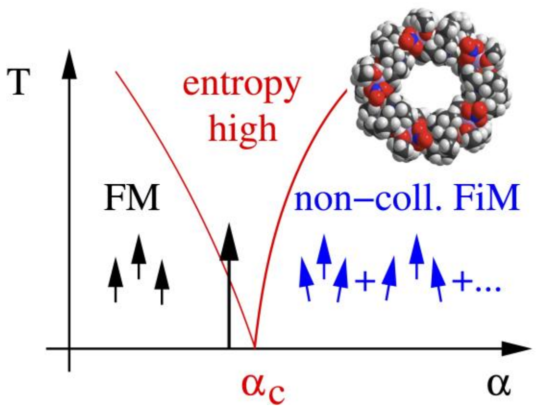

I-13

INTERCHAIN MEAN-FIELD THEORY FOR THE BIMETALLIC FERROMAGNETIC SPIN-CHAIN COMPOUND $MnNi(NO_2)_4(en)_2$ (en = ETHYLENEDIAMINE)

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$MnNi(NO_2)_4(en)_2$, en = ethylenediamine contains ferromagnetically coupled chains with alternating spins of magnitude 5/2 and 1. Two peak-like structures are observed in the field-dependent specific heat of this compound. This behavior is attributed to the existence of two modes in the spin-wave dispersion.

Here we present numerical results for the specific heat obtained by exact diagonalization and Quantum-Monte-Carlo simulations for the alternating spin- chain model, using parameters that have previously been derived from the high-temperature behavior of the magnetic susceptibility. $MnNi(NO_2)_4(en)_2$ orders antiferromagnetically at low temperatures in zero magnetic field, demonstrating relevant antiferromagnetic interchain coupling. We therefore develop an interchain mean-field approach: the magnetization of a chain generates an effective magnetic field on the neighboring chains that is computed self-consistently. In addition to this renormalization of the magnetic field, we derive and evaluate corrections to the specific heat arising from interchain coupling. In this manner we obtain a surprisingly accurate description of the three-dimensional ordering transition of $MnNi(NO_2)_4(en)_2$ based on Quantum-Monte-Carlo simulations of individual chains.

The antiferromagnetically ordered state of $MnNi(NO_2)_4(en)_2$ is suppressed already by a weak magnetic field. This observed strong effect of an applied magnetic on the ordered state and in particular the specific heat promises interesting magnetocaloric properties that we discuss from a theoretical perspective.

I-14
PROGRESS IN THE DEVELOPMENT OF JILES-ATHERTON MODEL OF MAGNETIC HYSTERESIS LOOP OF MODERN MAGNETIC MATERIALS – A REVIEW

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Jiles-Atherton model of magnetic hysteresis is one of the most popular and most efficient modes of both major and minor magnetic hysteresis loops. On the other hand, application potential of original Jiles-Atherton model presented in 1986 [1] is limited to the case of isotropic magnetic materials, such as ferrites. To describe the characteristics of modern magnetic materials, such as amorphous alloys, anisotropic extension of Jiles-Atherton model [2] should be considered. Moreover, the same extension should be taken into account during modelling the stress-dependence of magnetic hysteresis loop, where stress-induced anisotropy should be considered in the analyses of the total free energy or magnetic material. On the other hand originally presented anisotropic extension of Jiles-Atherton has to be corrected, due to typographical error mistakes in original paper.

Magnetic hysteresis in original Jiles-Atherton model was the subject of criticism [3]. As a result, the set of alternative approaches was recently presented and intensively discussed. However, the criteria of selection of description of the hysteresis in magnetic characteristics are not clear. As a result, this issue has to be the subject of further intensive research and discussion.

Considering the modelling of dynamic characteristics of magnetization, requires both eddy current and anomalous losses should be described. As a result, development of Jiles-Atherton model is strongly connected with recent discussion about the physical principles of anomalous losses.

Review presented in the paper would be the background for further discussion about development of Jiles-Atherton model. This discussion is important from the point of view of both technical applications as well as for fundamental physics analyses leading to deeper understanding of magnetization process.

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I-15

Fe BASED NANOPARTICLES FOR BIOMEDICAL AND ENVIRONMENTAL APPLICATIONS

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Fe based nanoparticles show promising magnetic properties due to their high saturation magnetization and magnetic susceptibility. These properties enable them for a wide range of technological applications both in the biomedical and environmental field (i.e. contrast agents, magnetic drug targeting, magnetic hyperthermia, chemical absorbers and photocatalysis).

In this work, two magnetic nanoparticle systems will be presented: (i) α-Fe nanoparticles dispersed in a carbon matrix, synthesized by controlled thermal decomposition of different sugars (glucose and fructose); (ii) Co-Zn ferrite nanoparticles synthesized by co-precipitated method. Different techniques were employed in the structural (X-ray diffractometry, Transmission Electron Microscopy, Raman spectroscopy), thermal (Thermogravimetry, TGA) and magnetic (SQUID magnetometry and calorimetric hyperthermia) characterizations.

Focusing on the metal Fe nanoparticles, Fe@C core-shell nanostructures were obtained through the reduction of Fe^{3+} ions during the sugar decomposition at high temperature (800-1000°C in inert Ar atmosphere). The magnetic characterization confirms the precipitation of high saturation magnetization Fe@C core-shell nanostructures with promising properties in the biomedical field (magnetic hyperthermia and magnetic particle imaging, MPI). With respect to the Co-Zn ferrite system, $Co_xZn_{1-x}Fe_2O_4$ nanoparticles ($0 \leq x \leq 1$) display maximum saturation magnetization for $x \approx 0.7$ as a result of the cation distribution between octahedral and tetrahedral spinel sites. Optimum heating capacities (magnetic hyperthermia) are also obtained in those samples with highest magnetization. Finally, regarding the environmental applications, the photocatalytic degradation of phenol under visible radiation were analyzed employing Co-Zn nanoparticles as photocatalysts. The results indicate the achievement of optimum photocatalytic response in those samples with maximum values of the magnetic moment. Thus, these ferrite photocatalysts can be employed as efficient magnetically recyclable catalysts, easily recovered using an external magnetic field.

I-16

MOLECULAR MAGNETOCOOLING

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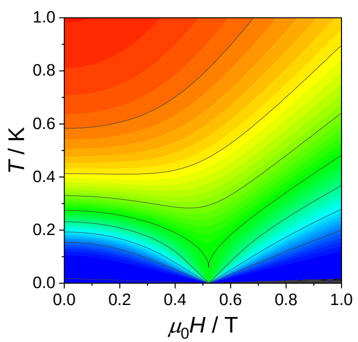
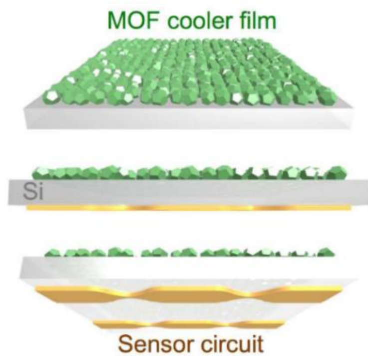
An important activity in cryogenics deals with the development of on-chip microrefrigerators that, in a not-too-distant future, will be used as cooling platforms for experiments requiring temperatures close to absolute zero, e.g., for gamma and X-ray detection in astronomy, materials science, quantum computing or safety instrumentation. Magnetic refrigeration based on the use of molecule-based magnetic materials is among the technologies that compete in such a race. The high chemical modularity of the molecules permits changing their quantum properties and outer functionalization at will. Besides, molecule-based materials are often soluble in organic solvents, allowing the transfer of their functionality to, e.g., the host microchips, when they are processed as thin-films or droplets.

The magnetocaloric properties of candidate molecule-based materials can be evaluated with "direct" techniques, which typically involve measurements of the sample temperature in varying magnetic fields. By so doing, one also explores the magnetic phase diagram of the material under study, which is determined by the underlying magnetic interactions. Recently, we have developed a method for measuring directly the magnetocaloric effect under quasi-adiabatic controlled conditions. Our procedures also permit to determine elegantly the intrinsic thermal conductivity of the sample, which is a characteristic of paramount importance for cooling applications. In this talk, we address this topic and present selected examples of Gd-based molecular nanoclusters and metal-organic frameworks in the form of pellets and thin-films.





I-17

SURFACE SPIN DISORDER IN Fe/Fe_xO_y CORE-SHELL NANOPARTICLES AND ITS INFLUENCE ON THE MACROSCOPIC BEHAVIOR

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Fe-oxide nanoparticles (NPs) are superparamagnetic and exhibit high saturation fields and extra anisotropy contributions, which recommend them for several medical applications, such as drug delivery or magnetic hyperthermia. They are usually obtained by chemical synthesis, which imposes limitations concerning their shape, properties and formation of the desired core-shell structure. On the contrary, for many engineering and medical purposes it is recommendable to have a ferromagnetic core and the superparamagnetic oxide formed only on the surface to reduce the magnetic losses. However, such a core-shell structure is not easily achievable by chemical synthesis, and alternative physical methods should be in place.

We report here our latest results on the effect of wet milling agent on the microstructure, induced surface anisotropies and magnetic properties of Fe/Fe_2O_3 and Fe/Fe_3O_4 core-shell NPs prepared by high-energy ball milling in H2O and oleic acid, respectively. To understand the surface spin disorder and its influence on the magnetic properties of Fe/Fe-oxide core-shell NPs, we used different milling times from 12 to 88 h. Fe/Fe_3O_4 NPs of 22-25 nm are obtained by milling the precursor Fe microparticles for 48 h in H_2O. After more than 80 h of milling in H_2O the core-shell structure evolves into Fe_3O_4/Fe_2O_3, as indicated by Topas analysis of XRD patterns and confirmed by EDS investigations. On the contrary, the milling in oleic acid does not change significantly the structure of precursor Fe microparticles, even after 80 h, as confirmed by the UHR-TEM images and very small variations of the shape of magnetic hysteresis curves. The magnetic properties of Fe/Fe_xO_y core-shell NPs prepared by milling in H_2O can be tailored from ferromagnetic to weak ferromagnetic depending on Fe/Fe_3O_4/Fe_2O_3 ratio. In addition, ZFC/FC curves indicate a strong influence of the milling time on magnetic properties, ascribed to the decrease of spin-orbital coupling and surface anisotropy of magnetic nanoparticles due to the surface coordination.

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I-18

TWO-DIMENSIONAL MAGNETIC VAN DER WAALS MATERIALS: WHAT DOES THE FUTURE HOLD?

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Two-dimensional (2D) magnetic van der Waals materials are emerging candidates for ultralow-power and ultra-compact device applications. Although the Mermin-Wagner theorem predicts suppression of long-range magnetic order at finite temperatures in such 2D materials, recent experiments have demonstrated the existence of intrinsic long-range ferromagnetic ordering in bulk van der Waals materials at the single layer limit [1-3]. In particular, our discovery of the strong room temperature ferromagnetism in epitaxially grown transition metal dichalcogenide (TMD) monolayers of VSe_2 has the potential to transform the field of van der Waals spintronics [3]. In this talk, I will present research progress in 2D magnetism, including our new findings of tunable exchange bias effect and light-controlled magnetism in monolayers of VSe_2 grown on MoS_2 substrates, as well as the design of a new class of highly sensitive magnetic sensor using this single layer magnet.

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I-19

SPIN-ORBIT COUPLING INDUCED WEYL POINTS IN A TWO-ELECTRON DOUBLE QUANTUM DOT

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Recent years have brought an explosion of activities in the research of topological aspects of condensed-matter systems. Topologically nontrivial phases of matter are typically accompanied by protected surface states or exotic degenerate excitations such as Majorana end states or Haldane’s localized spinons. Topologically protected degeneracies can, however, also appear in the bulk. An intriguing example is provided by Weyl semimetals, where topologically protected electronic band degeneracies and exotic surface states emerge even in the absence of interactions. Here we demonstrate experimentally and theoretically that Weyl degeneracies appear naturally in an interacting quantum dot system, for specific values of the external magnetic field. These magnetic Weyl points are robust against spin-orbit coupling unavoidably present in most quantum dot devices. Our transport experiments through an InAs double dot device placed in magnetic field reveal the presence of a pair of Weyl points, exhibiting a robust ground state degeneracy and a corresponding protected Kondo effect.

This research was supported by the National Research Development and Innovation Office of Hungary (Project No. 2017-1.2.1-NKP-2017-00001).

1 THEORETICAL PROBLEMS OF MAGNETICALLY ORDERED MATERIALS, MAGNETIZATION PROCESSES

O1-01

PECULIARITIES OF THE ENERGY SPECTRA AND MAGNETIC PROPERTIES OF 1D HEISENBERG SPIN MODELS FOR POLYMERIC COMPLEXES OF TRANSITION METALS AND HYPOTHETICAL GRAPHENE BASED NANOMAGNETS

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We studied the spin-Peierls instability of the periodic 1D Heisenberg spin systems formed by unit cells having half-integer ground state spin at different values of the coupling J between cells. Using the density-matrix renormalization group method we studied numerically the dependence of spin-Peierls critical exponents α for the ground-state energies of above spin systems on the value of J. In contrast to chain systems, we find significantly non-monotonous dependence $\alpha(J)$ for three-legs ladder system. Using perturbation theory we derived effective spin chain Hamiltonians describing the low-energy states of the system in the limit of weak coupling J. The presence of gapped excitations inside the unit cells at small values of J gives for our spin systems at least one intermediate plateau in field dependence of magnetization at low temperatures. The stability of this plateau against the increase of J and temperature is studied using the quantum Monte-Carlo method.

We also studied numerically the energy spectrum and thermodynamics of quantum Heisenberg spin model for graphitic nanoribbons with periodically embedded heteroatoms and model chain magnets formed by triangular graphene clusters. For several carbon nanoribbons we found macroscopic ground state spin and up to two intermediate magnetization plateaus. We demonstrated the possibility of spin switching for chain systems on the base of triangular graphene clusters caused by the change of corresponding coupling parameters.

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O1-02
ULTRAFAST MAGNETIZATION AND LATTICE DYNAMICS BEYOND THE THREE TEMPERATURE MODEL

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Magnetization can be modified on unprecedently short timescale employing femtosecond lasers. The associated magnetization and lattice dynamics has commonly been described employing the three temperature model, without verifying its validity. However, its limits should be more thoroughly examined.

Here we study magnetization dynamics with a special emphasis to non-thermal effects. These include the deviation of the phonon population from the thermalized one. We have calculated electron-phonon scattering rates for systems with high electronic temperatures [1], and phonon lifetimes due to phonon-phonon scattering. From these we obtain phonon populations that differ sharply from the thermal ones within picoseconds after the pump [2]. This allows us to understand recent experimental observations and disproves the applicability of the model based on one lattice temperature here [3].

In FePt nanoparticles a significant anisotropy of size change was observed upon the laser pump, in fact the lattice shinks along the c-axis, while it expands along a, b axis. After about 3ps the lattice parameter c starts to revert back to its original value, while a remains expanded for longer times. This unexpected behavior reveals that on such short timescales the relation between lattice dimensions and magnetization cannot be described just by the standard magnetostriction theory [4]. Ab initio calculations of the induced stress including the non-equilibrium phonon population recover this behavior when coupled together with a magnetic stress, which corresponds to the tendency to modify lattice parameters to those of a paramagnetic state. Our analysis allows us to suggest that the effect of magnetoelastic stress is seen on a sub-ps timescale, while later within ps the increasing occupation of phononic modes leads the system to a different type of deformation.

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O1-03

FREE ENERGY LANDSCAPE PROFILES OF MAGNETIC NANODOTS WITH DIFFERENT TYPE OF SPATIAL ASYMMETRY

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The magnetic vortex nucleation process is studied by micro-magnetic simulations in cylindrical permalloy nano-dots with various kind of spatial asymmetry. It was showed that the asymmetric geometry might lead to dynamical control of the vortex core polarity during vortex nucleation process [1]. It was shown that this effects can be caused by particular topology of the free energy surface. The free energy surface is reconstructed with the use of the metadynamics algorithm [2]. The connection between the shape asymmetry and the free energy landscape is presented with some hints how to actuate the effects of dynamical symmetry breaking.

Acknowledgement : We acknowledge the financial support to VEGA grant agency, grant No. VEGA-2/0150/18 and APVV grant agency, grant No. APVV-16-0068.

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O1-04
Withdrawn

O1-05

TENSOR-NETWORK STUDY OF QUANTUM SPIN SYSTEM ON HYPERBOLIC LATTICE GEOMETRIES

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Theory of the quantum gravity is a conjectured correspondence between the anti-de Sitter space (hyperbolic geometry) and the conformal field theory confined on hyperbolic boundaries. A typical example of such hyperbolic geometries can be represented as quantum spin networks with negative Gaussian curvatures. In this study we consider an infinite series of regular hyperbolic lattice geometries, on which the transverse-field Ising model is defined. This quantum spin system is analyzed by a tensor-network algorithm we have formulated for such purpose [1]. Analyzing the spin model at phase transition, the spontaneous magnetization and the entanglement entropy satisfy a unique power-law scaling with respect to the various Gaussian curvatures.

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O1-06

SPIN-1/2 HEISENBERG DIAMOND AND OCTAHEDRAL CHAINS IN A MAGNETIC FIELD AS A STATISTICAL-MECHANICAL PROBLEM OF HARD-CORE MONOMERS AND DIMERS

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Ground-state phase diagram of quantum spin-1/2 Heisenberg diamond and octahedral chains is elaborated from a mapping correspondence with effective mixed-spin Heisenberg chains, which are derived by employing a local conservation of a total spin on vertical dimers of a diamond chain and square plaquettes of an octahedral chain, respectively. It has been recently demonstrated that the lowest-energy eigenstates of the spin-1/2 Heisenberg diamond [1] and octahedral [2,3] chains follow in a highly-frustrated parameter region from flat bands, which correspond to magnons bound on vertical dimers of diamond chain and square plaquettes of octahedral chain, respectively. This fact allows a precise description of low-temperature thermodynamics above the monomer-dimer and monomer-tetramer ground states of the spin-1/2 Heisenberg diamond and octahedral chains from a mapping correspondence with a classical one-dimensional lattice-gas model of hard-core monomers. In the present work we will adapt the localized-magnon approach to a less frustrated parameter region supporting more peculiar dimer-tetramer and tetramer-hexamer ground states of the spin-1/2 Heisenberg diamond and octahedral chains with a spontaneously broken symmetry. It will be verified by a direct comparison between exact diagonalization and localized-magnon approach that the low-temperature thermodynamics above the dimer-tetramer and tetramer-hexamer ground states of the spin-1/2 Heisenberg diamond and octahedral chain can be satisfactorily described by a classical lattice-gas model of hard-core monomers and dimers.

Acknowledgement
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O1-07

NONENQUILIBRIUM CHARGE TRANSPORT THROUGH LAYERED FALICOV-KIMBALL SYSTEM WITH METALLIC LEADS

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We study a steady-state nonequilibrium charge transport in a model heterostructure where layers of interacting electrons modeled by spin-less Falicov-Kimball model are sandwiched between two noninteracting metallic leads. Our method of choice is a combination of a sign-problem-free Monte Carlo approach with nonequilibrium Green's function technique. We show that the transport characteristics depend qualitatively on the typical stable phases of the Falicov-Kimball model; namely charge density wave phase at low temperature and gapped or gapless disordered phases at high temperatures.

Despite of the insulating character of all these phases a pronounced step-like changes of the current and transmission are observed at their phase boundaries. The steps are evident even on a logarithmic scale. By analyzing finite size effects, we show that with the method used a relatively small central system can be utilized to address specific thermodynamic limits.

We also address the problem of the localization which plays different role for weak, intermediate and strong coupling between electrons.

O1-08

OVERCOMING LIMITATIONS OF THE ALLOY ANALOGY MODEL FOR AB INITIO TREATMENT OF FINITE TEMPERATURES

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Theoretical description of nonzero temperatures, including effects of spin fluctuations, has been problematic for a long time. In recent years, the alloy analogy model (AAM) became popular for a treatment of finite-temperature effect from the first principles [1]. Phonons, described as uncorrelated displacements of atoms, can be combined with spin fluctuations (magnons) and chemical disorder. The realistic inclusion of spin fluctuations is crucial especially for spintronic properties such as the spin polarization of the electrical current [2].

The AAM within the tight-binding linear-muffin-tin orbital method and the coherent potential approximation (CPA) successfully describes electrical transport at nonzero temperatures even in multisublattice half-Heusler alloys [3]. In the previous studies [1-3] (i) the Debye theory was employed for a conversion between displacements and temperature, (ii) the total magnetization as a function of temperature was obtained from experiments, and (iii) a change of a volume with temperature was neglected. These simplification will be addressed in details. A route to overcome it by proper *ab initio* approaches is envisaged. Obtained corrections are a few percents (compared to the previous techniques) for some materials. However, this more precise approach is essential for systems where the Debye theory fails. Moreover, the description of finite temperatures is finally obtained completely from the first principles. It is done by synergizing precise supercell methods with the numerically efficient CPA. We will present the usage of novel techniques for pure transition metals, both nonmagnetic and magnetic, but it can be easily generalized for more complex systems, such as previously studied random [1,2] and ordered [3] alloys.

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P1-01

ZERO- AND LOW-TEMPERATURE PROPERTIES OF THE FRUSTRATED BILAYER QUANTUM HEISENBERG ANTIFERROMAGNETS

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In this presentation, I intend to review a recent common work of the German, Slovak and Ukrainian teams [1,2,3]. We consider the spin-1/2 isotropic Heisenberg antiferromagnet on several frustrated bilayer lattices (square, honeycomb, and triangular) to discuss the ground-state and low-temperature properties of the frustrated quantum spin systems [1,2,3].

In the absence of an external magnetic field, the square-lattice bilayer has been discussed recently to illustrate a quantum critical end point [4]. We demonstrate that the ground-state phase diagram of this system (as well as of the honeycomb-lattice bilayer [5]) can be reproduced by a simple variational approach [6,3].

In the presence of an external magnetic field, one can utilize the concept of localized magnons to arrive at nontrivial classical lattice-gas models. As a result, the frustrated bilayer Heisenberg antiferromagnets may show interesting finite-temperature order-disorder phase transitions which belong either to the Ising-model or to the three-state Potts-model universality classes [1,2]. The recently synthesized magnetic compound $Ba_2CoSi_2O_6Cl_2$ seems to be an almost perfect candidate to observe the features of square-lattice frustrated bilayer in experiments [7]. We suggest new experiments to detect a field-driven phase transition in $Ba_2CoSi_2O_6Cl_2$ [1].

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P1-02

UNSATURATED BIPARTITE ENTANGLEMENT OF A SPIN-1/2 ISING-HEISENBERG MODEL ON A TRIANGULATED HUSIMI LATTICE

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The spin-1/2 Ising-Heisenberg model on a triangulated Husimi lattice with the coordination number two is exactly solved in a zero magnetic field by combining the star-triangle mapping transformation with the rigorous method based on exact recursion relations [1]. The investigated model mimics a magnetic architecture of the triangulated kagomé lattice, which is relevant to a series of the fascinating geometrically frustrated magnetic materials $Cu_9X_2(cpa)_6 \cdot nH_2O$ (X=F,Cl,Br and cpa=carboxypentonic acid) [2]. In particular, we have rigorously calculated the ground-state and finite-temperature phase diagrams, the total and sublattice magnetizations, and two different spatial components of the pair correlation functions, which enable to determine a quantum concurrence as a measure of the bipartite entanglement between the Heisenberg spins. It is shown that the bipartite entanglement is totally absent at zero temperature within the classical ferromagnetic phase as well as the highly frustrated disordered phase, while the quantum concurrence becomes nonzero within the spontaneously ordered quantum ferromagnetic phase. In addition, it turns out that the nonzero temperature may induce a relatively weak bipartite entanglement above the classical ferromagnetic ground state in a close vicinity of phase boundaries with the quantum ferromagnetic and disordered phases. The threshold temperature, above which the bipartite entanglement disappears, may seemingly exceed the critical (Curie) temperature of the quantum ferromagnetic phase accompanied with a cusp in the relevant temperature dependence of the quantum concurrence. A thermally-assisted reentrance of the bipartite entanglement above the classical ferromagnetic phase is comprehensively examined.

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P1-03

INTERPLAY BETWEEN NEAREST- AND NEXT-NEAREST-NEIGHBOR ENTANGLEMENT IN A SPATIALLY ANISOTROPIC SPIN-1/2 HEISENBERG TETRAHEDRON

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The energy spectrum, ground-state phase diagram, pair correlation functions and quantum concurrence are rigorously calculated by an exact analytical diagonalization of a spatially anisotropic spin-1/2 quantum XXZ Heisenberg tetrahedron in a magnetic field. The ground-state phase diagram in the interaction ratio versus magnetic field plane totally involves five different phases, which differ from each other either by the total spin, local pair correlation functions and/or quantum concurrence. In addition to the classical fully polarized ferromagnetic ground state there also appear four outstanding quantum ground states, two of which belong to the singlet sector and another two of which belong to the triplet sector. It is demonstrated that two ground states from to the same sector (either singlet or triplet one) basically differ from each other by a quantum concurrence between the nearest-neighbor and next-nearest-neighbor spins. The temperature and magnetic-field dependencies of quantum concurrence between the nearest-neighbor and next-nearest-neighbor spins become identical just in a very special limit of the spatially isotropic spin-1/2 Heisenberg tetrahedron. Except this very special case, the quantum concurrence between the nearest-neighbor and next-nearest-neighbor spins displays the same magnetic-field dependence above one quantum ground state from the triplet sector at low enough temperatures.

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P1-04

ENTANGLEMENT-ENTROPY STUDY OF PHASE TRANSITIONS IN SIX-STATE CLOCK MODEL

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The Berezinskii-Kosterlitz-Thoules (BKT) transitions of the six-state clock model on the square lattice are investigated by means of the corner-transfer matrix renormalization group method. A classical analogue of the entanglement entropy $S(L,T)$ is calculated for L by L square system up to L =129, as a function of temperature T. The entropy exhibits a peak at $T=T^{*}(L)$, where the temperature depends on both L and the boundary conditions. Applying the finite-size scaling to $T^{*}(L)$ and assuming presence of the BKT transitions, the two distinct phase-transition temperatures are estimated to be T_1=0.70 and T_2=0.88. The results are in agreement with earlier studies. It should be noted that no thermodynamic functions have been used in this study.

P1-05

MODELING OF HYSTERESIS CURVES OF IRON OXIDE/CERIUM DIOXIDE REACTIVE SORBENTS

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The new reactive sorbent prepared by the core-shell method (iron oxides/cerium dioxide) was developed. The sorbents exhibit high degradation ability to certain pollutants, e.g. organophosphates, and nerve agents like soman and VX. Degradation efficiency and magnetic properties are highly dependent on the calcination temperature during the sorbent preparation. When the calcination temperatures increase (calcination range was from 200°C to 900°C), the iron oxides exhibit phase transformations which are accompanied with a change from ferrimagnetic state to paramagnetic one about 600°C [1].

The paper deals with theoretical study of the hysteresis loops of the reactive sorbents by well-known Jiles-Atherton (J-A) model used for ferro/ferrimagnetic materials and by Langevin theory applied for paramagnetic and superparamagnetic materials, respectively.

It has been shown that J-A model is not quite suitable for the theoretical description of hysteresis loops with low coercive fields (hundreds of A/m) measured at calcination temperatures (200°C – 500°C), because it is not sufficiently sensitive to changes in the all parameters (especially alpha and c representing interdomain coupling and reversible domain wall, respectively, and k determining the hysteresis losses). Therefore, the loops were fitted by Langevin function and the estimated diameter of the magnetic particles that increases with increasing calcination temperature is in good agreement with the value obtained by Nanozetasizer. The paramagnetic behavior of the hysteresis loops related to the transformation from maghemite to hematite in the temperature range 700°C – 900°C was fitted by Langevin function too.

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P1-06

PAIRWISE ENTANGLEMENT IN DOBLE-TETRAHEDRAL CHAIN WITH DIFFERENT LANDÉ g-FACTORS OF THE ISING AND HEISENBERG SPINS

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The exactly solvable spin-1/2 Ising-Heisenberg double-tetrahedral chain is investigated in a longitudinal magnetic field by assuming different Landé g-factors for the Ising and Heisenberg spins [1,2]. The main attention is focused on analysis of the quantum entanglement between Heisenberg spin pairs at zero and finite temperatures through a concurrence. The physical quantity has been calculated from exact solutions of the sublattice magnetization and pair correlation functions of the Heisenberg spins [3].

It is shown that the ground state of the 1D mixed-spin system involves the classical ferrimagnetic phase, the fully saturated phase, two quantum non-chiral phases and two quantum chiral phases. The quantum entanglement between each Heisenberg spin pair appearing in quantum non-chiral phases is twice as strong as that one which can be observed in chiral phases. As expected, the phenomenon is gradually weakening with temperature until it completely vanishes at the threshold temperature no matter of chiral on non-chiral character of the ground state. Besides the standard monotonous decline, the concurrence also exhibits more peculiar non-monotonous thermal dependencies with a reentrant rise and fall above the classical ground states at finite temperatures. It is thus clear that the applied magnetic field induces thermal spin fluctuations promoting some degree of thermal entanglement even above the classical ground states with saturated or ferrimagnetic spin arrangements.

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P1-07

COMPARATIVE STUDY OF A CRITICAL BEHAVIOUR OF A COUPLED SPIN-ELECTRON MODEL ON A DOUBLY DECORATED SQUARE LATTICE IN THE CANONICAL AND GRAND-CANONICAL ENSEMBLE

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The critical behavior of a hybrid spin-electron model with the localized Ising spins placed on nodal sites and the mobile electrons delocalized over the bonds between two nodal lattice sites is analyzed by the use of a generalized decoration-iteration transformation. Our attention is primarily concentrated on a rigorous analyzis of the critical temperature in canonical and grand-canonical statistical ensemble at two particular electron concentrations, corresponding to a quarter (ρ=1) and a half (ρ=2) filled case. It is found that the critical temperature of the investigated spin-electron system in the canonical and grand-canonical ensemble may be remarkably different and is very sensitive to the competition among the model parameters like the electron hopping amplitude (t), the Ising coupling between the localized spins (J'), the electrostatic potential (V) and the electron concentration (ρ). In addition, it is detected that the increasing electrostatic potential has a reduction effect upon the deviation between the critical temperature in both statistical ensembles.

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P1-08

NONUNIVERSALITY OF SYMMETRIC 16-VERTEX MODEL

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A symmetric single-parameter 16-vertex model is numerically studied by the Corner Transfer Matrix Renormalization Group method on the square lattice. The single parameter ε (associated with the energies of the non-eight-vertex Boltzmann weights $w = e^{-\varepsilon}$) are allowed to vary in range $0 \leq \varepsilon < +\infty$. The Ising and the 8-vertex universality classes are satisfied for $\varepsilon \to 0$ and $\varepsilon \to +\infty$, respectively. We determined an intermediate region, $2 \lesssim \varepsilon \lesssim 14$, with a strong nonuniversal behavior of the critical exponents.

P1-09

ANOMALOUS THERMODYNAMIC RESPONSE IN A VICINITY OF PSEUDO-TRANSITION OF THE SPIN-1/2 ISING DIAMOND CHAIN

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Ground-state phase diagram and basic thermodynamic quantities of a spin-1/2 Ising diamond chain have been marginally examined in Refs. [1,2], which were primarily concentrated on finding an exact solution for a more general spin-1/2 Ising-Heisenberg diamond chain involving this particular model system as a special limiting case. In spite of these preliminary investigations a striking pseudo-transition of the spin-1/2 Ising diamond chain has been completely overlooked and not reported yet. It will be proved in the present work that the spin-1/2 Ising diamond chain may indeed display a remarkable pseudo-transition whenever the model parameters drive the investigated spin chain sufficiently close to a ground-state phase boundary between the unique ferrimagnetic phase and the frustrated phase with a high macroscopic degeneracy (residual entropy). The pseudo-transition can be thus related to vigorous thermal excitations from the unique ferrimagnetic ground state towards a highly degenerate manifold of excited states. The pseudo-transition of the spin-1/2 Ising diamond chain manifests itself in an anomalous response of basic thermodynamic quantities, which mimic a temperature-driven phase transition either of a discontinuous (entropy) or continuous (specific heat) nature though there are no true singularities of these quantities at pseudo-critical temperature. The universal values of the pseudo-critical exponents, which govern a power-law behavior of the specific heat, can be found within a temperature range sufficiently close but not too close to the pseudo-critical temperature.

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P1-10

INCLUSION OF SPIN FLUCTUATIONS TO THE FINITE-TEMPERATURE ELECTRICAL TRANSPORT CALCULATIONS

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Ab initio description of finite temperatures in bulk magnetic materials is a difficult task, especially because of both numerical expenses and analytical complexity. A robust treatment of spin fluctuations and phonons is necessary for a design of novel electronic or spintronic devices which are supposed to work in real-life conditions.

For this purpose, we have implemented the alloy analogy model (AAM) [1, 2, 3] within our tight-binding linear-muffin-tin orbital method with the coherent potential approximation [4]. It is numerically cheap and efficient; moreover, the AAM allows one to describe a combined effect of phonons (displacements of atoms), magnons (spin fluctuations), and chemical impurities.

We will present the results of *ab initio* calculations of finite-temperature electrical transport properties for a wide range of magnetic materials [1], including half-Heusler NiMnSb [2] or antiferromagnetic CuMnAs. We have successfully described electrical resistivity and the anomalous Hall effect in both random and ordered alloys. We will focus especially on the role of the magnetic disorder and its proper combination with phonons. It is essential especially for systems close to the Curie temperature. Last but not least, technical and numerical details will be discussed.

The developed formalism is of extreme importance for a theoretical description of spintronic phenomena such as the spin polarization of the electrical current [3]. To predict its value, we will present two models of the magnetic disorder which successfully simulate finite-temperature spin fluctuations.

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P1-11

PHASE DIAGRAM OF A GENERALIZED XY MODEL WITH GEOMETRICAL FRUSTRATION

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The two-dimensional *XY* model is known to exhibit an unusual infinite order phase transition belonging to the Kosterlitz-Thouless (KT) universality class [1]. Introduction of a nematic coupling into the Hamiltonian leads to an additional phase transition belonging in the Ising universality class [2]. Recently, it has been shown that higher order harmonics can lead to a qualitatively different phase diagram, with additional ordered phases originating from the competition between the ferromagnetic and higher-order (pseudonematic) couplings [3]. The new phase transitions were identified to belong to the 2D Potts, Ising, or KT universality classes.

In the present study we investigate effects of geometrical frustration on such a generalized *XY* model by considering it on a triangular lattice with antiferromagnetic (AF) coupling. The simplest generalization involving the second-order antinematic (AN2) coupling has been shown to display, besides the AF and AN2 phases, also an additional chiral phase above the KT line [4]. Here we modify this model by considering the AN3 term of the third instead of the second order AN2 and study how the phase diagram is affected by this change. Recent investigations of the ground-state properties of such a model suggested an interesting behavior with potential interdisciplinary applications [5]. We demonstrate that at finite temperatures such a modification leads to the overall change of the phase diagram topology, compared to the model with the AN2 term. Namely, besides the AF and AN3 phases which appear in the limits of relatively strong AF and AN3 interactions, respectively, it includes an additional complex noncollinear quasi-long-range ordered phase at lower temperatures wedged between the AF and AN3 phases. This new phase originates from the competition between the AF and AN3 couplings, which is absent in the model with AN2.

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P1-12

EMERGENCE OF A SKYRMION PHASE IN A FRUSTRATED HEISENBERG ANTIFERROMAGNET WITH DZYALOSHINSKII-MORIYA INTERACTION

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Particle-like spin structures of chiral and topological nature called magnetic skyrmions are of interest due to their small size, stability and sensitivity in terms of current-driven motion with surprisingly low current density [1]. It has been experimentally demonstrated that many magnetic materials host such structures [2]. One of the mechanisms of the skyrmions formation is mediated by an antisymmetric Dzyaloshinskii-Moriya (DM) exchange interaction [3, 4]. It has been shown that skyrmions can be stabilized not only in ferromagnetic systems, but also in antiferromagnetic ones, for example, due to a weak next-nearest neighbor interaction [5].

In the present study we consider a geometrically frustrated classical Heisenberg antiferromagnet on a triangular lattice with only nearest-neighbor interactions in the presence of the DM interaction and an external magnetic field. A recent study showed that at a sufficiently large strength of the DM interaction a three-sublattice skyrmion crystal can be stabilized within a certain range of the magnetic fields [6]. The goal of the present investigation is to establish the minimum values of both the DM interaction strength as well as the magnetic field intensity at which such a skyrmion phase can exist at very low temperatures (close to zero). To detect its emergence we apply hybrid Monte Carlo simulations and evaluate a total chirality as a topological order parameter of the skyrmion phase.

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P1-13

SPIN-GLASS-LIKE ORDERING IN A FRUSTRATED J_1-J_2 ISING ANTIFERROMAGNET ON A HONEYCOMB LATTICE

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A frustrated J_1-J_2 Ising model with first- and second-neighbor antiferromagnetic (AF) interactions on a square lattice has attracted a lot of attention due to a long-standing controversy regarding the nature of its critical behavior. While transition to the AF (Néel) phase for $\alpha \equiv J_2/J_1 < 1/2$ is believed to belong to the Ising universality class, conflicting results have been reported regarding transition to the superantiferromagnetic (SAF) phase for $\alpha > 1/2$. One scenario suggested a second order transition with non-universal exponents for any $\alpha > 1/2$ [1], while some other favored a first order transition for $1/2 < \alpha < \alpha^* \approx 0.67$ and a continuous one only for $\alpha > \alpha^*$ in Ashkin-Teller universality class [2].

Much less attention has been paid to this model on a honeycomb lattice [3, 4]. A recent study within an effective field theory predicted the existence of the AF phase for $\alpha < 1/4$, with a tricritical behavior, but no long-range ordering was found for $\alpha > 1/4$ [4]. Therefore, in the present study we focus on the region of $\alpha > 1/4$ and explore the possibility of some kind of ordering at low-temperatures using a Monte Carlo approach. Our results suggest that there is a peculiar phase transition accompanied by a spin-glass-like freezing to a highly degenerate state consisting of frozen domains with SAF type ordering separated by zero-energy domain walls. In spite of the local ordering within the respective domains there is no ordering among them and thus no long-range ordering spanning the entire system.

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P1-14

MAGNETOCALORIC PROPERTIES OF AN ISING ANTIFERROMAGNET ON A KAGOME LATTICE

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Owing to a high degree of geometrical frustration an Ising antiferromagnet on a kagome lattice (IAKL) is known to exhibit no long-range ordering at any temperature, including the ground state [1]. Nevertheless, at low temperatures it shows a strongly correlated, highly fluctuating regime known as a cooperative paramagnet or classical spin liquid. In the ground state it is characterized by a macroscopic degeneracy which translates to a relatively large value of the residual entropy [2]. It has been shown that the presence of a macroscopic degeneracy associated with geometrical frustration below the saturation field can facilitate an enhanced magnetocaloric effect (MCE), which can exceed that of an ideal paramagnet with equivalent spin by more than an order of magnitude [3].

In the present study we investigate magnetic and magnetocaloric properties of IAKL by Monte Carlo simulation. In particular, we calculate the entropy of the system using the thermodynamic integration method and evaluate quantities which characterize MCE, such as the isothermal entropy and adiabatic temperature changes in a varying magnetic field. It is found that IAKL shows the most interesting magnetocaloric properties in the region of low temperatures and moderate magnetic fields, suggesting its potential to be used in technological applications for low-temperature magnetic refrigeration.

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P1-15

MODIFIED STRONG-COUPLING APPROACH TO THE TRIMERIZED HEISENBERG CHAIN

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Quantum spin-1/2 antiferromagnetic Heisenberg trimerized chain is studied using the strong-coupling expansion developed about the exact solution of the Ising-Heisenberg version of the model. Such an approach, elaborated for the orthogonal-dimer chain, showed an excellent agreement with the data of numerical methods [1]. The trimerized chain appeared as a first example where the quantum plateau state was discovered, and the difference between the quantum and classical origin of fractional plateaux can be easily analyzed on its example [2]. Moreover, the one-third plateau was observed in the magnetic compound Cu3(P2O6OH)2 which represents an experimental realization of the trimerized Heisenberg chain [3]. Within the second-order perturbation theory, we obtain the effective Hamiltonians for the range of the magnetic field from zero to one-third plateau, and from one-third plateau to the saturation magnetization. We also calculate perturbatively the energy of the spin excitation observed in the neutron scattering experiment. The precision of the method is tested on the available results of numerical approaches. The refined values for exchange couplings of Cu3(P2O6OH)2 is found by matching the theoretical results with the available experimental data on the neutron scattering and the low-temperature magnetization.

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P1-16

AB INTITIO STUDY OF ELECTRONIC STRUCTURE PROPERTIES OF $CaAFe_4As_4$ (A = K, Rb AND Cs) SUPERCONDUCTORS

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A new series of layer – type structure $CaAFe_4As_4$ (A = K, Rb, Cs) compounds were found to be superconductivity below Tc ~ 31 ÷ 35 K) [1]. Though the electronic band structure of those materials have been investigated by several groups [2, 3, 4], however, there remain some important differences in the magnetic ground state and electronic bands. Therefore, our aspiration was reinvestigate using different self-consistent DFT calculations, hoping to get reasonable results of new information on the physics underlying an enhancement of Tc in the Ca-1144 superconductors. We utilized the Full-Potential Linearized Augmented Plane Wave method with the Generalized Gradient Approximation implemented in ELK code [5] and the Projector Augmented Wave (PAW) performed in VASP package [6]. In this contribution, some electronic ground state properties such as Density of states, Partial densities of states, Electronic band structures, Fermi surface and Electron localization function of Ca-1144 superconductors and their parent 122-materials are established. The obtained data will be compared with those of $SrAFe_4As_4$, recently reported by us [7].

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P1-17

INFLUENCE OF THE LONG-RANGE RKKY INTERACTION ON A FORMATION OF MAGNETIZATION PLATEAUS IN THE GENERALIZED ISING MODEL ON THE SHASTRY-SUTHERLAND LATTICE

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We present a simple model for a description of magnetization processes in metallic rare-earth tetraborides. It is based on the two-dimensional Ising model, in which two spins on the Shastry-Sutherland lattice interact via the long-range RKKY interaction mediated by conduction electrons. The model is solved by a combination of the standard Metropolis algorithm and the parallel tempering method and it yields the reach spectrum of magnetic solutions (magnetization plateaus), depending on the value of the Fermi momentum k_F and the external magnetic field h. In particular, we have found the following set of individual magnetization plateaus with fractional magnetization m/m_s = 1/12, 1/9, 1/6, 1/4, 1/3, 3/8, 5/12, 1/2, 7/12, 2/3, which for different values of k_F form various sequences of plateaus, changing from very complex, appearing near the points k_F =2π/1.15 and k_F = 2π/1.38 to very simple appearing away these points. The importance of these results for a description of real rare-earth tetraborides is discussed.

P1-18

MAGNETISM OF THE DILUTED ISING ANTIFERROMAGNET IN A MAGNETIC FIELD ON THE KAGOME LATTICE: SINGLE-SPIN CLUSTER APPROXIMATION

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An effective field theory based on the single-spin cluster has been used to study spin-1/2 Ising antiferromagnet on the Kagome lattice with nearest-neighbor interactions. The method is based on the exact single-spin cluster identity and utilizes a convenient differential operator technique. Within this scheme we neglect correlations between different spins but take all the relevant single-site kinematic relations exactly into account. However, to include the effect of the geometrical frustration in this simple effective-field theory, we divide the lattice into three interpenetrating sublattices in such a way that spins on one sublattice only interact with spins from the other two sublattices.

In particular, we find only trivial solution at all temperatures for the sublattice magnetizations which means that our effective-field approach reproduces the exact result of no long-range order down to T = 0 K [1]. On the other hand, the dependence of the total magnetization on the external magnetic field at low temperatures shows for the pure Kagome lattice antiferromagnet typical 1/3 magnetization plateau in accordance with recent Monte Carlo observation [2]. An explanation of the origin of the magnetization plateau, which is similar to that observed in the Ising antiferromagnet on the triangular lattice, is given. The effect of the random site dilution on the magnetization plateau is also investigated.

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P1-19

LOW TEMPERATURE THERMODYNAMICS OF SPIN-1/2 XX CHAINS WITH PERIODICALLY EMBEDDED ISING IMPURISIES

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This work is devoted to the theoretical study of quantum stationary states and thermodynamics of two exactly solvable quantum models based on spin-1/2 XX chain: a set of finite XX chains connected by Ising spins *S* into the ring or "tube" via one intermediate site with the same number for each XX chain. Z-projections of the impurity spins are the good quantum numbers, so Hamiltonians may treat as a set of independent Hamiltonians $\mathbf{H}(\sigma_n, \sigma_{n+1})$ of finite spin-1/2 XX chains with the effective "impurity" spins (s = 1/2) at the ends or at one of the intermediate sites.

We solved one particle Schrödinger equation in the lattice site representation and derived the dispersion relations for the exact energy spectrum in analytical form. We also derived and analysed the conditions for the appearance of the energy states, localized near to the impurity spins. We used above dispersion relations for the construction of the corresponding transfer-matrices. By means of a standard transfer-matrix scheme, we obtained the exact partition function of the systems considered.

Using these results, we performed numerical simulation of field and temperature dependencies of the magnetization and heat capacity for two our systems. One may expect the big effect of impurities when localized levels exist. For antiferromagnetic Ising interaction, the field dependence of the magnetization at very low temperatures demonstrates a jump associated with the spin-flip of impurity spins in sufficiently strong magnetic field. We found possibility of two- peak behavior for zero field temperature dependence of specific heat.

It is of interest that the results of above numerical study are close to the case of open ends XX-chain with zz-impurities at the both ends [1], and to the XX chain with two Ising appendixes at one lattice site for the first and second models respectively.

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P1-20

THEORETICAL STUDY OF THERMODYNAMIC PROPERTIES OF HUBBARD MODEL ON ASYMMETRIC TRIANGULAR CLUSTER

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The Hubbard model constitutes a fundamental model in physics of strongly correlated systems [1]. Apart from its applications to bulk systems, it can also be useful for description of nanoclusters [2–4]. Such zero-dimensional objects can exhibit interesting quantum size effects and their properties can depend crucially on the underlying geometry. Moreover, the external magnetic field can significantly influence the characteristics of nanoclusters.

In the paper we undertake the study of an asymmetric triangular cluster, extending the exhaustive works focused on the Hubbard dimer investigated with exact methods [5–7]. The system of interest is described with Hubbard Hamiltonian parametrized with two unequal values of hopping integral between the sites as well as the on-site Coulombic repulsion energy. The influence of the external magnetic field is taken into account. The calculations are based on the exact numerical diagonalization of the model Hamiltonian. The thermodynamic description is constructed within the framework of grand canonical ensemble, valid for an open system.

The numerical results for the thermodynamic quantities describing the system in question are obtained and discussed. The relation between the chemical potential and the average number of electrons in the system is studied first. Then other fundamental thermodynamic quantities of interest are investigated as a function of the temperature and the external magnetic field as well as the model parameters. In particular, the behaviour of the local magnetizations and the total magnetization is discussed for various interaction parameters.

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P1-21

ANALYSIS OF THE MAGNETIC DOMAIN STRUCTURE IN AMORPHOUS CoFeSiB WIRE

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We present the analysis of domain structure of the amorphous CoFeSiB wire with near-zero magnetostriction in frame of the Preisach model. The constricted hysteresis loop has been measured during slow premagnetization of the CoFeSiB wire. The symmetric double-peak dependences of magneto-impedance on the applied longitudinal dc magnetic field strength have also been recorded in the CoFeSiB wire. Additional application of a circumferential dc bias magnetic field was used to achieve the asymmetric magneto-impedance in the wire. The obtained results are theoretically interpreted taking into account the cylindrical core-shell magnetic domain structure, where the central area (core) of the wire is longitudinally magnetized and the shell of the wire exhibits helical anisotropy induced during the wire preparation.

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P1-22

MODELING THE REVERSAL MAGNETIZATION IN BONDED HARD MAGNETIC MATERIALS USING HYPERBOLIC T(x) MODEL

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Description of reversal magnetization processes using hyperbolic T(x) model is demonstrated. The applied method is related with decomposition of experimentally obtained demagnetization curve on the reversible and irreversible components. Basing on obtained results, using hyperbolic T(x) model, the major hysteresis loop and recoil curves are built. The simulated curves are compared with experimentally measured ones. All performed measurements are made for hard magnetic bonded magnet.

2 AMORPHOUS, NANOCRYSTALLINE AND OTHER SOFT MAGNETIC MATERIALS

O2-01

TEMPERATURE EVOLUTION OF MAGNETIC STRUCTURE IN Fe-Co-Si-B-Mo-P METALLIC GLASS BY MÖSSBAUER SPECTROMETRY

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Metallic glasses are still attracting the interest of researchers namely for their very good magnetic properties. With the aim to enhance their practical applications, new compositions are continuously scrutinized. Here, we present a Mössbauer spectrometry study of a novel $Fe_{51}Co_{12}Si_{16}B_8Mo_5P_8$ metallic glass prepared in a form of ribbons by conventional method of planar flow casting.

Our interest is focused on evolution of its structural arrangement and magnetic ordering with temperature. The investigated samples were exposed to heat treatment below the onset of crystallization. Fully amorphous character of all investigated samples was confirmed by diffraction of synchrotron radiation. Analysis of reduced pair distribution functions calculated from diffraction data revealed small changes in local structure. Notable changes in the corresponding Mössbauer spectra have unveiled pronounced effects of the annealing on structural relaxation. Consequently, the magnetic microstructure was also affected. This was confirmed by Mössbauer effect experiments performed at several temperatures ranging from 4.2 K up to 430 K. Low temperature experiments were accomplished also in external magnetic field of 6 T. On the other hand, high temperature Mössbauer spectra exhibit clear transition from ferromagnetic to paramagnetic state. In this way, precise values of the Curie temperature could be determined.

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O2-02
INFLUENCE OF SUBSTITUTION ON THE STRUCTURE AND MAGNETIC PROPERTIES OF RAPIDLY QUENCHED $Fe_{86}B_{14}$ ALLOY

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Influence of substitution Si and Co for Fe in rapidly quenched $Fe_{86}B_{14}$-type alloy (metallic ribbons form) on crystallization temperature, crystal structure and magnetic properties are reported for three different metallic glasses: $Fe_{86}B_{14}$, $Fe_{84}Si_2B_{14}$ and $Fe_{80}Co_4Si_2B_{14}$.

Firstly, the onsets of crystallization process for bcc-Fe type phase (primary crystallization) and bct-Fe_3B type phase (secondary crystallization) are defined by thermal analysis using heating rate of 10°C/min. Then basing on measured values the classical heat treatment process (with heating rate 10°C/min) in vacuum for wound toroidal cores is optimized to obtain best soft magnetic properties (B(H) dependencies and magnetic core loss P_s) at frequency 50 Hz. For heat treated samples the X-ray diffraction method is used to determine the unit cell parameters of bcc-Fe type nanocrystallites as well as their average crystallite size. Therefore, for optimal heat treated samples and their as spun metallic glasses the complex magnetic permeability in the frequencies 10^6 -10^9 Hz and temperature range from -50°C to 100°C is measured.

The final emphasis is placed on the correlation between the crystal structure parameters and the magnetic properties (coercivity, saturation magnetization, magnetic core losses and complex magnetic permeability). The knowledge of such correlation defined for classical annealing process (10°C/min) is the starting point for future optimization the ultra rapid annealing (up to 100°C/s) process.

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O2-03

FORC STUDY OF MAGNETIZATION REVERSAL AND INTERLAYER INTERACTIONS IN RAPIDLY QUENCHED Fe/Co- BASED BILAYER RIBBONS

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Study of the interlayer interactions and hysteresis processes was performed for the rapidly quenched bilayer ribbon consisting of soft magnetic $Fe_{73.5}Cu_1Nb_3Si_{13.5}B_9$ layer and semihard magnetic $Co_{72.5}Si_{12.5}B_{15}$ layer. Samples were prepared by modified double-nozzle planar flow casting method. Subsequently they were isothermally annealed under high vacuum for 180 seconds at 843K to ensure simultaneous process of primary crystallization in both layers. Measurement of the First Order Reversal Curves (FORCs) was utilized for determination of magnetic interactions and contributions of the individual layers to the hysteresis process. Calculated switching field distribution (SFD) consists of two distinct peaks, each representing specific magnetic phase. With decreasing reversal field value, SFD peak of the microcrystalline, semihard magnetic Co-based layer is shifted to the higher field values, indicating presence of strong positive exchange interaction. On the other hand, SFD peak of the soft magnetic nanocrystalline Fe-based layer is shifted to lower field values. Such behaviour was associated with the presence of magnetostatic bias field originating in the semihard magnetic layer.

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O2-04

GMI EFFECT IN AMORPHOUS RIBBONS AND POSSIBILITY OF ITS APLICATION IN NULL-DETECTOR MAGNETIC FIELD SENSOR

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The giant magneto-impedance (GMI) effect is the object of scientific interest of numerous research groups since the mid-1990s. In major perspective, these are the works of physicists to thoroughly understand the phenomenon and improve the impedance change factor (GMI ratio). There were few applications presented. What is more in literature is lack of research focused on material responses in the weak magnetizing field, for which the impedance change is small.

In this paper, the authors present the results of optimizing the parameters of cobalt-based ribbons with different chemical composition, towards the construction of weak field sensors. Research has focused on the ± 100 A/m area, for low and medium impedance test frequencies (<10MHz). It was shown that annealed ribbons show significantly larger impedance changes at full range of external magnetic field and an ultra large impedance change in the region of weak field. The highest GMI ratio equal to 506% was obtained for Joule-annealed $Co_{70}Fe_5Ni_2Mo_5B_3Si_{15}$ sample. The authors also highlights the difference between the maximum value of GMI impedance and a local minimum at zero magnetization. The biggest difference was 482%.

Thus the paper provides a preliminary investigation into the high performance, amorphous ribbon based, GMI null-detector magnetic field sensor. The sensor's task will be to detect the minimum impedance in the range of weak fields corresponding to zero material magnetization.

P2-01

MANIPULATION OF THE DOMAIN WALL SHAPE IN THIN MAGNETIC WIRE BY CURRENT ANNEALING

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Fast and controllable domain wall propagation is one of the crucial requirements for applications of thin magnetic wires. It was previously shown, that the domain wall dynamics in Fe-rich wires can be tuned by both furnace [1] and current annealing [2], resulting in tailored domain wall mobility. However, the exact mechanism of observed effects is not completely understood yet, partially because of the challenging task of determining the domain wall shape in cylindrical wires.

Usually, the magnetic structure of microwire's surface is observed by the means of Kerr microscopy. This technique suffers from the finite numerical aperture of the microscope, which allows only a small portion of the surface to be observed due to the curved shape of the wire [3].

Here we present a study of the surface domain wall shape in thin magnetic wires by a novel method. Current approach makes it possible to map the surface domain wall profile across the majority of the wire's circumference and along a few millimeters of wire's length, hence providing a wholesome picture of the evolution of the domain wall shape in motion. At the same time, the experiment is optimized for observing cylindrical samples, as is the case of studied thin wires. The evolution of the surface domain wall shape in glass-coated microwires of composition $Fe_{77.5}Si_{7.5}B_{15}$ was studied, comparing the shape in the as-cast sample and after DC current annealing with various values of annealing current.

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P2-02
MAGNETIC PROPERTIES OF NANOCRYSTALLINE ALLOYS AFTER ELECTRONS IRRADIATION OF PRECURSOR

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Precursor of nanocrystalline $Fe_{83}Sn_5B_{12}$ alloy was irradiated by electron beams of doses up to 4 MGy. Irradiation had an influence on the magnetic microstructure of the amorphous and nanocrystalline alloy. It has manifested as a change in the direction of the net magnetic moment, intensity of the internal magnetic field and volumetric fraction of the constituent phases. All these parameters were determined from the measured Mössbauer spectra. The direction of the net magnetic moment was the most sensitive parameter. Structural changes were identified by Mössbauer spectroscopy as ratio of amorphous and crystalline component. Irradiation of the amorphous precursor also reflected at the shape of hysteresis loop. The results indicated at the changes of the microscopic magnetic parameters due to electron irradiation.

P2-03

PERMEABILITY, PERMITTIVITY AND EM-WAVE ABSORPTION PROPERTIES OF POLYMER COMPOSITES FILLED WITH MnZn FERRITE AND CARBON BLACK

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Multifunctional low-weight and cost-effective ferrite-polymer composites are the subject of growing attraction due to their ability to suppress electromagnetic interference noise originated in electronic devices and circuits. MnZn/CB/NBR composite materials based on manganese-zinc (MnZn) ferrite with composition $\approx Mn_{0.68}Zn_{0.24}Fe_{2.08}O_4$ and carbon black (CB) as fillers and natural butadiene rubber (NBR) as a polymeric non-magnetic matrix have been prepared and studied. The compound of rubber batch with the constant content of carbon black and variable content (15-47 vol%) of MnZn ferrite was obtained by hot-mixing at 90 C and then the cross-linking of the compound was carried out for the optimum vulcanization time at 160 C and 15 MPa. The final composites were cut into the   ring and disc forms. The surface morphology and microstructure (particle size and shape) of fillers were observed using a scanning electron microscope. Various methods were used to evaluate magnetic, dielectric and electromagnetic wave (EM-wave) absorption performances of composites: (a) the frequency dispersion of complex (relative) permeability $\mu = \mu' - \mathrm{j}\mu''$ and permittivity $\ = \ ' - \mathrm{j}\ ''$ were measured using combined impedance/transmission line method within the frequency interval 1 MHz – 3 GHz, (b) the dc electrical conductivity σ_{dc} was established using standard two-probe method, and c) EM-wave absorption characteristics (return loss RL, matching frequency f_{m}, matching thickness d_{m} and bandwidth Δf for $RL \le -20$ dB) were determined through numerical simulations. Absorption parameters (RL, f_{m}, d_{m}, Δf) of composites depends on the relation between material parameters (μ, , σ_{dc}) and the volume content of hybrid MnZn/CB filler. The synthesized composite materials seem to be excellent electromagnetic shields in the frequency range of 300 MHz – 2 GHz.

Acknowledgement

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P2-04

SUBSTITUTED LITHIUM FERRITE UTILIZED AS MAGNETICALLY ACTIVE FILLER FOR THE COMPOSITES WITH ACRYLONITRYLE BUTADIENE RUBBER MATRIX

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Recently, the demands for increase the living standard in many spheres of human society triggered rapid development of new technologies and highly effective devices, especially in the field of telecommunications, multimedia, medicine, etc. Many electronic devices are designed for functioning at extremely high frequencies. The use of various devices in gigahertz range may often result in malfunctioning due to electromagnetic (EM) interferences. These undesirable effects of EM radiation may be decreased or even eliminated by using appropriate materials absorbing EM waves. Lithium ferrites, known as being magnetically soft materials, are widely accessible candidates for these purposes, [1-2].

Substituted lithium ferrite composed of $Li_{0.525}Zn_{0.30}Ti_{0.35}Fe_{1.825}O_4$ with a small addition of Bi and Mn has been used as magnetically active filler in elastomeric composite materials. The ferrite powder was prepared by auto-combustion wet procedure and further thermally treated (sintered) at 1050°C. The structure of synthesized ferrite has been investigated by means of X-ray diffractometer (XRD). Low-frequency magnetic characteristics specified from measured hysteresis loops and from the temperature dependences of magnetic susceptibility confirmed soft magnetic behavior of Li ferrite with good rectangularity and Curie temperature T_C = 323.5°C. The ferrite powder with an average particle size below 40 μm was incorporated into the acrylonitrile butadiene rubber matrix in an amount resulting in final concentration ranging from 0 to 44.5 vol.%. The effect of magnetic filler concentration on various magnetic and microwave absorption properties of magnetic polymer composites has been investigated and assessed from complex permeability measurements in the frequency range from 10 MHz to 6.5 GHz. The analysis of obtained result demonstrates clearly visible effect of magnetic filler in composite samples. The magnetic permeability increases with increasing of ferrite filler; however, the resonance frequency shifts towards lower values.

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P2-05

STRUCTURAL AND MAGNETIC STUDY OF Fe-Al_{20}-(Ti, Nb) ALLOYS

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The homogeneous binary Fe-Al alloys were formerly not considered for structure applications. The main reason was lack of their ductility. Later it was reported that this feature is not inherent which evoked their intensive research. The subsequent systematic investigations were directed into two-phase Fe-Al based alloys because it was found that impurities and processing of Fe-Al based alloys play an important role. A certain success was achieved by formation of metastable coherent precipitates uniformly distributed in a Fe-Al matrix influencing both mechanical and magnetic behavior.

The alloys with Al content between 20 and 25 at.% and with Ti or Nb as targeted impurities have appeared as perspective. Therefore, a set of Fe-Al alloys doped by Ti and Nb were produced and our first study was done on the $Fe_{71}Al_{22}Ti_7$ consisting of Fe-Al matrix and Fe_2TiAl cuboids. The results were compared with those obtained for binary Fe-Al alloys, see, e.g., Refs. [1, 2].

Here, the as-prepared $Fe_{80}Al_{20}$, $Fe_{75}Al_{20}Ti_5$, $Fe_{72}Al_{20}Ti_8$, and $Fe_{75}Al_{20}Ti_4Nb_4$ alloys were studied using X-ray diffraction, Mössbauer and magnetic measurements completed with structural observations. The experimental results have shown good agreement of the chemical compositions taken from the area of about 1 mm^2 with nominal ones for all samples. Regarding macroscopic magnetic properties the saturation magnetization decreases with increasing Ti content, however, a partial substitution of Ti by Nb evokes an opposite effect. The Mössbauer results show indications of the coexistence of a dominant ferromagnetic phase and a minor paramagnetic one for alloys with Ti or Ti+Nb addition at the expense of Fe.

The experimental results of studied alloys are complemented by quantum-mechanical calculations with the aim to examine magnetic and electronic properties of all phases and to determine the local magnetic moments of the Fe atoms in dependence on impurity (Ti, Nb) atoms in its neighborhood.

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P2-06

INVESTIGATION OF LOCAL AND GLOBAL STRESS STATE AND THE DEGRADATION IN METGLAS TAPES CAUSED BY THE LASER CUTTING

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In the as quenched state of glassy alloy tapes a macroscopic stress evolution can be detected. This phenomenon arising mainly from the difference in the local cooling rate between the vicinity of wheel and free surface sides. As a consequence, the magnitude of the quenched-in free volume is differ associated with the glassy state formation in the vicinity of the top and shiny surfaces.

The nature of stresses arising from the laser cutting are significantly different since the existence is associated with the local remelting and resolidification within a narrow heat affected zone caused by the laser beam.

The interaction and manifestation of these stress fields will be investigated by determining the local topology of microhardness and by measuring the coercivity (H_c) of the samples. These global informations will be correlated with the domain structure changes both in as quenched and laser threated ribbons.

The local structural change and stress filed extension appears as an extended effect, when the H_c of the as received and laser cut samples are compared. The overall property changes highly depend on the applied laser power density, the on the cutting speed and also on the applied shielding gas as well (Ar,He, N_2, O_2). The outlined effects will be summarized in the present paper.

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P2-07

MORPHOLOGICAL AND STRUCTURAL STUDY OF HEAT-AFFECTED ZONE INDUCED BY LASER CUTTING OF GLASSSY METAL TAPES

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Recently, the extension of application of soft magnetic glassy alloys seems to be promising in the field of asynchronous motor structural parts by decreasing the core loss of soft magnetic elements.

In order to apply these materials, several additional requirements have to be satisfied. One of the most chrytical task is the shaping of the soft magnetic base material into the appropriate geometries, while avoiding the structural and magnetic degradation (local crystallization) of the individual glassy elements.

In this article the results of laser cutting experiments will be introduced. Due to the nature of laser beam-glassy tape interaction a local degradation process occurs as a consequence of heat evolution in the vicinity of the laser cut. The heat affected zone has a parallel front with the cutting edge and he thickness of this front depends mainly on on several cutting parameters (power density of beam, scanning rate, or the flow rate of applyied working gas).

In this paper the fine structure of the heat affected zone is investigated. The high resolution pictures shows a clomnar microstrure of this heat affected layer resembling a resolidified microstructere. The dimension of columnar units drastically changes according to the unidirectional heat condution. The magnitude of heat affected zone will be correlated with the soft magnetic properties of the samples.

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P2-08

MAGNETIC RESPONSE OF AMORPHOUS AND NANOCRYSTALLINE FeSn(P)B RIBBONS TO ELECTRON IRRADIATION

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Rapidly quenched Fe-based materials are used in industrial practice for their excellent magnetic properties in various fields. They can serve as a substitute for structural steels in many cases and be beneficial in nuclear power. Ribbons of metallic glass with $Fe_{83}Sn_5B_{12}$ composition and supplemented tin with 2% phosphorus were irradiated with a 4 MGy electron beam. With such modified samples, we examined the effect of irradiation to amorphous and nanocrystalline magnetic properties. In addition to measuring hysteresis loops, we subjected samples to multiple test methods, TGA, DSC, MS and EDS.

From the thermogravimetric analysis, we find that the alloy with P has a lower T_C of 14 °C than an P-free alloy, this value being about 50 °C below the first crystallization temperature (T_{p1} = 400 °C). For ribbon with P it is more about 80 °C. Using Mössbauer spectroscopy we investigated the magnetic induction, the A_{23} coefficient, the amorphous and crystalline phase before and after irradiation. Both irradiated and non-irradiated samples were annealed at 400°C for 1/2 hour in vacuum to reach the nanocrystalline phase. The results show that while the amorphous ribbons show a significant change after irradiation (better pronounced longitudinal magnetic anisotropy) the nanocrystalline ribbons show almost no effect. P causes slower nanocrystallization, i.e. the crystalline phase contents is lower after the same heat treatment than in P-free samples. Phosphorus sample coercivity is lower, which is better in terms of magnetic softness, but the saturation induction is lower by 3% than in the basic alloy. An advantage is that both materials after nanocrystallization are almost resistant to the electron beam irradiation.

P2-09
IRREVERSIBLE PERMEABILITY OF Fe-BASED SOFT MAGNETIC COMPOSITES

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Soft magnetic composites (SMC) represent a remarkable kind of materials consisting of insulated ferromagnetic particles. Most significant advantages of SMC over traditional soft magnetic materials are relatively low energy losses at medium to higher frequencies, magnetic and thermal isotropy, or relatively high saturation induction. Application range of SMC covers various electromagnetic devices and is still expanding. Some magnetic quantities dependences of SMC are different from majority of bulk ferromagnets, as magnetization process in SMC is significantly influenced by inner demagnetizing fields.

In continuation on previous work [1], the derivation of the relation for irreversible relative permeability at initial magnetization curve μ_{irr}^{IN} was specified using the linear functions approximation (LFA) for Fe-phenolformaldehyde resin SMC. The LFA arises from the Steinmetz law and expresses the DC energy losses of SMC as a function of magnetic induction, by approximating the shape of minor hysteresis loop typical for SMC with the parallelogram and triangles, i.e. linear functions. The quantity coercive field H_C is used and DC losses $W_{DC} = 3\, H_C\, B$, where B denotes the induction of minor hysteresis loop peak point lying on initial curve. The induction range of validity of the LFA is wider than that of the Steinmetz law for the case of Fe-based SMC.

Comparing the experimental and the calculated dependences of irreversible permeability vs. magnetic induction, the empirical function in relation was found to be a constant (C_{Lin}), leading to the final form of the relation: $\mu_{irr}^{IN} = 3\, C_{Lin}\, H_C\, \mu_0\, \mu_{tot}^2\, B^{-1}$. The relation covered the range of validity of the LFA with higher accuracy than the previous one [1] derived from the Steinmetz law, enabling to express irreversible permeability of Fe-phenolformaldehyde resin SMC and so find the proportions of irreversible magnetization processes.

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P2-10

INFLUENCE OF FERRITE AND RESIN CONTENT ON INNER DEMAGNETIZING FIELDS OF Fe-BASED COMPOSITE MATERIALS WITH FERRITE-RESIN INSULATION

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This work presents the investigation results on the inner demagnetizing fields of soft magnetic composites with ferrite-resin insulation, with the aim to better understand the influence of ferrite and binder (resin) content on DC magnetic properties. Soft magnetic composite samples were composed from Fe powder coated by boron modified phenolic resin (PFBR) with addition of NiZnCu ferrite powder (FRX-146). As base ferromagnetic material polycrystalline Fe (ABC 100.30) was chosen. Fe powder was mixed ultrasonically with pre prepared resin-ferrite mixture. The various volume content ratios of resin to ferrite powder were prepared. The obtained mixtures were compacted into the ring-shape samples.

The initial magnetization curves and the anhysteretic curves were measured. The total relative permeability of composites was calculated from the initial curves. The inner demagnetization factor was determined from the tilt of anhysteretic curves. The higher permeability corresponding to lower inner demagnetization factor was found with the addition of ferrite powder, which is magnetically active. On the other hand, the highest content of ferrite resulted in the porosity increase, lowering the permeability.

The measured initial curves and the total relative permeability were recalculated to an ideal SMC containing 100 % of magnetic material (filling factor 1) with infinitely low non-magnetic (resin) content.

P2-11

NEUTRON IRRADIATION EFFECTS ON METALLIC GLASSES STUDIED BY MÖSSBAUER SPECTROMETRY AND DIFFRACTION OF SYNCHROTRON RADIATION

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Amorphous Fe-based alloys have become attractive not only due to their good soft magnetic properties but also due to their relatively good radiation resistance. Such combination of properties is crucial for applications in some of the nuclear devices.

Metallic glasses with nominal chemical composition of $Fe_{79}Cu_1Mo_8B_{12}$, $Fe_{79}Cu_1Nb_7B_{13}$ a $Fe_{78}Si_9B_{13}$ in the shape of ribbons were irradiated by fast neutrons from $\mathrm{p}(35) + \mathrm{Be}$ source with the mean energy of 14 MeV with total neutron flux up to $3 \times 10^{16}\ \mathrm{cm}^{-2}$.

Analysis of reduced pair distribution function calculated from X-ray diffraction patterns did not reveal any crucial differences between non-irradiated and irradiated samples. However, slight changes of peak positions which might be connected with structural rearrangements were observed.

Furthermore, Mössbauer spectrometry revealed changes of the net magnetic moment. Results show that the vector of the net magnetic moment was in all cases tilted to the direction parallel with the surface of studied samples. In addition to that, no significant changes of hyperfine magnetic field or isomer shift were observed.

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P2-12

GLASS-COATED MICROWIRES FOR TEMPERATURE SENSORS

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Magnetic microwires demonstrated large variety of magnetic properties which are depending mainly on the chemical composition and on the magnetic structure of the metallic ferromagnetic core. This work evaluates the possibility of amorphous and nanocrystalline microwires with positive magnetostriction for technical and biomedical applications at low temperatures. The static magnetization in wires with positive magnetostriction has only two values +M or –M and its magnetization is reversed by a large Barkhausen jump. Switching between these two magnetized states is driven at the switching field, which is sensitive to external parameters, like the stress, temperature, thermal treatment, magnetic field, etc. In given contribution, the temperature dependence of the switching time was studied in new Nanoperm–based microwires with a higher content of molybdenum. These wires show high sensitivity to temperature within narrow temperature range from 300 to 320 K. Taking into account small dimensions of microwires, together with their biocompatibility due to the Pyrex glass-coating, they are suitable for medical applications.

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P2-13

MAGNETIC PROPERTIES OF $LiFeSi_2O_6$ PREPARED BY MECHANOCHEMICAL/THERMAL PROCESS USING DIFFERENT Fe(III) SOURCES

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$LiFeSi_2O_6$ belongs to the pyroxene family crystalizing in monoclinic (clinopyroxene) structure at room temperature. Its attractiveness lies in interesting magnetic and electric (multiferroic) properties [1-2]. In the present work, two kinds of $LiFeSi_2O_6$ material were prepared via combined mechanochemical/thermal process using different iron precursors, namely hematite (α-Fe_2O_3) and goethite (FeO(OH)). Tóthová et al. have found that starting materials used for the synthesis influence magnetic properties of the product with the same chemical composition [3]. The phase quality and purity of mechanochemically/thermally synthesized $LiFeSi_2O_6$ products were examined by X-ray diffraction and FT-IR spectroscopy analyses. Magnetic properties of as-prepared products, measured by SQUID magnetometry, were compared. The obtained data have shown differences between both materials in temperature dependence of magnetic susceptibility and the effective magnetic moment. The temperature of antiferromagnetic transition for both synthesized products is in agreement with that determined for clinopyroxene-type $LiFeSi_2O_6$ by Redhammer et al [4].

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P2-14

DOMAIN WALL DYNAMICS OF WIRES IN PERPENDICULAR MAGNETIC FIELD

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The velocity of the domain wall is a key factor that determines the operational functionality of modern spintronic devices. It has been presented in previous papers that domain wall dynamics can be tuned by various parameters such as electric current, the shape of the wire, or temperature. One of them is a perpendicular magnetic field, as well.

Amorphous glass-coated microwires is a suitable material for domain wall dynamics studies. Microwires have been studied in previous papers, where the influence of the perpendicular magnetic field on the domain wall velocity was examined and unexpected results turned out. In particular, it has been presented that the domain wall velocity increased in a perpendicular magnetic field applied in one direction and decreased in another one [1].

In this work, we measured the velocity of the domain wall as a function of the axial magnetic field in the presence of the perpendicular magnetic field. Furthermore, we rotated microwire around its axis after 45 degrees. Rotation after 45-degree angles showed a periodic change in mobility, which is the consequence of the perpendicular magnetic anisotropy in the cross-section of the wire. Our results are confirmed by micromagnetic simulations.

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P2-15

RAPID CRYSTALLIZATION OF METALLIC GLASSES STUDIED BY IN-SITU XRD FLASH-ANNEALING

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Metallic glasses (MGs) are known to exhibit excellent mechanical and magnetic properties. A very effective way to further improve their properties is to incorporate nanocrystals into the glass. Usually it is done by conventional annealing just below primary crystallization temperature. Direct current fast Joule heating (flash-annealing) represents an alternative way to introduce fine and randomly dispersed nanocrystals within MGs. Achieving high heating/cooling rates (well above 1000 °C/s) by flash-annealing opens up new possibilities for study of fast kinetics. Phase composition and microstructure of a material can be tailored by proper heat-treatment in order to improve its overall performance. In this contribution we will introduce a novel setup for studying rapid crystallization of metallic glasses using an in-situ X-ray diffraction flash-annealing. Capabilities of the in-situ XRD flash-annealing with high temporal resolution will be demonstrated by studying crystallization behavior of selected metallic glasses.

P2-16
THE PREPARATION OF Co-BASED HEUSLER ALLOYS BY TAYLOR-ULITOVSKY TECHNIQUE IN THE FORM OF GLASS-COATED MICROWIRES

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Heusler alloys, as a perspective material for applications with many interesting properties like high spin polarization, magnetocaloric effect, shape memory effect, superconductivity, etc. Heusler alloys, depending on the structure, are divided into two large groups such as full-Heusler alloys with composition X_2YZ and half- Heusler alloys with composition XYZ [1-2]. Heusler alloys can be prepared in different form such as bulk, rod, ribbon or glass-coated microwires.

Heusler alloys in the form of glass-coated microwires consist of inner metallic nucleus covered with different type of glass (PYREX, SIMAX, etc.). Glass-coated microwires are prepared by Taylor-Ulitovsky method. Firstly, the master alloy is melted inside the glass tube with high frequency AC inductor. Afterwards the heat transfer causes that the surrounding glass is softened. When the working temperature of the glass tube is reached, the microwire can be withdrawn and wound around a bobbin cap. The prepared microwires can exhibit diameters of the metallic core in the range of 1-100μm and glass coating between 1-50μm [3].

In the given contribution, we have studied chemical, structural and magnetic properties of Co-based microwires. Single-crystal x-ray diffraction analysis was used to estimate the structural properties. Chemical composition was determined by SEM/EDX analysis and magnetic properties (hysteresis loops, temperature dependence of magnetization) were determined using MPMS.

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P2-17

AXIAL DOMAIN WALL DIMENSION IN BISTABLE GLASS-COATED MICROWIRE

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Bistable glass-coated microwires provide a unique opportunity to study the dynamics of a single domain wall between axial domains. However, this so-called head-to-head wall is not a standard 180° domain wall since the normal to the wall component of magnetization is not equal to zero. For this reason, this kind of a wall is the source of a stray field. This stray field influences the shape of voltage peaks induced in the pick-up coils in the Sixtus–Tonks experiment. If the shape of some these peaks is to be used to obtain information about the axial dimension of the wall, the parameters (length and radius) of a pick-up coil has to be taken into account.

In the experiment presented in this contribution, two pairs of pick-up coils are used. The coils differ only in their radius, which means that differences between induced peaks in the coils are caused only by the stray field.

Comparison of theoretical and experimental voltage peaks was used to determine the axial dimension of the propagating domain wall.

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P2-18

REAL STRUCTURE INVESTIGATION IN SOFT METALLIC GLASSY TAPES USING GLOW DISCHARGE OPTICAL EMISSION SPECTROSCOPY

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Since the development of metallic glassy ribbons, it is well known, that local cooling rate is gradually changes across the ribbon thickness, resulting continuously changing free volume entrap across the ribbon cross section. This inhomogeneous free volume is gradually disappear during the structural relaxation. It is also suspected, that not solely the entrapped free volume, but also the distribution of components can exhibit small concentration gradient in the as quenched glassy tapes.

This existence of concentration gradient is verified using Glow Discharge Optical Emission Spectroscopy. This method is able to evaporate gradually very thin layers from the vicinity of surface of the sample analyzing gradually the concentration of the evaporating layers.

According to the analyses, both the metallic and the non-metallic (metalloid) components exhibit characteristic gradient change versus the depth of evaporated zone.

From this preliminary experiment, it is suspected, that not only the local component concentration, but also the local bonding strength of components do change across the cross-sectional area, which have also contribution magnetic properties, like H_C or anisotropy of the as quenched ribbons and the core loss.

The correlation between the decomposed surface thickness and the simultaneous magnetic property change in the remainder part of sample are measured in several glassy tapes.

P2-19

THE EFFECT OF FEMTOSECOND LASER IMPULSES FOR METALLIC GLASS MAGNETIC PROPERTIES DURING LASER CUTTING PROCESSES

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Advanced and new magnetisable materials such as FINEMET metal glass ribbon have very good magnetic properties. However, it is not enough to produce these materials, because the manufacturing processes like cutting and surface treating can damage the magnetic properties of the material.

The cutting process can be carried out with waterjet, punching tools or even a plate cutter, but in case of mechanical cutting, due to the plastic deformation, the amorphous structure changes, so a solution that has the minimum impact on the metal glass structure should be used. High-energy laser beam technology can provide a solution to this. Conventional CO_2 lasers and other continuous-wave laser technologies are inadequate because they cause too much heat into the structure of the material. This problem can be solved by cutting using femtosecond laser pulses, so the microstructure and the surface of the cutting side do not change. This preserves the raw material magnetic properties as positive for the usage.

These cutted metal glass ribbon can be later installed into a stationary or rotaring part of an electric motor. In this research program, the project deals with the experimentation of the parameters of the laser cutting programs and the magnetic properties changing. The effect of the cutting parameters were investigated using microscopy analysis.

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P2-20

DIRECT (XRD) AND INDIRECT STRUCTURAL ANALYSIS OF HEAT AFFECTED ZONE AFTER LASER CUTTING AT FINEMET AND METGLAS ALLOYS

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Nowadays the electric drive of cars and other vehicles gain higher and higher popularity and prestige among the manufacturers and customers as well. The standing part (stator) and rotating part (rotor) in electric motors are conventional, predominantly FeSi alloys, which are currently being made by punching.

For the increased efficiency it is obvious to introduce of modern soft magnetic material like Metglas or Finemet for the manufacture of electromotor components. The structure of the base material is amorphous, resulting in great hardness and tendency to embrittlement.

The punching press tool would be highly frayed by the glass (and the cut-off product could crack), therefore it is necessary to examine the introduction of other cutting technologies. The choice fell for laser beam cutting. The disadvantage of it the heat affected zone (HAZ), which can cause a significant structural change, as partial crystallization in nano and micro scale, in amorphous materials. This can affect the magnetic and mechanical properties of the manufactured disk segment in an unfavorable direction.

It is known from the literature that the mentioned properties are highly affected by the phase content and ratio as well. Of course it is depends on the absorbed heat during laser cutting of amorphous materials. The issues of this examination were to identify the phases appeared in the HAZ and determination of the range of it.

In this paper hardness measurement and X-ray diffraction were compared after laser cutting on specified soft magnetic specimens according to a measurement schedule. X-ray diffraction was made to detect the amount of crystalline phases formed in the material structure. Microhardness measurement was carried out to determine the range of the HAZ.

The results were accumulated and processed so that it could be concluded with other direct structural analysis.

P2-21

DIRECT (SEM) AND INDIRECT STRUCTURAL ANALYSIS OF HEAT AFFECTED ZONE AFTER LASER CUTTING AT FINEMET AND METGLAS ALLOYS

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For the increased efficiency it is obvious to introduce of modern soft magnetic material like Metglas or Finemet for the manufacture of electromotor components. The structure of the base material is amorphous, resulting in great hardness and tendency to embrittlement.

The punching press tool would be highly frayed by the glass (and the cut-off product could crack), therefore it is necessary to examine the introduction of other cutting technologies. The choice fell for laser beam cutting. The disadvantage of it is the heat affected zone (HAZ), which can cause a significant structural change in amorphous materials. This can affect the magnetic and mechanical properties of the manufactured disk segment in an unfavorable direction.

It is known from the literature that the mentioned properties are highly affected by the phase content and ratio as well. Of course it is depends on the absorbed heat during laser cutting of amorphous materials. According to the X-ray diffraction, crystalline phases were identified in the HAZ, and the range of it was determined indirectly by microhardness measurement in a previous investigation. The issues of this examination were to perform the direct structural analysis of HAZ by Scanning Electron Microscope (SEM), and comparison with the indirect microhardness results.

In this paper hardness measurement and SEM were compared after laser cutting on specified soft magnetic specimens according to a measurement schedule.

The results were accumulated and processed so that it could be concluded with other direct structural analysis.

P2-22

WETTABILITY CHANGING OF FINEMET SUBSTRATES USING HIGH-ENERGY FEMTOSECOND LASER IMPULSES

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FINEMET materials are widely used for excellent magnetic properties. Many improvements are being made to replace the stationary and rotaring part of an electric motor with FINEMET metallic glass ribbon, where the efficiency of the motor can be increased by utilizing the magnetic properties. In order for the femtosecond laser beam cut-off metallic ribbon to be specifically applied in the electric motors, isolation of the coils from each other is extremely important. There are many solutions for these isolations in the scientific world, but the best solution for this is the isolation with direct coating of the surfaces. In order for the coating process to be carried out and to be successful from a qualitative point of view, it is necessary to have good surface and wetting properties of the tapes, in favor of good adhesion conditions between the coating and the ribbon.

The surface treatment of metals can change their surface properties and their adhesion conditions. We have proved from previous experiments that in the case of femtosecond laser beam or atmospheric pressure plasma, the interface properties suffer significant changes, resulting in an improving wetting contact angle that shows a major role in the development of bonding technologies.

The interaction of these femtosecond laser impulse treatments on the material may change the surface magnetic properties. The problem may be that the surface treatment can damage the magnetic properties of the magnetic tape. In our research, development of a technology was performed to improve these surface properties while the magnetic properties of the material do not change. The effect of the femtosecond laser scanning was investigated using contact angle measurement and the surface free energy was calculated from the wetting results.

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P2-23

MAGNETOELASTIC ANISOTROPY IN GLASS-COATED MICROWIRES STUDIED USING SAMR METHOD

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The small-angle magnetization rotation (SAMR) method is usually applied to measure the saturation magnetostriction in amorphous ferromagnetic ribbons. Changes in the field of magnetoelasic anisotropy caused by the applied tensile stress enable the saturation magnetostriction to be determined. The conditions in this experiment are very similar to the situation in glass-coated microwire prepared by rapid quenching from the melt. The preparation process causes strong axial stress to develop in the metallic core of these microwires. This stress results in bi-stable behaviour of microwires with positive magnetostriction. In our contribution we present an experiment in which the field of magnetoelatic anisotropy was measured using the SAMR method. The specific condition of this experiment when it is carried out on a single piece of microwire is discussed. The results of measurement of the magnetoelastic anisotropy field are presented, and of the corresponding axial mechanical stress in the metallic core of the microwire. The results of measurement of this field’s temperature dependence are also presented. The difference in thermal expansion coefficients between the glass coating and the metallic core causes the magnetoelastic anisotropy field to increase with decreasing temperature. This behaviour was confirmed by the experiment based on the SAMR method.

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P2-24

GLASS-COATED MICROWIRES FOR ENGINEERING APPLICATION

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Thin glass-coated microwires are suitable materials for many technological applications due to their outstanding properties, such as magnetic bistability, magneto-optical, and tunable microwave absorption properties, chemical sensing, superelasticity, and high frequency behaviour. The greatattention recently paid in glass-covered microwires derivesfrom their reduced dimensionality, composite nature, and proposed use as novel functional materials [1].

The accuracy results of mechanical properties can be enhanced by using nanocrystalline compositions of Glass-coated microwires that combines low anisotropy of amorphous alloys with high structural stability of crystalline materials [2]. Bistable Fe-Si-B-P glass-coated magnetic microwires belong to technical materials suiable for application like bending sensors [3].

The aim of this work is to develop the method for fixation of the glass-coated magnetic microwires and to find the right way for its fixing using different adhesive media. In this paper it were characterized different materials with microwires fixing on its surface by measuring of switching time. The method is very sensible for characterization of material with fixed microwire on external mechanical treatment and increase the sensitivity of such analysis in range of hundert percent.

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P2-25

THE FREQUENCY DEPENDENCE OF SWITCHING FIELD OF MAGNETIC MICROWIRE

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Conditions imposed on today's magnetic sensors for various technological applications are closely related to its size and power. Between functional materials belong also glass coated magnetic microwires for their excellent properties resulting from their magnetic bistability.

One of important property of microwire's sensors is their frequency behavior which is the base in search of its working point. For real using of magnetic sensor is it essential to characterize the frequency dependence of switching field as a variable of different conditions.

In this paper we have studied the effect of the shape of bistable glass - coated Fe-Si-B-P magnetic microwires on the sensitivity and stability and frequency dependence of the switching field. We have found that the length of microwire and the thickness of magnetic core leads to the change frequency dependence of the switching field. Moreover, the switching field fluctuation decreases after temperature treatment as a result of domain structure stabilization through the structural relaxation.

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P2-26

ENGINEERING OF MAGNETIC PROPERTIES OF Co- RICH MICROWIRES BY POST-PROCESSING

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Magnetic wires exhibiting excellent magnetic softness combined with good mechanical properties are extremely demanded by developing industries [1,2]. The purpose of this paper is to present our last results on tailoring of magnetic properties and GMI effect of Co-rich glass-coated microwires by annealing.

We studied giant magnetoimpedance (GMI) effect and domain wall (DW) dynamics of Co- rich $Fe_{3.7}Co_{69.3}Ni_{1}B_{12.3}Si_{11}Mo_{1.5}C_{1.2}$ glass-coated microwires (metallic nucleus diameter, d ≈22.8μm; total diameter D=23.2μm) prepared by Tailor-Ulitovsky technique as described in detail elsewhere [2].

Considerable coercivity increase related to transformation of hysteresis loops from linear to rectangular in studied microwires is observed upon conventional annealing. Despite that the stress-annealed microwires also present rectangular hysteresis loops, the H_c –values of the stress-annealed microwires are considerably lower than that annealed without stress. We also observed an increase of GMI effect in annealed and stress-annealed microwires as compared to as-prepared microwires.

In all the annealed and stress-annealed samples presenting rectangular hysteresis loops we observed the remagnetization by single DW propagation. The DW velocity, v, and DW mobility, S, depend on annealing conditions. At certain annealing conditions we observed v up t0 4 km/s and S up to 29 ($m^2/s \cdot A$).

Observed change of hysteresis loop discussed considering the modification of the magnetostriction coefficient after annealing and modification of the domain structure (increase of the volume of the inner axially magnetized core radius) related to the stress relaxation and stress-induced magnetic anisotropy.

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P2-27

PREPARATION AND CHARACTERIZATION OF Fe BASED SOFT MAGNETIC COMPOSITES COATED BY SiO_2 LAYER PREPARED BY STÖBER METHOD

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Recently, soft magnetic composites (SMCs) are attractive for researchers, especially for their exceptional magnetic properties, including stable permeability at higher frequencies, low energy losses, magnetic anisotropy and relatively high magnetic saturation. They are suitable for various ac and dc applications as cores for transformers and electric motors, but they will find use also in sensors, low frequency filters or magnetic shielding. SMC's are manufactured using conventional powder metallurgy, by compression of a ferromagnetic powder coated with a thin, non-conducting insulating layer on the surface. Recently, researchers have been more focused on inorganic coatings (such as MgO, SiO_2 or Al_2O_3). The reason is that they are thermally much more stable than organic coatings [1-3].

Atomised iron powders of two different particle sizes (particle size below 63 μm and 75-100 μm) were coated with an SiO_2 insulating layer by a chemical procedure, also called Stöber's method and have been used as the basis material for the formation of a compact Fe/SiO_2 soft magnetic composite (SMCs) by warm compaction techniques. Compared with particle sizes 75-100 μm, a more coherent coating was formed on the particles sized below 63 μm. This fact is confirmed by SEM images as well as by higher measured electrical resistance on iron-based SMCs with a lower Fe particle size.

The used SiO_2 coating appears to be appropriate for production of SMCs, suitable for annealing at high temperatures without negative impact on their soft magnetic properties. Annealed Fe/SiO_2 SMCs show an increased relative initial permeability (from 100 to 120) and a decreased value of coercivity (from 480 A/m to 310 A/m).

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P2-28

CHARACTERIZATION OF STRUCTURE AND MAGNETIC PROPERTIES OF WARM COMPACTED Ni-Fe-Mo SOFT MAGNETIC ALLOY

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NiFe (permalloy) and NiFeMo (supermalloy) alloys are known for their high permeability and low coercivity and are widely used as magnetic cores and magnetic shielding in electrical components, such as transformers or electric motors. The samples were prepared by conventional powder metallurgy, which gives us the opportunity to produce materials of different but precise shapes, with minimal waste [1, 2].

The main goal was investigation of the microstructure and basic soft magnetic properties of compacted $Ni_{80}Fe_{15}Mo_5$ material. Firstly we prepared the filings from the sheet by a rotary drill grinder mounted in a lathe, followed by milling in a planetary ball mill. The last step before compaction was mechanical treatment of powder leading to near to spherical shape of powder elements. The NiFeMo powder was then warm compacted under vacuum at a pressure of 700 MPa at the temperature of 410 °C, for 5 min to get ring shaped compact. The relative initial permeability, coercivity and specific electrical resistance measurements were conducted on both un-annealed and annealed samples. The results show positive influence of mechanical treatment of powder elements and annealing of the compacts on their soft magnetic properties.

Used technological way leading to creation of ring shaped sample is suitable for preparation of soft magnetic material with reasonable magnetic properties where the initial relative permeability has increased from 120 to 200 due to mechanical treatment and to 3300 after annealing. This sample exhibits the lowest coercivity of 4.8 A/m.

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P2-29

STUDY OF REVERSIBLE AND IRREVERSIBLE MAGNETIZATION PROCESSES PROPORTIONS OF Fe-MgO SOFT MAGNETIC COMPOSITES

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Soft magnetic composites (SMCs) represent a group of materials for low and medium frequency applications such as parts of electromotors, sensors and transformer cores etc. SMCs consist of small ferromagnetic particles, which are separated from each other by thin insulator layer. This kind of materials can be effectively prepared by methods of powder metallurgy.

Traditionally, there are two different kinds of insulators used in SMCs. Organic (various resins) and inorganic materials (metal oxides). The advantages of organic insulators in SMCs are the easy creation process for compaction and the sufficient mechanical properties of final product. On the other hand, the presence of the resin limits annealing process after the compaction of SMCs, usually below 200°C. SMCs with inorganic insulators tolerate high temperature heat treatment, causing improvement of magnetic properties of metallic particles.

Fe based soft magnetic composite samples with 2 wt. %, 3 wt. % and 5 wt. % of MgO insulator particles were prepared. ASC iron powder particles (average diameter ~ 100 μm) and MgO particles (average diameter ~ 1 μm) were mixed together in acoustic resonance mixer Resodyn and cold compacted by uniaxial pressure at 600 MPa to obtain ring-shaped samples. The samples were microwave heat treated at 600°C for 15 min. in air atmosphere. In order to detect the magnetic properties of resulting composites we measured the magnetic field dependence of the reversible and the differential permeability by modified DC hysteresisgraph. Then, we determined the irreversible permeability and calculated the proportions between reversible and irreversible magnetization processes.

The study revealed that the lower content of MgO in samples caused the increase of irreversible magnetization processes proportions, as a result of the lower inner demagnetizing fields. Improvement of magnetic interaction between ferromagnetic particles, leading to higher numbers of active domain walls displacing on shorter distances, hence facilitating the magnetization reversal.

P2-30

INFLUENCE OF MECHANICAL STRESS ON MAGNETIZATION REVERSAL IN RAYLEIGH REGION IN AMORPHOUS FINEMET

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Magnetic properties of most ferromagnetic materials change under the influence of mechanical stresses so markedly that besides magnetic field strength and temperature mechanical stress can be considered one of the basic factors influencing magnetic properties of ferromagnetics. For this reason our study concerns the influence of mechanical stress (in the range $\sigma = 0 - 80$ MPa) on the magnetic reversal by reversible domain wall motion in a low magnetic field region (Rayleigh region). The study was carried out on rapidly quenched FINEMET ribbon in as-quenched amorphous state.

Since crystallographic anisotropy is not present in amorphous materials, magnetoelastic anisotropy plays a dominant role. It is considered a cause of distinct differences in the behavior of the studied material at different values of applied mechanical stress. The changes in total magnetic anisotropy cause differences in domain wall widths. The applied mechanical stress causes the increase in domain walls width up to 100 % which is reflected in the increase in their mobility.

P2-31

THE EFFECT OF SILICON SUBSTITUTION FOR BORON ON THE STRUCTURAL AND MAGNETIC PROPIERTIES OF MELT-SPUN $Fe_{79.3}Co_2Cu_{0.5}Mo_{0.2}Si_xB_{18-x}$ (x = 5-9) ALLOYS

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The effect of Si substitution for B on the structural and magnetic properties (magnetic saturation, magnetic remanence, coercivity, power losses) of melt-spun $Fe_{79.3}Co_2Cu_{0.5}Mo_{0.2}Si_xB_{18-x}$ (x = 5-9) alloys has been investigated. The effect of heat treatment was also investigated.

The optimal parameters were obtained for the composition $Fe_{79.3}Co_2Cu_{0.5}Mo_{0.2}Si_5B_{13}$ [at.%] after a heat treatment of 355°C in 20 mins: magnetic saturation B_{max} = 1.56 [T], magnetic remanence B_r = 0.459 [T], coercivity H_c = 12.1 [A/m], core losses P_s = 0.62 [W/kg] at 50 Hz and magnetic field equal to 1007 [A/m].

X-ray diffraction results showed that each of the selected compositions was partially surface crystallized duringmelt-spun process, while in compositions with increased silicon content, partial volume crystallization was also observed and, as expected, proved to be suboptimal compositions during the magnetic measurements.

Studies of the α-Fe(Si) phase grain size after heat treatment at different temperatures correlated with the coercivity values. It has been shown that for ribbons with x=5,6,7 with crystallites above 30 nm there is a significant increase in the coercivity above 100 A/m. The formation of the Fe_2B phase in the investigated alloys was observed in the case of suboptimal heat treatment (too high temperature) providing to deterioration of the soft magnetic properties.

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P2-32

SOFT MAGNETIC COMPOSITES PREPARED BY 3D LASER PRINTING

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In this study, some iron and insulator powders have been used for preparing soft magnetic metal-insulator type composites by 3D laser printing. These samples have been compared with those obtained by traditional pressing and sintering method. Considering the permeability spectra, an increase of the frequency limit has been found for the laser printed samples. Beside the AC and DC magnetic parameters, the results of XRD, SEM investigations will be also presented.

P2-33
MAGNETIC FIELD SENSORS WITH REDUCED TEMPERATURE DEPENDENCE

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A typical feature of using magnetic sensors is that measurement of the magnetic field is not usually the main task. Magnetic sensing allows indirect and contactless measure direction, orientation, presence, rotation, angle and electrical current characteristics based on the evaluation of changes that cause the object in magnetic field. Therefore, magnetic measurement is usable in a very wide application spectrum.

Disadvantages as linearity, measuring range and temperature dependence of magnetometers can be overcome by using amorphous glass-coated magnetic microwires with a bistable hysteresis loop. The width of hysteresis loop (switching field) varies with the measured magnitude (temperature, force, etc.). The bistable microwires are also sensitive to a static external magnetic field that shifts its hysteresis loop.

The advantage of magnetization process in bistable microwire (single Barkhausen jump) is that one can use a simple induction method to measure the switching field. When the external field exceeds the switching field, domain wall propagates along the wire (placed coaxially in the primary and pick-up coil) and emf maximum is induced in the pick-up coil. We can determine the values of the observed quantities from the time differences of maximas. Such a method can be successfully employed also in practical applications [1].

In the given contribution we have constructed a fluxgate like magnetometer based on microwires. We have study temperature dependence of measured magnetic field (shift of hysteresis loop), its linearity and fluctuation of measured data.

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P2-34

ANHYSTERETIC MAGNETIZATION FOR NiFeMo SOFT MAGNETIC COMPACTED POWDER

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The appropriate structure of NiFeMo having initial permeability much larger than that of pure iron arises after proper heat treatment. The form of a sheet is not suitable for some applications and therefore it is logical to attempt to prepare such material in another form, for example as a ring, which would be more convenient for construction of some type components for electronic devices. One of these methods is compaction of the powder prepared by mechanical milling or mechanical alloying.

We prepared the filings from the $Ni_{79}Fe_{16}Mo_5$ sheet by a rotary drill grinder mounted in a lathe, followed by milling in a planetary ball mill, Retsch PM 100 with hardened steel vials and balls for 6 hours with ball to powder ratio of 9:1. This powder was consequently compacted (in the shape of a ring) at a pressure of 700 MPa at the temperature of 410 °C stabilized for 5 min.

In this work various methods for the determination of anhysteretic magnetization are presented and compared. The anhysteretic curve was measured on modified DC hysteresisgraph [1]. Decreasing AC field was applied at every measurement point along the hysteresis loop by the third toroidal winding to obtain experimental points of anhysteretic curve. Demagnetization factor was determined by the linear part of anhysteretic curve to quantify influence of non-magnetic part of compacted ring-shaped sample to inner demagnetizing fields inside the volume of the sample. The anhysteretic magnetization curve was used in the characterization of material.

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P2-35

STRUCTURAL AND MAGNETIC CHARACTERISTICS OF $Fe_{73.5}Cu_1Nb_3Si_{13.5}B_9$ GLASS-COATED NANOWIRES

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Results on the magnetic and structural investigation of $Fe_{73.5}Cu_1Nb_3Si_{13.5}B_9$ glass-coated nanowires with diameters from 100 to 500 nm are reported. These ultrathin wires have been prepared from amorphous precursors by conventional furnace annealing at temperatures from 250°C to 650°C for 60 min. Amorphous precursors have been obtained by glass-coated melt spinning.

Ultra-high resolution transmission electron microscopy (UHR-TEM) has been employed to monitor the microstructure evolution with annealing by using a LIBRA 200MC UHR-TEM microscope. Magnetic characterization has been performed using inductive hysteresis loop measurements and domain wall velocity measurements through an improved Sixtus-Tonks method.

The main result is that nanocrystalline phase formation, i.e. exchange coupled α-FeSi nanograins within a residual amorphous matrix, requires a more elevated temperature in case of ultrathin samples as compared to larger materials with similar composition, such as microwires and ribbons. This temperature is 600°C for the nanowires, while for microwires it is usually 550°C and for ribbons it can be as low as 530°C.

In the case of nanowires, internal stresses are large due to the small radial dimensions involved in the rapid solidification process. Hence, their exchange length is smaller. For the sample annealed at 550°C, the coupling between the α-FeSi grains is not achieved, as the average intergrain distance is larger than the exchange length. Annealing at 600°C results in the coupling of the grains (they increase and get closer) and implicitly in the nanocrystalline phase formation. Structural investigation results are confirmed by magnetic measurements, which show that lowest coercivity is reached after annealing at 600°C.

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P2-36

CURRENT DRIVEN MAGNETIC SWITCHING AND DOMAIN WALL VELOCITY IN TWISTED GLASS-COATED MICROWIRES FOR SENSOR APPLICATIONS

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In nanowires the magnetization switching and domain wall motion can be driven by either applied external magnetic field or spin-polarized electric current. The possibility to switch the magnetization in micro sized glass coated wires by applying a current trough the magnetic sample was only recently highlighted [1]. In this paper we report results on torsion effect on current driven large Barkhausen effect (LBE) and domain wall velocity (DWV) in glass coated microwires. For the glass coated microwire with 20 μm in diameter and 11 μm glass coating, the current at which the LBE occurs decrease from 120 mA to 43 mA, and from 17 mA to 9 mA for $Fe_{77.5}Si_{17.5}B_{15}$ and, respectively, $Co_{68.18}Fe_{4.32}Si_{12.5}B_{15}$ wires, when torsion angle, φ, is increasing from 42 rad/m to 168 rad/m. When a current is applied trough the wire the outer region of the metallic core tends to become circumferential magnetized, reducing the diameter of the LBE involved domain.

For the $Fe_{77.5}Si_{17.5}B_{15}$ sample the diameter of the LBE involved domain reduces from around 19.9 μm to 17.1 μm, for an applied current, of 44 mA and respectively 240 mA at φ of 168 rad/m. For $Co_{68.18}Fe_{4.32}Si_{12.5}B_{15}$ sample the diameter of the wire involved in LBE changes between 19.6 μm and 15.8 μm when the applied current is increasing from 9 mA to 240 mA at φ of 168 rad/m. The DWV was found to decrease for Fe-based wires and to increase for Co-Fe-based samples with the increasing of the excitation current. For an applied current having 150 mA in amplitude, the DWV decreased from 494 m/s to 396 m/s when the torsion angle was increased from 42 rad/m to 168 rad/m for $Fe_{77.5}Si_{17.5}B_{15}$ sample, whereas for $Co_{68.18}Fe_{4.32}Si_{12.5}B_{15}$ wire, in the same torsion interval, the DWV was found to increase from 1110 m/s to 1940 m/s. This can be explained by considering the supplementary stresses induced by torsion. The observed behavior of the current induced magnetization switching is suitable for development of new magnetic logic systems or new types of magnetic sensors.

Acknowledgement: Work supported by the Nucleu Programme (Project PN 19 28 01 01) and Contract No. 11PFE/16.10.2018 financed by the Romanian Ministry of Research and Innovation (MCI).

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P2-37

EFFECTS OF IRON DEFICIENCY ON MAGNETIC PROPERTIES OF NiZn FERRITES

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NiZn ferrites are among the most widely used soft magnetic materials for high frequency applications due to their high electrical resistivity and low losses. The electrical and magnetic properties of ferrites are strongly dependent on the purity of ferrite powder, the microstructure and grain boundary chemistry. The amount of Fe deficiency affects the electromagnetic properties of NiZn ferrites. Fe deficiency results in the variation in chemical composition and microstructure of NiZn ferrites. The study of iron content in composition is one of the most important factors to determine the electrical and magnetic properties of ferrite. The influence of the non-stoichiometry of the NiZn ferrite magnetic properties has been investigated for initial compositions given by the chemical formula of $(Ni_{0.33}Zn_{0.67})_{1+x}Fe_{2-x}O_4$. There were values of x from 0.0 up to 0.20. The thermo-magnetic analysis was mainly used to select a convenient substitution, Fe ions deficiency and appropriate Fe^{3+}/Me^{2+} ions ratio in substituted ferrite and to estimate the annealing temperature of prepared ferrite sample (T_a). The decrease in initial permeability and the increase in Curie temperature, and resonant frequency with increasing Fe deficiency, are due to the increase in the ratio of Ni to Zn derived from the separation of zinc from spinel lattice. The phase compositions observed by thermo-magnetic curves were compared with Mössbauer spectroscopy analysis and X-ray diffraction results. The size and shape of the ferrite powder particles has been examined by scanning electron microscope.In the present work, attention was focused on NiZn ferrites, which were prepared by a wet method from an organo-metallic precursor with glycine, using the low-temperature autocombustion. In addition, these NiZn ferrite powders can also be used as magnetic fillers in ferrite polymers composite materials for microwave applications.

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P2-38

EFFECTS OF MAGNETIC ANNEALING ON THE GMI EFFECT IN Co-RICH NANOCRYSTALLINE HITPERM ALLOYS

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The giant magnetoimpedance (GMI) effect was studied in $(Fe_{1-x}Co_x)_{81}Nb_7B_{12}$ (x=0.75, 0.86 and 1) nanocrystalline alloys in frequency range 1-1000 MHz by two different methods. An auto-balancing bridge method was used to acquire impedance in the lower frequency region (1-100MHz). High frequency GMI characteristics were investigated by network analyzer (100-1000MHz). The amorphous ribbons were nanocrystallized at 773 K for 1 hour in longitudinal (LF) or transversal (TF) magnetic field in order to induce a controllable magnetic anisotropy in parallel or transverse direction to the ribbon length. Reference samples were annealed in zero (ZF) magnetic field. The GMI response of LF annealed samples exhibits a single-peak behavior in whole frequency range investigated. On the other hand, ZF and TF annealed samples are characterized by a double-peak behavior. Our results show that the samples with higher amount of Co exhibit a stronger GMI response. The highest values of $\Delta Z/Z$ ratio ≈307% and sensitivity $\eta \approx 0.288\%/Am^{-1}$ were observed at frequency 90MHz for $Co_{81}Nb_7B_{12}$ sample annealed in transverse magnetic field. The high frequency data taken in the range 100-1000MHz revealed that the $\Delta Z/Z$ ratio gradually decreases towards 1 GHz. A marked response to magnetic field annealing in these alloys can be utilized for tuning their GMI characteristics for sensor applications.

Acknowledgement
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3 MAGNETIC MATERIALS FOR ENERGY APPLICATIONS (PERMANENT MAGNETS, MAGNETOCALORIC MATERIALS, MOTORS, TRANSFORMERS, ...)

O3-01

SHAPED CRYSTAL GROWTH OF Fe-Ga AND Fe-Al ALLOY PLATES BY THE MICRO PULLING DOWN METHOD

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Conversion technique of mechanical vibration energy into electrical energy using magnetostrective materials have been brought to attention in energy harvesting applications. Among the magnetostrective materials Fe-Ga and Fe-Al alloys areattractive materials due to figure of merits such price, mechanical strength, high magnetostrectiv constant. Up to now, bulk crystals of these alloys are produced by the Bridgman–Stockbarger method or the Czochralski method. Using these methods big bulk crystal up to 2~3 inch diameter can be grown. However, uniformity of chemical composition along to the crystal growth direction cannot be avoid, which results in uniformity of magnetostriction constant and reduction of the production yield. The micro pulling down (μ-PD) method has been developed as a shaped crystal growth technique. Our group have reported shaped crystal growth of oxide, fluoride single crystals with different shape such rod, plate tube, thin fiber, etc. Advantages of this method is low segregation due to high growth rate and small diffusion of melt at the solid-liquid interface, and small kerf loss due to near net shape crystal[1].

In this presentation we report the shaped long plate crystal growth of Fe-Al alloys using the μ-PD method. Alloy crystals were grown by μ-PD method using calcium oxide crucible and induction heating system under nitrogen atmosphere. A <100> oriented iron-based alloy was used as a seed crystal. 5 x 1 x 320mm3 alloy crystal plates were successfully grown. The results of crystal growth, chemical composition analysis, magnetostrictive properties and a prototype vibration energy harvester are reported.

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O3-02

OPTIMIZATION OF THE MAGNETIC PROPERTIES OF HARD MAGNETIC Hf-Co-B ALLOYS BY STRUCTURAL MODIFICATIONS

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The Curie temperature and magnetic anisotropy of the Hf-Co-based alloys are not sufficiently maximized to consider this kind of hard magnetic materials as candidates for applications. Grain refinement can be achieved by partial substitution of transitions metals elements or by thermomechanical treatment and is believed to play a crucial role in further improvement of magnetic properties, especially anisotropy.

X-ray diffraction patterns of annealed melt-spun $Hf_2Co_{11}B$ ribbons exhibit the coexistence of two Hf_2Co_{11} phases of different magnetic anisotropy in multiphase alloy [1]. The presence of the hard magnetic phase was confirmed by transmission electron microscopy. The high pressure torsion combined with heat treatment caused the evolution of crystalline structure, which in turn strongly affect magnetic properties. Coercivity of the amorphous material after annealing was equal to 0.7 kOe and decreased to 0.2 kOe after deformation. The deformed sample was subjected to the subsequent reannealing which significantly improved the coercive field up to 1.3 kOe. This shows that combined severe plastic deformation and heat treatment allow tuning of the structure and consequently the magnetic properties.

Acknowledgement
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O3-03

INTRINSIC MAGNETIC PROPERTIES OF THE $L1_0$ MnAl AND FeNi

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The transition towards environmental friendly technologies resulted in an increased demand of high-performance permanent magnets (PM), which are extensively used in wind turbines as a renewable energy source, and electrical vehicles to reduce the CO_2 emission. There is also a continuous growth of using PM in power and consumer electronics.

Modern high-performance PM are based on intermetallic compounds containing rare-earth (RE) elements. However, there is a continuing risk of a shortage and price volatility of the RE. Therefore, there is an increased interest in development of novel magnetic materials without RE metals, but with comparable properties.

Novel magnetic materials must exhibit high coercivity (H_c>1.5T), and high remanent magnetization (M_r>1.35T) at ambient conditions, as well as to be operational within a temperature range from -50 to 200°C. These criteria could be fulfilled if the magnetic phase exhibit the following intrinsic properties: high spontaneous magnetization M_s, high uniaxial magnetic anisotropy constant K_1, and high Curie temperature T_C.

Tetragonal $L1_0$ phases of MnAl and FeNi are considered the most promising RE-free materials suitable for high-performance permanent magnets. We estimate the intrinsic magnetic properties of these phases by performing first-principle calculations and atomistic spin dynamics [1]. By means of electronic structure calculations we evaluated the spontaneous magnetization, magneto-crystalline anisotropy energy and exchange integrals. Obtained values were used as input to calculate some finite temperature properties like anisotropy constant, and the Curie temperature, as well as the domain wall width and exchange stiffness, which can be used in the micromagnetic simulations to design and optimize the microstructure.

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O3-04

COMPARISON THE EFFICIENCY OF LASER CUTTING AND ELECTRICAL DISCHARGE MACHINING DIRECTED TO SHAPING OF GLASSY TAPES PRODUCING ELECTRICAL ROTOR-ELEMENTS

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In order to use the glassy alloys as asynchronous motor rotary elements, the shaping of as quenched glassy tapes is inevitable. Among the possible shaping methods various laser-cutting methods as well as the EDM technology as promizing possibilities are reported. These methods are compared from the point of view of local mechanical degradation and deterioration of initial soft magnetic properties. In the experiments METGLAS raw material is applied, being already available in the form of 140 mm wide tapes. In addition to EDM technology, the CO_2 laser, fiber-laser and pulse-laser were applied during the cutting experiments. Subsequently the cutting, the thickness of the heat affected zone is measured using classical metallography. The resulting (global) magnetic effects are measured by astatic magnetometer (determination of magnetization curve, Hc).

From the point of view of heat affected zone minimization both of the fiber laser as well as the EDM technoogy are promizing. However the productivity of the laser cutting (fiber and pulse cutting) are superior.

O3-05

EFFECT OF REFINED SURFACE DOMAIN WALLS ON THE CORE LOSSES COMPONENTS IN GO SILICON STEEL AT DIFFERENT FREQUENCIES

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The grain oriented steels are iron - 3% silicon alloys developed with a strong {110}<001> crystallographic texture to provide very low core loss and high permeability in the rolling direction. Normally these steels are used as core materials in transformers with high efficiency. The improvement of core losses in high-permeability grain-oriented steels is very important for the industry, and the efforts are continued to reduce the losses by using the domain refining methods. For the industrial utilization of refinement process, the so-called "laser scribing" technique is usually applied due to its no-contact nature, high flexibility and little damage of the surface coating.

Focus of this present work is to investigate the influence of laser scribing technique as important factor that affect different loss-components. The laser treatment was applied on the GO steel surface in order to induce thermal stresses, which influence on the modification of the internal structure of magnetic domains. It was found that power of the laser beam in the range up to 30W allows to reduce the core loss without significant damage of surface coating. Reducing the laser scribing line spacing to a certain width can also achieve low core loss. The final domain structures were optimized in relation to the minimization of magnetic losses and to the optimization of thermal stresses application on the both surfaces of treated experimental samples. Clear improvements in final magnetic characteristics were observed for all the regimes using the power density of the laser beam. A semi quantitative relationship has been found between the domain patterns and the used fiber laser treating method. The magnetic losses of the experimental samples before and after laser processing were tested in the DC and AC magnetic field in the frequency range from 10 Hz up to 200 Hz. On the base of these measurements a loss separation procedure was performed.

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O3-06
DIRECT STUDIES OF THE MAGNETOCALORIC EFFECT IN CYCLIC MAGNETIC FIELDS IN $Ni_{50}Mn_{37-x}Al_xSn_{13}$ RIBBONS SAMPLES

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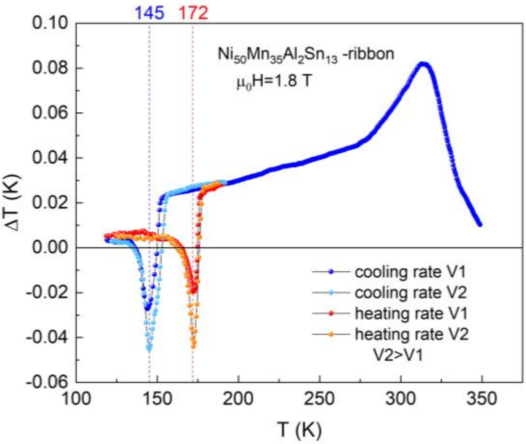
The results of direct studies of the MCE of $Ni_{50}Mn_{37-x}Al_xSn_{13}$ (x=2, 4, 6, 8) ribbons samples Heusler alloy in cyclic magnetic fields are presented. Figure shows the temperature dependences of the MCE for the $Ni_{50}Mn_{35}Al_2Sn_{13}$ sample in a cyclic magnetic field of 1.8 T in the heating and cooling protocols. The maximum value of the direct effect was 0.082 K at T=314 K. An inverse MCE was observed near the magnetostructural phase transition accompanied by a wide hysteresis (~ 28 K). As experiments showed, the value of the inverse MCE turned out to be dependent on the rate of temperature scanning of the sample. The figure shows the temperature dependences of the MCE at different scanning rates; we observed that higher rate of the temperature change of the sample led to larger value of the inverse MCE. The maximum inverse effect value in the field of 1.8 T was observed at a heating rate of V_2=7.2 K/min and was equal to ΔT=-0.045 K.



It is shown that in cyclic magnetic fields, the MCE value near the magnetostructural phase transition depends on the rate of temperature scanning. Higher rate of change in the sample temperature causes the MCE to have greater value. The observed effect is explained by irreversible phase transition, induced by a magnetic field, from a low-symmetry martensitic phase to a high-symmetry austenitic phase. Moreover, it is observed only within the temperature hysteresis loop of the magnetostructural phase transition.

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O3-07

MAGNETIC INDUCED MARTENSITIC TRANSITION IN HEUSLER ALLOYS IN HIGH MAGNETIC FIELD

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In present one of the topical areas in the solid state physics field is the search for new materials with magnetostructural phase transitions (MPT), which are induced by temperature and a magnetic field [1]. In the case of MPT, there is a connection between the crystal lattice and the magnetic spin subsystem, which leads to a simultaneous change in the structure and magnetic properties under the influence of external parameters. It also leads to the manifestation of such effects as giant magnetoresistance, magnetocaloric effect (MCE) and other [2].

MCE is the special interest [3]. MCE in magnetic compounds opens the possibility of creating solid-state magnetic refrigerators. In alloys with MPT the contributions from the structural and magnetic subsystems in the MCE are the main ones [1]. Therefore, a more detailed study of the structural and magnetic properties directly in the MPT process induced by a magnetic field will make it possible to understand the nature of the interaction of solid-state subsystems and their contributions to the MCE.

The authors created an original experimental device [4], which allows one to directly study the microstructure of magnetic alloys under the influence of high magnetic fields under adiabatic and isothermal conditions. Heusler alloys were selected as samples.

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O3-08

CRYSTAL STRUCTURE AND MAGNETOCALORIC EFFECT IN $La_xAg_{1-x}MnO_3$ NANOPARTICLES

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In the present study we report on our complex study of the effect of sample preparation on the crystal structure, magnetic properties, magneto resistance and magneto caloric effect in the system of stoichiometric and non - stoichiometric $La_xAg_{1-x}MnO_3$ nanoparticles prepared by glycine – nitrate method. The paper is continuation of our study which was already presented in [1] and is related to preparation of nanoparticles for hyperthermia.

The particle size and crystal structure were modified by conditions of synthesis and by heat treatment. Crystal structure changes from orthorhombic Pnma for as prepared to rhombohedral $R\bar{3}c$ after annealing inducing the abrupt enlargement of the Curie temperature T_C from about 90 K to 205 K. The additional tuning of T_C by the variation of heat treatment including time and temperature of annealing and by varying of Ag content leads to enhanced T_C = 317.5 K. The amount of parasitic Ag phase can be reduced by using of non- stoichiometric composition.

A large magnetic entropy change $|\Delta S|$, deduced from isothermal magnetization curves, has been observed in our samples with a peak centred near their respective T_C. The maximal values were obtained for $\mu_0\Delta H = 5$ T and is comparable with the value $-\Delta S = 5.80$ Jkg^{-1}K^{-1} which was already obtained on ceramic sample [2]. The application of hydrostatic pressure leads to small enlargement of $|\Delta S|$.

The insulator – metal transition takes place in the vicinity of the transition from the paramagnetic to ferromagnetic state. The colossal magnetorezistivity was observed in the magnetic field with induction up to 9 T.

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O3-09

MAGNETIC-FIELD DEPENDENCE OF MAGNETOCALORIC EFFECT IN Gd UNDER DIFFERENT THERMODYNAMIC CONDITIONS

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An experimental verification of the field dependence of the magnetocaloric effect (MCE) for Gd near the Curie point was performed. It turned out that the value of the degree in the ratio $\Delta T \sim H^k$ strongly depends on the external conditions of the experiment. In a stationary calorimeter in quasiadiabatic conditions [1] (when a sufficiently large outflow of heat from the sample is observed when the magnetic field is turned on), the value of k in certain experiments exactly coincides with the theoretical k = 0.65...0.66. At the same time, a generalization of the results of different experiments gives slightly larger values of k = 0.69..0.72.

Summarizing the experimental results in an extraction calorimeter [2] (insertion/removal of the calorimeter to/from the magnetic field avoids the heat outflow from the sample by reducing the duration of the experiment) showed that k = 0.73..0.85, which is significantly higher than the theoretical value of 2/3.

The results of measurements in a pulsed magnetic field [3] show that in single experiments the value k = 0.96..1.07, and when summarizing the results of different experiments, the value close to 1 is also obtained, k = 0.95, which is clearly not corresponds to a theoretical value of 2/3.

According to the results of experimentats, it can be concluded that the closer the experimental conditions are to adiabatic (short turn on/off time of the magnetic field, no heat transfer through the thermal sensor), the higher the k value, and in ideal adiabatic conditions for Gd near the Curie k = 1.

The field dependence of the MCE in quasi-isothermal conditions can be expressed as $\Delta Q \sim H^n$. The ΔQ values were obtained using an extraction calorimeter [2]. For different temperatures, the exponents will be the following n(273K) = 0.95, n(293 K) = 0.76, n(297 K) = 0.76. The data obtained confirm the conclusions made in [4] that for soft magnetic materials n = 1 is lower than the Curie temperature, and n ≈ 0.75 at $T = T_C$.

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O3-10

HIGH THERMOELECTRIC POTENTIAL OF NANOGRAINED $CuFeS_2$

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Chalcopyrite $CuFeS_2$, strong antiferromagnet with Neel temperature exceeding 800 K, is studied with respect to its thermoelectric potential and magnetic properties. As the thermoelectric efficiency of $CuFeS_2$ is essentially depressed due to its high lattice thermal conductivity, which amounts for optimally doped ceramic $CuFeS_2$ at 300 K to ~ 7 $Wm^{-1}K^{-1}$, it is highly desirable to lower the thermal conductivity. Due to the close interconnection between the thermal conductivity, magnetic order and grain size in magnetic ceramics we attempted to produce nanostructured chalcopyrite either via (i) mechanosynthesis or (ii) high energy milling activated nanopowders from natural mineral.

Indeed, nanostructured ceramics exhibit highly depressed thermal conductivity comparing to micrograin ceramics. We discuss the origin of low thermal conductivity with respect to size and magnetism and confirm the high technological potential of high-energy milling with respect to thermoelectric potential of $CuFeS_2$.

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P3-01
Withdrawn

P3-02

MAGNETOCALORIC AND THERMOPHYSICAL PROPERTIES OF $LaFe_{11.2-x}Co_{0.7}Mn_xSi_{1.1}$ COMPOUNDS

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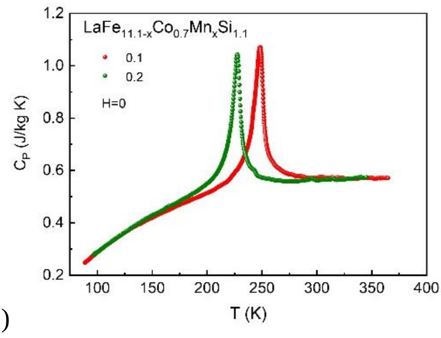
During the last time, increased attention has been devoted to the development of a new magnetic refrigeration technology, based on magnetocaloric effect (MCE), as a promising alternative to the conventional gas compression technique. From the view of practical applications, magnetic cooling needs to explore materials showing MCE behavior that can be operated near room temperature. Compounds based on the $La(Fe,Si)_{13}$ phase are among the most promising magnetocaloric materials.

In this paper presents the results of studies of heat capacity, thermal diffusivity and magnetocaloric effect in the $LaFe_{11.2-x}Co_{0.7}Mn_xSi_{1.1}$ system (x = 0.1; 0.2; 0.3) in the temperature range 80–320 K and in magnetic fields up to 8 T.

Figure 1 shows the results of the temperature dependences of the heat capacity for x=0.1 and x=0.2 at the H=0 in heating mode. As we see, the $C_P(T)$ dependences show pronounced anomalies associated with the FM-PM phase transition with maxima at 247 and 227 K, respectively, for x = 0.1 and 0.2. Direct measurements of the MCE for samples with x = 0.1, 0.2, and 0.3 at the H=1.8 T are shown in Fig.2. As can be seen from Fig.2, as the concentration of Mn increases, the temperature of the MCE maximum shifts toward lower temperatures. Also, there is a slight decrease in the MCE with increasing Mn concentration.



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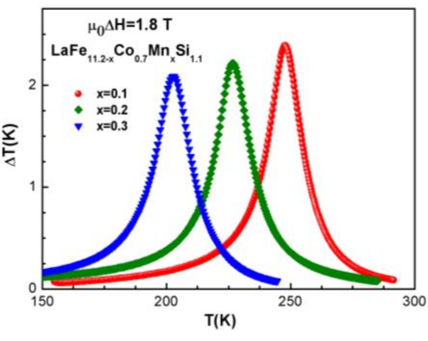

2)

Fig.1,2. 1) Dependences $C_P(T)$ vs T for x=0.1 and x=0.2 at the H=0. 2) MCE.

The research was supported by a grant of the Russian Science Foundation (Project No. 18-12-00415).

P3-03

FABRICATION AND MAGNETOCALORIC CHARACTERIZATION OF GLASS-COATED Ni_2FeGa MICROWIRES

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In this work we report the fabrication and magnetocaloric behaviour of glass – coated Ni_2FeGa microwires. The magnetic glass-coated microwires were produced using the Taylor-Ulitovsky technique from a bulk Ar arc melted pellet of nominal composition Ni_2FeGa using SIMAX® glass; highly pure Ni (99.95 %), Fe (99.9 %) and Ga (99.99 %) were used as raw materials.

The metallic core thickness in microwires was estimated to be ~ 46 μm. The microstructure, elemental chemical composition and magnetic properties of microwires were studied by scanning electron microscopy (SEM), energy dispersive spectroscopy (EDS), and magnetization measurements.

The magnetocaloric effect was evaluated in perpendicular and parallel directions to the wire´s axis. The magnetocaloric response is higher in parallel direction.

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P3-04

MAGNETIC CHARACTERIZATION OF $Ni_{50}Fe_{19}Ga_{27}Co_4$ GLASS COATED MICROWIRE

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Heusler alloys are materials with promising technological applications such as spintronics, magnetocaloric cooling, sensors etc. [1]. Taylor–Ulitovsky method gives the opportunity of fast preparation of very thin metallic Heusler-based microwires with properly selected chemical composition and additional protective glass coating.

In this work, magnetic properties of $Ni_{50}Fe_{19}Ga_{27}Co_4$ glass coated microwire are presented. The SEM/EDX analysis approved that the chemical composition of the microwire, $Ni_{47,7}Fe_{18,5}Ga_{29}Co_{4,8}$ is in good agreement with the desired one.

The smooth surface of the metallic nucleus may indicate the monocrystalline structure similarly as in the previous studies [2]. Additionally, the wire is characterized by appropriate Curie temperature for magnetic cooling ($T_C \approx 315$ K). The structural transformation from martensite to austenite around room temperature can be found in alloys with similar composition. In our case, such an alloy was prepared in the form of a microwire but the structural transformation was not observed. The lost of the structural transformation may be due to the internal stresses induced during the fabrication of the glass-coated microwire. On the other hand, the microwire shows the largest efficiency of magnetocaloric effect at low magnetic fields. Such behaviour makes the microwire suitable candidate for low field micromagnetic cooling.

This work has been financially supported by project VEGA 1/0053/19 and project APVV-16-0079.

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P3-05

INFLUENCE OF HIGH PRESSURE OXYGENATION ON THE STRUCTURE AND MAGNETIC PROPERTIES OF La-Ca-Sr-Mn-O PEROVSKITE CERAMIC MATERIAL

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In this work, the influence of high pressure oxygenation on the structure and magnetisation behaviour of polycrystalline $La_{0.67}Ca_{0.33-x}Sr_xMnO_3$ (x = 0.33; 0) (LCSM) perovskite ceramics samples prepared by conventional solid state synthesis in air has been studied.

The phase purity of prepared powders were determined by X-ray diffraction and the single phase composition of prepared samples after solid state synthesis was confirmed. The microstructure of LCSM samples was analysed using a scanning electronic microscope and revealed that grain size and porosity depends on the strontium content in the samples.

High pressure annealing at 95 bar of pure oxygen atmosphere leads to changes in oxygen stoichiometry which directly affects the Mn^{3+}/Mn^{4+} ion ratio as evidenced by XPS measurements.

All of the prepared samples exhibit a single magnetic transition from ferromagnetic to paramagnetic state but only a slight change of the Curie temperature after high pressures oxygenation was observed.

Acknowledgement
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P3-06

NANOFLUID BASED ON A NEW GENERATION TRANSFORMER OIL: SYNTHESIS AND FLOW PROPERTIES

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Nowadays we often encounter the term nanomaterials, a wide range of which appears on the market of various products. The main ingredients are nanoparticles of different origins, in particular, either dispersed in the liquid medium or a gel, which are indicated by the term nanofluids (NFs). Due to their unique properties they found use in a number of scientific disciplines. In the field of electrotechnics and power engineering, these composite materials represent a way of reducing the dielectric and thermal losses of various devices and are a perspective cooling and insulating medium. However, current technologies have reached their limits due to the inadequate intrinsic thermal conductivity of conventional cooling liquids. Using the new generation insulating oil manufactured by the gas to liquid technology (GTL) is one of the possible approaches to improve their properties. GTL transformer oils are based upon manufactured iso-paraffinic hydrocarbons extracted from natural gases. This technology produces transformer oils that are purer, chemically stable, and have significantly higher lightning impulse breakdown voltage. Their lower viscosity could provide better performance over normally used mineral oils on the paraffinic, naphthenic base. The specific heat capacity and thermal conductivity values of GTL transformer oils are higher, indicating enhanced thermal transport properties.

For these excellent properties of GTL oils, in this contribution we focused on the synthesis, basic characterization and flow properties of magnetic NFs based on GTL oil. Magnetite nanoparticles were synthesized by employing chemical co-precipitation technique. The magnetization of samples was determined by using the vibrating sample magnetometer and the M-H loop recorded at room temperature revealed their superparamagnetic behavior. Rheological characterization of small concentration NFs was performed by using a rotational rheometer in the temperature range from 20 up to 80 °C. Preliminary experimental results show that the crucial properties of GLT oil are positively reflected in the obtained experimental data of NFs based on GLT oil.

P3-07

THERMAL STABILITY AND MAGNETIC CHARACTERIZATION OF $Gd_{54}Co_{37}Ni_9$ METALLIC GLASS

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Metallic glasses (MG) belong to family of metallic materials with metastable glassy states exhibiting unique properties, making the attractive for practical applications. Among many amorphous metallic alloys prepared to this day, the $Gd_{54}Co_{37}Ni_9$ at.%. is drawing particular attention. They exhibit the large value of refrigerant capacity (RC) at a temperature of ~ 200 K and therefore they are attractive candidates for a magnetic refrigerant.

In the present work, the magneto-caloric effect (MCE) and the Curie temperature of a ternary $Gd_{55}Co_{35}Ni_{10}$ as-spun ribbons was investigated using SQUID (Superconducting Quantum Interference Device).

The structure of the $Gd_{54}Co_{37}Ni_9$ alloy was investigated using X-ray diffraction (XRD). Amorphous phase stability of metallic glass the $Gd_{55}Co_{35}Ni_{10}$ alloy was examined by Differential Scanning Calorimetry (DSC). Surface and chemical composition of the sample was documented by Scanning Electron Microscopy (SEM) combined with Energy Dispersive Spectroscopy (EDS) while microstructure by transmission electron microscopy (TEM).

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P3-08

MAGNETIC AND STRUCTURAL CHARACTERIZATION OF Gd-BASED METALLIC GLASSES

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Metallic glasses, in contrast to its crystalline counterparts, exhibit unique mechanical and structural properties, which make them attractive for practical applications. The amorphous alloys seem to be ideal candidates for magnetic refrigerants because they usually exhibit ultrahigh refrigeration capacity due to their broadened magnetic entropy change vs temperature curve.

In this paper, the magneto-caloric effect (MCE) and the Curie temperature of a binary $Gd_{50}Co_{50}$ and ternary $Gd_{50}Co_{48}Fe_2$ as-spun ribbons was investigated using SQUID (Superconducting Quantum Interference Device).

The structure of $Gd_{50}Co_{50}$ and $Gd_{50}Co_{48}Fe_2$ metallic glass was investigated using synchrotron X-ray diffraction and transmission electron microscopy (TEM). The surface and chemical analysis was documented using scanning electron microscopy (SEM). Thermal stability of the alloy in temperature range of 273 – 1023 K has been determined using differential scanning calorimetry (DSC).

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P3-09

LOW-TEMPERATURE HEAT CAPACITY MEASUREMENTS IN Gd -BASED NANOCOMPOSITES

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Lately there is a great deal of interest of using magnetic materials as essential parts in number of devises such as memory media, permanent magnets, electromotors, transducers as well as in environmental and industrial technologies. In particular, researches in magnetic refrigeration (MR) are topic in many investigations nowadays. For instance, it is based on magnetocaloric effect (MCE) which is related to magneto-thermodynamic phenomenon when a temperature change is caused by the changing of external magnetic field. Systems based on nanoparticles have attracted much attention for several decades already not only because of there known applications in medicine, technics and industry, but also due to its magnetocaloric properties. MR together with nanoscaled devices or materials constitute a promising choice to force the development of efficient cooling techniques, as they have much more advantages comparing to bulk materials. The measurement of the heat capacity as a function of temperature in constant magnetic fields and pressure $C_{p,H}(T)$ provides the most complete characterization of MCE in magnetic materials.

In our work we studied the MCE in Gd_2O_3@SiO_2 nanocomposites prepared by embedding Gd_2O_3 nanoparticles into periodic nanoporous silica matrix with hexagonal and cubic symmetry. Heat capacity C_p measurements in temperature range 0.5–55 K under external magnetic field were made using commercial PPMS (Quantum Design) apparatus. After the subtraction of lattice heat capacity contribution, the isothermal magnetic entropy change ΔS was obtained. The comparison of analysed results from heat capacity Cp(T) to the independent magnetic measurements data $M(H)$ revealed the accordance of fundamental magnetocaloric characteristics obtained by both methods.

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P3-10

THE EFFECT OF TEMPERATURE ON MAGNETIZATION CURVES NEAR CURIE POINT IN LaFeCoSi

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The paper considers two versions of a phenomenological hysteresis model applied to describe the effect of temperature on hysteresis curves in $La(Fe,Si)_{13}$ magnetocaloric alloy. Both descriptions are derived from the $T(x)$ model advanced by J. Takács. The variations of model parameters with temperature for the novel hybrid product-$T(x)$ description are presented.

P3-11

EFFECT OF THE TEMPERATURE ON THE MAGNETIC AND ENERGETIC PROPERTIES OF SOFT MAGNETIC COMPOSITE MATERIALS

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Magnetic materials play a very important role in many applications; mostly are widespread in the electrical machines sector. Recently new magnetic materials have been developed and adopted in various electrical motors, overcoming traditional solutions showing several technological limits. Soft Magnetic Composites (SMCs) are generally made of ferromagnetic particles covered by an insulating layer. The layer can be of organic (metal oxides) or inorganic (resins) origin. SMCs can successfully substitute laminated steel in several applications. Owing to their lower eddy currents losses, SMCs can operate at medium-high frequencies keeping almost unchanged the magnetic characteristics. Furthermore, such materials give the possibility to design electrical motors with very complex geometries, taking advantage of their 3D behavior.

In general, SMCs are characterized at room temperature, but the operating temperature in the electrical motor, normally at about 70-100°C, can reach up to 150°C.

The aim of this work is to investigate the magnetic and energetic properties at typical operating temperatures. Different SMC samples have been tested and analyzed. The content of the polymeric binder and compacting pressure level are considered parameters of the study. The promising results have been obtained with a view towards industrial applications.

P3-12

MAGNETOTHERMAL PROPERTIES OF MESOSCOPIC SYSTEMS BASED ON Ni_3Pt NANOPARTICLES

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Magnetocaloric cooling is a promising alternative to classical cooling methods due to its high environmental safety and energy efficiency. Another equally important issue is finding the corresponding geometric schemes, which would maximize the magnetocaloric effect (MCE) [1-2]. Thereby, the aim of our work is to study the magnetothermal characteristics of mesoscopic structures based on Ni_3Pt nanoparticles with a different geometry of the structures.

The fabrication of various types of structures (nanowires, cylindrical nanomagnets) based on Ni_3Pt was carried out using electron-beam lithography and electrochemical deposition method. Glassy carbon plates with size of 0.5×0.5 mm^2 were used as subtrates. The electrolyte solution for electrodeposition consisted of 0.003 mol/l K_2PtCl_4 + 0.1 mol/l $NiCl_2$ + 0.5 mol/l NaCl (pH = 2.5).

Studies of the phase composition and crystal structure have showed that the samples have a phase composition of FCC-Ni_3Pt with a crystal lattice parameter $a_{aver.} = 0{,}362$ nm and an average grain size $d_{aver.} = 8$ nm. The magnetothermal characteristics showed a significant effect of system geometry on the value of MCE. For example, for magnetic field 0.5 T, for nanowires the maximum value of $-\Delta S_M = 0.05$ JK^{-1}kg^{-1} is observed at $T_{max} = 350$ K, for cylindrical nanomagnets $-\Delta S_M = 0.13$ JK^{-1}kg^{-1} at 360 K and for nanoparticles Ni_3Pt the maximum value of $-\Delta S_M = 0.03$ JK^{-1}kg^{-1} is observed at 270 K. Thus, the ability of manipulation of the MCE value and adjusting of the operating temperature by changing the system geometry have been shown.

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P3-13

THE INFLUENCE OF FIBER LASER SCRIBING ON MAGNETIC DOMAINS STRUCTURES AND MAGNETIC PROPERTIES OF NO ELECTRICAL STEEL SHEETS

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In this paper, the fiber laser in different modes was used to study its effects on the resulting changes in magnetic domains structures, coercivity and thermal stresses values in the area of interaction of laser beam with surface of high silicon non-oriented electrical steel sheets. The laminations for the cores used in electrical applications like motors, generators, ballasts are manufactured by punching, mechanical cutting or cutting by laser of coils of non-oriented fully processed electrical steels. The magnetic material close to the cutting edge is essentially influenced by these processes. Depending on the parameter, the magnetic properties can vary substantially. The pulse laser with power of 0-50 W, constant frequency of 50kHz and 20μs pulse duration were used to perform the series of four various laser scribing treatments. The results showed that compared to the laser untreated material with a coercivity of 222 A/m, a significant improvements in core losses (i.e. watt losses reduction) were obtained after the laser treatments used. At the same time, clearly lowered nanohardness values were indicated in central parts of laser pulsed areas. This major effects are responsible for the observed core losses improvements are related to optimal refinement of magnetic domains structures by applied laser treatments.

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P3-14

EFFECT OF MILLING ENVIRONMENT ON MICROSTRUCTURE AND MAGNETIC PROPERTIES OF NdFeB NANOPARTICLES

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High performance permanent magnets are indispensable for many commercial and military applications. Development of green energy technologies, such as hybrid and electric cars, and wind power, is demanding high energy density permanent magnets. In powder technology, which is the preferred method of hard permanent magnet preparation, synthesis of hard magnetic nanoparticles with precise control over the size, size distribution, high coercivity and phase purity is challenging.

Different methods have been employed to prepare hard magnetic nanoparticles including chemical methods, electrodeposition, spark erosion and ball milling. High-energy ball-milling is an inexpensive and efficient technique for preparation of nanocrystalline powders. However, irregular shapes and agglomeration of the powder are obtained. Therefore, the best approach for the preparation of nanoparticles is to use an appropriate environment carrier liquid which is more efficient in reducing the particle size and can prevent the natural tendency of agglomeration that usually take place during ball milling. Also, the milling temperature has been proved to be an important parameter for preparing nanostructured materials.

Considering these, the aim of our work is to investigate the effect of the milling environment on microstructure and the magnetic properties of Nd–Fe–B powders prepared in various conditions, by high-energy ball milling from ribbons with compositions $Nd_{13}Fe_{81}B_6$. The precursor ribbons have been prepared by melt-spinning technique and present an amorphous or partial amorphous structure which depends of the velocity of the wheel. In order to obtain the optimum nanocrystalline structure, as cast ribbons were annealed for different periods of time at temperatures ranging between 610 and 690 °C. The milling of the annealed ribbons was performed in three different environments: Ar, oleic acid/heptane, and liquid nitrogen. The best hard magnetic properties, such as H_c = 7 kOe and M_r=64.5 emu/g were obtained for of powder milled in liquid nitrogen for 7 h.

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P3-15
MULTIPARAMETER OPTIMIZATION OF MECHANICAL CUTTING PROCESS OF GRAIN ORIENTED SILICON STEEL

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Selecting the optimal cutting parameters for magnetic materials is a challenging task in the electrotechnical manufacturing industry, due to its cut surface quality, strain and stress state after process and magnetic properties.

Existing experimental methods require lots of cutting experiments and off-line tests, which may lead to high operation cost and low efficiency. In this paper mathematical, physical and numerical model of shear-slitting process and its application in Ansys/Ls-Dyna system using mesh-free method (SPH) is developed. The numerical model is used to analysis of states of stresses and strains at cut surface of material in the dependance of technological process parameters for example cutting velocity and cutting clearance. To obtain knowledge of the influence of this parameters on quality of cut surface (for example burr formation) and magnetic properties of material experimental research is done. Examined dependent variables, as the most important operational indicators are described by regression equations from technological parameters. These equations are used in multiparameter optimization process with delivered scripts in Matlab program. A set of acceptable solutions is developed on the plane of controllable variables (of technological parameters) on account of accepted criteria (operational indicators) and limitations. Using obtained relationships, functions and results its possible to control cutting process and obtain high cut surface quality and minimum deterioration of magnetic properties.

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4 MAGNETIC THIN FILMS AND SURFACES, SPINTRONICS, PARTICLES AND NANOSTRUCTURES

O4-01

LOCAL SURFACE EFFECTS IN FERRITE NANOSPHERES

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The magnetic properties of nanosized material differ from their bulk analogies and are crucially determined by surface effects [1-4], e.g. non-saturation of the magnetization curve and reduced spontaneous magnetization is commonly attributed to surface spin disorder. Discrimination of the magnitude and local structure of surface effects in nanoparticle based on macroscopic techniques is challenging. Routinely, batches with various sizes of nanoparticles are compared with each other to extract the volume averaged surface anisotropy. Here we will present the chemical and magnetic morphology of ferrite nanoparticles with sub-Å resolution using a combination of X-ray and neutron small-angle scattering with magnetization measurements.

In particular, half-polarized small-angle neutron scattering technique allows to extract the spatially resolved magnetization distribution through the nanoparticle and the field-dependence of coherently magnetized volume. We will show that even at a high magnetic field of 1.2 T spin disorder at the surface remains and corresponding to 11% of the nanoparticle volume. In-depth analysis allows us to extract the local variation of the magnetic surface anisotropy within the nanoparticle and associate it with the nanoparticle spin structure. Moreover, we will show that the observed, reduced spontaneous magnetization is not only originating from surface effects, but is related to the defect-rich structure of the nanoparticle core, which leads to a non-homogeneously magnetized spin structure.

Acknowledgement
We thank Jan Duchoň for HRTEM measurements and EDX maps at Research Centre Rez, Rez near Prague, Czech Republic, and Michael Smik for support during SAXS measurements at the GALAXI instrument, JCNS, Forschungszentrum Jülich, Germany. We acknowledge the Institut Laue-Langevin, Grenoble, France for provision of beamtime at the instrument D33. Financial support from the German Research Foundation (DFG: Emmy Noether Grant DI 1788/2-1) is gratefully acknowledged.

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O4-02

CuMnAs: CONDUCTIVITY AND ANISOTROPIC MAGNETORESISTANCE

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The emergent field of antiferromagnetic (AFM) spintronics [1] has brought one particular AFM metal to prominence: CuMnAs. Its transport properties are nevertheless poorly understood, the main focus has so far been on the spin-orbit torque which allows to conveniently manipulate magnetic order in CuMnAs [2]. Such manipulation effectively amounts to writing information and prototype memory devices operating at room temperature have been demonstrated [3]. As for reading, anisotropic magnetoresistance (AMR) has been used offering different signals at read-out for AFM moments oriented along two mutually orthogonal directions. We aim at fiding microscopic origin of AMR in CuMnAs.

In exploring CuMnAs, the first step is the solid knowledge of its band structure. To that end, we compare optical conductivity and photoemission spectra with ab initio calculations (DFT+U). We find a good agreement and our confidence in the band structure is further bolstered by GW calculations that render the use of Hubbard U, along with its caveats, redundant [4]. With this band structure as a reference, we proceed to calculate temperature-dependent resistivity R(T) in coherent potential approximation (CPA) and compare it to new experimental data on bulk samples grown by solid-state reaction. In contrast to thin layers [2], these samples allow for resistance both in-plane and out-of-plane to be measured. Our comparison of experimental R(T) and various ab initio based models implies that swapping Mn and Cu atoms in otherwise perfect lattice of CuMnAs is a plausible scenario for DC transport in this material.

Finally, we explore the AMR. On experimental side, the bulk samples respond moderately (~0.1%) to fields up to 14 T which compares well to thin layers [5]. We analyse angular dependence of R(B) and, using Stoner-Wohlfarth model, infer magnetic anisotropy of CuMnAs and its temperature dependence. Again, we compare CPA-based tight-binding linear-muffin-tin orbital calculation to experimental data and discuss the likely source of scattering. Calculated AMR tends to be larger than experimental values hinting at multi-domain character of the studied samples and only a small part of system responding to magnetic field.

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O4-03
MAGNETIC STATES OF FERROMAGNETIC/NON-MAGNETIC MULTILAYER DOTS

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Ultrathin structures with broken symmetry, such as Pt/Co/Ir multilayers, are intensively studied because of the Dzyaloshinskii-Moriya interaction (DMI) induced at the interfaces with the ferromagnetic metal. Surface induced DMI leads to interesting phenomena, which include the occurrence of spiral magnetic states, skyrmion lattices, or isolated skyrmions [1,2]. Many concepts based on the skyrmions has been proposed, e.g., racetrack memories [3] or future magnon-spintronics devices [4]. It was found that the confinement due to geometry can increase stability of the skyrmion significantly [5]. Thus low-dimensional patterned structures can lead to room temperature stable, reconfigurable magnetic elements. In this work we are focusing on the numerical and experimental study of skyrmions in multilayer patterned dots.

Experimental samples were made from Co layer embedded between Pt and Au layer. All layers are sputtered in-situ step by step on a Si substrate. We prepared a series of samples with various thicknesses of individual layers ranging from 1 nm to 3 nm. Sample also differs by number of repetitions of Co/Pt/Au multilayers. After deposition process, electron beam lithography was used to define dot array on the sample and then a 15-nm thick layer of titanium was deposited and followed by the lift-off process. A Kaufmann type Ar-ion beam etching source was used afterwards to transfer the titanium circle-shape mask pattern into the Co/Pt/Au multilayers. The magnetic structure of final dot array was examined by a magnetic force microscope (MFM).

We expect that skyrmion can be stabilized in a dot at certain value of interfacial DMI. The stability of skyrmion depends also on competition of the DMI, interlayer exchange, anisotropy and magnetostatic interactions. The strength of the magnetostatic interaction can be tuned by changing the number of the repeats of the Co layers in the dot. The dot diameter can influence final magnetic state of the dots, i.e. a single isolated skyrmion state, the vortex state or domain walls can be presented in the dot.

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O4-04

SPIN HALL EFFECT IN RANDOM PLATINUM-BASED ALLOYS FROM AN AB INITIO THEORY

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The formulation of a material-specific parameter-free theory of the spin Hall effect (SHE) in random alloys represents a long-standing problem for several reasons. First, the correct definition of the spin-current operators is not trivial in systems with spin-orbit interaction. Second, the presence of disorder calls for an efficient technique of configuration averaging. In this contribution, we present our approach to the SHE in substitutionally disordered alloys based on the concept of intersite electron transport developed within the tight-binding linear muffin-tin orbital (TB-LMTO) method [1]. This scheme leads to non-random and spin-independent effective current (velocity) operators, which enables one to define easily the corresponding effective spin-current operators that are non-random as well. The formulation of the spin Hall conductivity and the configuration averaging of its Fermi-surface and Fermi-sea contributions within the coherent potential approximation (CPA) can then be done in close analogy with an approach developed earlier for the standard conductivity tensor [2]. The relativistic effects are included in the Dirac theory with four-component wave functions.

Properties of the developed formalism will be discussed for a simple TB model of a random binary alloy with particular attention paid to the dilute limit. Applications to realistic alloy systems will be presented for concentrated Pt-based fcc solid solutions, such as Pt-Au, Pt-Re, and Pt-Ta. In all these systems, large values of the spin Hall angle (around 20 percent) have been obtained for special compositions which correspond both to metastable (Pt-Au) and stable (Pt-Re, Pt-Ta) alloys according to the equilibrium binary phase diagrams.

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O4-05

SPIN WAVE EDGE STATES IN ARRAY OF MAGNETIC RINGS

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Due to the large number of degrees of freedom and possibilities of magnetic spin texture formation, the topological effects of spin waves (SWs) and their applications are far from being exhausted. One of the important aspects of arising topological non-trivial phase is related to breaking time symmetry, nonrecirpocity of the wave. SWs can exhibit this property in relatively easy way in uniformly magnetized thin films. It is due to the surface localization of SWs propagating in-plane, perpendicular to in-plane magnetic field. It is sufficient to change properties near one of the surface, by pinning or placing metal overlayer, to obtain nonreciprocal dispersion [1]. Another way of inducing nonreciprocity of SWs is by including chiral interactions [2] or purely geometrical effects [3].

An example of the magnonic crystal with nonreciprocal properties is an array of connected rings. Such rings have already been fabricated for elastic waves and shows to support phononic topological edge states [4]. We have shown previously that azimuthal SW propagating near the edge of the disk can acquire nonrecirpocal properties that can be controlled with magnetization orientation [5]. This effect is related to Berry phase of SW in circular geometries [3]. In this work we present how the geometry of magnetic shape and micromagnetic state induces nonreciprocity of azimuthal SWs in nanoring and leads to formation of topological edge states in magnonic crystal.

Acknowledgment
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O4-06

LASER-INDUCED SPIN CURRENTS AND SPIN TRANSFER TORQUE IN NONCOLLINEAR MAGNETIC STRUCTURES

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A laser pulse as long as few femtoseconds can trigger rapid changes in magnetic materials. Recent theoretical and experimental results suggest that ultrafast demagnetization of conduction metals is a concoction of more physical features. An extensive part of ultrafast demagnetization in metallic system is ellucidated by generation spin-polarized currents of hot electrons excited by the laser pulse, which can be described by means of superdiffusive spin-dependent transport model [1].

Importantly, spin-polarized currents of hot electrons can be potentially used as a mediator of spin momentum in spintronics. Experiments demonstrate that superdiffusive spin flow can not only reduce magnetization in a magnetic film but also exert spin transfer torque and induce magnetization dynamics. In magnetic trilayers magnetization precessions induced by hot electron current can reach THz frequencies [2].

Here, we shall present our theories on transport of hot electrons through structures with noncollinaer magnetic moments. To this end, we generalize the model of superdiffusive spin-dependent transport for the case of noncollinear magnetizations. In case of magnetic multilayers, the spin-dependent transport through the interfaces between the layers is described by energy-dependent reflections and transmissions taking into account spin mixing. It is shown that laser-induced demagnetization of the multilayer strongly depends on the magnetic configuration. Moreover, the angular dependence of spin transfer torque substantially departs from standard sine-like variation, which can lead to unusual modes of magnetization dynamics.

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O4-07

SKYRMION CONFINEMENT AND CONTROLLED MOTION IN MAGNONIC ANTIDOT LATTICES

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Magnetic skyrmions are topologically protected nano-meter sized chiral spin textures which can be manipulated by electric current via spin transfer and spin orbit torque. Skyrmions have higher current induced mobility compared to magnetic domain walls which makes them a promising candidate for future spintronic applications such as low dissipation magnetic information storage devices, skyrmion racetrack memories as well as logic devices.

Skyrmions in thin films have been observed to achieve a transverse velocity when displaced by an in-plane DC current exploiting the spin Hall effect. The skyrmion motion is randomized by the thermal diffusion and presence of pining centers in real experiments on homogeneous samples. The observation that edges of the sample and defects repel skyrmions led to idea to use antidot lattice as a medium with well defined and robust motion of skyrmions.

We study theoretically the skyrmion motion driven by the in-plane current pulses in the presence of a magnetic antidot array which creates an effective potential of attractive valleys located between the antidots. Our calculations are based on the micromagnetic model as well as on the modified Thiele equation which significantly reduces the computational time while keeping the reasonable level of accuracy. We demonstrate that skyrmion transport between individual valleys can be controlled by applying a proper current pulse. Resulting from the interplay between antidot potential and skyrmion Hall effect skyrmions can be manipulated in the longitudinal and even in the transversal direction with respect to the current flow. We define the regions of the current pulse parameters which correspond to the identical final positions of the skyrmion after the pulse is switched off. By using the sequence of electrical current pulses, the magnetic antidot arrays can be used as a controller for skyrmion motions, whereby the results make a step towards skyrmion based devices.

O4-08
MAGNETOFERRITIN-INDUCED TRANSVERSE RELAXIVITY ENHANCEMENT IN MRI

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Magnetoferritin (apoferritin containing a magnetite crystal) is currently considered as the most suitable model system of pathological ferritin [1]. Pathological ferritin is associated with various disorders, including neurodegenerative diseases [2]. Magnetic moment of magnetoferritin is up to 20 times larger than magnetic moment of native ferritin containing ferrihydrite crystal [3]. Thus, the effect of magnetoferritin on longitudinal and transverse relaxation rates should be more than 200 times larger [3]. We investigated the relaxivity properties of native ferritin in comparison with magnetoferritin with the same loading factor at 7 T MRI system. Our results indicate the transversal relaxation rate enhancement of magnetoferritin, however only in range of 1-50 times (Fig. 1). Changes in longitudinal relaxation rate were not significant. On the other hand, we observed more than 400 times increase in transversal relaxivity of magnetoferritin in comparison with native ferritin (Fig. 2). Such result is important for MRI diagnostics of pathological processes associated with pathological ferritin.

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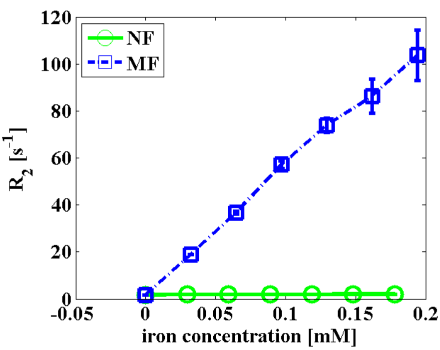

Fig 1.

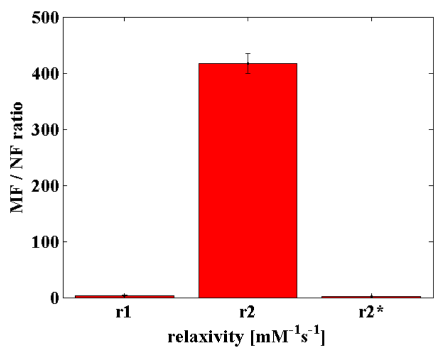

Fig. 2

P4-01

TRANSPORT PROPERTIES OF ANTIFERROMAGNETIC CuMnAs ALLOY

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Electronic, magnetic, and transport properties of the antiferromagnetic (AFM) CuMnAs alloy with tetragonal structure, a promising material for the AFM spintronics, are studied from first principles. The experiment on real samples gave the residual resistivity around 90 μΩcm for low temperature. This indicates the presence of defects. Our theoretical analysis identified the Mn_{Cu} and Cu_{Mn} antisites and vacancies on Mn or Cu sublattices as most probable defects in CuMnAs.

We estimated the in-plane resistivity of CuMnAs with defects of low formation energies. Our numerical simulations fitted experiment very well if we assumed concentrations 3.5-5% Mn_{Cu} antisites in the samples, much larger concentrations would be needed for Cu_{Mn} antisites or Mn-vacancies.

Our transport studies employ the Kubo-Greenwood linear response theory. In real conditions the resistivities depend on the actual occupation of sublattices by the alloy constituents resulting in the presence of antisite sublattice disorder. This is a challenging problem for the structural X-ray analysis in the present alloy because of similar scattering cross sections of atoms forming the alloy (Cu and Mn). We compare resistivities for two samples of experimentally obtained compositions. Calculated planar resistivities are in a good agreement with the X-ray structural analysis of samples grown on GaP(001) substrate and also the simulations for systems with Cu- and Mn-vacancies have the resistivity close to that found in the experiment.

Finally, we estimate the Néel temperature of the ideal and disordered AFM-CuMnAs alloy using the Monte Carlo approach. The Néel temperature has been estimated from the peak in the magnetic susceptibility or the peak in the heat capacity. We have obtained a good agreement between experimental and calculated Néel temperatures. Specifically, the vacancies on Mn and Cu as well as the antisite Mn_{Cu} defects reduce the calculated Néel temperature (446 – 465 K) in comparison with that for the ideal CuMnAs (495 K) while keeping a good agreement with experiment (480 K).

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P4-02

MAGNETO-STRUCTURAL PROPERTIES AND SPIN POLARIZATION OF Co_2MnSn HEUSLER MELT-SPUN RIBBON

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Heusler alloys are well-known suitable candidates for many applications, due to their tunable electronic structure, which influences their peculiar physical properties ranging from superconductivity [1], through semiconductivity [2], even to half-metallic ferromagnetism [3]. Half-metallicity is characterized by a metallic behavior in the majority spin channel and a semiconducting behavior with a gap at the Fermi level in the minority spin channel, which provides a 100% spin polarization [4].

Specially Co_2-based Heusler alloys have a peculiar role in the potential application in spintronics due to their theoretically predicted half-metallic nature at the Fermi energy level, experimentally observed high spin polarization, high Curie temperature and small Gilbert damping [5].

It was found that one of the most crucial property to achieve high spin polarization values in Heusler alloys consist in the highly ordered $L2_1$ crystal structure. According to simply rules [4] by choosing a suitable chemical composition, it is possible to obtain required Heusler structure without any additional long thermal annealing.

In this work, we report on structure, magnetism and spin polarization of Co_2MnSn ribbons prepared by melt spinning. This rapid quenching technique allows preparing Heusler compounds with highly ordered $L2_1$ phase. SEM analysis displayed an averaged chemical composition of $Co_{47.8}Mn_{31.5}Sn_{20.7}$ checked by EDS. The well-defined magnetic anisotropy together with spin polarization values ranging from 70-78 % makes this Heusler alloy suitable candidate for applications in spintronics.

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P4-03

IRON-BASED CORE-SHELL NANOPARTICLES PRECIPITATED FROM COPPER-IRON ALLOY

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Iron-based nanoparticles have been lately extensively studied by many scientific groups all around the world. Their unique properties ensure their high application potential in many fields e.g. biomedicine, environmental protection, water purification, etc.

Studied nanoparticles were prepared by precipitation from solid solution of saturated binary Cu-Fe alloy with subsequent electrochemical dissolution of the remaining matrix. The primary alloy was annealed at 970 K for different time periods. Copper was subsequently dissolved with help of $NH_4OH + H_2O_2$ solution.

As-prepared nanoparticles were studied by Mössbauer spectrometry (MS) and X-ray diffraction (XRD) and transmission electron microscopy. Results shows that the mean size and size distribution of studied nanoparticles is strongly dependent on annealing time. XRD revealed major crystalline phase which was identified as α-Fe phase and relatively disordered minor phase which was identified by MS as maghemite (γ-Fe_2O_3). It seems that as-prepared nanoparticles consist of α-Fe core and γ-Fe_2O_3 shell which is also supported by results obtained by electron microscopy. Furthermore, Mössbauer spectra under blocking temperature at 4.2 K consist only of magnetically ordered phases. However, superparamagnetic spectral component with relatively small contribution to spectra can be observed at room temperature.

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P4-04

STRUCTURAL AND MAGNETIC PROPERTIES OF MECHANICALLY ALLOYED $Fe_{50}Co_{50}$ SYSTEMS

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Mechanical alloying is one of methods to obtain nanostructured alloys, the main feature of which is a large fraction of grain boundaries with different atomic arrangement in comparison to grain interior. Among others, iron - cobalt nanocrystalline alloys can be produced in this way. Fe-Co alloys are known to have many applications in a wide variety of areas due to their soft magnetic properties: high Curie temperatures, high saturation magnetization, high permeability.

Mixture of Fe and Co powders in ratio 50:50 was milled in a high-energy planetary ball mill at 180 rpm. The milling was performed under a protective argon atmosphere during: 1 h, 5 h, 10 h, 15 h, 20 h and 40 h. This maked it possible to study the structural evolution of the milling product with the passage of grinding time. In addition to X-ray diffraction and thermomagnetic investigations, ^{57}Fe based Mössbauer transmission spectroscopy was used for this purpose. Two following methods for fitting Mössbauer spectra were used: (i)utilizing a continues distribution of hyperfine magnetic field (HMF) correlated with isomer shift distribution (ii) using a discrete HMF distribution based on the local environment model. There were no indications of the presence of pure iron component in Mössbauer spectra. Therefore, all iron was melted with cobalt after just one hour of milling. The value of HMF was equal to 34.74 T after 1 h of milling, increased to 34.82 T after 2 h and next it did not change really. This means that no significant structural changes occurred during further grinding. A slight but regular increase in the standard deviation was observed, indicating an enhancement of chemical disorder or/and increase in internal stresses.

The disordered BCC Fe–Co solid solution was identified by both X-ray diffraction and Mössbauer spectroscopy. We have focused that the magnetic characteristics as coercivity and saturation magnetization of the milled alloys strongly depend on the Co content.

P4-05

LOCAL MATERIAL CHARACTERIZATION OF TOPOLOGICAL-INSULATOR/FERROMAGNET THIN FILM HETEROSTRUCTURES USING REAL- AND K-SPACE IMAGING IN PHOTOEMISSION ELECTRON MICROSCOPY

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Chalcogenide-type 3D topological insulator (TI) materials like Bi_2Se_3 host Dirac-like topological surface states (TSSs), where opposite momentum states +*k* and -*k* are locked to opposite spins[1]. Due to the intimate link between time-reversal symmetry and TI properties, stable spin moments coupled to the TSS should cause an energy gap at the TSS`s Dirac point (DP)[2]. This effect could be the basis of a magnetoresitive logic element, where on/off resistance values can be reached via magnetically induced topological phase transitions.

For potential spintronic applications it is necessary to utilize current growth techniques such as molecular beam epitaxy (MBE) to realize high-quality TI thin films on insulating substrates and implement heterostructure concepts, where the band structures can be tuned e.g. via interface and confinement effects[3].

In this work, we approach Bi_2Se_3-based heterostructures from a materials science point of view. Using an *Omicron NanoESCA* instrument we address morphologic, structural, chemical, and electronic properties on a micrometer scale. We study systems of varying number *n* of pure Bi_2Se_3 quintuple layers (QLs) MBE-grown ontop of a buried and thus oxidation protected 500 nm thick Mn-doped Bi_2Se_3 magnetic layer (Mn concentration ~ 6% per f.u.). Important results are that (i) heterostructure interfaces are sharp without indications of vertical Mn diffusion, (ii) with decreasing *n*, the Mn-induced formation of sub-micrometer scale 60° rotational domains become visible in local momentum-resolved photoemission electron microscopy (k-PEEM). At the same time DPs are pushed up towards the Fermi level. SQUID proves a Curie temperature ~ 6K of the buried Mn-doped Bi_2Se_3 layers.

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P4-06

MAGNETIC ANISOTROPIES IN ANTIFERROMAGNETIC TRANSITION-METAL DIFLUORIDES

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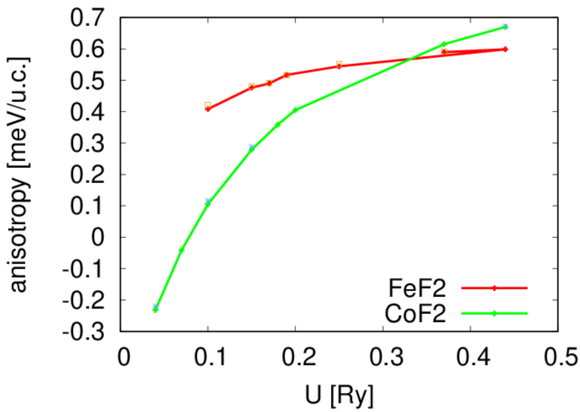
Magnetic anisotropies in antiferromagnets (AFM) emanate from at least two sources: dipolar interactions between pairs of magnetic moments and spin-orbit interaction affecting their band structure. We assign magnetocrystalline anisotropy energy (MAE) to the latter (admittedly, the terminology is not settled).

Taking prototypical rutile-type AFM used in spintronics applications, we evaluate MAE using ab initio methods and compare it to experimental data implied by measurements of the spin flop. Overall, we find satisfactory level of agreement but some remarks are in order. With MnF2, MAE is negligible as expected from the atomic ground state (closed d-shell for majority spin). With NiF2, theoretically calculated MAE has the correct sign, pushing the magnetic moments into the ab-plane, but anisotropies within this plane are too small to be resolved in calculations. Largest share of attention is paid to FeF2 and CoF2 where the Hubbard *U* parameter in DFT+U needs to be carefully adjusted [1].



We find that while MAE depends moderately on *U* in FeF2, allowing for theoretical predictions in this material, situation is very different in CoF2. Yet, MAE inferred from experiments is compatible with ab initio results for CoF2.

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P4-07

MODELLING OF STRUCTURAL AND MAGNETIC PROPERTIES OF NANOCOMPOSITES FOR MAGNETOCALORIC AND BIOMEDICAL APPLICATIONS

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Periodic nanoporous silica (PNS) with its perfect regular structure, biocompatibility, thermal stability and durability, and high specific surface is very promising material from the application point of view.

We have prepared series of nanocomposites, where PNS serves as a matrix in which nanoparticles of Gd_2O_3 or Fe_2O_3 are embedded. Such materials have already exhibited extraordinary large magnetocaloric effect [1] and applicability as contrast agents for MRI [2], while their utilization for targeted drug delivery is currently being examined. In this, the detailed information on the structure of as prepared nanocomposites is essential for understanding and tailoring their properties.

We have examined our PNS by means of small angle neutron scattering (SANS) and we proposed model assuming general features of the inner structure of the composite. By fitting the model to experimental data we are able to obtain information on matrix (size, shape and mutual distance of pores) as well as on size distribution and concentration of nanoparticles embedded in the pores. Hence, the combination of SANS experiments along with our model application appears to be suitable and effective tool for the revelation of inner structure of these kinds of nanocomposites.

This work has been supported by the JINR topical themes 04-4-1121-2015/2020 and 04-4-1133-2018/2020.

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P4-08
Withdrawn

P4-09

MAGNETIC Fe_3O_4 NANOPARTICLES COATED BY POROUS SiO_2: CORE@SHELL NANOSYSTEMS FOR BIOMEDICAL APPLICATIONS

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Nanotechnological applications are getting more attention in recent years and it is important to maintain this progress by developing functional, compatible and versatile nanomaterials for various applications. Very promising area, where these materials can be employed, is in nanomedicine. Magnetic based nanosystems can be utilized in diagnostic and imaging techniques or can help in treatment process by acting as a drug carrier in intelligent drug delivery systems. For such applications these systems must be stable, biocompatible, with reasonable magnetic properties and non-invasive in relation to living organisms. Among others, core@shell platforms are widely used for these purposes.

Therefore, we have prepared composites consisting of Fe_3O_4 magnetic core and SiO_2 biocompatible shell through combination of self-assembly and co-precipitation techniques. Three different concentrations and sizes of cores were prepared and subsequently coated with SiO_2. Afterwards, magnetic properties of prepared Fe_3O_4@SiO_2 were investigated in temperature range 2-400 K using SQUID-based magnetometer. Hydrodynamic properties, which involve Zeta potential, isoelectric point and size of the particles, were measured by dynamic light scattering method. Structure and morphology were characterized by transmission electron microscopy.

Our experimental study confirms, that magnetic properties of studied nanosystems are affected by the size of particles in way that smaller particles have lower values of magnetic moment. We have confirmed that while in uncoated Fe_3O_4 magnetic core the ferromagnetic phase is dominant, in coated Fe_3O_4@SiO_2 composites the superparamagnetic phase increases and became substantial.

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P4-10

MICROMAGNETIC SIMULATION OF THERMAL GENERATION OF SPIN WAVES USING MUMAX3

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More than 10 years ago there was reported the Spin Seebeck Effect (SSE) [1]. This effect was measured by the means of the Inverse Spin Hall Effect (ISHE), where a small voltage signal was induced by the spin currents. Due to the recent development of low power electronics it appeared, that the SSE+ISHE could be considered as a new way of thermoelectric generation. Thus it became important to model the thermal generation of spin waves (SWs). In the paper we would like to discuss the possibility of the use of MuMax3 software [2,3] to investigate this phenomenon. The MuMax3 software is widely used for micromagnetic simulations, however it has not been shown if it could be used for simulation of SWs at room temperature.

We have performed a simulation for a nanostripe of permalloy of 6000x100x5 nm^3 dimensions. The grid cell size is 2x2x5 nm^3.

First, at 0K temperature, it was verified and confirmed if the generated SWs' frequency agrees with analytical predictions [4]. The Heaviside pulse of external magnetic field was applied to introduce a local disturbance of spins and generate the SWs.

Next simulations at non-zero temperatures were performed. MuMax3 takes into account the thermal noise introducing stochastic external magnetic field. The FFT analysis of the magnetisation vector <m> was performed and the dominating SW frequency has been revealed. This frequency agrees with the analytical prediction. Thus it was shown the by the means of MuMax3 it is possible to obtain thermally generated SWs at room temperature.

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P4-11

INFLUENCE OF SINGLE SUBSTITUTION ON MAGNETIC PROPERTIES OF NOVEL Y_2FeSi HEUSLER ALLOY

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The paper presents results of density functional theory (DFT) studies on novel Y_2FeSi Heusler material characterized by spin polarization at Fermi level of σ = 83% and magnetic moment of 1.56 μB. The total magnetic moment of investigated material is dominated by Iron sites, while magnetic moments coming from Yttrium sites are aligned antiparallel to the Iron. Then, we introduced several systematic substitutions to alter magnetic and electronic properties of studied material.

The Heusler alloys are very sensitive to electronic structure changes induced by ionic substitutions, thus allowing to specifically shape their properties.

Here we present results of DFT study on structural, electronic and magnetic properties of novel Y_2FeSi material according to the various ionic single substitutions.

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P4-12

ASYMMETRIC BUBBLE EXPANSION IN THIN FERROMAGNETIC LAYERS

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Magnetic skyrmions are particle-like spin structures of topological origin found in several magnetic materials [1-2]. Their suitability stems from highly efficient motion [3-4] and low influenceability by edge roughness. Such features are required in recent development of proposed race-track memory devices, where information should be stored by skyrmions in magnetic nanowires or nanostrips.

However, a key prerequisite for practical application of skyrmion is detail knowledge of the origin of the large mass of skyrmions since the mass strongly affects the trajectory of the skyrmion [7]. One of possible factors is a chirality of the magnetic configuration of the skyrmion that is strongly affected by the Dzyaloshinsky-Moriya interaction (DMI). Therefore the DMI is expected to have a large influence on the mass of skyrmions and therefore on the dynamics of the skyrmion, too.

Here, we study the strength of Dzyaloshinsky-Moriya interaction in thin magnetic layers with perpendicular magnetic anisotropy. Our samples are prepared by electron beam lithography and magnetron sputtering. The studies are performed by asymmetric bubble expansion in two different samples: Ta/CoB/Pt multilayers and asymmetric Ir/Co(Fe)B/Pt layers where the Dzyaloshinsky-Moriya interaction can be expected.

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P4-13

AB-INITIO CALCULATIONS OF LAYERED TOPOLOGICAL INSULATORS UNDER CHEMICAL AND STRUCTURAL DISORDER

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Spintronics represents a possible route to solve the increasing demands on the computational devices. One of the possible materials to use there are time reversal symmetry protected topological insulators (TRS TI). They host linearly dispersed spin-polarized states on their surfaces, which makes the surface band structure gapless. Whereas in the bulk a band gap is kept. The occurrence of surface conductive states, so-called 'Dirac states', is based on the presence of a strong spin-orbit coupling leading to the inverted parity of surface valence and conductive states, where the TRS is kept. In our study we focus on properties of well known bismuth chalcogenides under a chemical and structural disorder, which includes native point defects, stacking faults and magnetic doping as well. The inclusion of native defects is important to the real description of the TIs behavior in the comparison to experiments. Besides, magnetic defects can serve to control the transport behavior by breaking TRS.

Using ab-initio TB-LMTO-ASA calculation within the layered Green's functions formalism we studied the resistance of gapless surface state to the presence of the disorder. The inclusion of native and magnetic defects in studied layered structures was treated by CPA. We will discussed induced modification of the surface band structure and the influence on the transport properties. The critical concentration for magnetic doping leading to the vanishing surface conductivity will be shown. Finally we compare how realistic are our calculations in comparison to the experiments.

P4-14

THE MAGNETITE NANOPARICLES: DIVALENT IRON CONTENT FROM IN-FIELD MÖSSBAUER SPECTROSCOPY

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While magnetite structure is stable for bulk samples, high specific surface of nanoparticles (NPs) allows quick oxidation during the synthesis and/or after exposure to oxygen-rich environment. Non-stoichiometric magnetite can be described as

$$(Fe^{3+})[Fe^{2+}_{1-3\delta}Fe^{3+}_{1+2\delta}\Upsilon_{\delta}]O_4,$$

where Υ are vacancies in the octahedral positions of magnetite structure. The formula describes magnetite (Fe_3O_4) for $\delta = 0$ and maghemite (γ-Fe_2O_3) for $\delta = 1/3$, respectively.

The nanoparticles in this study were synthetized by various methods, including the production by bacteria. The NPs morphology and size distribution were characterized by using transmission electron microscopy. The magnetite/maghemite structure was confirmed by X-ray diffraction.

The effect of synthesis route on the stoichiometry of magnetite NPs or mixture maghemite-magnetite NPs was investigated by means of ^{57}Fe in-field Mössbauer spectroscopy (MS) at liquid helium temperature. Due to the ferrimagnetic arrangement of the magnetic moments of iron ions, the external magnetic field helped to distinguish the originally overlapped sextets belonging to the tetrahedral and octahedral positions of magnetite/maghemite at liquid helium temperature. The content of divalent iron in the samples of non-stoichiometric magnetite NPs is determined from the ratios of sextet intensity in octahedral and tetrahedral positions. The presence of maghemite in the sample is identified by different hyperfine parameters of magnetite and maghemite. The Mössbauer spectra of the magnetite nanoparticles are compared to spectra of a magnetite microcrystalline powder and a single crystal.

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P4-15

PROPERTIES OF LSMO/YBCO INTERFACE

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The properties of $La_{0.67}Sr_{0.33}MnO_3$ (LSMO)/$YBa_2Cu_3O_{7-\delta}$ (YBCO) interface in thin film LSMO/YBCO cross-strip type junctions have been investigated by means of electrical transport measurements. Resistance vs. temperature and current-voltage dependences as well as conductance spectra were used to characterize electrical parameters of the interface. The results indicate a low resistance (below 10 Ω) but dielectric properties of the interface corresponding to a dielectric potential barrier - 10 nm wide and 40 meV high. The oxygen vacancies in both LSMO and YBCO films at the interface and charge transfer through the interface were considered to explain the insulating character of the LSMO/YBCO interface.

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P4-16
STRUCTURAL CHARACTERIZATION OF EPITAXIAL LSMO THIN FILMS GROWN ON LSAT SUBSTRATES

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Perovskite manganite $La_{0.67}Sr_{0.33}MnO_3$ (LSMO) has been one of the most extensively studied colossal magnetoresistance material (CMR) because of its high Curie temperature, the temperature at which the CMR materials undergo a ferromagnetic-paramagnetic transition. Hence, the LSMO thin films reveal a great potential in industrial applications. On the other hand, the substrates lying under the LSMO films can significantly influence the structural, electrical and magnetic properties of the LSMO films due to a lattice-mismatch-induced biaxial strain.

High resolution X-ray measurements were used to characterize the crystalline structure of LSMO thin films grown on $La_{0.26}Sr_{0.76}Al_{0.61}Ta_{0.37}O_3$ (LSAT) substrate under a small compressive strain (-0.2%). The accommodation of lattice mismatch gives rise to a lattice modulation structure. A series of linear h scans (rocking curves) across LSMO 004 diffraction for various values of φ angle (rotation of sample around [001] axis) was performed to provide better insight into this structural feature. Despite the cubic structure of the substrate the stress relief mechanism of the LSMO film is considerably anisotropic. Whereas in [010] substrate direction no LSMO lattice modulation was observed, in [100] direction a lattice modulation was developed having no influence on good electrical properties of the prepared LSMO films.

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P4-17

EXCHANGE BIAS IN Co/CoO COMPOSITE POWDER FABRICATED BY HIGH-ENERGY BALL MILLING COMBINED WITH ANNEALING

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Co/CoO composite powders were prepared by a high-energy ball milling and subsequent annealing with the aim to probe exchange bias effect. X-ray diffraction result revealed that the amount of CoO and Co_3O_4 phase has been changed with the increase of annealing temperature from 200 to 450 °C. The optimal temperature for the formation of Co/CoO composite structure was found to be 300 °C. Magnetic measurements revealed that saturation magnetization, M_s, of annealed Co/CoO decreased as compared to that of as-milled Co. This implies that a fraction of the oxide phase was formed after heat treatment. Furthermore, the hysteresis loop measured at 5 K after cooling in magnetic field of 5 T from 350 K (fig. 1) showed a presence of exchange bias, which reached the value of 120 Oe. It is closely related with the formation of antiferromagnetic CoO phase, which interact with adjacent Co layers.

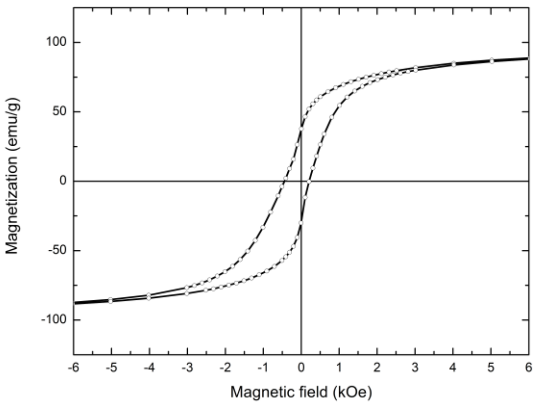

Figure 1. The hysteresis loop of Co/CoO composite powder measured at 5 K after cooling from 350 K in a magnetic field of 5 T.

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P4-18

INVESTIGATIONS OF A $Ni_{2.00}Mn_{1.16}Ga_{0.84}$ SINGLE CRYSTAL AND $Rh_2Mn_5Bi_4$ THIN FILMS USING A VARIABLE TEMPERATURE MAGNETO OPTICAL SETUP

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In our contribution, we show recent results of magneto-optical Kerr effect (MOKE) measurements performed by a new MOKE instrument installed in the Institute of Physics (ASCR). Equipped by a helium flow cryostat (Oxford instruments), the instrument can access temperatures between 3 and 380 K. Magnetic fields in the vertical and horizontal directions allow measurements in longitudinal and polar geometries and additionally, in-situ electrical transport properties can be monitored at the same time.

First measurements were performed on a single crystal of $Ni_{2.00}Mn_{1.16}Ga_{0.84}$ exhibiting magnetic shape memory effects even at small magnetic fields (below 0.1 T) [1], thus having a big application potential. For the first time we proved that Kerr effects are detectable in this type of compound also in the longitudinal geometry. This gives an access to the information about magnetic domains reorientations propagated to the surface. Our MOKE data are compared with measurements realized in a SQUID magnetometer revealing the expected scaling between bulk magnetization and Kerr rotation in different magnetic/crystal structures [2]. The same holds for coercive fields determined by these two methods. MOKE appears to be a possible method for fast and reliable initial characterization of prepared NiMnGa ingots e.g. in a future mass production.

In order to test the capabilities of our system in probing materials in nanometer ranges, we undertook a study on $Rh_2Mn_5Bi_4$ magnetic thin films deposited on MgO substrates via magnetron sputtering. This compound orders ferromagnetically in the proximity of room temperature and might be a promising material for spintronic devices. Thanks to the large spin-orbit coupling of the contained elements, also in this case we observed a sizable Kerr rotation signals even for samples with 50 nm thickness.

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P4-19

OBSERVATION OF THE SHARP VERWEY TRANSITION IN Fe/Fe_3O_4 NANOCOMPOSITES PREPARED BY A COMBINED HIGH ENERGY BALL MILLING AND ANNEALING METHOD

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A Verwey phase transition is well-known as a sudden change of crystal structure at a critical temperature (T_v) in Fe_3O_4 near 125 K and is accompanied by other anomalies on the magnetic, electric, thermodynamic properties in the solid. The T_v tends to be suppressed due to the degradation in crystallinity of Fe_3O_4 upon size reduction. In this paper, Fe/Fe_3O_4 nanocomposites were prepared by high energy ball milling and subsequently heat treated under flowing of (O_2 + N_2) gas to address the question of whether or not T_v could be observed. Structural and magnetic properties changes of M10 and M30, corresponding with oxygen concentrations of 10 and 30 % volume, were characterized by X-ray diffraction, and SQUID magnetometer. The X-ray diffraction data show that the Fe_3O_4 phase coexists with Fe and their volume fraction increases in sample M30 relative to sample M10. The field dependent magnetization measurement show that the decrease in Ms in sample M30 as compared to M10 is consistent with the fact that Fe volume fraction decreases while Fe_3O_4 volume fraction increases. Interestingly, we observed a sharp Vervey transition near 125 K in the temperature dependent magnetization curves. The degree of magnetic interaction between two Fe and Fe_3O_4 phases as well as the individual contribution of Fe_3O_4 to T_v also analysed and discussed.

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P4-20

HIGH TEMPERATURE MEMORY EFFECTS IN MAGNETIC NANOPARTICLES

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Magnetic properties and behaviour of nanoparticle system can be tailored by tunning the degree of interparticle interactions. Due to this possibility, nanoparticle materials have become a promising candidate for a new kind of storage media based on thermaly induced memory effects. In this study, we have investigated magnetic memory effects and possibility of thermal inscription of digital data in iron oxide nanoparticles obtained by polyol method. Synthesis method was modified in order to allow control of particle agglomeration and consequently the strength of interparticle interactions. Structure, morphology and the degree of agglomeration of the nanoparticles were studied by XRD, TEM and DLS techniques, while magnetic properties and memory effects were measured by MPMS XL5 SQUID magnetometer.

Results of the study confirmed that in super spin glass magnetite nanoparticles magnetic memory effects can be observed at much higher, industry accessible temperatures in comparisson to spin glasses and other glassy materials. Procedures of writing and reading of digital information were demonstrated and discussed in details.

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P4-21

PHONON-ASSISTED TRANSPORT THROUGH CAPACITIVELY COUPLED AHARONOV-BOHM INTERFEROMETERS

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Transport through a pair of wires attached to two electrostatically coupled Aharonov-Bohm rings, each of which contains embedded noninteracting and interacting dots in the presence of local vibrational modes is considered. We examine the impact of phonons on Coulomb induced transfer of conductance and thermopower oscillations between the rings. Both cases of infinite and finite Coulomb interactions are discussed. The analysis is carried out with the use of the mean field slave boson Koliar-Ruckenstein approach and complementary by the equation of motion method. Variation of the main Fano-Kondo peaks and phonon satellites with magnetic field and electron-phonon coupling are analyzed. The amplitude of A-B oscillations decreases with the increase of coupling with phonons. The magnitude and the sign of the thermopower can be changed not only by magnetic field or gate voltages, but also by coupling with local vibrations.

P4-22

PREPARATION AND CHARACTERIZATION OF $La_xAg_{1-x}MnO_3$ MAGNETIC SUSPENSIONS FOR SOFT HYPERTHERMIA

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Ferromagnetic order in perovskite type manganites originates from the double exchange interaction between Mn^{3+} and Mn^{4+} ions and its strength depends mainly on the average oxidation number of manganese ions and average size of cation replacing La in the lattice.

$La_xAg_{1-x}MnO_3$ magnetic nanoparticles are well known for the possibility to tune their Curie temperature T_C up to room temperature in a controlled way by doping in La positions of the lattice by silver ions [1]. The value of T_C is significantly influenced by the process of synthesis and heat treatment together with other important physical characteristics such as the particle shape and size distribution. We will compare two series of samples of the same chemical composition prepared by glycine nitrate method, in one series NH_4NO_3 was added to increase porosity of the sample and avoid forming of agglomerates. The Curie temperature was found to change from about 115 K for as prepared sample with orthorhombic crystal structure symmetry group *Pnm*a up to 318 K for the samples annealed at 800 °C for 48 hours with rhombohedral crystal structure symmetry group $R\overline{3}c$. The effective magnetic moment changes from 4.38 μ_B for $La_{0.70}Ag_{0.25}MnO_3$ / $(NH_4)(NO_3)$ compound annealed at 800 °C for 1 hour up to 5.31 μ_B for $La_{0.80}Ag_{0.15}MnO_3$ / $(NH_4)(NO_3)$ compound annealed at 800 °C for 12 hours. Magnetic particles were processed by ball milling and consequently covered by silica in order to obtain suspension suitable for magnetic hyperthermia. Field dependence of magnetization taken from nanoparticles shows very small almost negligible coercive field and remnant magnetization for the whole series.

Acknowledgement This work was supported by the Slovak Research and Development Agency under contract SK-SRB-18-0066 and by VEGA 2-013719.

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P4-23
Withdrawn

P4-24

STUDY OF THE DYNAMIC BEHAVIOR OF VORTICES DEPENDING ON THE CURVATURE OF CONFINEMENT

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Magnetic properties of micro- and nanoscale samples are strongly dependent on confinement. In magnetic nanodots of cylindrical shape the influence of sample surface leads to stabilizing magnetic vortex as a ground state [1]. Magnetic vortex as a ground state is also observed in samples with different shapes, e.g. in 3D structures - nano cups [2]. It was shown that the resonance properties of such structures can be classified as vortex core translational mode (gyrotropic) and standing modes outside the vortex core (spin wave states with azimuthal or radial quantizations) [1, 3]. There is an interest to control vortex dynamics from an application point of view, e.g., in STNO [4]. However, in spite of trend to transfer from planar 2D magnetic structures to 3D curved shapes [2], the research on the influence of curved confinement on magnetic vortices dynamics is practically not present.

The goal of our research described in this paper is to explore the possibility of control vortex dynamic by curvature confinement of the magnetic sample. The study is performing by analysis of time behaviour of space-dependent magnetization (micromagnetic simulation in MuMax3) after excitation of the system by the external in-plain wide-band pulse. Curvature parameter of 2nd power function allowed to define the homogeneous transfer of study structure from cylindrical shape to conic one. Spectral analysis and analysis of spatial distribution of selected eigenoscillations of specific modes is made with the use of Fourier transform of out of plain magnetization dynamics behaviour at each point of the mesh. Our further study focused on research of sample curvature influence of frequencies of vortex modes.

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P4-25

VALENCE BAND OF MANGANESE TELLURIDE

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MnTe is an old material endowed with a new twist owing to the emerging field of antiferromagnetic (AFM) spintronics [1]. In seventies, bulk crystals of this semiconductor were explored while thin epitaxially-grown layers are in focus more recently [2]. Motivated by measured transport properties, which may further sensitively depend on strain [3], we develop an effective model of the valence band in MnTe based on input from ab initio calculations. (As a matter of fact, nearly all available experimental data are on p-doped samples.)

Until very recently, the common understanding was that the valence band maximum (VBM) occurs close to the A-point of the Brillouin zone (BZ). This view has been challenged [3] and we start by arguing that the picture put forward in this reference is flawed. As a new argument, we compare our ab initio calculations with photoemission spectra [4] (additionally, our DFT+U band structure can be validated against QSGW including the spin-orbit effects). We show how the band structure depends on lattice constants of the material within the range of variations implied by temperature and/or choice of substrates used for epitaxial growth of thin layers [2]. Importantly, the top of the valence band may move to the vicinity of the BZ centre only under very special circumstances.

Next, we develop a k.p model from symmetry arguments and discuss the role of spin-orbit interaction. Interestingly, we find large splittings of the order of 1 eV when magnetic moments are oriented out of plane which could be the origin of strong in-plane magnetic anisotropy. Using Kubo formula, we calculate the transversal component of the anisotropic magnetoresistance (AMR) and compare it to results of Ref. [3].

It turns out that the valence band of MnTe is more complex than that of most other common semiconductors. We conclude that modest strain can change the global VBM and this in turn, has a strong influence on measurable quantities such as [2] recently measured AFM AMR.

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5 LOW-DIMENSIONAL MAGNETIC MATERIALS, MOLECULAR MAGNETS AND FERROFLUIDS

O5-01

PHASE BOUNDARY RESIDUAL ENTROPY AND FINITE TEMPERATURE PSEUDO-TRANSITION FOR ONE-DIMENSIONAL MODELS

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Recently was observed clues of pseudo-critical temperature in one-dimensional spin models, such as the Ising-Heisenberg spin models, among others, exhibiting the pseudo-transitions. Here we report an intrinsic relationship between the zero-temperature phase boundary residual entropy and pseudo- transition. Usually, the residual entropy increases at the phase boundary, which means the system becomes with more accessible states in the phase boundary compared to its adjacent states. However, this is not always the case; there are some phase boundaries where the entropy remains equal to the largest residual entropy of the adjacent states. Therefore, we propose the following statement at zero temperature. If the phase boundary residual entropy is continuous at least from the one-sided limit, then the analytic free energy exhibits a pseudo-transition at finite temperature. This condition would be essential to study more realistic models. Just by analyzing at zero temperature behavior of the residual entropy, we can know whether the system will exhibit pseudo-transition. To illustrate our argument, we use a couple of examples of Ising-Heisenberg models to show the pseudo-transitions behaviors due to the phase boundary residual entropy continuity. These are a frustrated coupled double tetrahedral chain and an unfrustrated diamond chain.

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O5-02

RING-SHAPED MAGNETIC MOLECULES WITH COMPETING INTERACTIONS: COEXISTENCE OF FRUSTRATION AND BIPARTITENESS

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Many phenomena observed in recently synthesized molecular clusters are related to competing interactions of magnetic ions. They are revealed in many systems, including the ring-shaped homo- and heterometallic molecules, and can be characterized in terms of quantum spin models. Some of these finite spin systems are bipartite (in the sense of Lieb-Mattis theorem, LMT) and geometrically frustrated, at least in the well-determined domains of Hamiltonian parameter(s) and for limited system sizes [1,2]; this coexictence is excluded for infinite lattices. Therefore, the so-called Lieb-Mattis Level Order (LMLO) is present. However, strict algebraic results and many numerical calculations show that the LMLO is also present for larger wheels and outside the above mentioned domains. The other characteristic feature is a sequence of the total spin numbers and the presence of a non-trivial (and non-vanishing in the classical limit) domain of the Hamiltonian parameters in which competing interactions do not inluence the total spin number–it is identical as for the non-frustrated systems, i.e., in the absence of interaction competitions.

We have started systematic study of the ground state sequences relevant for the Kahn degeneration problem in the molecular rings and centered cycles with uniform local spin values [1], and we want to present some new developments here, considering among others the effects of non-uniform spins and a wheel topology. It is shown that large central spin may modify a sequence of the ground state spin numbers. On the other hand, the recent experimental findings have confirmed that such systems satisfy restrictions imposed by the LMT [2].

Taking this class of rings as the paradigmatic example we consider other properties of analogous systems such as the Kahn degenerate frustration or steps and plateaus in magnetization The findings are applicable to both the low-spin and the high-spin magnetic complexes, i.e. may help in tailoring emergent materials for storage and quantum information processing or magnetic field driven cooling.

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O5-03

TUNING THE THERMAL ENTANGLEMENT IN A ISING-XXZ DIAMOND CHAIN WITH TWO IMPURITIES

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We study the local thermal entanglement in a spin-1/2 Ising-XXZ diamond structure with two impurities. In this spin chain, we have the two impurities with an isolated XXZ dimer between them. We focus on the study of the thermal entanglement in this dimer. The main goal of this paper is to provide a good understanding of the effect of impurities in the entanglement of the model. This model is exactly solved by a rigorous treatment based on the transfer-matrix method. Our results show that the entanglement can be tuned by varying the impurities parameters in this system. In addition, it is shown that the thermal entanglement for such a model exhibits a clear performance improvement when we control and manipulate the impurities compared to the original model without impurities. Finally, the impurities can be manipulated to locally control the thermal entanglement, unlike the original model where it is done globally.

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O5-04

TUNING OF PHYSICAL PROPERTIES OF $Fe_7(PO_4)_6$ BY SODIUM INTERCALATION

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The iron phosphates with open framework structure are composed of the earth-abundant elements and are of interest due to their catalytic properties in various chemical reactions and gas separation. Besides, these compounds are in the focus in sodium iron batteries research. The intercalation of alkali ions into the pores of crystal structure itself represents a kind of scientific philosophy when the physical properties of a substance can be radically alternated/tuned by an introduction of another material. The guest not only contributes to the overall property but changes the basic features of the host.

The sodium intercalation of mixed – valence iron phosphate $Fe_3^{2+}Fe_4^{3+}(PO_4)_6$ results in drastic transformation of its physical properties. The parent compound $Fe_7(PO_4)_6$ reaches magnetically ordered state through succession of phase transitions at $T_{N1} = 45.5$ K and $T_{N2} = 16$ K marked by sharp singularities in both specific heat C_p and magnetic susceptibility χ. The introduction of sodium suppresses the formation of antiferromagnetic state down to $T_N = 33$ K in $Na_{0.65}Fe_7(PO_4)_6$. The low temperature phase transition in this compound smears being substituted by broad anomalies in magnetization and specific heat related to the spin/charge disorder effects. The sharp well resolved electron spin resonance spectra in parent material transform into asymmetric broad line in sodium – intercalated substance. The dielectric permittivity ε of $Fe_7(PO_4)_6$ demonstrates a kink at T_{N2}, while no singularity marks T_{N1}. No features accompany magnetic phase transition in dielectric property of $Na_{0.65}Fe_7(PO_4)_6$ but ε reaches the relaxation maxima at high temperatures which can be attributed to the freezing of sodium ions [1].

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O5-05

QUANTUM ENTANGLEMENT IN SPIN-1/2 MOLECULAR NANOMAGNETS WITH TRIANGLE-BASED GEOMETRY

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Molecular nanomagnets constitute a highly interesting class of magnetic systems and offer a variety of intriguing properties. Some of them emerge due to the presence of magnetic frustration in the system, resulting from interplay of geometry and magnetic interactions. For example, the triangular geometry with antiferromagnetic couplings is known to be favourable for the appearance of frustration.

One of the interesting examples of molecular magnets with triangle-based geometry is V6 polyoxovanadate [1], where the magnetic vanadium ions form two weakly coupled triangles with antiferromagnetic interactions. Another example belonging to that class is Cu5 [2] in which two corner-sharing spin triangles with antiferromagnetic interactions form a hourglass-like structure. In both cases the metal ions carry quantum spins $S = 1/2$.

The aim of the present paper is to characterize the quantum entanglement within spin pairs for the two mentioned molecular nanomagnets. The study is based on exact diagonalization approach within the framework of canonical ensemble. The quantum Heisenberg model with coupling constants taken from the experiment is used to capture the physics of spin-spin interactions in the studied systems.

The quantum entanglement within spin pairs is quantified using the Wootters concurrence [3]. The behavior of this quantity is studied as a function of the temperature and the external magnetic field. For V6, the robustness of entanglement within the triangles up to the temperature of the order of a few tens of K is predicted and the significant effect of the external magnetic field is shown. For the case of Cu5, the entanglement is present between all the spin pairs, whereas its magnitudes and robustness vs. temperature and magnetic field is rather diverse. The entangled states present in molecular nanomagnets may find crucial applications in quantum computing [4].

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O5-06
MULTIFUNCTIONAL MOLECULAR MAGNETS BASED ON OCTACYANOMETALLATES: MAGNETOCALORIC EFFECT

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A strong motivation for the synthesis of molecule-based materials is the merging of multifunctionality into these systems. The key materials in the field of molecular magnetism are octacyanometallate- based compounds displaying a rich pallet of interesting physical and chemical properties. One of the functionalities of the octacyanometallate-based coordination polymers is the magnetocaloric effect (MCE).

In this report, we will present the results of MCE obtained for the family of the ferrimagnetic Mn_2-L-$[Nb(CN)_8]$ (L= bridging ligand: pyridazine, imidazole, pyrazole) compounds showing ordering temperatures within the broad T_c range (24 K - 98 K). Among these compounds, one can find examples of magnetic sponges and material sensitive to the application of hydrostatic pressure. Using the MCE results obtained for compounds with different T_c, due to dissimilar ligands or other phases of the material, the $\Delta S_m \sim T_c^{-2/3}$ relation stemming from the molecular field theory was confirmed. The temperature dependences of the n exponent characterizing the dependence of ΔS on ΔH have been also analyzed. The $n(T_c)$ values- consistent with the shape of the magnetization curves, as well as values of critical exponents β, γ and δ allowed to classify these particular compounds to 3D Heisenberg universality class.

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O5-07

EFFECT OF THE INTERLAYER SPECIES AND INTERACTIONS ON MAGNETIC BEHAVIOUR OF Co(II)-CONTAINING LAYERED DOUBLE HYDROXIDES

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Layered double hydroxides (LDHs) are composed of positively-charged mixed metal M^{II}-M^{III} hydroxide layers with change-compensating anions and water molecules intercalated into interlayers. The metal cations in the hydroxide layers are coordinated by six hydroxyl ions in such a way that O-H bonds are perpendicular to the plane of the layers. LDHs are natural examples of immensely flexible chemical structure, in which the M^{II}/M^{III} cations ratio can vary between about 1 and 4, thereby providing a wide range of the layer charge per formula unit. This and other features of LDHs allow non-destructive change of the chemical composition via anion exchange with various species different in nature, size, charge, and in a way of the interlayer arrangement.

LDHs containing magnetic cations in the mixed metal hydroxide layers are of interest as available and suitable objects for experimental modelling of 2-D quantum magnets [1].

Here we report on a systematic study of magnetic properties of $Co^{II}Al^{III}$ LDHs intercalated with different inorganic and organic anions that allowed to obtain a series of compounds with the interlayer height values from about 0.3 to 1.2 nm. Magnetization of these LDHs was measured as function of temperature and frequency of magnetic field. The characteristic parameters were found to correlate with the interlayer distance. The observed unusual behaviour of their effective magnetic moment has been associated with the features of temperature fluctuations of the O-H bonds.

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O5-08

LOW-DIMENSIONAL FERROMAGNETISM IN SODIUM NICKEL PHOSPHATES $Na_5Ni_2(PO_4)_3$ (H_2O) AND $Na_6Ni_2(PO_4)_3OH$

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This work reports the magnetic properties of two novel sodium nickel phosphates representing the rare case of Ni^{2+}-based magnetic systems with dominating FM interactions. $Na_5Ni_2(PO_4)_3{\cdot}H_2O$ (**I**) and $Na_6Ni_2(PO_4)_3OH$ (**II**) are quasi-one-dimensional FM showing two different exchange topologies: the spin chain and spin ladder, respectively. The temperature dependence of magnetic susceptibility of $Na_5Ni_2(PO_4)_3{\cdot}H_2O$ does not show any anomalies down to 2 K, while the temperature dependence of specific heat exhibits a clear hump at 4 K indicating the low-dimensional character of magnetic system. Exchange couplings obtained from ab initio calculations reveal two leading FM interactions, J_1 = - 21 K and J_2 = - 9 K, within the Ni1-Ni2 zigzag chain. Weak AFM interactions between the FM chains does not lead to a long-range magnetic order down to at least 2 K, implying $T_N/|J_1| < 0.1$, thus suggesting a more pronounced 1D than in any other FM spin-chain compound of Ni^{2+} reported to date. The $Na_6Ni_2(PO_4)_3OH$ experiences the AFM ordering at 2.65 K. Ab initio calculations and fitting of the experimental data evidence for forming FM dimers along rung of spin ladder with J_1 = - 5 K, while the AFM interactions J_2 = 15 K between the FM dimers lead to an overall AFM order below 2.5 K. The observed in both compounds unusual magnetic behavior is dictated by the peculiarities of crystal structure. Specifically, the FM interaction J_2 in $Na_5Ni_2(PO_4)_3{\cdot}H_2O$ at 106.4^o of Ni^{2+}-L-Ni^{2+} bridging angle is well above the crossover value, which according to the Goodenough-Kanamori-Anderson (GKA) rules is 96^0. Even more surprisingly, J_2 in $Na_6Ni_2(PO_4)_3OH$ is only weakly AFM, despite the fact that the bridging angle exceeds the crossover value by 24^o. These imply that the FM nature of J_2 is enhanced through additional structural features beyond the Ni-O-Ni links. The PO_4 bridges may play the role by creating additional superexchange pathways not accounted for by the GKA rules.

O5-09

COMPARISON OF STRUCTURAL PROCESSES IN MAGNETIC FLUIDS BASED ON TRANSFORMER OILS

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Magnetic nanoparticles $FeO.Fe_2O_3$ in magnetic fluids created new structures whose size and shape dependent on an applied magnetic field. The next important factor is type of carrier liquid. In this contribution we compare the structural changes in three type of transformer oils–based (ITO, TECHNOL, MOGUL) and water–based magnetic fluids upon an effect of a magnetic field and temperature by the acoustic spectroscopy. The comparison was made for three different time development of the magnetic field: a step change to constant value, linear increase or decrease and an application of constant magnetic field with change of its orientation to the acoustic wave. At step change of the magnetic field was observed slow and quick change of the acoustic attenuation. At slow change (TECHNOL, MOGUL) a stabile value of the acoustic attenuation was reached after 20 minutes. After switch off magnetic field an immediate decrease of the acoustic attenuation was observed only for ITO- and water-based magnetic fluids. At linear changes of the magnetic field the structural processes were step-by-step and a hysteresis effect was observed. The max value of the acoustic attenuation depended on the type of magnetic fluid, slow was for MOGUL and water, the highest was for ITO. The effect of anisotropy of the acoustic attenuation was observed at all types of magnetic fluids and from its analyzation the radius, the number density of the nanoparticles structures, and some other parameters of magnetic nanoparticles were determined. The biggest structures were created in TECHNOL and MOGUL. The type and size of structures created in the magnetic field in the investigated magnetic fluids are discussed in terms of application.

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P5-01

DIELECTRIC BREAKDOWN DRIVEN BY MAGNETIC FIELD IN GRADUALLY AGED FERROFLUID

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The study deals with a specific problem of the magnetic field impact on the breakdown strength (BDS) in gradually aged ferrofluid (FF). The examination were conducted on the samples containing a certain volume of the mineral oil with several volume concentrations of iron oxide superparamagnetic nano-scaled particles. The surface modification was performed by the oleic acid.

It is known that certain concentrations of the particles in dielectrical insulating oil can improve its electrical withstanding capability. However, the improvement yields specific operational conditions. In the context of the current research effort we report more complex study where external magnetic field was applied in BDS tests conducted with the FF thermally aged for three consecutive, 200-hours aging periods. At the end of the particular period, the measurements of BDS were conducted. During the measurements, the DC low-level external magnetic field was applied. The measurements followed recommendations of the international standard IEC 60156, however, due to smaller volume of available ferrofluids, the modified testing cell arrangement was designed, Fig. 1. The interaction of diluted particles with external electric and magnetic field resulted in change of the expected breakdown voltages. We present the BDS variations in dependence on two-parameters: the thermal aging and application of external magnetic field, respectively. The ability of the particles acting as space charge scavengers was observed at each stage of the experiment. Measurements were analyzed statistically. Finally, the study shows that the external magnetic field improves electrical withstand capability of thermally aged ferrofluids based on transformer oil.

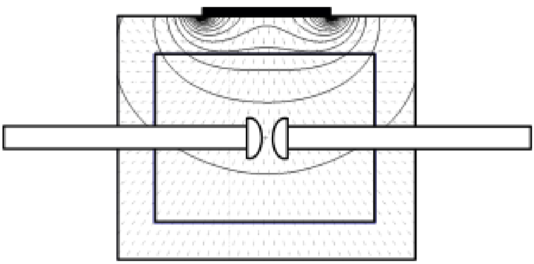

Figure 1: AC BDS test cell with attached neodymium magnet, top view, and magnetic field distribution

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P5-02

SMALL ANGLE X-RAY SCATTERING STUDY OF MAGNETIC NANOFLUID EXPOSED TO ELECTRIC FIELD

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Magnetic nanofluids are known for their fascinating combination of fluidity and magnetism. The intuitive interaction of dispersed magnetic nanoparticles with magnetic field results in various nanofluid structural phenomena. When based on non-polar insulating liquids, the nanofluid structural macroscopic patterns can be induced even by an electric field, as observed optically and by Small Angle Neutron Scattering (SANS) technique [1]. In this paper, we report on the investigation of a transformer oil-based magnetic nanofluid exposed to an electric field by means of synchrotron Small Angle X-ray Scattering (SAXS). Two types of SAXS experiments were carried out. In the first one, the electric field up to 6 kV/cm was generated in the nanofluid between two immersed electrodes (contact mode). The other experiment focused on the nanofluid in an external electric field up to 10 kV/cm, when the electrodes were not in a direct contact with the nanofluid, but fixed out of the sample holder (non-contact mode). It was found that in the available momentum transfer range q (0.02 – 4.5 nm^{-1}), the non-contact mode has no effect on the scattering intensity. On the other hand, the contact mode yielded noticeable low-q intensity variations. However, in comparison to SANS, the SAXS study did not prove the proportional increase in the low q scattering intensity with increasing electric field, but rather stochastic variations. The observed intensity variations can be associated with the local structural nanofluid changes caused by the induced electrohydrodynamics. To point out the favorable conditions for electrohydrodynamics in the studied magnetic nanofluid, we also present dielectric properties of the transformer oil and the magnetic nanofluid.

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P5-03

HUBBARD DIMER WITH ELASTIC INTERACTIONS. STUDIES OF THERMAL EXPANSION, MAGNETOSTRICTION AND ELECTROSTRICTION

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The dimer (pair cluster) is studied within the framework of the extended Hubbard model and the grand canonical ensemble. The cluster constitutes an open electronic system and is embedded in the external magnetic (H) and electric (E) fields. For such a system the Hubbard Hamiltonian is diagonalized exactly [1]. In addition, the elastic interatomic interactions are taken into account in a form of the Morse potential. The thermal vibrational energy of the atoms is also included in the quasiharmonic approximation.

The complete description of the thermodynamic and statistical properties is based on the construction of the total grand potential. In particular, the equation of state is derived, providing a relationship between the relative deformation of interatomic distance (ε), temperature (T), and the external fields: H and E. The method is suitable for the arbitrary concentration of the electrons physically possible in the open system in question.

The numerical results are obtained for the half-filling case, when the mean number of electrons per atom is equal to one. For this purpose, the chemical potential of electronic system is calculated. It is shown that in the presence of elastic interactions and the nearest-neighbour Coulomb repulsion, the chemical potential for half-filling is no longer constant, but it depends on T, H and E.

In equilibrium state, the cluster deformation ε, as well as its derivatives, are studied as a function of temperature T and the fields H and E. In particular, the thermal expansion and such effects as magnetostriction or electrostriction are examined for arbitrary temperature, in a wide range of Hamiltonian parameters.

A special attention is paid to the low-temperature region, where discontinuous changes of the quantities are found in the points corresponding to the quantum phase transitions from singlet to triplet states. In the high-temperature region, the cluster size deformation, as well as the magneto- and electrostriction coefficients, are presented in a form of contour plots on the (H,E)-plane. The areas, where negative values of the magneto- and electrostriction coefficients do occur, are identified for various temperatures and Hubbard energy parameters U. A thorough discussion of the results is made.

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P5-04

EXPERIMENTAL STUDY OF THE MAGNETOCALORIC EFFECT IN [Ni(fum)(phen)] – THE FERROMAGNETIC DIMER WITH SPIN 1

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The title compound [Ni(fum)(phen)] (NIFUM) (fum = fumarato, phen = 1,10 - phenanthroline) crystallizes in the monoclinic structure, P2/c space group. The crystal structure exhibits two-dimensional character. The formed layers are built of Ni(II) dimers linked by bridging fumarato ligands. Both Ni(II) atoms are hexa-coordinated in the cis-NiO_4N_2 form. The layers are interconnected by π–π interactions operating between aromatic rings of the phen ligands. NIFUM has been previously identified as the array of antiferromagnetic S = 1 dimers with the easy-axis uniaxial magnetic anisotropy D comparable to the intradimer exchange coupling J, $D/J \approx 1$ and $D/k_B = 6$ K [1]. Heat capacity measurements taken on NIFUM have shown the absence of any kind of magnetic phase transition down to 0.4 K in zero magnetic field. Magnetocaloric studies have been performed on powder sample NIFUM in the temperature range from 1.8 K to 44 K in magnetic fields up to 7 T using isothermal magnetization curves measured in a commercial Quantum Design SQUID magnetometer. Large conventional magnetocaloric effect was found around 5.8 K ($-\Delta S_{max} = 8.2$ J/(kg K) for 7 T). The analysis of magnetocaloric effect in NIFUM has shown that the temperature dependence of the isothermal entropy change under different magnetic fields is in good agreement with theoretical predictions for the S = 1 ferromagnetic dimer with $D/k_B = -12$ K, $E/k_B = -3.5$ K and intradimer exchange coupling $J/k_B = 3$ K. Theoretical analysis of MCE revealed that the presence of ferromagnetic coupling improves the MCE properties. Investigation of magnetocaloric properties of NIFUM suggests that the studied system can be considered as a good material for magnetic cooling at low temperatures.

This work was supported by the projects APPV-14-0073, VEGA 1/0255/19 and VEGA 1/0269/17.

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P5-05

INTERLAYER DZYALOSHINSKII-MORIYA INTERACTIONS IN A QUASI-TWO-DIMENSIONAL SPIN 1/2 ANTIFERROMAGNET $Cu(en)(H_2O)_2SO_4$

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Cu(*en*)$(H_2O)_2SO_4$ (*en* = $C_2H_8N_2$) (CUEN) was originally identified as a quasi- two-dimensional easy-plane antiferromagnet with spin ½ on the spatially anisotropic triangular lattice [1]. Recent experimental and theoretical study established CUEN as a representative of a Heisenberg model on a zig-zag square lattice [2]. This picture suggested by *ab-initio* calculations, was corroborated by finite-temperature quantum Monte-Carlo simulations and single-crystal measurements of specific heat, susceptibility and magnetization. Symmetry analysis of magnetic layers indicated only the presence of symmetric spin anisotropies and anticipated an easy-axis within the easy plane. The easy-axis was identified experimentally through the observation of a spin-flop transition in a magnetic field 200 mT applied along the b-axis. The emerging picture of a *collinear* antiferromagnet with the two intralayer symmetric anisotropies is consistent with most of the data, but some issues remain unexplained. The differences in susceptibility measured in the field-cooling and zero-field-cooling regimes, the susceptibility peak below the Neel temperature [2], and the observed hysteresis in a field along the b-axis [3] suggest the presence of hidden spin canting. Spin canting is usually produced by antisymmetric Dzyaloshinskii-Moriya spin interactions (DMI), which are allowed for the *interlayer* couplings [1]. Here we analyze the *interlayer* DMI in detail and elucidate its role. We show that the DMI in CUEN should not lead to spin canting, and emphasize the need for an alternative explanation of the experiment, which is also shortly discussed.

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P5-06

POWDER SAMPLE SUSCEPTIBILITY FOR SINGLE ION MAGNETS WITH S = 1 AND 3/2 AND WITH RHOMBIC ANISOTROPY

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Powder sample magnetic susceptibility is one of the widely used characteristics of magnetic materials. It provides information about the directionally averaged magnetic moment of a magnetic compound. Unless the intrinsic interactions are isotropic it is not simple, if not impossible, to extract a detailed description of these interactions. Working out exact formulae for the powder magnetic susceptibility is a crucial step in solving the issue.

Here we report exact expressions for the temperature dependence of the powder susceptibility of the single-ion magnets with integer (S=1) and half-integer (S=3/2) spin displaying axial and rhombic local anisotropy and characterized by the isotropic spectroscopic tensor. In the case of the single-ion magnet with spin S=1 it is in general possible to extract both anisotropy parameters D and E from the powder susceptibility data. Moreover, the procedure based on the low-temperature behaviour of the susceptibility signal, which effectively reduces the number of anisotropy parameters, is proposed. By contrast, in the case of the single-ion magnet with S=3/2 it is explicitly demonstrated that the powder susceptibility depends on the combined anisotropy parameter $\Delta = \sqrt{D^2 + 3E^2}$, precluding the full resolution of the axial and rhombic anisotropy constants.

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P5-07

MAGNETIC PROPERTIES OF BiOCl:Ti AND BiOCl:Sm SINGLE CRYSTALS

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The activated BiOCl:Ti4+ and BiOCl:Sm2+ single crystals were grown by the method of chemical gas transport reaction in closed volume. The $TiCl_4$ and $SmCl_2$ was used as activators. Water vapor was used as the transport agent.

The *BiOX* materials possess the Matlockite (*PbFCl*) type tetragonal crystal structure with *P4/nmm* (No. 129) as the space group. The Ti^{4+} and Sm^{2+} ions in *BiOCl* matix are coordinated to four oxides and four + one chlorides in a distorted monocapped tetragonal antiprism arrengement yielding C_{4v} as the point symettry of the Bi^{3+}, Ti^{4+} and Sm^{2+} site.

Magnetic susceptibility measurements were carried out between 2 and 300 K singlecrystalline samples weighing between 2 and 8 mg with a Quantum Design MPMS SQUID magnetometer using an applied magnetic field of 100 Oe.

The temperature dependence of the inverse magnetic susceptibility of $BiOCl{:}Ti^{4+}$ is complex: characteristic to a Cuire-Weis paramagnet at high temperatures, constant for the lower temperature range between 125 and 15 K and then sharply decreasing below 10 K.

The complex behaviour for $BiOCl{:}Sm^{2+}$ is probably due to the strong mixing of the crystal field componrnts of the first excited free ion $^6H_{7/2}$ level with those of the $^6H_{5/2}$ ground one.

The fitting C and θ parameters of Cuire-Weiss law and effective magnetic moments μ_{eff} of $BiOCl{:}Ti^{4+}$ and $BiOCl{:}Sm^{2+}$ are present in table.

BiOX	C (emuKmol^{-1})	θ (K)	μ_{eff} (μ_B)
BiOCl	23.56	-3022	4.31
BiOCl:Ti^{4+}	45.56	-4054	6.04
BiOCl:Sm^{2+}	22.21	-1853	4.2

P5-08

FIELD INDUCED VERSUS LOCAL ANISOTROPY IN SINGLE ION MAGNETS

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The aim of this research is to compare the anisotropies in a system containing isolated magnetic centers produced by two independent effects. The first one is the interaction of an otherwise isotropic ion with the external magnetic giving rise to the field induced anisotropy (FIA). The other one is due to the local interaction with the ligand field known as the zero field splitting (ZFS). Integer and half integer spins are considered. Field induced anisotropy is of the easy-plane character and, under the constraint of $g\mu_B SH=D$, it is inferior to that due to ZFS except for the case of the half integer spin at the lowest temperatures. At high temperature the anisotropy vanishes independent of the spin parity as expected.

P5-09

MECHANICAL PROPERTIES OF $Cu(en)(H_2O)_2SO_4$ – A LOW-DIMENSIONAL QUANTUM MAGNET WITH SPIN 1/2

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The two-dimensional S = ½ Heisenberg antiferromagnetic system on a square lattice represents an important paradigm in the low-dimensional quantum magnetism. In the presence of the spatial anisotropy of the exchange coupling between the nearest neighbours, various lattices can be derived.

Our previous study found that $Cu(en)(H_2O)_2SO_4$ (en = $C_2H_8N_2$) represents the realization of the Heisenberg model with spin ½ on a zig-zag square lattice [1]. A complex analysis of experimental heat capacity, magnetic susceptibility and magnetization including ab-initio and quantum Monte Carlo simulations provided the value of the antiferromagnetic exchange coupling within the zig-zag chains, $J/k_B \approx 3.5$ K, which are bonded by the antiferromagnetic interchain exchange coupling, $J' = 0.35J$ [1].

Current work is focused on the investigation of the lattice subsystem in $Cu(en)(H_2O)_2SO_4$ - the metal-organic structure composed of covalent chains packed to three-dimensional structure via the net of hydrogen bonds. For that purpose, heat capacity of $Cu(en)(H_2O)_2SO_4$ was measured from 2 to 30 K in the zero magnetic field and elastic constants were determined using the nanoindentation method. Various approaches were used to extract the lattice contribution to specific heat from which the average value of Debye temperature was estimated. The analysis of the lattice contribution using a three-dimensional Debye function provided the temperature dependence of Debye temperature. The obtained values are in good agreement with the Debye temperature derived from the elastic constant obtained from the application of nanoindentor along the *b*-axis and the values from *ab-initio* calculations. In addition, the values coincide with temperatures where electron paramagnetic resonance spectra significantly change due to phonon contribution [2].

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P5-10

MAGNETIC AND MAGNETOCALORIC PROPERTIES OF Gd_2MoO_6

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The experimental study of the specific heat, magnetic susceptibility and magnetization of Gd_2MoO_6 powder sample was performed in the temperature range between 0.4 K and 300 K in the magnetic fields up to 9 T. Powder sample was prepared via nonconventional mechanochemical/thermal process from powdered oxide precursors [1]. Gd_2MoO_6 crystalize in a monoclinic system with a unit cell parameters, $a = 16.527$ Å, $b = 11.184$ Å, $c = 5.420$ Å, $\beta = 108.438°$ and $V = 950.4$ Å^3. It was discovered that the product creates a spherical and nonuniform nanoparticles of various sizes from about 0.5 to 1 μm connected into agglomerates with bigger sizes. Magnetic ion Gd^{3+} with spin $S = 7/2$ is responsible for the magnetic properties. The specific heat study in zero magnetic field revealed two anomalies; a phase transition to the ordered state at $T_{c1} \approx 0.98$ K and a smaller maximum at $T_{c2} \approx 0.6$ K. Analysis of the inverse susceptibility data showed the Curie constant $C = 8.02 \pm 0.05$ emu K/mol corresponding to the value of the g factor, $g = 2.018$, and the Curie–Weiss temperature, $\Theta_{CW} = -6.41 \pm 0.01$ K. Relatively high magnetic density 6.85 g/cm^3 of Gd_2MoO_6 predetermines this compound as possible magnetocaloric material with high cooling performance at cryogenic temperatures. Large conventional magnetocaloric effect was found around 3 K with magnetic entropy change $-\Delta S_{max} \approx 38$ J/kg (260 mJ/K cm^3) for magnetic field change from 9 T down to zero with a refrigerant capacity of 333 J/kg. Maximal temperature change $-\Delta T_{ad} \approx 18$ K was found at $T_{init} \approx 24$ K. The theoretical calculation of the thermodynamic properties described with a finite number of Gd^{3+} ion will be presented.

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P5-11

FIRST - PRINCIPLES STUDY ON ELECTRONIC AND MAGNETIC PROPERTIES OF Sc-, Ti- AND Zn-DOPED GRAPHENE

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Graphene is an attractive candidate for the future generation of nanoelectronic and nanophotonic devices, gas sensors, biosensors, and batteries for energy storage. The fact that pristine graphene is not magnetic limits its application in areas such as magnetic storage and spintronics. However, recent theoretical and experimental results indicate that adsorption of metal adatoms and substitutional doping is a promising way to modulate the electronic properties and induce ferromagnetic state of graphene-based systems.

Using the density functional theory we study the properties of graphene sheets substitutionally doped with Sc, Ti and Zn atoms. In particular, the influence of metal doping on geometric structure, electronic structure and magnetic behaviour of graphene were analysed. The obtained results indicate that the optimized geometries show distortion on doping and the electronic structures are significantly modified. The ferromagnetic, antiferromagnetic and nonmagnetic states were investigated. Our study suggests that the intriguing properties arising from different doping could be useful in the future graphene-based magnetic devices.

P5-12

DIELECTRIC SPECTROSCOPY OF TWO CONCENTRATIONS OF MAGNETIC NANOPARTICLES IN OIL-BASED FERROFLUID

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The study of the changes of dielectric parameters leads to a better understanding of polarization and relaxation phenomena in ferrofluids. The impact of the electric field and magnetic flux density cause the changes in dielectric parameters and structural arrangement of magnetic nanoparticles in ferrofluid and this effect have been studied using by the dielectric spectroscopy. The frequency dependence of dissipation factor were measured within the frequency range from 1 mHz to 10 kHz at wide range of temperatures from -35 °C to 35 °C at the application of the magnetic flux density and the electric field by a capacitance method. The object of our study was the ferrofluid with two different concentration of magnetic nanoparticles in transformer oil MOL. The dielectrics parameters were measured at application parallel and perpendicular orientation of the magnetic flux density of value 200 mT to the electric field as a function of temperature. The Cole-Cole relaxation model was used to analyzing measured data. From this model basic dielectric parameters as a function of temperature were determinate at different fields.

P5-13

SAW INVESTIGATION OF STRUCTURAL CHANGES IN OIL-BASED MAGNETIC FLUIDS

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The surface acoustic waves (SAW) are used to study structural changes in transformer oil–based magnetic fluids under magnetic fields. The measurement of the attenuation of SAW propagating along magnetic fluid is showed as an effective tool to study such processes in the cases when the longitudinal acoustic wave is not available. The magnetic particles $FeO.Fe_2O_3$ in several volume concentration from 0.05 % up to 3.50 % were added to the transformer oil MOL. Both linear increasing magnetic field and jumped magnetic field were applied to study structural changes. The interaction between the magnetic field and the magnetic moments of the nanoparticles led to the aggregation of magnetic nanoparticles and following chain or cluster formation that had the influence on the value of the SAW attenuation. The measurement of the dependence of the acoustic attenuation on the angle between the magnetic field direction and acoustic wave vector (anisotropy) give additional useful information about the structure of magnetic nanoparticles formations. The temperature of magnetic fluids showed also very important influence on the structural changes because of the mechanism of thermal motion that acts against the cluster creation. Obtained results are compared and discussed.

P5-14

EFFECT OF MAGNETIC PARTICLES ON STRUCTURAL CHANGES AND MAGNETO-OPTICAL BEHAVIOR OF LIQUID CRYSTAL

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Structural changes in the nematic liquid crystal (6CHBT) doped with low concentration (1×10^{-4}; 5×10^{-5}; 1×10^{-5}) of magnetic nanoparticles caused by applied weak magnetic field in the increasing/decreasing mode, as well as pulsed-field change, are investigated by using surface acoustic waves (SAW) and magneto-optical effect. The structural changes were measured by the response of both SAW attenuation and optical transmission of the linearly polarized laser beam (532 nm) propagating through the sample. The role of the concentration of magnetic particles on structural changes and corresponding magneto-optical behavior concerning system stability and switching time under applied field was determined. The obtained results of both methods manifest an effective orientational coupling between magnetic moments of magnetic particles and the LC molecules.

P5-15
"STRUCTURE-MAGNETIC SUSCEPTIBILITY" CORRELATION OF BISMUTH OXYHALIDE SINGLE CRYSTALS

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The high-resolution X-ray powder diffraction patterns on the poly- and sing crystalline BiOX (X=Cl, Br, I) were measured. The BiOX materials possess the Matlockite (PbFCl) type tetragonal crystal structure with P4/nmm (No. 129) as the space group. There are two BiOX molecules per unit cell. The Bi^{3+} and halogen ions reside in the 2c (1/4, 1/4, z) position while the oxides lie in the 2a (1/4, 3/4, 0) position. The Bi^{3+} ion is coordinated to four oxides and four + one halogens in a distorted monocapped tetragonal antiprism arrangement yielding C_{4v} as the point symmetry of the Bi^{3+} site. Magnetic susceptibility measurements were carried out between 2 and 300 K single crystalline samples weighing between 2 and 8 mg with a Quantum Design MPMS SQUID magnetometer using an applied magnetic field of 10-100 Oe. The high temperature inverse susceptibility data were fitted to Curie-Weiss law $\chi = C/(T-\theta)$, where $C = N_A(\mu_{eff})^2/3k$ is the Curie constant , θ the Weiss constant, N_A Avogadro's number, μ_{eff} the effective magnetic moment, and k Boltzmann's constant. The high absolute values of θ for the Bi^{3+} ion suggest significant deviation from the the free ion Curie-type behavior (see table).

BiOX	C_{II} (emuKmol^{-1})	$C_{\perp}$ (emuKmol^{-1})	θ_{II} (K)	$\theta_{\perp}$ (K)	μ_{II} (μ_B)	μ_{II} (μ_B)
BiOCl	29.29	17.84	-3049	-2996	4.84	3.78
BiOBr	208.77	72.73	-5086	-3904	12.92	7.63
BiOI	25.18	46.53	-3224	-8147	4.49	6.10

P5-16

THE THERMAL RESPONSE OF MAGNETIC YARN TO THE APPLIED ALTENNANTIC MAGNETIC FIELD

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At present, there are several methodologies for the preparation of nanofibrous materials. We can include here, for example, solid phase extraction, attaching magnetic nanoparticles to polyelectrolyte bundles, linking magnetic particles by biotinized DNA fragments and others. One of the most popular techniques due to versatility and simplicity for fabrication of continuous polymer micro- and nanofibers is electrospinning. Nanofibrous materials prepared in such a way are widely studied in medicine and material engineering. Poly(vinyl butyral) (PVB) nanofibers were generated by a rod-shaped spinning-electrode. Nanofibers were modified by magnetic fluid (MF) added into the PVB solution. These magnetic nanofibers can be considered as material for magnetic hyperthermia applications, either as implants or for surface heating. The samples with various magnetic particle concentrations were tested in the alternating magnetic field (Fig 1). Immediate increase in temperature after field application was observed. The nature of the temperature rise is interesting; we can see a non-linear increase, which is in contrast to the rising temperature for pure magnetic fluid.

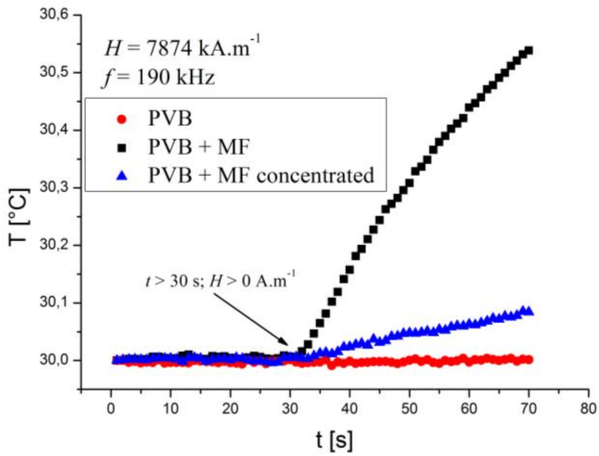

Fig. 1 Time dependence of temperature profiles for pure PVB and magnetically modified nanofibers

P5-17

EFFECT OF DC VOLTAGE RAMP RATE ON BREAKDOWN IN FERROFLUID BASED ON TRANSFORMER OIL

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The research on oil based ferrofluids has been growing rapidly in the last decades. Oil based nanofluids came up as a potential substitute of mineral oils, as an insulation and heat transfer fluid for high voltage equipment. The transformer oil based magnetic fluids (ferrofluid) may be regarded as the successor of transformer oil as they offer better dielectric properties. Although much research has been conducted in the field of ferrofluid based dielectrics, there are several challenges we face till today. In the paper we present DC breakdown as a variable depended on the voltage ramp rate at ambient conditions.

In presented experimental study the transformer oil based magnetic nanofluids were prepared by dispersion of Fe_3O_4 nanoparticles into the transformer oil. As a base MOGUL oil was used with various concentrations of nanoparticles with 0.05vol%, 0.15vol% and 0.35vol%. These ferrofluid samples and also pure transformer oil (MOGUL) were tested.

The DC breakdown voltage measurement was conducted in accordance with IEC 60897 by using a needle to sphere electrodes geometry. Carrier oil and ferrofluids were tested at negative polarity (needle) towards grounded sphere and then vice versa. By utilizing particular breakdown measurement method with a variable DC voltage ramp rate, a statistically large set of breakdown data was obtained. Data were collected as a function of negative DC voltage ramp rates 500, 750, and 1000 Vs^{-1}, respectively.

The test results showed that the higher the ramp-rate of DC voltage the higher the dielectric breakdown strength. It has been found that with the negative needle – grounded sphere geometry, there was dielectric breakdown at higher voltage than the other way around. Also, the effect of nanoparticles concentration in the oil on the increasing dielectric breakdown strength was observed.

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P5-18

SYNTHESIS AND MAGNETIC PROPERTIES OF HYDROPHILIC AND HYDROPHOBIC HYBRID NANOCOMPOSITE

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The magnetic properties of hydrophilic hybrid nanocomposite (multi-walled carbon nanotubes - MWCNTs modified with magnetite nanoparticles) and hydrophobic hybrid nanocomposite (multi-walled carbon nanotubes - MWCNTs modified with magnetite nanoparticles coated with oleic acid) were studied in the temperature range 2 – 290 K and magnetic field up to 6 T.

Hydrophilic hybrid nanocomposite synthesized through the co-precipitation method of magnetite preparation in the presence of MWCNTs was functionalized with oleic acid to attain hydrophobic hybrid nanocomposite.

Both samples were characterized morphologically, thermally and magnetically. Magnetite nanoparticles bounded to MWCNTs were close to spherical and the particle size was distributed from 10 to 25 nm, as observed by transmission electron microscopy. The thermogravimetric analysis of the hydrophobic hybrid nanocomposite revealed a strong interaction between oleic acid and nanoparticles. The hydrophobic as well as the hydrophilic nanoparticles exhibit a typical superparamagnetic behavior at room temperature. The magnetic measurements at 2 K indicate ferromagnetic behavior. The value of coercivity of hydrophilic or hydrophobic nanocomposites at 2 K is 0.018 T and 0.037 T, respectively. It was found that the presence of the bounded oleic acid results in the decrease in the magnetization of saturation, as compared to the hydrophilic nanocomposite. On the other hand, the hydrophobic nanocomposite exhibits higher values of real AC magnetic susceptibility measured at room temperature.

P5-19

EXPLORING ENHANCED MAGNETOCALORIC EFFECT IN LOW DIMENSIONAL MAGNETS AS POTENTIAL REFRIGERANTS IN HIGH MAGNETIC FIELDS

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In 2018, the 36 T, 40 mm bore Series Connected Hybrid (SCH) magnet became available [1]. In 2019, the first of a couple of 32 T, 34 mm bore All-Superconducting (AS) magnets [2] is expected to be ready and equipped with a specialized dilution refrigerator system providing minimum lattice temperatures down to nominally 20 mK. These advances allow the possibility of pondering whether temperatures lower than typically available with dilution refrigerators can be achieved without using another magnet to adiabatically demagnetize a refrigerant like $PrNi_5$ [3]. This work explores one plausible avenue of exploiting the enhanced magnetocaloric effect of low dimensional antiferromagnets [4] as a means of refrigerating samples by using part of the high field generated by the main magnet. Several groups have studied the large or enhanced magnetocaloric effect of different materials [5-7], and the present work considers possible options for adiabatic demagnetization refrigerants that employ other linear chain materials in fields near 30 T.

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P5-20

MAGNETIC, THERMAL PROPERTIES AND H-T PHASE DIAGRAMM OF QUASI-1D FRUSTRATED SPIN-½ MAGNET β-$TeVO_4$

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Zigzag spin-½ chain with competing nearest-neighbor ferromagnetic ($J_1<0$) and next-nearest-neighbor antiferromagnetic ($J_2>0$) couplings reveals rich physics at low temperatures and in applied magnetic fields. At zero magnetic field the helical order is expected for $|J_1|/J_2<4$. At the presence of nonzero magnetic field the quantum fluctuations are the main source of instability of helical order which lead to its modification and the emergence of new spin-modulated phases: chiral phase, spin-density-wave phase and different types of multipolar order.

The experimental study of the peculiarities of the magnetic and thermal properties and magnetic phase transitions in a quasi-one-dimensional magnet β-$TeVO_4$ has been presented.

The β-$TeVO_4$ compound is found to be a quasi-one-dimensional magnet (T_N=4.65 K) consisting of weakly interacting zigzag chains of the V^{4+} ions (S = ½) with two intrachain exchange coupling constants with the ratio of $|J_1|/J_2=1.3$.

It is shown that the phase H-T diagram of β-$TeVO_4$ contains of four different spin-modulated states, which are well described by using an isotropic 1D J_1-J_2 model with two competing intrachain interactions. It is found the ground state of β-$TeVO_4$ is chiral phase and the competition of ferromagnetic/ antiferromagnetic intrachain interactions, temperature and magnetic field determines stability of different spin-modulated phases. In the phase diagram for $H||b$ a tricritical point has been found which is related to the spatial anisotropy of the ground state of β-$TeVO_4$.

P5-21

ESTIMATION OF CRYSTAL-FIELD ANISOTROPY IN Co(II)-BASED SINGLE-ION MAGNETS USING X-BAND EPR

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In mononuclear Co(II)-based complexes with an easy-plane anisotropy a slow spin-lattice relaxation typical for single-molecule magnets (SMM) is observed in a non-zero magnetic field. The spin-lattice relaxation is mediated by the combination of direct and Raman relaxation processes, not the Orbach process as in conventional SMMs. The existence of low-energy intramolecular vibrations [1] allows the observation of a direct relaxation process within the ground Kramers doublet induced by hyperfine interaction [2]. A correct estimation of crystal-field parameters and resulting energy barrier is of great importance for understanding spin-lattice relaxation in anisotropic complexes. We have studied low-temperature X-band electron-paramagnetic resonance (EPR) of a series of Co(II)-based compounds $[Co(phen)_2(dca)_2]$, $[Co(phen)_3](tcm)_2$, $[\{Co(phen)_2(\mu_1\text{-}tcm)\}_2(\mu_{1,5}\text{-}tcm)]tcm\cdot H_2O$, and $[Co(dcnm)(H_2O)(phen)_2](dcnm)$ [3], where phen = 1,10-phenanthroline, dca = dicyanamide, tcm = tricyanomethanide, and dcnm = dicyanonitrosomethanide, with an easy-plane anisotropy. The relation between effective *g*-factors of the ground Kramers doublet estimated from EPR and spin-Hamiltonian parameters revealed strong rhombic anisotropy in all studied complexes with an energy barrier of at least 230 K. The experimental results were confirmed by *ab initio* calculations using SA-CASSCF/NEVPT2 method implemented in ORCA.

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P5-22
SLOW MAGNETIC RELAXATION IN THE COPPER COMPLEX DUE TO THE PHONON-BOTTLENECK EFFECT

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We have studied the spin dynamics in the complex $\{[Cu(tn)_2]_3[Pt(CN)_4]_2\}[Pt(CN)_4]$ (tn = $C_3H_{10}N_2$ = propane-1,3-diamine), in which Cu^{2+} ions form an antiferromagnetic S=1/2 trimers with a major exchange interaction of 0.95 K.

Measurements of ac susceptibility in the range 1.8–10 K suggest the presence of field-induced slow magnetic relaxation in the copper complex similar to single-ion magnets [1]. The field and temperature dependence of the relaxation time τ were extracted from Cole-Cole diagrams. Two relaxation channels were observed with distinct timescales of 1 s and less than 1 ms at the applied field of 1 T. The relaxation time of the slower relaxation channel increases up to 3 T, with no evidence of acceleration at high fields as observed in other single-ion magnets.

The temperature dependence of the relaxation time of the slower relaxation channel was studied in detail at the fixed field of 1 T. Using the Arrhenius law, for the Orbach relaxation process, we determined the height of the magnetization reversal barrier in the absence of other mechanisms as U = 4 K. The analysis was also performed using $\tau \sim T^{-n}$ dependence, which indicates the presence of other relaxation processes, Raman, direct and phonon-bottleneck relaxation, yielding n = 1.55 often observed in single-ion magnets. As suggested by Tesi et al. [2], the spin-lattice relaxation in molecular magnets may slow down in the applied magnetic field due to the phono-bottleneck effect as a result of the interplay between increased specific heat of the sample and slow heat transfer between the sample and its surrounding. After enhancing the thermal contact by increasing the amount of the exchange gas into the sample chamber, the slower relaxation channel in the studied complex was suppressed.

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P5-23

MIXED-SPIN HEISENBERG MAGNET ON A KAGOME STRIP

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Using both strong-coupling expansions and different numerical exact-diagonalization techniques, we analyze the quantum phase diagram and the related low-lying excited states of a quasi-one-dimensional Heisenberg model with two types of site spins ($S = 1$ and $\sigma=1/2$) defined on a strip which is a cutout from the kagome lattice. The five-spin unit cell includes a pair of corner-sharing triangles with four σ spins on the outer vertices and a S spin on the central site. The nearest-neighbor S-σ and σ-σ exchange bonds are related, respectively, to the exchange constants J_1 and J_2. The spin model is a natural mixed-spin extention of a previously studied spin-1/2 Heisenberg model defined on the same kagome strip [1-4].

It is established that the mixed-spin strip system exhibits a rich quantum phase diagram containing – apart from the fully and partially polarized collinear magnetic phases for ferromagnetic σ-σ bonds ($J_2 < 0$) – two Haldane-type non-magnetic phases with effective site spins $S_c = 1$ and 3 for antiferromagnetic σ-σ bonds ($J_2 > 0$). The Haldane-type nondegenerate gapped ground states can be considered as counterparts of the critical phases studied in Refs. [2, 4], the latter being characterized as Heisenberg spin chains with effective site spins $S_c = 3/2$ and 5/2. Finally, there is a large region around the limit of independent chains $J_1 = 0$ occupied by an exotic doubly-degenerate nonmagnetic phase resulting from the macroscopically degenerate canted classical state.

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P5-24

MAGNETIC PROPERTIES OF Mn-12-STEARATE SINGLE MOLECULE MAGNETS ANCHORED ONTO SPHERICAL SILICA'S SURFACE

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The present study is devoted to spherical silica nanoparticles covered with Mn_{12}-stearate (Mn_{12}-st) single molecule magnets. Such a compound exhibit superparamagnetic-like properties and has significant prospects to be used as a base of materials with unique magnetic properties. The main advantage of SMMs lies on the high intrinsic spin (S=10) and slow relaxation of the magnetization. Thanks to the use of pre-functionalization of the silica's surface with anchoring units (propyl-carboxyl acid) we were able to attach the Mn_{12}-st at the surface homogenously and investigate their mutual interactions. It is one of the few works describing single-molecule magnets in separated form, not in a bulk.

To study the magnetic properties of such sample were made a series of various measurements. An AC and DC magnetic measurements were carried out with a Quantum Design MPMS magnetometer. To determine the type of magnetism and related parameters, measurements of magnetization dependence on the applied magnetic field at fixed temperature T=2K were carried out. The evidence of slow relaxation time was confirmed by the set of measurements of the magnetization dependence on the time for various temperature values at the blocking temperature range. The study of magnetization dependence on the temperature (ZFC/FC set of measurements) and magnetic susceptibility dependence on the temperature was also carried out.

P5-25

IMPROVING COLLOIDAL STABILITY OF $Fe_{3-x}Gd_xO_4$/CITRIC ACID NANOPARTICLES AND THEIR EMBEDDING IN HUMAN SERUM ALBUMIN MICROSPHERES

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In this work, we report on preparation of citric acid coated $Fe_{3-x}Gd_xO_4$ nanoparticles with arithmetic mean of the diameter around 8 nm. Different techniques were used to characterize their physical properties, morphology, and influence of doping. Increase of the Gd content induced changes in average particle size and magnetic properties. A colloidal sample of Fe_3O_4@citric acid (CA) was mechanically milled and dynamic light scattering and zeta potential measurements were employed to monitor the hydrodynamic size and colloidal stability of the magnetic nanoparticles. $Fe_{2.80}Gd_{0.20}O_4$@CA nanoparticles were embedded in human serum albumin to produce magnetic microspheres which could be used as a drug delivery platform.

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P5-26

PHOTOELECTRICAL PROPERTIES OF SUPERCONDUCTOR/ PHOTOSEMICONDUCTOR HETEROJUNCTIONS

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The integration of high temperature superconductors(HTSC's) with conventional semiconductor(SeC) - based technology would have important consequences for micro- and cryophotoelectronics, with the promise of high performance hybrid circuits incorporating the best of what superconductors and semiconductors have to offer as well as the possibility for novel devices.

HTSC's are considered to be low carrier density materials. Therefore, the light can penetrate the superconductor and can effectively excite the quasiparticles in it. The study of light detection by a "HTSC – photosemiconductor" hybrid contact structures (HCS's) is very perspective for fabrication of multifunctional photonic circuits - high speed detectors with reasonable sensitivity covering a broad electromagnetic spectrum.

The special magnetic and transport properties of Cooper pairs provide new applications in the field of tunnel contacts, electronic devices and the generation of very high magnetic fields. Compared to classical ultrasonic sources, superconducting tunnel contacts emit phonons with higher frequency. Therefore, the properties of different HTSC/photosemiconductor heterojunctions are of great interest for the development of new electronic devices such as diodes with very high rectifying parameters and transistors based on the Josephson field effect.

In recent years, two-dimensional (2D) nanostructured materials, such as nanoplates and nanosheets, have attracted much attention because of not only their unique electronic, magnetic, optical, and catalytic properties, which mainly arise from their large surface areas, nearly perfect crystallinity, structural anisotropy, and quantum confinement effects in the thickness. The potential of 2D nanostructured materials uses for building blocks for advanced materials and devices with designed functions in areas as diverse as lasers, transistors, catalysis, solar cells, light emission diodes, chemical and biological sensors. We report physical properties of YBCO/BiOX and Nb/BiOX heterojunctions (X- halogen).

P5-27

MAGNETOCALORIC PROPERTIES OF V6 MOLECULAR MAGNET

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Magnetocaloric effect is a highly promising phenomenon exhibiting a significant potential for applications in cooling. For this purpose the development of novel magnetic materials is highly desirable. Molecular magnets with their exceptional properties are certainly worthy of interest within this context [1].

Out of the great diversity of such materials, molecular nanosystems containing a triangle as the basic unit of structure represent an intriguing category due to the possible presence of magnetic frustration.

An interesting and still not thoroughly studied representant of this class is V6 polyoxovanadate single-molecule magnet [2–5] with 6 vanadium ions carrying a quantum spin S = 1/2. In V6 vanadium ions form two weakly coupled triangles with all the interactions of antiferromagnetic sign, leading to the presence of ground-state frustration.

The aim of our paper it to calculate the magnetocaloric properties of V6, which are still unexplored experimentally. The basis of our computations is exact diagonalisation of the Hamiltonian of the quantum spin model and then application of the formalism of the canonical ensemble. Such thermodynamic quantities as magnetic entropy, specific heat and the isothermal entropy change quantifying the magnetocaloric effect are extensively discussed for wide ranges of temperature and magnetic field. The interesting behavior of the isothermal entropy change as a function of the initial and final magnetic field value is highlighted.

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P5-28

CRITICAL BEHAVIOR OF A 2D SPIN-PSEUDOSPIN MODEL IN A STRONG EXCHANGE LIMIT

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Coexistence and competition of charge and spin, superconducting and charge orderings is one of the topical problems in the physics of high-Tc cuprates [1]. To consider the competition of spin and charge orderings in cuprates, a simplified static 2D spin-pseudospin model was proposed [2-3] as a limiting case of a general pseudospin model [4]. This model is equivalent to a two-dimensional diluted antiferromagnetic Ising model with charged impurities.

We present a study of the critical behavior of the model, using the method of Monte Carlo simulations. We calculated the values the critical heat capacity index α depending on the average charge density of doped impurities n and the parameter of local charge-charge interactions Δ. It was shown that α has a singularity at Δ values, corresponding to the boundary between charge and magnetic orderings.

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P5-29

FRUSTRATED CLASSICAL HEISENBERG WHEELS: UNIVERSALITY OF THE LOWEST ENERGY CONFIGURATIONS

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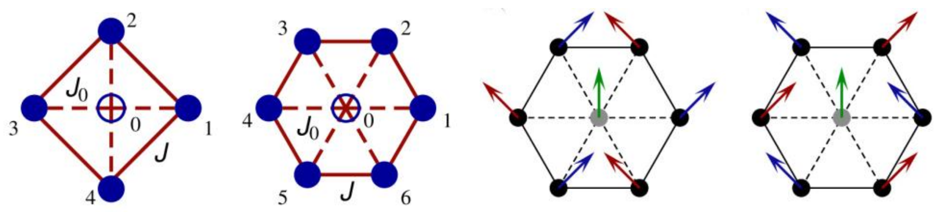
Classical counterpart of quantum Heisenberg model is discussed for systems consisting of odd number of spin vectors, where a single vector is located at the center and the remaining vectors occupy *n* (an even number) sites on a ring. We minimize the energy function of the model in question using the Lagrange manifold method developed recently [1]. Such approach allows to obtain general and strict (algebraic) results for any system size, though for small systems the appropriate solutions can be determined within less sophisticated method [2].

A slight modification in this approach allows to include heterogeneous systems, so we can analyze, e.g., classical analogue of $CrNi_6$ molecule [3]. The lowest energy geometrical configurations of the spin vectors corresponding to the global energy minima are determined. We reveal two subsets of collinear *n*/2 spin vectors which are tilted by an angle ψ in the opposite directions with respect to that fixed by the central vector. We prove that this angle does not depend on *n* and is equal to zero, i.e., all the spin vectors are collinear, if the system is unfrustrated or it is subject to weak frustration, otherwise the sublattices start to rotate. There are two such coplanar configurations with $0<|\psi|<\pi$. Our findings confirm that the classification of spin frustration holds in the classical limit and allow to discriminate different domains by the proper configurations. We demonstrate the correspondence between the total spin in the ground state of the quantum model and a component of the net total spin vector which can be exploited in analysis of the quantum models and physical complexes.



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6 RARE-EARTH AND 5f-SYSTEMS

O6-01

TWO-ION MAGNETIC ANISOTROPY IN U-COMPOUNDS: U_2Ni_2Sn

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One of the most striking features of the light-actinide compounds is a giant magnetic anisotropy, originating from sizeable orbital magnetic moments induced in the system of bonding itinerant electrons by a strong spin–orbit interaction. Such a situation leads to the so-called hybridization-induced anisotropy, which is two-ion by nature. This bonding directionality results in the orientation of 5*f* magnetic moments perpendicular to the shortest U–U bonds.

One of the structure types, which allows to observe the impact of cross-over of U-U distances, is the tetragonal structure Mo_2FeB_2 (SG *P*4/*mbm*), in which numerous U_2T_2X compounds form for late transition metals T and X representing In, Sn or a few other *p*-metals. Majority of U_2T_2X compounds, crystallizing in this structure, have the closest U-U spacing along the *c*-axis. Magnetic moments are, as a rule, in the basal plane. U_2Ni_2Sn represents an important case for considerations on origin of magnetic anisotropy in U intermetallics as the U-U spacing in the basal plane is slightly smaller. What is the anisotropy in this case?

We have successfully prepared a single crystal of U_2Ni_2Sn by Czochralski method. Magnetization, magneto-acoustic, and neutron-diffraction experiments on a single crystal provide evidence that the uranium moments align parallel to the *c*-axis with the anisotropy energy of ~170 K. The magnetic structure of U_2Ni_2Sn is fully compatible with the 5*f*-5*f* two-ion anisotropy model dominant in most of U band systems. The U magnetic moments of 0.88 μ_B, the low magnetic entropy and the enhanced Sommerfeld coefficient $\gamma = 187$ mJ/mol K^2 suggest that U_2Ni_2Sn can be classified as an itinerant antiferromagnet with strong electron-electron correlations.

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O6-02

PRELIMINARY RESISTIVITY RESULTS ON U_2Ni_2Sn SINGLE CRYSTALS

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U_2Ni_2Sn is a member of a large family of intermetallic compounds with the tetragonal Mo_2FeB_2 crystal structure, which has been studied intensively over the past years [1]. It orders antiferromagnetically at 25 K with a propagation vector q =(0,0,1/2). Magnetization, magneto-acoustic, and neutron-diffraction experiments on a single crystal provide evidence that the uranium moments align parallel to the c-axis with the anisotropy energy of ≈170 K, indicating that U_2Ni_2Sn can be classified as an Ising system. This behavior is rather exceptional, majority of the isostructural uranium ternaries have U moments confined into the basal plane.

Last results [1] are actually at variance with previous studies on polycrystals, which indicated different magnetic structure, and which were incompatible with the 5f-5f two-ion anisotropy model dominant in most of U band systems. High-field magnetization studies exhibit a weak linear response for fields along the basal plane up to the highest field applied (60 T), while the c-axis magnetization curve exhibits three metamagnetic transitions.

The first finding is that single crystal resistivity has better RRR value, reaching 10 for i // [110] and 3 for the [001] direction. The polycrystal value is about 3. None of the two directions exhibits the negative resistivity slope, $d\rho/dT < 0$, found for the polycrystal, and $\rho(T)$ shows merely a saturation.

Further differences are revealed by a numerical analysis. Fitting for *i* // [110] indicates the quadratic dependence, compatible with the high uniaxial anisotropy, not permitting a population of magnons with energy lower than the anisotropy gap. On the other hand, *i* // [001] exhibits an additional gap excitation term, $\rho = \rho_0 + AT^2 + C * exp(-\Delta/T)$ with Δ = 40-60 K, i.e. much smaller than the anisotropy gap 170 K. Such exchange gap has to be identified as a spin gap, suggesting an easy spin flipping along *c*. The measurements under external pressure are in progress.

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O6-03
MAGNETIC STATES IN $UCo_{1-x}Rh_xGe$ SYSTEM

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The ferromagnetic superconductors UCoGe and URhGe have the easy magnetization axis in the ferromagnetic state along the orthorhombic *c* axis. However, the response of magnetization on fields along *b* plays important role in physics of these materials. URhGe at 2 K undergoes a first-order metamagnetic transition at H_R = 12.5 T whereas the $M(H)$ curve of UCoGe exhibits a broad S-shape around $H_m \approx 50$ T. Moreover, the magnetic susceptibility $\chi_b(T)$ curve of URhGe shows a sharp peak at T_{max} = 9.5 K (= T_C) in contrast with a broad maximum around T_{max} = 37 K (>> T_C = 3 K) for UCoGe[1]. We will present an extensive single crystal study of the $UCo_{1-x}Rh_xGe$ alloy system by the heat capacity and steady-field and pulsed-field magnetization method. Our detailed investigation of $UCo_{1-x}Rh_xGe$ single-crystals has revealed the evolution of the characteristic temperature (T_{max}) and magnetic fields (H_R, H_m) with Co/Rh concentration. For x ≤ 0.3 we observed $T_{max} > T_C$ and for $x \geq 0.4$ $T_{max} = T_C$. Two different paramagnetic regimes can be distinguished in the *H-T* phase diagrams: a) low-temperature field-polarized paramagnet for $H > H_R$ for $x \geq 0.4$, b) correlated paramagnetic regime for $T < T_{max}$ and $H < H_m$ for $x \leq 0.3$[2]. We will show the evolution T_{max} and (H_m,H_R) with impact on the character of the FM ground state and various paramagnetic regimes. We will discuss relations of these paramagnetic regimes on the field-induced re-entrant superconductivity domes of parent compounds. Character of the paramagnetic regimes seems to be essential in the context of the recently discovered paramagnetic superconductor UTe_2 with extremely high H_{c2}[3].

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O6-04

A SPIN-GLASS GROUND-STATE IN AN $Er_2Zr_2O_7$ SINGLE CRYSTAL

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$A_2B_2O_7$ oxides with A standing for a rare-earth element and B for a transition or main block metal have been systematically studied for their frequently exotic crystallographic and electronic properties. In general, $A_2B_2O_7$ crystallize either in a pyrochlore structure (*F d -3 m*, 227) or defect-fluorite structure (*F m -3 m*, 225). Well-known pyrochlore structure consists of a net of interpenetrating corner-sharing tetrahedra (A^{3+} and B^{4+} cations on Wyckoff positions *16d* and *16c*, respectively) while oxygen anions form octahedra around B's position. Such a structure represents one of the canonical examples for a structure where a unique ground state is difficult to achieve for a system of magnetically coupled moments (of A and/or B ions). Defect-fluorite structure, where the A and B cations are randomly distributed on the *4a* Wyckoff position and surrounded by seven oxygen atoms on the *8c* Wyckoff position, is another example of a geometrically frustrated lattice. However, the rare-earth/transition metal octahedra are edge-, not vertex-sharing leading to a different exchange pathway type and thus different magnetic exchanges.

We present our recent results on $Er_2Zr_2O_7$ crystallizing in latter structure type. An $Er_2Zr_2O_7$ single crystal was prepared for the first time, being concurrently the first single crystal in the $A_2Zr_2O_7$ family adopting the defect-fluorite type of cubic structure. The present study contains the first low-temperature (magnetization, AC-susceptibility and specific heat) results on $Er_2Zr_2O_7$ [1]. The obtained results are dominated by a pronounced low-temperature anomaly of magnetic origin in all types of measurements. Several scenarios to explain the presence of the anomaly are introduced, leaving a spin-glass state in $Er_2Zr_2O_7$ as the most probable explanation. Further, we investigated powdered $Er_2Zr_2O_7$ employing low-temperature (0.3 K) neutron diffraction experiment (E6, HZB). Measured diffraction patterns contained except nuclear (reflections) peaks also a magnetic feature at around 20 degrees in 2θ. The temperature evolution of magnetic signal is well in agreement with a development of the anomaly in magnetization and specific heat data. The results are discussed in broader context of $A_2B_2O_7$ oxides.

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O6-05
ROTATING MAGNETOCALORIC EFFECT IN FRUSTRATED TmB_4

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The metallic antiferromagnetic tetraboride TmB_4 with a geometrically frustrated Shastry-Sutherland lattice has attracted recently a lot of attention [1, 2]. It exhibits a strong Ising-like anisotropy along the *c*-axis and a rather complex phase diagram of the ordered magnetic phase below $T_N \approx 11.7$ K in which besides the main magnetization plateau also small fractional plateaus can be observed [3-5].

We have investigated the rotating magnetocaloric effect (R-MCE) of this system, which was obtained from detailed temperature dependencies of heat capacity in various magnetic fields of a single crystalline sample for crystal axes orientations $c \parallel B$ and $c \perp B$. The received results exhibit rather complex distributions of positive and negative entropy $\Delta S(T, B)$ and temperature $\Delta T(T, B)$ differences below and above T_N when the direction of the magnetic field changes between directions $c \parallel B$ and $c \perp B$. The calculated results were confirmed by direct R-MCE measurements which, moreover, show an interesting angular dependence of R-MCE in the ordered phase, which seems to be related with the change of the effective magnetic field along the *c*-axis during sample rotation. Thus, our study presents a new type of magnetic refrigerant with a rather large R-MCE for low temperature magnetic refrigeration, and points to further interesting magnetic features in the ordered phase of this frustrated system.

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P6-01
THE GROWTH AND HIGH TEMPERATURE STUDY OF $Er_2Ti_2O_7$ SINGLE CRYSTALS

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A large group of $RE_2T_2O_7$ compounds with RE being the rare-earth element and T transition metal crystallize in the cubic pyrochlore lattice, s. g. *F d -3 m*. Both RE and T cations form a net of interpenetrating corner-sharing tetrahedra while oxygen anions form octahedra around T's position. The interactions between magnetic moments of RE^{3+} and/or T^{4+} together with the geometrically frustrated lattice provide a rich playground for exotic spin ground states and topologically nontrivial electronic states. $Er_2Ti_2O_7$ compound, the object of our long-term study, crystallizes with the pyrochlore lattice (in contrast to light rare-earth titanates crystallizing in monoclinic $P2_1$) and orders antiferromagnetically below 1.2 K. The magnetic structure was discussed for decades and eventually identified as a so called XY antiferromagnet with Er^{3+} moments arranged within the plane perpendicular to local [111] direction [1]. The ground state is selected (from six equally-populated magnetic domains) by thermal or quantum fluctuations, so called order by disorder mechanism.

The crystal growth of $Er_2Ti_2O_7$ as well as other titanites is well established. The crystals are prepared from a polycrystalline 227 precursor employing the floating zone method [2]. We present a modified (and more straightforward) recipe of a single crystal preparation directly from a mixture of constituent oxides. The crystal quality was confirmed by x-ray and neutron diffraction methods. The low temperature magnetization and specific heat data, perfectly in agreement with previous results [3], than allow to acknowledge presented growth technique as correct and advantageous. Furthermore, the structure instability of $RE_2Ti_2O_7$ series motivated us to study the ordered pyrochlore $Er_2Ti_2O_7$ at elevated temperatures. Dilatometry, differential scanning calorimetry and high-temperature x-ray diffraction measurements indicate a structural change at ~1400 K. The obtained results on structural change are discussed in the context of calculations in [4] and other $Er_2T_2O_7$ compounds.

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P6-02

MALTESE CROSS ANISOTROPY IN THE ANTIFERROMAGNETIC STATE OF $Ho_{0.8}Lu_{0.2}B_{12}$ METAL WITH DYNAMIC CHARGE STRIPES

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The model strongly correlated electron system $Ho_{0.8}Lu_{0.2}B_{12}$ which demonstrates a cooperative dynamic Jahn-Teller instability of the boron sub-lattice in combination with rattling modes of Ho(Lu) ions, dynamic charge stripes [1,2] and unusual antiferromagnetic (AF) ground state has been studied in detail at low temperatures by magnetoresistance ($\Delta\rho/\rho$), magnetization and heat capacity measurements. For this non-equilibrium AF metal the angular H-φ-T magnetic phase diagram in the form of "Maltese cross" has been reconstructed experimentally for the first time. It was shown that the dramatic symmetry lowering in the AF ground state of the rare earth dodecaboride with *fcc* crystal structure should be attributed to the redistribution of conduction electron spin density by RKKY oscillations to dynamic charge stripes which cause extraordinary changes in the indirect exchange interaction between magnetic moments of Ho^{3+} ions and result in the emergence of a number of various magnetic phases and phase transitions. Moreover, the two main contributions to magnetoresistance in this complicated AF phase, (*i*) the positive and linear on magnetic field and (*ii*) the negative quadratic $-\Delta\rho/\rho{\sim}H^2$ components were separated and analyzed quantitatively in terms of charge carrier scattering on spin density waves of the magnetic structure and on local *4f-5d* spin fluctuations of holmium sites.

Acknowledgement. This work was supported by the Russian Science Foundation, project no. 17-12-01426 and by the Slovak agencies VEGA (grant no. 2/0032/16) and APVV (grant no. 17-0020).

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P6-03

DISAPPEARANCE OF MAGNETIC TRANSITION IN (Ce,Gd)Ni_5 SYSTEM

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We present the results of an experimental study focused around $CeNi_5$ in the $Ce_xGd_{1-x}Ni_5$ system. The binary Ce-based alloy, within this system, is a well-known example of spin fluctuations (Stoner enhanced paramagnet) without magnetic ordering down to the lowest temperatures [1]. On the other hand, the $GdNi_5$ alloy shows ferromagnetism with a Curie temperature T_c = 31.8 K [2].

Pseudo-binary bulk samples of $Ce_xGd_{1-x}Ni_5$ compositions, with concentrations x = 0.85, 0.9, 0.95 and 0.97, have been prepared by arc melting. The structural analysis confirmed the hexagonal crystal structure of these samples, with space group P6/mmm, and proved the existence of a single phase in all of them.

The measurement of the magnetic properties (M(T) and M(H)) shows that the increase of the Ce content lowers the T_C value. Above x = 0.9, the spin fluctuation behaviour appears, with a characteristic maximum in M(T) around 100 K. The applied magnetic field slightly shifts its position to lower temperatures, whereas it does not move in $CeNi_5$ [1]. Heat capacity measurements support these observations.

The effect of possible quantum criticality will be analysed.

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P6-04

$CePt_2Al_2$ - STRUCTURAL AND BULK CHARACTERIZATION OF NEW INTERMETALLIC COMPOUND

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$CePt_2Al_2$ is a new member of the deeply studied group of CeT_2X_2 intermetallic compounds. $CePt_2Al_2$ is a Pt homologue of $CePd_2Al_2$ which is at the forefront last years due to presence of enhanced magneto elastic interaction called as vibron states. The success in preparation of this homologue could help to explain the origin of the vibron states. In the presented study we perform a detailed structural characterization, transport and bulk measurements. This compound crystalizes in the tetragonal $CaBe_2Ge_2$ structure at high temperatures, but below 405 K undergoes structural phase transition to the orthorhombic structure (*Cmme*). Very similar structural behavior was also observed in $CePd_2Al_2$, but the transformation temperature is at 13.5 K in this case. Such a high temperature of structural transition of $CePt_2Al_2$ allows to study the orthorhombic structure directly at room temperature. $CePt_2Al_2$ and $CePd_2Al_2$ exhibit also comparable magnetic properties. $CePd_2Al_2$ is an antiferromagnet below 2.7 K with the amplitude-modulated magnetic structure described by an incommensurate propagation vector k = (0.06, 0.54, 0). The magnetic moments order antiferromagnetically within the *ab* planes stacked along the *c* axis and are arranged along the direction close to the orthorhombic *a* axis [1]. The magnetic measurement of new $CePt_2Al_2$ points to the antiferromagnetic order below 2.5 K.

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P6-05

MAGNETIC PHASE TRANSITIONS IN $UIrSi_3$

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Results of magnetization, specific-heat, electrical and thermal transport mea-surements on a $UIrSi_3$ single crystal will be presented. Ising-like antiferromag-netism below $T_N = 41.7$ K with easy-magnetisation direction along the c-axis of the non-centrosymmetric tetragonal $BaNiSn_3$-type structure has been confirmed. The AFM ordering is suppressed by magnetic fields > H_c ($\mu_0 H_c$ = 7.3 T at 2 K) applied along the c-axis. The first-order metamagnetic transition at H_c exhibits asymmetric hysteresis reflecting a slow reentry of the expected complex ground-state AFM structure when sweeping the field down. The hysteresis narrows with increasing temperature and vanishes at 28 K. The AFM ↔ PM (paramagnetic) transition at higher temperatures is of the second-order type. The order of transi-tions changes at the tricritical point (TCP; T_{tcp}~ 28 K, $\mu_0 H_{tcp}$ ~ 5.8 T) [1].

We have observed that the unequivocally different character of the first- and second-order transitions is leading to distinctly different transport properties in the neighborhood of the corresponding critical temperatures and magnetic fields, respectively. The magnetic contributions to the electrical and Hall resistivity in the AFM state in the polarized and normal PM regimes are driven by different underlying mechanisms. Keeping this in mind, we propose a scenario, which can successfully explain why the electrical and Hall resistivity anomalies at phase transitions change polarity at TCP [2]. The jumps in the specific heat, electrical resistivity, Hall resistivity and Seebeck coefficient, respectively, observed at the first-order transitions indicate a Fermi-surface reconstruction, which is characteristic of a magnetic-field induced Lifshitz transition [3].

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P6-06
AMBIENT PRESSURE CHARACTERIZATION OF THE $EuRu_2P_2$ SINGLE CRYSTAL

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Eu-based compounds are specific among other rare-earth-based ones for the unusual properties due to the presence of the Eu element. The rare earth elements are usually trivalent if contained in the compound, on the contrary the divalent (magnetic Eu^{2+}) electronic state of Eu is more stable than the trivalent (nonmagnetic Eu^{3+}) one [1]. Since the energy difference between the Eu^{2+} and Eu^{3+} states is not extensively large, the Eu^{2+} electronic state can be changed by several methods. Among them the application of external pressure plays an irreplaceable role [2].

We focus on the $EuRu_2P_2$ compound for its assumption of closeness to the valence change. The flux growth method was found as a successful way to prepare a singlecrystalline sample.

We have performed a thorough investigation of the transport and magnetic properties at ambient pressure with respect to the particular crystallographic directions. We confirm the Curie temperature $T_c = 29K$ from the results of the magnetization, heat capacity and resistivity measurements. Magnetization measurements revealed saturated magnetization of $7\mu_B/f.u.$ at $2K$, which is in a good agreement with the magnetic moment of free Eu^{2+} ($7\mu_B/Eu$) and agrees well with reported data in [2]. Relatively small but nonzero magnetocrystalline anisotropy occurs with a-axis as the easy direction in our experimental data and agrees well with our theoretical calculations.

We will present results of characterization of $EuRu_2P_2$ single crystal at ambient pressure which is important foundation and starting point for further studies under hydrostatic pressure.

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P6-07

MICROSCOPIC DESCRIPTION OF ROTATING MAGNETOCALORIC EFFECT IN FRUSTRATED ANTIFERROMAGNETIC SYSTEM TmB_4

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TmB_4 is an anisotropic magnetic system with geometrical frustration of Shastry-Sutherland type. Experimentally was the rotating magnetocaloric effect (R-MCE) of TmB_4 evaluated from measurements of temperature dependences of heat capacity in various magnetic fields and crystallographic orientations. R-MCE in this system shows a complex behavior of the adiabatic temperature change (AdT) - cooling above T_N and two heating regions in ordered phase [1]. In this contribution a theoretical model with spin-electron Hamiltonian was suggested to explain the complex AdT behavior. It is based on the idea of two interacting subsystems: the localized spins of rare earth ions and the itinerant electrons in conduction band. The received results from Monte Carlo approach successfully reproduce the observed heating and cooling regions. Thus, our study shows that measurements of R-MCE can be an effective tool for investigating the microscopic properties of magnetization processes.

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P6-08

ANOMALOUS CONTRIBUTIONS TO HALL EFFECT IN $Ho_{0.5}Lu_{0.5}B_{12}$

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The exotic features of antiferromagnetic (AF) ground state in the strongly correlated electron system $Ho_{0.5}Lu_{0.5}B_{12}$ appear under influence of a cooperative dynamic Jahn-Teller instability of the rigid boron cage in combination with rattling modes of loosely bound Ho(Lu) ions and dynamic charge stripes [1,2]. We report here the detailed study of resistivity, magnetization and Hall effect carried out on the single crystals of this AF metal at temperatures 1.9 – 6 K in magnetic fields $B \leq 7$ T. The comparison of the data obtained in magnetic field applied along the [100], [110], [111] principal directions of the *fcc* lattice shows that two anomalous Hall effect components (AHE) can be separated from the ordinary Hall effect by analyzing of the $\rho_{xy}(B)$ curves. The first contribution, which is proportional to magnetization ($R_S\mu_0M$), is observed both in the AF phase and in the high field spin polarized paramagnetic state of $Ho_{0.5}Lu_{0.5}B_{12}$. The second AHE component appearing only below Neel temperature $T_N \approx 3.5$ K depends non-monotonously on magnetic field, its amplitude increasing strongly with temperature lowering. Both components of AHE are anisotropic with respect to magnetic field, their amplitude being maximal for the **B||**[100] direction to be transverse to dynamic charge stripes. The data obtained are discussed in terms of strong magnetic carrier scattering on dynamic charge stripes that could be influenced by Berry phase effects.

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P6-09

STRUCTURE AND MAGNETIC PROPERTIES OF RAPIDLY SOLIDIFIED ALLOYS BASED ON Nd-Fe-Y-B COMPOUND

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In this paper, the influence of production parameters on structure and magnetic properties of Re-Fe-B alloys, with different amount of Nd exchanged with Y, was investigated. The amount of Y was warring in range from 0 to 4 at%. The production conditions were differing with applied linear speed of cooper wheel (16, 18, 20 m/s). The structure was investigated using X-ray diffraction. The applied changes were leading to production of magnetic media, in as cast state, characterized by partially crystallized or nanocrystalline structure. The obtained results allowed to select proper fabrication conditions in coherence to alloy composition, that allowed to obtain materials exhibiting the strong short-range ordering between the atoms. The proper phase composition and fine grain sizes are primary conditions to obtain strong exchange interactions and good hard magnetic properties. The magnetic measurements were done using Vibrating Sample Magnetometer working on 2 T field strength. Their results were compiled with structure studies and manufacturing conditions, such a set allowed us to choose best conditions for manufacturing hard magnetic materials in as cast state.

P6-10

DEFECT MODE EVOLUTION IN THE FAMILY OF BORON RICH BORIDES YbB_6−YbB_{12}−YbB_{66} AND THEIR SOLID SOLUTIONS

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Modern crystal growth methods allow to synthesize the family of boron rich borides YbB_6−YbB_{12}−YbB_{66}. While YbB_6 and YbB_{12} have *bcc* and *fcc* structures (Pm-3m and Fm-3m with $a \approx 4.138$Å and 7.469Å, respectively), YbB_{66} is characterized by a complicated *fcc* structure (Fm-3c, $a \approx 23.5$Å) with a unit cell containing 24 metal and 1584 boron atoms, of which 1248 are assigned to eight super-icosahedra $B_{12}(B_{12})_{12}$. In all these compounds are the Yb ions weakly bound with the rigid boron cage and may be treated as independent Einstein oscillators. In this work we report a comparative study of specific heat performed on high purity crystals of YbB_n (n = 6, 12, 66) and their solid solutions $Eu_xYb_{1-x}B_6$, $Tm_xYb_{1-x}B_n$ ($x \leq 0.25$) in the temperature range 2 − 300K in magnetic fields up to 9T. The obtained data allow to estimate phonon components such as (*i*) the Debye temperature of the boron sublattice ($\Theta_D \approx$ 1160−1300K) and (*ii*) the contribution from quasilocal vibrational modes of Yb ions ($\Theta_{Ei} \approx$ 92−170K). Our data also suggest (*iii*) a defect mode component with a characteristic temperature $T^* \approx$ 33−52K originating from presence of $n_{vac} \leq$ 4.2% boron vacancies. Result (*iii*) may be attributed to the transition into cage-glass state below T^* [1−2].

Acknowledgement. This work was supported by the Slovak agencies VEGA (grant no. 2/0032/16) and APVV (grant no. 17-0020).

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P6-11

DEPRESSION OF MANY-BODY STATES IN NARROW BAND SEMICONDUCTOR $Sm_{1-x}Yb_xB_6$

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In RB6 series, there are only two compounds (SmB6, YbB6) that are discussed in the literature as possible candidates for topological insulators (TI). But they have ~~a~~ different TI states which are realized due to hybridization of 4*f*-5*d* (Kondo mechanism) and 5*d*-2*p* states in SmB_6 and YbB_6, respectively [1, 2]. In this situation, chemical doping of the SmB_6 sublattice with divalent nonmagnetic Yb should modify considerably the position of Fermi level $E_F(x)$ and consequently the physical properties of parent material. In current work we report a complex study of transport (resistivity, magnetoresistance, Hall effect), magnetic and thermal (Seebeck effect, specific heat) properties of high quality $Sm_xYb_{1-x}B_6$ single crystals (x = 0, 0.005, 0.02, 0.05, 0.1) in the temperature range 2-300 K in magnetic fields up to 8T. The data obtained allow to observe (*i*) an enhancement of the indirect gap from 19 meV (SmB_6) to 22 meV (x = 0.1) which is accompanied by (*ii*) a strong reduction of Hall mobility $\mu_H \approx 20 - 90 \text{cm}^2/\text{V·s}$ in the regime of intragap states (5 K < T < 14 K). The increase of Yb content leads to (*iii*) a noticeable depression of the energy E_a which describes the many-body effects and approaches zero values at x(Yb) ~ 0.13.

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P6-12

CRYSTAL DYNAMICS OF THORIUM AND THORIUM MONOCARBIDE

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Actinide carbides are considered to be one of the most promising nuclear fuel materials of generation IV reactors. These carbides pose higher thermal conductivity and operational temperature over standard oxide fuels (e.g. UO2). However, the number of experimental known quantities about these materials are scare or often outdated (early 70's at the latest).

In this contribution, we investigate the importance of including spin-orbit coupling for thorium metal as well as for thorium monocarbide and its effect on the electronic, elastic, phonon, and thermodynamic properties.

By adding the carbon atom into the structure, the properties (elastic constants, phonon dispersion curves, mean-square displacement, heat capacity, thermal expansion, and thermal conductivity) are very much different from single element Th. Our calculated results for Th and ThC are in excellent agreement with available measured values.

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P6-13

INFLUENCE OF SUBSTITUTION ON THE MACROSCOPIC PROPERTIES OF METALLIC FRUSTRATED MAGNETIC SYSTEM TmB_4

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Rare-earth tetraborides have a tetragonal crystal structure in which the layout of rare-earth ions forms a Shastry-Sutherland lattice with geometrical frustration. A well known example of them is TmB_4 exhibiting a strong magnetic anisotropy [1]. Substitution of Tm^{3+} magnetic ions with total angular momentum $J = 6$ and spin $S = 1$ by non-magnetic Lu^{3+} ($J = S = 0$) ions or by magnetic Gd^{3+} ($J = S = 7/2$) ions will have an influence on the macroscopic properties of TmB_4. The increasing concentration of Lu and Gd can lead to distortion of frustration in this compound. Moreover, there is a theoretically predicted formation of a new type of skyrmions [2] in solid solutions of $Tm_{1-x}Lu_xB_4$ and $Tm_{1-x}Gd_xB_4$ at low Lu and Gd concentrations. In our contribution we show the EDX analysis of newly prepared single crystalline solid solutions samples and present investigation results of their macroscopic properties by resistivity, heat capacity and magnetization measurements in various magnetic fields and crystallographic orientations.

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P6-14

CORRELATION OF MAGNETIC PROPERTIES AND CRYSTAL STRUCTURE OF PRASEODYNIUM-ORGANIC FRAMEWORK CONTAINING TPPS LIGAND

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Metal-organic frameworks (MOFs) are highly studied materials due to their versatile potential applications [1]. Nowadays, one of the new intensively investigated subgroup of MOFs are metalloporphyrinic frameworks (MPFs) which consist of porphyrine derivatives and their combination with suitable metal ions leading materials with interesting magnetic properties [2].

Our work is focuses on binary system constructed of praseodymium (III) ions and H_2TPPS porphyrinic ligand (H_2TPPS= 4,4′,4″,4‴-(Porphine-5,10,15,20-tetrayl)tetrakisbenzenesulfonic acid) witch form $\{[Pr_4(TPPS)_3]\cdot nH_2O\}_n$ coordination polymer. Prepared MOF have been synthesized *via* solvothermal reaction and characterized by single-crystal X-ray diffraction, elemental and thermal analyses and magnetic susceptibility measurement. Single crystal X-ray diffraction showed three-dimensional open porous framework constructed by mutually staggered TPPS ligands. Pr(III) are arranged in 1-D polymeric chains propagating along *c* crystallographic axis with Pr-Pr distance 4.984 Å and shortest distance between Pr(III) within the cavity is 15.393 Å. The framework contains three crossing cavities propagating along all crystallographic axes with sizes approximately 4.9 x 10.4 Å^2 and 9.7 x 5.1 Å^2. We have used SQUID based magnetometer in external *dc* field up to 5 T in the temperature range from 2 to 300 K to observed magnetic properties of our coordination polymer. Experimental results of molar magnetic susceptibility χ_M versus T confirm the high irreversibility during cooling and warming process suggesting on the spin state transition. When crossing the characteristics temperature T*~120K upon warming the Pr(IV) transforms to Pr(III) and showing the spin crossover phenomenon.

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P6-15

MAGNETIC Gd_2O_3 NANOPARTICLES COATED BY POROUS SiO_2: CORE@SHELL NANOSYSTEMS FOR BIOMEDICAL APPLICATIONS

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In recent years the nanomedicine has received a lot of attention. Many nanomaterials find its application in diagnostics as well as therapy. In these aspects, mesoporous silica (MPS) with core@shell structure has a great potential. MPS is specific by its large specific surface area to weight ratio and its ability to modify the surface by various organic groups, and thereby affect the interactions between surface and biologically active molecules. Gadolinium is such a unique element that can be applied in the form of its oxide as a core of a silica core@shell nanosystem. Gadolinium oxide can be used simultaneously in X-ray tomography, neutron capture therapy and magnetic resonance imaging. The promising features of such a nanosystems empowers scientist to speed up the development of new drug delivery systems and verify its functionality by being able to directly track their movement in the body.

In our work, we prepared magnetic nanosystem composed from Gd_2O_3 particles close to spherical shape with size up to 7 nm and drug 5-fluorouracil inside a periodic porous silica matrix with hexagonal symmetry. The prepared samples structure was characterized by TEM (Transmision Electron microscopy), EDX measurement and magnetic measurements were provided by MPMS apparatus. Magnetic properties were characterized by two basic measurements: i) magnetization dependence on external magnetic field up to 5 T at constant temperature and ii) magnetization dependence on temperature in range of 2 – 300 K in two regimes – ZFC (zero field cooling) and FC (field cooling) at constant external dc magnetic field. Magnetic measurement confirmed the paramagnetic Gd_2O_3 nanoparticles with high magnetization about 90 emu/g at 50 000 Oe. We combined the advantages of mesoporous silica and magnetic particles to fabricate a nanocomposite with high surface area, magnetic separability and targeted drug delivery systems, which carries the drug directly to a specific organ or location in the body under an external magnetic field.

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P6-16

MONTE CARLO SIMULATION OF MAGNETIC RELAXATION IN RARE-EARTH AMORPHOUS ALLOYS

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Using the Monte Carlo method in the frame of the Heisenberg model, the computer simulation of magnetic properties of Re-Tb and Re-Gd amorphous alloys was performed.

For pure amorphous Tb and Re-Tb amorphous alloys the model Hamiltonian contained two terms responsible for nearest-neighbour exchange interaction between the Tb ions with the mean value J0 and for random single-ion anisotropy D. In the models of the Re-Tb amorphous alloys the spin-glass-like phase transition was also observed. With increasing concentration of Tb atoms, the transition temperature linearly increases, which is in a good agreement with the experimental results. The spin-glass transition is observed only above the percolation threshold in this system, i.e. at x>13 at. % Tb.

For pure amorphous Gd and Re-Gd amorphous alloys the model Hamiltonian contained two terms responsible for ferromagnetic exchange interaction J_1 between the nearest-neighbour Gd ions and for antiferromagnetic exchange interaction J_2 between the Gd ions that were in the second coordination sphere. In the models of the Re-Gd amorphous alloys the spin-glass phase transition was also observed. With increasing concentration of Gd atoms, the spin-glass transition temperature linearly increases, which is in a good agreement with the experimental results.

The magnetization relaxation after switching-off the external magnetic field at different values of D/J_0 (for Re-Tb alloys) J_1/J_2 (for Re-Gd alloys) was studied. For amorphous Tb and Re-Tb amorphous alloys the magnetization relaxation goes on in two stages. In the first stage, the magnetization decreases abruptly by a definite magnitude ΔM_Z. At this stage the magnetic moments reorients to the directions determined by the random anisotropy axes. At the second stage the magnetization decreases very slowly according to the logarithmic law. At this stage the magnetic moments of Tb atoms rotate by small angles due to competition of exchange interaction and random anisotropy.

In the models of amorphous Gd and Re-Gd amorphous alloys, the jump of the magnetization after the switching-off the external magnetic field is not observed. Thus, in these systems the relaxation is one-stage. The time dependence of magnetization is not logarithmic, but is described by the lineal combination of two decreasing exponential functions.

P6-17

HEXANUCLEAR CLUSTERS $Co^{II}_3Ln^{III}_3$ (Ln=La, Gd, Tb, Dy AND Ho): EXPERIMENTAL AND THEORETICAL STUDIES AND OBSERVATION OF SLOW MAGNETIC RELAXATION BY THE COBALT(II)-DYSPROSIUM(III) ANALOGUE

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A family [1] of 3×3 hexanuclear 3d-4f complexes $[(\mu_3\text{-}CO_3)\{Co^{II}Ln^{III}L(\mu_3\text{-}OH)(OH_2)\}_3]\text{-}(ClO_4)\cdot xC_2H_5OH\cdot yH_2O$ [Ln = La (**1**), Gd (**2**), Tb (**3**), Dy (**4**), and Ho (**5**)] have been prepared in moderate to high yields (62-78%) following a self-assembly reaction when stoichiometric amounts of the ligand 6,6',6"-(nitrilotris(methylene))tris-(2-methoxy-4-methylphenol) (H_3L), $Co(OAc)_2\cdot 4H_2O$ and the lanthanide ion precursors (1:1:1 mol ratio) are allowed to react in aerobic environment in the mandatory presence of tetrabutylammonium hydroxide. During the reaction, atmospheric carbon dioxide is fixed in the product molecule as a carbonato ligand which connects all the three lanthanide centers of this molecular assembly through a rare $\eta^2{:}\eta^2{:}\eta^2{:}\mu_3$ mode of bridging as revealed from X-ray crystallography. The metal centers in all these compounds, except the Gd^{III} analogue (**2**), are coupled in antiferromagnetic manner while the mode of coupling in the $Co^{II}_3Gd^{III}_3$ complex is ferromagnetic. DFT calculations revealed that this ferromagnetic interaction occurs most likely by the Co^{II}-Gd^{III} superexchange, mediated via the oxygen atoms which was further confirmed by the phenomenological modeling revealing an agreement with measurements of the magnetic moment and magnetic susceptibility. Only the Co^{II}-Dy^{III} compound (**4**) displayed a slow relaxation of the magnetization at a very a low temperature as established by AC susceptibility measurements. The data provides an estimation of the activation energy U/k_B = 9.2 K and the relaxation time constant $\tau_0=1.0\times 10^{-7}$ s, assuming that the relaxation process is dominated by a single relaxation time and the Arrhenius law is fulfilled at low temperatures.

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P6-18

MAGNETIC PROPERTIES OF SUBSTITUTED Ce_2Ni_2Sn

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The topic of Ce based intermetallic compounds is receiving significant attention due to the observation of many unconventional phenomena. The observation of existence of split superconductivity regions in $CeCu_2$(Si,Ge) compounds which was proposed to be mediated by valence fluctuation rather than spin fluctuation strengthen this interest. In the family of Ce_2T_2X compounds (where T is transition metal and X is Sn, In or Pb) the Ce ion is on the border between magnetic $4f^1$ configuration and non-magnetic $4f^0$ state. The change of the symmetry occurs upon In for Sn replacement. The relation between the crystal lattice and the magnetic ground state will be investigated on selected $Ce_2(Ni,Cu)_2Sn$ and $Ce_2Ni_2(Sn,In)$ compounds. The magnetic ground state of Ce can be stabilized by hydrogen insertion or particular substitution or destabilized by external pressure which leads to increase hybridization of the Ce f-electrons. We prepared samples of substituted and hydrogenated Ce_2Ni_2Sn and performed magnetization measurement and neutron powder diffraction experiment. The hydrogen absorption leads to the lattice expansion which have significant effect on the long range magnetic ordering. The studied compounds can easily form hydride at relatively low pressure and temperature however the preparation of deuterated compounds was more difficult and the absorption occurred only at elevated temperatures.

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P6-19

SPIN, CHARGE AND LATTICE DYNAMICS IN FRUSTRATED TmB_4

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The metallic tetraboride TmB_4 with a geometrically frustrated Shastry-Sutherland lattice has attracted recently a lot of attention [1, 2]. It exhibits a strong Ising-like anisotropy along the *c*-axis and a rather complex phase diagram of the ordered magnetic phase below $T_N \approx 11.7$ K in which besides the main magnetization plateau also small fractional plateaus can be observed [3-5].

To learn more about the properties of fractional plateaus we have investigated the dynamics of magnetization processes in TmB_4 by magnetization vs. applied magnetic field measurements at different temperatures and field sweep rates. In addition, experiments of charge carrier mobility and magnetostriction as a function of temperature and magnetic field were carried out to specify the interplay between magnetic structure and the charge dynamics, and the role of the magneto-elastic interaction in this compound, respectively.

It was shown that the magnetization values of fractional plateaus become elevated with the increase of temperature at which magnetization takes place and with the decrease of magnetic field sweep rate. These results point to inconsistency with predictions based on Glauber dynamics [6]. Moreover, it turned out that the transitions between magnetic phases are accompanied by an anomalous behaviour of charge mobility and distinctive variations of magnetostriction.

Acknowledgement: The work was supported by Slovak agencies VEGA (grant no. 2/0032/16) and APVV (grant no. 17-0020).

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7 STRONGLY CORRELATED ELECTRON SYSTEMS, SUPERCONDUCTING MATERIALS

O7-01

POSSIBLE TWO-GAP SUPERCONDUCTIVITY IN Mo_8Ga_{41} ADDRESSED BY THERMODYNAMIC AND SPECTROSCOPIC MEASUREMENTS

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Two-gap superconductivity is a compelling phenomenon as it comprises novel riches of condensed matter physics. The hunt for its representatives continues since the experimental justification of two energy scales in MgB_2 in 2001.

In Mo_8Ga_{41} it was suggested that Mo site-selective orbital contributions lead to existence of two energy gaps elucidating scanning tunneling spectroscopy (STS) [1] and muon spin rotation/relaxation measurements [2]. However, our detailed thermodynamic and spectroscopic experiments using ac-calorimetry and low-temperature scanning tunneling microscopy/spectroscopy exposed that the observed „two-gap" features are actually a consequence of multi-phase character of the surface [3] arising from complicated structure of Mo_8Ga_{41} formed by endohedral clusters.

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O7-02

DFT CALCULATIONS ON THE MÖSSBAUER PARAMETERS OF THE NONCENTROSYMMETRIC Th_7Fe_3 SUPERCONDUCTOR

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Superconductivity in a hexagonal Th_7Fe_3 compound (space group $P6_3mc$) with T_c ~ 1.8 K was reported many year ago by Mathias et al. [1]. In the last few years, the physical properties of this material have become interesting in perspective on the relation between superconductivity and the lack of inversion center.

Recently, we measured magnetic, specific heat, electrical transport properties and ^{57}Fe Mössbauer spectra of Th_7Fe_3 in the temperature range 0.4 – 300 K and magnetic fields up to 9 T. The obtained bulk properties suggested two-gap BCS-type structure [2], while the ^{57}Fe Mössbauer data pointed to the existence of crystal-electric field effect below 60K [3]. The ground state electronic structure was investigated using Density Functional Theory (DFT) calculations [2, 4].

In this contribution, we present theoretical hyperfine parameters, including Mössbauer isomer shift, electric field components, asymmetry parameter and quadrupole splitting, which were obtained from X-ray and DFT optimized geometries. The calculations were performed using the ELK implantation of the full-potential linearized augmented wave method [5] in the Generalized Gradient Approximation [6]. The theoretical results of our calculations for Th_7Fe_3 are compared with the experimental data [3] and discussed with respect to usefulness of DFT calculations for interpretation of the Mössbauer spectra.

Acknowledgement The financial support by the national Science Centre of Poland under the grant No 2016/21/B/ST3/01366.

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O7-03

EXPLORING KONDO LATTICES WITH TWO INEQUIVALENT Ce-SITES

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Strongly correlated electron systems with competing interactions provide a fertile ground for discovering exotic states of matter. As a particularly interesting setting we study heavy fermion (HF) systems with two crystallographically inequivalent local moment sites. These may lead to the formation of two Kondo sublattices with largely different Kondo temperatures. We expect such systems to show better tunability towards various kinds of quantum phase transitions compared to single-site Kondo systems, and to form novel phases of matter [1]. Here we present recent results on selected compounds, like Ce_3Al_{11} [2], Ce_3PtIn_{11} [3,4] and other. Ce_3PtIn_{11} is highly interesting as it shows coexistence of antiferromagnetism (T_N = 2K) and superconductivity (T_c = 0.32K). From entropy analysis it has been speculated that in this compound the Ce_I (2 ions) remains paramagnetic and at lower T evokes superconductivity while the Ce_{II} site is responsible for the magnetic ordering. Recent ^{115}In NMR/NQR data are in support of this scenario [5]. Furthermore we will discuss several pressing questions: Do the two Kondo scales compete or cooperate? Can the interplay lead to Kondo breakdown, partially screened phases, or even fractionalized Fermi liquids?

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O7-04

ANTIFFEROMAGNETIC DOME AND QUANTUM PHASE TRANSITIONS IN HEAVY FERMION SYSTEM $Yb_2Pd_2In_{1-x}Sn_x$

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The competition of Kondo coupling and RKKY interactions is known to determine the electronic properties of heavy-fermion intermetallic systems. In this respect, Yb-based compounds are particularly interesting. Thanks to the high sensitivity of Yb 4*f* electrons to chemical- and external pressure, an increase in pressure promotes a transition from a non-magnetic $4f^{14}$ (J = 0, μ.= 0) to a magnetic $4f^{13}$ (J = 7/2, μ = 4.5 μ_B) state with antiferromagnetic (AF) order.

In this work we present the paradigmatic case of $Yb_2Pd_2In_{1-x}Sn_x$, where chemical pressure can be tuned through In-Sn substitution: at the phase-diagram boundaries [x(Sn) = 0 and 1] the system is nonmagnetic, and exhibits low temperature non Fermi-liquid (NFL) properties. In the $0.5 \leq x \leq 0.9$ doping range, the system develops a dome-like region with long-range AF order and a maximum Néel temperature of about 3 K (at ambient pressure). Preliminary muon-spectroscopy (μSR) studies in the x = 1 case detected an unexpected AF dome, delimited by two pressure-driven quantum critical points at 1 and 4 GPa.

Here, we show a systematic μSR-study of $Yb_2Pd_2In_{1-x}Sn_x$ as a function of both chemical substitution, x(Sn)=0, 0.3, 0.6, 0.8, and applied pressure, up to ~ 2.4 GPa and down to T = 0.25 K. Our experimental results allowed us to fully map the AF dome in the p-T-x space. We show that the magnetic ordering temperature, T_N, increases systematically with p, reaching ~ 4.9 K at 2.4 GPa for x = 0.6. Interestingly, the x = 0.3 compound, although nonmagnetic at ambient pressure, develops a robust AF order with T_N = 3.8 K at 2.4 GPa.

O7-05
SUPERCONDUCTING FERROMAGNETIC NANODIAMOND

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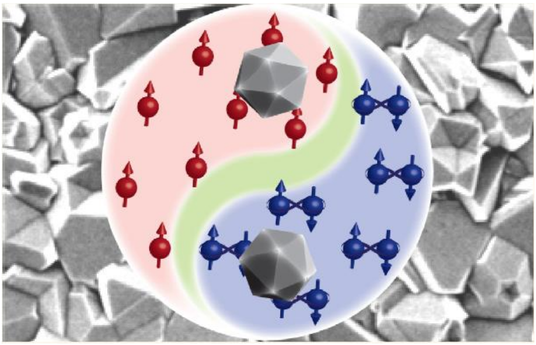
Hydrogenation of various carbon forms, including diamond, can induce intrinsic ferromagnetism. Boron doping of diamond, on the other hand, is known to induce superconductivity. Our study of hydrogenated boron-doped diamond nanostructures revealed a striking coexistence of ferromagnetism and superconductivity, two mutually antagonistic phenomena.[1] Additionally, detailed investigations of the local density of states disclosed spatially distributed in-gap states extended over tens of nanometers. To elucidate our observations, we developed a microscopic theory, that demonstrated the emergence of Yu-Shiba-Rusinov bands in a 3D superconductor with a 2D spin lattice on its surface. Our model accurately reproduced our experimental measurements. These findings suggest that apart from the Fulde-Ferrell-Larkin-Ovchinnikov state and the domain wall superconductivity, Yu-Shiba-Rusinov effect can be another microscopic mechanism behind the coexistence of ferromagnetism and superconductivity.



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O7-06

THERMODYNAMIC PROPERTIES OF SUPERCONDUCTING STATE IN DOPED GRAPHENE BILAYER

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With the successfully synthesized standalone graphene sheet, interest in two dimensional materials has start to rise drastically. Studies show superior physical and electric properties of carbon in atomic layer form which are the main stimulus to investigate other possible features of graphene in other areas of research. To this day, no evidence of superconducting state in monolayer graphene has been observed, however easily manageable two dimensional structure allows doping almost freely which in the case of graphene can have great impact on properties. In fact, the resistivity drop has been detected in pure, tilted by small angle graphene bilayer and Ca intercalated bilayer.

This work comprises the investigation on thermodynamic properties of superconducting state in intercalated graphene bilayer system C_6XC_6 (where X is either K, Ca, Rb or Sr). The combination of density functional theory and Eliashberg theory of superconductivity allowed to compute on the quantitative level the thermodynamic quantities, including the transition temperature, free energy, entropy and specific heat difference between the superconducting and the normal state. Phonon-mediated pairing mechanism assumption is based on obtained electron-phonon constant values λ (λ^{K} =0.86, λ^{Ca} =1.18, λ^{Rb} =0.93, λ^{Sr} =0.85).

Highest critical temperature was obtained for calcium intercalated bilayer (T_c=14.56 K) which is close to the experimental results ($T_{c,exp}$=11.3 K), potassium and strontium insertion lead to similar values of 8.67 K and 8.74 K, with rubidium doping having the smallest transition temperature. Free energy difference function gives insight on thermodynamic stability of superconducting phase, the outcome show the greatest values for C_6CaC_6. Specific heat difference functions related to superconducting gap share the above trend. Further collation of generalized approach to transition temperature based on analytical Allen-Dynes and McMillan formulas indicate big discrepancy compared to Eliashberg formalism in case of studied structures. Additionally, BCS R_{Δ},R_C and R_H ratios deviate significantly from constant, theoretical values.

O7-07

FIELD DEPENDENT DENSITY OF STATES OBSERVED ABOVE THE UPPER CRITICAL MAGNETIC FIELD IN STRONGLY DISORDERED MoC THIN FILMS

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Low temperature STM and transport studies on ultrathin polycrystalline MoC films provide evidence that, in contrast to the previously studied TiN, InO_x and NbN films, where the bosonic scenario of the superconductor-insulator transition (SIT) is found upon increased disorder, unambiguous signs of the fermionic scenario are present [1]. The superconducting energy gap decreases at the same rate as the transition temperature T_c leading to a disorder independent superconducting coupling strength. Global superconducting coherence is manifested by the presence of vortex lattice and most importantly, the superconducting state is spatially homogeneous for all thicknesses down to 3 nm.

In this presentation we study the influence of applied magnetic field on the superconducting and normal state (NS) properties in 3 nm thin MoC thin films, where the level of disorder approaches its critical value. Applying transport and low temperature STM measurements we observed evident differences between the normal state (NS) properties above T_c at zero field and the upper critical magnetic field $B_{c2}(T \rightarrow 0)$. When the system is driven to NS with increased temperature the suppression of the tunnelling density of states DoS follows the BCS theory. The DoS above T_c is constant, showing evidently metallic character. On the other hand, when the NS transition is achieved by magnetic field at low temperatures we observe markedly different behavior. Exceeding B_{c2} a field dependent logarithmic reduction of the DoS near the Fermi energy is observed. The origin of this unique, experimentally yet unobserved field dependent effect in the tunnelling NS DoS is the main subject of the presentation.

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O7-08

RESPONSE OF CRITICAL CURRENTS TO NEUTRON IRRADIATION OF REBaCuO TAPES IN LOW AND HIGH MAGNETIC FIELDS

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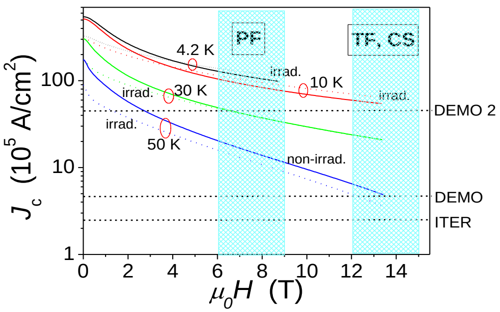
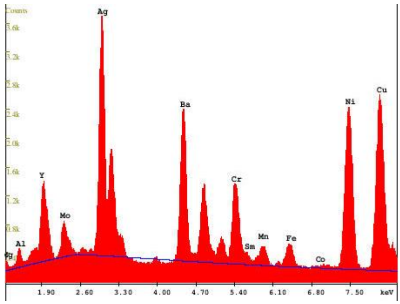
Superconducting REBaCuO (RE=Y and/or Gd) tapes intended for wiring of HTS magnets for fusion reactors were investigated in response to neutron irradiation by different neutron fluences [1,2]. The results indicate that the tapes are appropriate for the above mentioned purpose, however only at low temperatures, below 30 K. There, critical currents in high magnetic fields are enhanced due to neutron irradiation, however this effect is in different tapes different, most probably in dependence of the initial pinning landscape. On the other hand, at low magnetic fields critical currents in all tapes are reduced proportionally to the irradiation fluence. To find the reasons for such behavior, SEM and TEM analyses are under way, results of which will be presented, together with critical current dependence on neutron fluence for various tapes, and with a discussion of the problem.





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O7-09

MAGNETIC PHASE DIAGRAM OF Ca-DOPED $EuFe_2As_2$ COMPOUNDS

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Eu-magnetism has a crucial influence on superconductivity in $EuFe_2As_2$-based compounds, making them unique among other $A$$Fe_2As_2$-based superconductors ($A$= Ba, Ca, Sr). [1,2] Depending on the chemical substitution or applied pressure, $EuFe_2As_2$-based compounds can simultaneously exhibit spin density wave ordering, superconductivity – both associated with Fe-sublattice – and localized magnetism on Eu-sublattice. Although one may expect that by supressing Eu-magnetism it is possible to enhance superconductivity, in the Eu-by-Ca substituted compounds superconductivity is not observed under ambient pressure. [3-5] On the other hand, we found that Fe-by-Co substitution not only induces superconductivity but also influences the magnetic structure on the Eu-sublattice. This brings a question what is the interaction between the Fe and Eu layers.

In this contribution we present results of magnetic properties and muon-spin relaxation measurements on Eu-by-Ca doped compounds. We show that even nearly 50% doped compounds display similar features as the $EuFe_2As_2$ parent compound; remain antiferromagnetic with the same magnetic structure. This leads to conclusion that the interaction between Eu-magnetic moments is a RKKY interaction, mediated by Fe-conduction electrons [6].

This work is partially based on experiments performed at the Swiss Muon Source SμS, Paul Scherrer Institute, Villigen, Switzerland and was financially supported in part by the Schweizerische Nationalfonds zur Förderung der Wissenschaftlichen Forschung (SNF), Grant No. 200021-169455.

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P7-01

FERROELECTRIC CURRENT, ELECTROSPINONS AND FERRONS IN THE UNDERDOPED COPPER OXIDES

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Our contribution is devoted to the study of the magnetoelectric effects in the normal phase of the copper oxides. We show that in the underdoped copper oxides there arises a peculiar, alternative to the magnon fractalization, mechanism of spinon excitations. Next we prove, that within the CuO planes spinons are coupled to the local electric dipole moments, which results in composed excitations called electrospinons. Further, we show that when external electric field is applied, along with the electric current there can also arise the ferroelectric current being the ferroelectric counterpart of the well known spin current. Finally we show that magnetoelectric phenomena can contribute to the second harmonic generation.

P7-02

EVIDENCE OF GRIFFITHS PHASE BEHAVIOR IN THE PARAMAGNETIC STATE OF HEAVY FERMION COMPOUNDS $Ce_xLa_{1-x}B_6$ ($0.2 \leq x \leq 1$)

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We have investigated the doping-induced changes of magnetic properties of the archetypal heavy fermion compound CeB_6 on a series of substitutional solid solutions $Ce_xLa_{1-x}B_6$ ($0.2 \leq x \leq 1$). These model strongly correlated electron systems are attributed usually to Kondo-lattices (x~1) or, to dilute Kondo-impurity metals (x<<1) with a Kondo temperature of T_K=1 - 2 K which is comparable with the temperatures of two magnetic phase transitions observed in CeB_6 at $T_Q \approx 3.2$ K and $T_N \approx 2.3$ K [1]. In the present study high precision measurements of magnetic susceptibility $\chi(T)$ of $Ce_xLa_{1-x}B_6$ were undertaken in small external magnetic field aligned along three principal directions in the *bcc* cubic lattice of these hexaborides. It was shown that for all crystals and for all orientations of the magnetic field the $\chi(T)$ dependences obey a power law $\chi \sim T^{-\alpha}$ at temperatures in the range 10 - 300 K. The observed critical exponents α=0.75-0.85 demonstrate an approximately a linear decrease with the increase of Ce content. This Griffiths phase type behavior is very different from the convenient Curie-Weiss dependence and should be attributed to emergence of disordered magnetic clusters of Ce-ions in the matrix of hexaborides. Taking into account the loosely bound state of Ce(La) atoms in the *bcc* crystal lattice it is natural to conclude that the random local displacements of rare earth ions lead to the formation of nanometer magnetic domains in the RB_6 matrix. Following the analysis developed in [2] we have estimated the magnetic moments of spin clusters and discuss the possible model of magnetic properties of $Ce_xLa_{1-x}B_6$.

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P7-03

STUDY OF MISFIT SUPERCONDUCTOR $LaSe_{1.14}$ $NbSe_2$

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In analogy to the high-T_c copper oxides, $(LaSe)_{1.14}(NbSe_2)$ and $(LaSe)_{1.14}(NbSe_2)_2$ are layered superconductors, but substantially simpler with a Tc below 6 K. Our experiments show a large anisotropy of the upper critical field, comparable to the anisotropy of the normal-state resistance. Strikingly, the in-plane upper critical field is much larger than the Pauli field [1], determined solely by the Zeeman coupling, when the orbital motion of the Cooper pairs is negligible. We presume, that this behavior corresponds to the Ising spin-orbit coupling stemming from the layered structure of the compounds. STM study revealed strange surface behavior, despite superconducting transition in transport measurements of bulk sample at 4 K, there is no superconducting gap observed on cleaved surface even at 1.2 K. Furthermore, STM measurements enable us to observe misfit modulations in surface density of states, thus allowing us to observe minute differences in crystal structure between superconducting and non-superconducting samples.

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P7-04

COEXISTENCE OF FERROMAGNETISM AND SUPERCONDUCTIVITY IN Ni_2NbSn HEUSLER ALLOY

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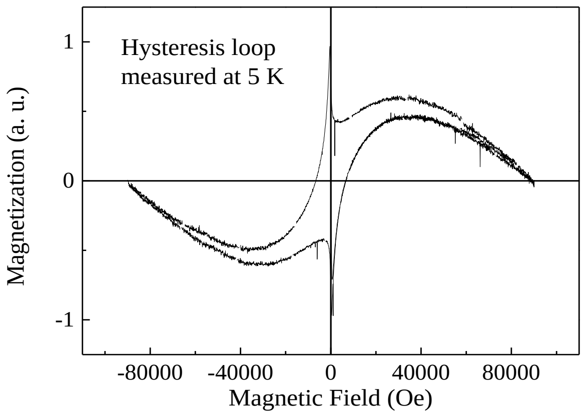
Heusler alloys show many physical properties, like magnetic and electrical transport properties, shape memory effect, magnetocaloric effect and so on. In some Heusler alloys like Ni_2NbSn, superconducting state can be observed [1].

Classical superconductive materials are characterized by no resistance and diamagnetic properties. In recent years, coexistence of ferromagnetism and superconductivity was observed. One example of such an alloy is Ni_2NbSn [2].

In this contribution we have studied the magnetic and structural properties of Ni_2NbSn Heusler alloy prepared by arc-melting. The SEM and XRD analysis were used to estimate the composition and structure of the alloy. Magnetic measurements reveal the coexistence of ferromagnetism and superconductivity. We show that Ni_2NbSn Heusler alloy exhibits the superconducting state at temperatures up to 10K.



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P7-05

MAGNETIC PHASE DIAGRAM OF $Tm_{1-x}Yb_xB_{12}$ (x < 0.1) ANTIFERROMAGNETS WITH DYNAMIC CHARGE STRIPES AND Yb VALENCE INSTABILITY

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Strongly correlated electron system $Tm_{1-x}Yb_xB_{12}$, which shares features of rare-earth dodecaborides RB_{12} as the cooperative Jahn-Teller instability of the boron sub-lattice in combination with rattling modes of R^{3+} ions and dynamic charge stripes [1], undergoes metal-insulator and antiferromagnetic-paramagnetic (AF-P) transitions with the variation of Yb content [2]. To find out, how Yb-ions modify the AF ground state and charge carriers scattering in TmB_{12}, we have studied the anisotropy of magnetoresistance $\Delta\rho/\rho$ (MR). For AF solid solutions (x < 0.1) precise resistivity measurements on single crystals combined with rotation in external magnetic field allowed us to construct the angular *H-φ-T* magnetic phase diagram in the form of a "Maltese cross". It was shown that the dramatic symmetry lowering of the AF ground state in rare earth dodecaborides with *fcc* crystal structure should be attributed to the spin density redistribution of conduction electrons by RKKY oscillations to dynamic charge stripes which cause significant changes in the indirect exchange interaction between magnetic moments of Tm^{3+} ions and result in appearance of a number of various magnetic phases and numerous phase transitions. Yb doping suppresses magnetic order abruptly, but the anisotropy of AF phase boundaries remains the same. On the other hand, in P-phase the MR anisotropy changes its sign and angular dependence.

This work was supported by the Russian Science Foundation, project no. 17-12-01426 and by Slovak agencies VEGA (grant no. 2/0032/16) and APVV (grant no. 17-0020).

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P7-06

SUPERCONDUCTING PHASE DIAGRAM OF LuB_{12} AND $Lu_{1-x}Zr_xB_{12}$ ($x \leq 0.20$) DOWN TO 60 mK

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It is well known that lutetium dodecaboride LuB_{12} is a type-I BCS superconductor with critical temperature $T_c \approx 0.4$ K, whilst zirconium dodecaboride is a type-II BCS superconductor with the highest critical temperature $T_c \approx 6.0$ K among this group of materials [1]. In case of lutetium substitution by zirconium ions in LuB_{12} the crossover from type-I to type-II superconductor can be studied. We have investigated the evolution of critical temperature T_c and critical field B_c in high-quality single crystalline superconducting samples of $Lu_{1-x}Zr_xB_{12}$ ($0 \leq x \leq 0.20$) by measuring magnetic ac-susceptibility between 1 K and 60 mK. To obtain this kind of experimental data, a new susceptometer was designed, constructed and tested, which can work in a wide temperature range of 0,06 K – 3 K in ^3He-^4He dilution refrigerator. The measurements with this new susceptometer revealed how $T_c(x)$ and $B_c(x)$ increases with increasing concentration of zirconium in $Lu_{1-x}Zr_xB_{12}$ solid solutions as well as how their superconducting phase diagram develops.

Acknowledgement. This work was supported by the project VEGA 2-0032-16, by the Slovak Research and Development Agency under the contract no. APVV 17-0020 and by the Program of Fundamental Research of the Presidium of the Russian Academy of Sciences 'Fundamental Problems of High-Temperature Superconductivity'. Liquid nitrogen for experiments was sponsored by U.S. Steel Kosice.

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P7-07
LOCAL MAGNETOMETRY OF SUPERCONDUCTING Mo_8Ga_{41} AND Mo_7VGa_{41}: VORTEX PINNING STUDY

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Substitution of one element with another in a compound may influence its properties in positive or negative way, especially in terms of superconductivity. Recently, attention was drawn to endohedral gallide cluster superconductor Mo_8Ga_{41}. This material indicated some unusual non-BCS superconducting properties accompanied with possible multi-gap superconductivity. Moreover, these properties seem to vanish after substitution of vanadium atom for molybdenum. Here we present a local magnetization study of both compounds, Mo_8Ga_{41} and Mo_7VGa_{41}. Array of miniature Hall probes was used for study of magnetic profile which reflects vortex distribution inside the sample. Evolution of the lower critical magnetic field H_{c1} related to penetration of magnetic vortices into the sample with temperature was also studied. Molybdenum substitution effect on superconducting properties of Mo_8Ga_{41} is discussed.

P7-08

BOSONIC TYPE OF SUPERCONDUCTOR-INSULATOR TRANSITION IN NANODIAMOND ARRAYS

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The study of superconductor- insulator transition (SIT) is very popular in the last few years. There are two types of SIT: fermionic, where the whole sample transits from superconductor to insulator state, and bosonic, where the superconducting phase persists locally in the form of bosonic islands even in the bulk insulating state.

In superconducting materials presence of the granular disorder may lead to localization of Cooper pairs that can be responsible for the creation of the bosonic islands.

Here we report on the scanning tunneling microscopy and spectroscopy measurements of the boron doped nanodiamond arrays prepared by chemical vapor deposition. The superconducting diamond seeds, ranging from few nanometers to micrometers in diameter, are situated on Si substrate and connected by conducting but non-superconducting diamond wetting layer.

We showed indications of localized Cooper pairs, destruction of the superconducting coherence and creation of the bosonic islands by analyzing the shape of tunneling conductance spectra, temperature evolution of superconducting gap and coherent peaks in local density of states.

P7-09

SPIN DYNAMICS OF THE FRUSTRATED ANTIFERROMAGNET HoB_{12} INVESTIGATED BY INELASTIC NEUTRON DIFFRACTION AND MODELLED BY MC METHODS

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Hob12 crystallizes in the fcc – structure and is known as to exhibit antiferromagnetic order. Here the interactions are derived from the magnon dispersion measured by neutron spectroscopy [1]. A model with nearest (NN) and next neared (NNN) interaction is analyzed using first MonteCarlo (MC) stimulation to establish the spin correlations as a function of temperature. The dynamic behavior is obtained by a numerical integration of the classical equation of motion [2]. The results show dominant NNN interaction~~s~~ and the NN interaction appears to be weak.

The methods are then applied to the paramagnetic state and compared with inelastic neutron diffraction data. The neutron data confirm predictions of the spin relaxation obtained originally for the pyrochlore structure [3] for the fcc structure here. It is exponential along nodal lines. The dynamics is modelled well by our methods because the MC simulation can provide the paramagnetic correlations as starting point for the dynamic model.

The results are discussed with respect to the unusual critical behavior of HoB_{12}. The paramagnetic spin correlations are strongly anisotropic. They become isotropic at T_N but remain gapless for a finite temperature range below T_N.

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P7-10

COMPLEX CONDUCTIVITY OF STRONGLY DISORDERED ULTRA-THIN MoC SUPERCONDUCTING FILMS

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Disordered superconductors are currently a subject of intense research, motivated by the appeal of dealing with the most fundamental issues of condensed matter physics, as well as by the high promise for their applications. Molybdenum carbide (MoC) is a highly disordered superconductor, in which the extent of disorder can be conveniently tuned by varying the carbon content and/or the film thickness. The high sheet resistance of these films results in a high kinetic inductance in the superconducting state.

To determine the complex conductivity of MoC films in the GHz frequency range, we used a broadband non-contact flip-chip transmission line technique. The sample is placed above a coplanar waveguide designed to minimize the impedance mismatch, and thus enabling broadband measurement. The real part of the complex conductivity affects the transmission of the wavequide via the sheet resistance of the film, while the imaginary part of the complex conductivity affects the phase of the traveling wave via the sheet inductance of the sample.

Here, we present the measurement carried out on MoC films of 5nm thickness, with differing sheet resistances as tuned by varying their carbon content. The obtained conductivities, measured in a frequency range of several GHz and at temperatures reaching down to 0.5K, are analyzed in the frame of the modified Mattis-Bardeen theory with introduced finite quasiparticle lifetime [1].

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P7-11

EFFECT OF TiO_2 FIBERS ON PROPERTIES OF SINGLE-GRAIN BULK GdBCo SUPERCONDUCTORS

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In this study, the influence of TiO_2 fibres doping on superconducting properties of single-grain bulk $GdBa_2Cu_3O_{7-\delta}$ (Gd123, GdBCO) high-temperature superconductor was investigated. We prepared Gd123-TiO_2 and pure Gd123 superconductors via the top-seeded melt growth method in air, applying the slow cooling time-temperature regime. The ceramic fibres were prepared using the needle-less electrospinning method and were added in the small quantity (0.05 wt. %) for the increase of number of flux pinning centres. The average diameter of fibres after the conventional calcination was 0.54 μm.

The TiO_2 fibres distribution in the matrix with respect to the distance from the seed was observed with scanning electron microscope from the polished sample cut into two halves. A microstructural analysis demonstrated no reaction between the fibres and GdBCO mixture powder during the melting process.

The measurements of superconducting properties (critical temperature T_c and critical current density J_c at 77 K) were carried out using a vibrating sample magnetometer. Magnetization measurements were performed on the specimens taken from several different locations from both studied samples. The experimental results showed that TiO_2 do not affect the T_c along with the increase of J_c.

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P7-12

SPECIFIC HEAT MEASUREMENTS OF HEAVY FERMION SUPERCONDUCTOR $CeCoIn_5$

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$CeCoIn_5$ is a heavy fermion system where superconductivity emerges from an environment of strong magnetic fluctuations. In the normal state it changes its character from Fermi liquid to non-Fermi liquid. We have measured the specific heat of the compound between 0.4 K and 10 K in magnetic fields up to 18 Tesla applied perpendicular to the basal plane. Based on these results we have constructed a Magnetic field vs. Temperature (*H-T*) phase diagram. The normal-superconducting phase boundary was determined. The crossover from the non-Fermi liquid to the Fermi liquid behavior is clear from our measurements. The *H-T* phase diagram constructed from our specific heat measurements is compared with the diagrams determined from resistivity [1], thermal-expansion [2] and Hall effect measurements [3]. A field-induced quantum critical point in $CeCoIn_5$ is discussed.

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P7-13

OXYGENATION TEMPERATURE DEPENDECY ON THE CRITICAL TEMPERATURE AND THE CRITICAL CURRENT OF THALLIUM BASED SUPERCONDUCTORS

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A thallium based superconductors were synthesized in double silver foil in 880 °C for 30 minutes under flowing oxygen. Additional oxygenations lasting 20 hours each were performed in temperatures varying from 700 °C to 820 °C to improve the critical temperature and the critical current of the superconductor. Optimal temperature of the oxygenation seems to be 760 °C. A sample oxygenated in 820 °C lost diamagnetism in temperatures down to 77 K.

P7-14

MAGNETIC CONTRIBUTION TO HEAT CAPACITY OF $YbNi_4Si$

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Yb compounds are still in huge interest due to great variety of heterogenous attributes. One of important property is the competition between Kondo exchange coupling and RKKY exchange interaction. First interaction screens the local f-moments to produce a non-magnetically ordered state, characterized by heavy quasiparticles (the Kondo singlet state), while second correlates the same f-moments via conduction electrons, hence driving the system to a long-range magnetically ordered state. This competition could also yields to interesting phenomenon presenting the effects connected with quantum criticality. The heat capacity measurements in the low temperature range and in the high magnetic field has shown transition into antiferromagnetically ordered state [1]. In this work the analysis of magnetic contribution in the heat capacity of YbNi4Si is presented in means of Schottky anomaly due to crystal electric field splitting. The energy levels were determined as Δ_1 = 95 K and Δ_2 = 196 K and suggest that nonlinear electrical resistivity dependence of YbNi4Si [2] is influenced mainly by crystal electric field effects.

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P7-15

INVESTIGATION OF Co-DOPED GdFeAsO-BASED MAGNETIC SUPERCONDUCTORS

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In this contribution we present synthesis and physical properties of newly obtained Co-doped GdFeAsO magnetic superconductors.

Crystallites of $GdFe_{1-x}Co_xAsO$ (x = 0.1; 0.15, 0.2) were grown utilising the salt-flux method using GdAs, Co, Fe, Fe_2O_3 and KCl in molar ratios of 1:x:⅔-x:⅓:30. The substrates were sealed in double quartz ampules under vacuum, then heated slowly to 1050℃ and kept at this temperature for several hours. Next, the ampules were cooled down to ~770℃ with ~2℃/h cooling rate. The KCl flux was removed via dilution in water.

At room temperature GdFeAsO-based compounds crystalize in tetragonal structure. Below certain temperature ($<T_{SDW}$) they exhibit tetragonal to orthorhombic structural phase transition accompanied by a spin density wave order on iron sublattice; and at T_N they exhibit localized (antiferro)magnetic order associated with *f*-electrons of Gd. With Co-doping it is possible to tune the T_{SDW} and introduce superconductivity in this system [1, 2].

Therefore, these materials have promising properties, where interplay of superconductivity and *f*-electron magnetism is expected, similarly to the $EuFe_2As_2$-based superconductors [3, 4].

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P7-16

MEAN-FIELD STUDY OF THE AMPEREAN PAIRING STATE

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One of the central problems in the field of high temperature superconductivity is to explain the origin of the so-called pseudogap phase. A promising description of this phase is in terms of the pair density wave (PDW) state. According to P.A. Lee [1], such a state may be stabilized by the current-current interactions which follow from the gauge theory description of the CuO plane.

Making use of a simplified non-singular form of current-current interactions predicted by the gauge theory, in this work we study the stability of the PDW states within the mean-field approximation. We consider several PDW states with different total momenta Q of the Cooper pairs and for each of them we calculate its physical properties.

We find that, if we take the same value of Q as in [1], we can reproduce the experimentally observed Fermi arcs as well as the correct total momentum of the secondary charge density wave. However, PDW states with different values of Q in general do not agree with experimental observations. Next we compare the free energies of the candidate PDW states. Our preliminary results suggest that the optimal value of Q is different from the choice in [1], and therefore it seems that the Amperean pairing state can not explain the pseudogap phase.

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P7-17

UNCONVENTIONAL DENSITY OF STATES ABOVE THE UPPER CRITICAL FIELD IN HOMOGENEOUSLY DISORDERED SUPERCONDUCTING Mo_2N FILMS

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We studied transport and local electronic properties of homogeneously disordered superconducting Mo_2N films at temperatures down to 400 mK and in magnetic fields up to 8 T by means of four-probe van der Pauw method and scanning tunneling microscopy and spectroscopy. The superconducting density of states (DOS) extracted from the tunneling measurements remains gapless down to the lowest temperatures, similar with the case of MoC films [1]. Above the upper critical magnetic field $H_{C2}(0)$ the DOS exhibits an approximately field independent reduction around the Fermi energy which becomes especially pronounced on the energy scale of the superconducting gap in zero field. Above $H_{C2}(0)$ this effect persists up to several times the superconducting transition temperature in zero field $T_C(0) \cong 2.9$ K, however, it was not observed in zero field above $T_C(0)$. We elaborate on the possible origin of this phenomenon and draw comparisons with the theoretical predictions for low-dimensional, highly disordered systems.

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P7-18

FIELD-INDUCED FIRST-ORDER TRANSITIONS IN DYNES SUPERCONDUCTORS

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The density of states in dirty superconductors is quite often well described by the phenomenological Dynes formula [1]. Recently, a microscopic derivation of this formula within the coherent potential approximation has been found [2]. The central assumption was that a Lorentzian distribution of random pair-breaking magnetic fields with fixed orientation is present inside the superconductor.

The present work is motivated by experiments on thin superconducting aluminum films in parallel magnetic field, which find a first-order transition between the normal and superconducting phases in the low-temperature limit [3]. According to the tunneling data, aluminum is a Dynes superconductor (i.e. a superconductor with a density of states described by the Dynes formula) with a small pair-breaking scattering rate. However, the orientation of the random fields inside the film is unknown.

The theory described in [2] can be applied only if the external field is parallel to the internal random fields. However, in this case we find that the region of metastable states is too large compared with experiment. Therefore we have generalized the Dynes phenomenology to systems with an arbitrary orientation of magnetic fields. As a special case, next we assume that the internal random fields are perpendicular to the external field. We will present the results for the magnetic phase diagram in this case.

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P7-19

PHASE DIAGRAMS OF A MODEL 2D CUPRATE

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Competition of spin, charge and superconducting orderings is the important issue in the physics of high-Tc cuprates such as $La_{2-x}Sr_xCuO_4$. In theoretical works devoted to this problem[1,2] it was assumed that the on-site Hilbert space is reduced to only three effective charge states $CuO_4^{5-,6-,7-}$ of copper ions in the CuO_2 planes. These charge states are associated with components of the S = 1 pseudospin triplet. Hamiltonian of the system:

$$\hat{H} = \sum_i (\Delta S_{iz}^2 - \mu S_{iz}) + V \sum_{\langle ij \rangle} S_{iz} S_{jz} + t \sum_{\langle ij \rangle} \left(S_{i+}^2 S_{j-}^2 + S_{i-}^2 S_{j+}^2 \right)$$

where $V > 0, t > 0$. The first single-site term relates with the on-site density-density interactions. The second term may be related with a pseudo-magnetic field which acts as analog of chemical potential μ for doped charge. The third term describes the effects of inter-site density-density interactions. The last term describes the two-particle inter-site hopping. Conventional spin $s = 1/2$ can be built in this effective pseudospin Hamiltonian with transformation:

$$\hat{H}_{ex} = J \sum_i (1 - S_{iz}^2)(\hat{s}_i \cdot \hat{s}_j)(1 - S_{jz}^2),$$

where J is the conventional exchange integral, $(1 - S_{iz}^2)$ is the projection operator that picks out the s = 1/2 CuO_4^{6-} state.

We previously investigated the competition of different types of ordering in static (*t = 0*) model [3,4] and model with two-particle inter-site hopping [5], using Monte Carlo simulation technique. In this work, we show that the addition of a one-part transport effects makes it possible to obtain qualitatively the phase diagram of high-Tc cuprates.

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P7-20

MAGNETIC GROUND STATE AND PHASE DIAGRAM OF γ_{II}-Li_2FeSiO_4

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Multi-faceted magnetic characterisation of γ_{II}-Li_2FeSiO_4 (space group *Pmnb*) is presented. Elastic neutron scattering on a powder sample reveals commensurate two-sublattice antiferromagnetic (AFM) order with the propagation vector $\boldsymbol{q}$ = (1/2, 0, 1/2) and with the spins ordered collinearly along the *a*-axis. The Néel temperature is found to be at T_N = 17.1(2) K. Density-functional-theory calculations based on the local-density approximation predict the predominant AFM interactions as lying along the *c*-axis ($J_c \approx 34.0$ K) and *a*-axis ($J_a \approx 12.6$ K), indicating a (quasi-)two-dimensional nature of the ground-state magnetic interactions.

Static magnetic susceptibility measurements on single crystals confirm the AFM ground state with T_N = 17.1(1) K and the magnetic easy *a*-axis, and detect magnetic anisotropy extending up to the highest measured temperatures. A broad maximum in χ_a at $T_m \approx 28$ K further evidences the low dimensionality of the ground state.

Pulsed-field magnetisation measurements in fields up to B = 60 T detect along the *a*-axis the presence of further two high-field phases above AFM ground state induced at B_{C1} = 16.0(1) T, and B_{C2} = 18.7(2) T, respectively. The saturation fields are found to be at $B_{a,sat}$ = 32(2) T, $B_{b,sat} \approx$ 60(-1)(3) T, $B_{c,sat}$ = 49(1) T.

Anomalies in the thermal expansion coefficient at B = 0 T corroborate the neutron and static magnetic susceptibility results and reveal the uniaxial pressure dependences of the Néel temperature: $\partial T_N/\partial p_a < 0$, $\partial T_N/\partial p_b > 0$, $\partial T_N/\partial p_c > 0$. Field-dependent thermal expansion and magnetostriction measurements in static fields up to B = 35 T indicate strong magneto-crystalline coupling, and elaborate the *a*-axis magnetic phase diagram.

The experimentally obtained axis-dependent magnetic phase diagrams are presented are compared with theoretical predictions for two-dimensional Heisenberg antiferromagnets.

8 MULTIFUNCTIONAL MAGNETIC MATERIALS (MULTIFERROIC, MAGNETOELASTIC, SHAPE MEMORY, ...)

O8-01
TUNABLE EXCHANGE BIAS IN THE MULTIFERROIC $BiFe_{0.5}Sc_{0.5}O_3$ PEROVSKITE

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Multiferroic $BiFe_{0.5}Sc_{0.5}O_3$ perovskite synthesized under high-pressure exists in two metastable modifications, namely an antipolar *Pnma* polymorph and the polar *Ima*2 one [1]. The exchange bias (EB) effect has been revealed in the polar phase of $BiFe_{0.5}Sc_{0.5}O_3$ obtained by annealing of the high-pressure stabilized antipolar phase. The exchange field, H_{EB}, and the coercive field, H_C, were found to be strongly dependent on temperature and strength of the cooling magnetic field, H_{cool}. H_{EB} increases with increasing the cooling magnetic field and reaches the maximum value of about 1 kOe at 5 K (H_{cool} = 20 kOe). H_{EB} decreases with increasing temperature and vanishes above the Néel temperature $T_N \sim 220$ K with the disappearance of the long-range magnetic ordering. The EB effect is associated with a weak ferromagnetism driven by the Dzyaloshinskii-Moriya antisymmetric exchange interactions revealed in the $BiFe_{0.5}Sc_{0.5}O_3$ perovskite and nano-scale spontaneous magnetic phase separated state of the compound. Below T_N, the two nano-scale antiferromagnetic (AFM) phases coexist in the polar $BiFe_{0.5}Sc_{0.5}O_3$, one of the phases being weakly-ferromagnetic. Interface exchange coupling between the AFM domains and weakly-ferromagnetic AFM ones causes unidirectional anisotropy of the magnetization resulting in the EB effect. The effect is promising for the application in electronics as it is large enough and tunable by the cooling magnetic field and temperature.

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O8-02
EFFECT OF DRIVE SIGNAL AND TEMPERATURE ON HYSTERESIS OF MAGNETICAL SHAPE MEMORY ALLOY-BASED ACTUATOR

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Because of high frequency response, large strain and high energy density, the magnetical shape memory alloy(MSMA) based actuator possesses distinct advantages over traditional actuators in nano-physics and multifunctional magnetic materials field[1-2]. However, the MSMA-based actuator is not widely used in practice fields due to the displacement of the MSMA-based actuator has strong sensitivity to the change of the drive signal[3].

The present work is devoted to study the effect of external conditions and drive signal on the displacement of MSMA-based actuator. Firstly, the structure and principle of the MSMA-based actuator are introduced. Then the displacement curves of the MSMA-based actuator are tested under different environment temperature, input frequencies and amplitudes. Finally, the hysteresis characteristics of the MSMA-based actuator under different environment temperature and drive signal are discussed and analyzed.

Experiment details indicate that different temperatures have a significant effect on the shape of the hysteresis curve of the MSMA-based actuator. In the temperature range of 10℃~25℃, the maximum displacement of the MSMA-based actuator increases with the increase of temperature. When the temperature is higher than 25℃ and continues to increase, the maximum displacement of the MSMA-based actuator will gradually decrease. In addition, experimental results also show that with the increase of input frequency, the width of hysteresis loops increases and the output amplitude of hysteresis loops decreases.

Acknowledgement
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O8-03
Withdrawn

O8-04

MICROSTRUCTURAL AND MAGNETIC PROPERTIES OF SORBENTS BASED ON CERIUM DIOXIDE

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Recently, a new reactive sorbents based on cerium dioxide and/or iron oxide/cerium dioxide nanoparticles were successfully used to decompose some of the dangerous organophosphate compounds and chemical warfare agents like soman and VX [1]. Their degradation efficiency, magnetic, and microstructural properties are governed mainly by the calcination temperature applied during the sorbent preparation that seems to be optimal between 473 K and 673 K. Additional increase of the temperature leads to marked reduction in degradation capabilities [1].

The present studies deals with two problems:

1) Precise preparation of nanoparticle/nanocrystal size CeO_2, known as ceria, by several technological procedures including analyses of input chemicals with subsequent investigation of structural, chemical and phase composition, morphology, and micro- and macro-magnetic properties executed at room and low temperatures. Particular attention has been paid to the presence of small amount of iron in units of ppm not only in the ceria but also in input chemicals applied for its production. The presence of Fe was independently confirmed by Inductively Coupled Plasma Atomic Emission Spectroscopy and Mössbauer spectroscopy.

2) More detailed study of the iron oxide/ceria sorbents, prepared by core/shell methods, was focused on the structure, composition and magnetic behavior of iron oxides and their phase transformations during calcination process in the temperature range from 473 K to 1073 K. A direct correlation between the magnetic properties and the sorbent degradation capability has been confirmed.

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P8-01

MAGNETIC PROPERTIES OF $Gd_xMn_{1-x}Se$ SELENIDES

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Materials in which manifests the interrelation of magnetic and electrical properties [1, 2], magnetoelectrics and multiferroics [3] are of interest from both fundamental and applied points of view. Particular attention in materials that detect the magnetoelectric properties in the field of room and higher temperatures due to the practical application in microelectronics for recording and storing information.

The aim of the work is to study the effect of electron doping on the magnetic characteristics and the metal – dielectric phase transition in $Gd_xMn_{1-x}Se$ solid solutions depending on the composition in wide temperature range.

Samples of $Gd_xMn_{1-x}Se$ ($0 \leq x \leq 0.15$) were synthesized by solid-state reaction method from manganese and gadolinium selenides initial powders in evacuated quartz ampoules in a single-zone resistance furnace. X-ray phase analysis of synthesized solid solutions of the $Gd_xMn_{1-x}Se$ system was carried out in Cu-Kα radiation at room temperatures.

The temperature specific magnetization dependences were studied by the ponderomotive method in the 77–900 K temperature range in a magnetic field of 8.6 kOe. At low temperatures, the magnetic moment magnitude increases with concentration x increasing, which is characteristic for ferrimagnetic and antiferromagnetic materials with "inclined" magnetic cell. Thus, the substitution of manganese ions by gadolinium ones leads to a Néel temperature decreasing and to a sharp paramagnetic Curie temperature decreasing with concentration increasing.

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P8-02
THE EFFECT OF Co-DOPING ON MAGNETIC PROPERTIES OF BISMUTH FERRITE

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Based on bismuth ferrite $BiFeO_3$ (BFO) solid solutions are promising materials for new memory elements, sensors, magnetoelectric switches and other electronics and spintronics devices creating. The main reason for the interest in BFO is the coexistence in this compound of ordered antiferromagnetic (AFM) and ferroelectric (FE) phases with high Neel (T_N = 643 K) and Curie points (T_C = 1083 K) [1–3].

The aim of the work is to study the crystal structure features and magnetic properties correlations in multiferroics of $R1_xR2_{(0,2-x)}Bi_{0.8}FeO_3$ type (x=0; 0.05;0.10; 0.15, R1, R2 = La, Gd, Dy, Er) depending on the concentrations and types of substitutive rare earth elements cations.

Isovalent substitution of Bi^{3+} cations by rare earth elements ones in the bismuth ferrite leads to suppression of spatially modulated magnetic spin structure and appearance in $R_xBi_{1-x}FeO_3$ (x= 0.05; 0.10; 0.15; 0.20, R=La, Nd, Gd, Dy, Er) compositions of weak ferromagnetic response, the magnitude of which depends on the concentrations of the substituting cations and the values of crystal-chemical characteristics of the studied structures. Systematic changes in the intensity of magnetic interactions depending on the type and concentration of REE cations substituting Bi^{3+} cations are revealed. Is of great interest to continue the research of the bulk and thin-film samples obtained by co-doping of the cationic and anionic sublattices of bismuth ferrite.

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P8-03

STRUCTURAL AND MAGNETIC CHARACTERIZATION OF GLASS-COATED MICROWIRES OF Ni_2FeGa HEUSLER ALLOY

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Ferromagnetic shape memory alloys (FSMAs) belong to the group of smart materials which combine the properties of sensors and actuators. The shape memory effect originates in the ability of material undergo a phase change between austenite and martensite, called martensitic transformation [1]. Heusler alloy based on Ni-Mn-Ga is a prototype of FSMAs owing to large magnetic field induced strain reaching up to 10% accompanied by large changes of magnetic properties. However, lack of ductility of this system and difficult preparation due to evaporation of Mn during melting can limit its potential applications.

Alternatively, Heusler alloy based on Ni-Fe-Ga with composition close to the stoichiometric 2:1:1 have been proposed as promising candidate of FSMAs with transformation characteristics quite similar to Ni_2MnGa [2]. Heusler alloy Ni_2FeGa for our study was prepared by Taylor – Ulitovsky method, which allows easy production of single-crystall microwire. Structural transformation at about 220 K was studied by optical microscopy, magnetic measurement and X-ray diffraction. Mossbauer spectroscopy was used to evaluate the changes during transformation at the different temperatures. Magnetic properties were analyzed by MFM which shows influence of magnetic field on the size and direction of magnetic domains in the austenite.

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P8-04

MARTENSITIC STRUCTURAL VARIANTS RECOVERED BY THE MAGNETIC FIELDS IN Fe_2MnGa HEUSLER ALLOYS

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The large magnetic field-induced strain associated with a rearrangement of martensitic variants is strongly influenced by the external fields. In particular, compositional disorder plays a fundamental role in strain modulations observed in Heusler alloys undergoes paramagnetic $L2_1$ Heusler phase to ferromagnetic $L1_0$ martensitic transformation.[1] This area of research has been received enormous research attention not only because of their potential applications in magnetic shape memory application, but also its magneto-structural, magneto-electronic and magneto-optical from the standpoint of condensed matter physics.[2] To date, the control of the Magnetic field induced structural transformations in the Fe-based Heusler band structures remains essentially unexplored, in contrast to Ni-based alloys that have been investigated in detail.[3-4] One of the candidate for observation of magnetic-field-induced shape recovery is Fe_2MnGa alloy. In this contribution, we report the of a structural and magnetic properties of Fe_2MnGa (FMG) Heusler alloy prepared by arc-melting (bulk-form) and Taylor-Ulitovsky (micro-wires) methods. Structural phase, morphology and composition features of the as prepared alloys studied by employing the X-ray diffraction, Scanning Electron Microscopy and Elementary Dispersive Spectroscopy. The magnetic properties have been investigated by measuring the M(T) in cooling and heating processes under the external applied field (H) using Vibrating Sample Magnetometer.

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P8-05

SPECTROSCOPIC AND THERMODYNAMIC INVESTIGATION OF THE NEW ALTERNATING CHAIN SYSTEM $Fe(Te,Se)_2O_5Cl$

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In search of new materials with specific magnetic properties, the exploration of isostructural relatives of already known multiferroics [1,2] is essential. Alternating antiferromagnetic spin chains composed of Fe ions in high spin state together with Te and Se ions, both containing lone pair electrons, make $Fe(Te,Se)_2O_5Cl$ a promising candidate for particular magnetic properties [3]. Magnetic susceptibility temperature dependence of layered $FeTe_{1.5}Se_{0.5}O_5Cl$ reveals a broad maximum at 65K and a transition into a magnetically ordered state at T_N=23K, further confirmed by specific heat measurements. Being sensitive to many degrees of freedom Raman scattering is a helpful tool to reveal an interplay of lattice dynamics and magnetism. All modes deviate from conventional anharmonic behavior around 60K, which can be attributed to spin-phonon coupling. Phonons demonstrate large intensity variations with temperature, as a consequence of strong polarizability of lone pair ions.

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P8-06

MAGNETISM OF $GdMn_{1-x}Fe_xO_3$ ($0 \leq x \leq 1$) NANOPARTICLES

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We present the study of magnetism in the $GdMn_{1-x}Fe_xO_3$ ($0 \leq x \leq 1$) substitutional system studied on the nanocrystalline samples prepared by glycine-nitrate method. Multiferroic $GdMnO_3$ compound was found to order antiferromagnetically below $T_N = 43$ K, which is consistent with the literature [1]. Fe doping increases T_N, which exceeds 400 K for $x = 0.5$.

Additional magnetic order-order phase transition was found for concentrations $x \leq 0.2$ and temperatures $T_1 \sim 10$ K. This transition is from pure antiferromagnetic state to a weak ferromagnetic ground state represented by hysteresis loop with coercitive field H_c within interval 0.169 T ($x = 0$) and 0.202 T ($x = 0.2$). The weak ferromagnetic ground state evolves also at higher concentrations and Hc at 2 K linearly decreases with x, however, there was observed no anomaly below T_N and for $x < 0.5$. For $x \geq 0.6$, the additional magnetic phase is observed at temperatures higher than the weak ferromagnetic phase.

The maximum moment at 7 T and 2 K was found to linearly increase from roughly 4.8 μ_B/f.u. for $x = 0$ (comparable to moment of Mn^{3+} in high spin state) to 7.3 μ_B/f.u. for $x = 1$. This suggests that iron ions in this compound polarize/order the gadolinium ions.

In our contribution we will present the complete overview of the magnetic phase diagram of $GdMn_{1-x}Fe_xO_3$ substitutional system. It is well known that in this type of compounds the magnetism is dependent on the type of samples (single crystal, polycrystal, nanoparticles) as well as the preparation route, so we compare our results with results obtained by other groups for the concentrations, for which the data are available.

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P8-07

MAGNETIC PROPERTIES OF $(La_xDy_{1-x})_2Ti_2O_7$

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$La_2Ti_2O_7$ is a well-known high temperature, layered perovskite, ferroelectric compound (Curie point, T_C = 1461 ± 5°C) with low crystal symmetry (monoclinic structure with the space group P21). The high temperature prototype of $La_2Ti_2O_7$ is orthorhombic. On the other hand $Dy_2Ti_2O_7$ is identified as a spin-ice material with the pyrochlore structure crystallizes into a face centred cubic structure Fd-3m. The dynamical freezing behaviour seen in $Dy_2Ti_2O_7$ differs from the critical slowing down observed in conventional disordered spin-glass materials. Another difference between the spin freezing in $Dy_2Ti_2O_7$ and that in conventional disordered spin glasses is the magnetic field dependence.

In our paper we focus on magnetic properties of $(La_xDy_{1-x})_2Ti_2O_7$ system, which may combine ferroelectric properties of $La_2Ti_2O_7$ with magnetic structure of spin frustrated system of $Dy_2Ti_2O_7$. The effect of substitution on AC susceptibility is demonstrated in Fig.1.

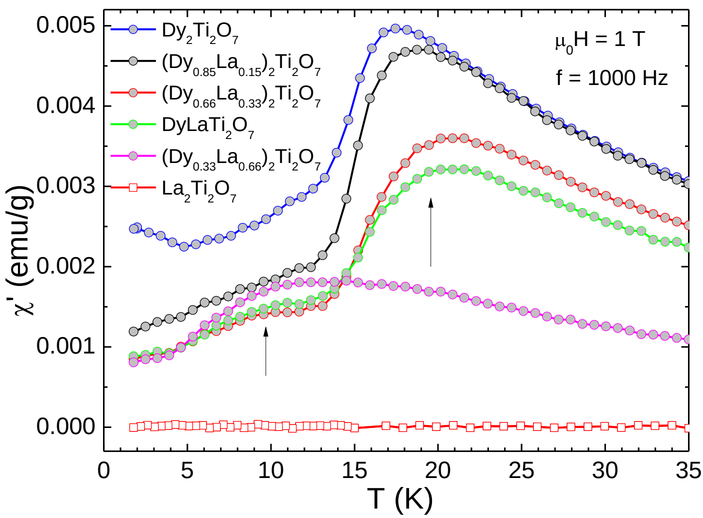

Fig.1. In phase susceptibility of powdered samples shows the effect of substitution on two maxima denoted by arrows, which we will discuss in the paper.

Acknowledgement: This work was supported by the project VEGA 2/0137/19.

P8-08

DISCOVERY OF THE PIEZOMAGNETOELECTRIC EFFECT IN $LiCoPO_4$

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The piezomagnetoelectric (PME) effect was discovered experimentally in a $LiCoPO_4$ single crystal. The possibility of its existence in antiferromagnets was theoretically predicted in the 1960's [1] however, attempts at its experimental detection were unsuccessful.

PME is a piezoelectric effect caused by the presence of a constant magnetic field H, or piezomagnetism stimulated by a constant electric field E, or deformation-dependent renormalization of the linear magnetoelectric effect.

We have registered PME in an experiment on nonresonant acoustoelectric transformation [2]. The measuring procedure was described in detail in [3]. In a $LiCoPO_4$ single crystal, the effective electric piezo module grows linearly with the increase of the magnetic field. The temperature dependence of the component of a piezomagnetoelectric tensor, whose form resembles the temperature dependence of the antiferromagnetic order parameter, shows that PME exists only in the magnetically ordered state of the crystal.

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P8-09

MAGNETIC AND STRUCTURAL TRANSITIONS IN $Pb_{1-x}Ba_x(Fe_{0.5}Nb_{0.5})O_3$ FROM MÖSSBAUER, MAGNETIC AND XRD STUDIES

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The temperature dependences of Mössbauer spectra, powder XRD and magnetic properties of mixed multiferroic perovskites $Pb_{1-x}Ba_x(Fe_{0.5}Nb_{0.5})O_3$ (x being 0, 0.25, 0.5, 0.75 and 1) are studied in detail from 4.2 K to temperatures above ferroelectric ordering of the pure $Pb(Fe_{0.5}Nb_{0.5})O_3$. In the samples, which were prepared by the solid state synthesis, the Fe (enriched to 20% of ^{57}Fe) and Nb atoms are believed to be fully disordered.

We paid special attention to the magnetic and structural transition temperatures and the differences of two similar materials with the perovskite structure - $Pb(Fe_{0.5}Nb_{0.5})O_3$ (PFN) and $Ba(Fe_{0.5}Nb_{0.5})O_3$ (BFN) and samples with intermediate concentrations of Pb/Ba.

The powder XRD spectra were acquired at 4.2–300 K by conventional XRD diffractometer. The space group of the pure PFN sample is trigonal (*R3m*) at room temperature (RT) with the unit cell parameters *a*~5.672(2) Å and *c*~6.965(0) Å, in agreement with former measurements [1], while the BFN sample is cubic *(Fm-3m*) with the unit cell parameter *a*~8.119(5) Å.

The hyperfine parameters (isomer shift IS, quadrupole splitting QS, hyperfine field Bhf) were determined by the analysis of Mössbauer spectra in the temperature range 4.2–300 K.

The temperature dependence of Bhf suggests a magnetic ordering below Neél point T_N~165 K and T_N~32 K for the PFN and BFN samples, respectively. The in-field spectra acquired at 4.2 K in an external magnetic field of 6 T point to an antiferromagnetic ordering of these materials.

The spectra of samples with mixed compositions indicate the existence of the domains with higher and lower concentration of Pb or Ba, and show two different transition temperatures from (anti)ferromagnetic to paramagnetic state.

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P8-10

COMPLEX HALL EFFECT IN HEUSLER $Ni_{48}Mn_{39}Sn_{13}$ ALLOY

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The Heusler $Ni_{48}Mn_{39}Sn_{13}$ alloy belongs to a group of multifunctional Mn-rich Ni_2MnSn alloys that exhibit martensitic transformation from cubic high-temperature austenite (A) to orthorhombic low-temperature martensite (M). The structural transition is accompanied by pronounced changes of magnetic, magneto-striction, -caloric and -transport properties [1]. The antiferromagnetic interactions are considered as a cause of lower magnetization of M-phase with respect to A-phase. Moreover, magnetization of M-phase goes to zero at temperature T_C^M, far below the temperature of the M-A transition of the alloy.

The complex transport properties of the $Ni_{48}Mn_{39}Sn_{13}$ alloy are documented in this contribution by a surprising dependence of the Hall effect and anomalous Hall effect (AHE) on temperature. The opposite signs of the Hall coefficient R_H were found in M-phase and A-phase of the alloy, respectively. So, different type of charge carriers that participate on the Hall effect should be taken into consideration, i.e., electrons in austenite and holes in martensite phase of the alloy. A considered participation of holes on the Hall effect implies an unclear existence of an energy gap in band structure of the studied alloy. The temperature dependence of mobility of charge carriers, $\eta(T)$, that was derived from the temperature dependence of the Hall coefficient shows much lower mobility of holes in martensite in comparison with high mobility of electrons in austenite phase of the alloy.

The non-zero values of AHE of antiferromagnetic M-phase of the alloy are very surprising. Together with no significant change of AHE at around temperature T_C^M, it points to the non-collinear antiferromagnetic arrangement of magnetic moments in M-phase of the $Ni_{48}Mn_{39}Sn_{13}$ alloy. The observed pronounced decrease of magnetization at temperature T_C^M is in that case the result of a transition from uncompensated non-collinear antiferromagnet into compensated one at low external field. However, we have to emphasize a need of detailed theoretical calculations of the electronic structure of the mentioned alloys for a deeper understanding of the presented experimental results.

The authors acknowledge the support from the Grant Agency of CR, Project No. 18-12761S.

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P8-11

CHARACTERISATION OF 'MULTIPIEZO' Pb_2MnO_4

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Manganese based oxides are of great interest due to the spin, charge and orbital degrees of freedom of Mn cations. Pb_2MnO_4 is a notable material as it has an acentric but non-polar crystal structure (space group P-42_{1c}), which allows piezoelectricity with non-zero coefficients d14 and d36. Its antiferromagnetic structure observed below T_N = 18 K (propagation vector (000) has magnetic group P-4'2_{1c}' is compatible with piezomagnetism with non-zero terms c14 and c36, making Pb_2MnO_4 a potential "multipiezo" material where stress is expected to induce coupled electric and magnetic polarisations [1]. We are currently studying magnetic-field induced changes in low temperature properties of Pb2MnO4 using magnetisation and Resonant Ultrasound Spectroscopy (RUS) measurements.

Magnetisation hysteresis loops reveal a metamagnetic transition with H_c ranging from 3.55 T at 4 K to 2.15 T at 16 K. In RUS measurements the acoustic resonance frequency f shows a clear softening occurs around T_N = 18 K revealing magnetoelastic coupling. T_N, as measured by acoustic loss, Q^{-1}, and the RUS peak frequency, appears to be initially suppressed by field, decreasing from 19 K at 0.5 T to 13 K at 4 T, but then increases again up to 17 K at 5 T.

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9 APPLICATIONS AND OTHER MAGNETIC MATERIALS NOT INCLUDED IN 1-8

O9-01

TUNING ELECTRONIC PHASE SEPARATION IN $CaFe_3O_5$ BY DOPING

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Recent study of the $CaFe_3O_5$ revealed an electronic phase separation into two phases with different electronic and antiferromagnetic spin orders below their joint magnetic transition at 302 K [1], similar to ones widely reported in manganite perovskites [2]. Electronic phase separation in manganites is known to be very sensitive to perturbations by field, pressure, and chemical substitutions.

We are investigating effects of substituting Fe^{2+} with Co^{2+} and Mn^{2+} in $CaFe_3O_5$. Following the successful preparation of $CaFe_{3-x}M_xO_5$ (M = Co, Mn) with x up to 0.5, changes in lattice parameters, consistent with the ionic radius of substituting M^{2+} cation, were observed.

The magnetic susceptibilities show small net magnetisation observed at 2 K and an increase in T_M for the Mn and Co samples, respectively.

Subsequent neutron study on WISH has shown that Mn^{2+} and Co^{2+} have different influence on the phase separation. Synchrotron data were used to refine HT structure and confirm the anisotropic thermal expansion observed in $MnFe_3O_5$ [3].

Acknowledgement
Authors would like to thank ERC for funding and EPH Foundation (Nadácia EPH) for providing further financial support.

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O9-02

THE FINITE ELEMENTS MODEL OF ACTIVE COMPENSATION OF EARTH MAGNETIC FIELD AND MAGNETIC ENVIRONMENTAL NOISES IN MAGNETIC ATOMIC SENSORS

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The new generation of non-cryogenic atomic sensors of very small magnetic fields is explored for the applications in the medicine e.g. for the assessment of magnetic fields of biological internal organs or in the military area e.g. for the assessment of disturbances of Earth magnetic field caused by hidden military objects [1]. The gold standard of the high sensitivity magnetic sensors, the SQUID, has several limitations significantly decreasing its applicability. Those limitations include: an obligatory liquid helium cooling system and the requirement for at least a passive compensation of the Earth magnetic field by a Magnetic Shielded Room (MSR). Recently some successful attempts for the high sensitivity SQUID measurements without use of MSR were reported however, the majority of SQUID sensing applications need a shielding enclosure. Using the finite element magnetic modelling we show that the localized active real time compensation systems could be a viable solution for the atomic sensors because they are significantly smaller than SQUID. For presented investigation the open-source ELMER software was used [2]. On the base of modelling, the guidance for development the magnetic compensation system were elaborated. On the base of these guidelines, magnetic compensation module was optimized to reduce local magnetic field non-uniformity on the sensor's characteristic As a result presented simulation opens the possibility of measurements of the very small magnetic fields without the MSR that is too expensive or impractical for many medical and military applications.

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O9-03
MAGNETIC-FIELD-INDUCED TRANSITIONS IN BISMUTH

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Bismuth is an ideal playground for testing novel hypothesys in condensed matter physics. Despite being a layered single-atomic composite, historically, many high-profile quantum phenomena have been observed in this system first (such as quantum oscillations and Dirac quasiparticles). It also presents many excentricities, such as superconductivity in its disordered phase and in grain boundaries at around 3 K, and in its crystalline phase at 0.05 mK. It also behaves as a topological insulator when grown as a bilayer and as a higher order topological insulator in bulk form.

In this work, we probe the influence of low magnetic fields (up to tenths of mili Tesla) on the low-temperature electrical properties of Bismuth single- and highly-oriented crystals. We report the occurence of a sharp transition in Bi R(T) curves below a critical temperature when $B \neq 0$ T, being consistently suppressed as higher fields are applied. Such magnetic-field-induced transition reveals a rather peculiar dependence on the magnetic history of the sample, hinting on the possibly of yet un-observed intrinsic magnetism in the system.

By comparing electrical transport and magnetic measurements, our results suggest the presence of antiferromagnetic ordering in Bismuth, happening in localized regions and being triggered in the same temperature vicinity where a superconducting transition is expected for disordered crystals. We discuss the possibility of simmilar physics as found in cuprates, where superconductivity is precluded by antiferromagnetism.

Acknowledgement: Polish National Science center, grant nr. 2016/23/P/ST3/03514.

O9-04

DYNAMIC HYSTERESIS MODELING FOR MAGNETIC SHAPE MEMORY ALLOY ACTUATOR VIA A PI-SIGMA NEURAL NETWORK WITH A MODIFIED BACKLASH-LIKE OPERATOR

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Along with science and technology development, micro-nano precision positioning system composed of magnetic shape memory alloy (MSMA) actuator attracts more and more attention. However, the hysteresis of the MSMA actuator definitely hinders the location accuracy of the system [1]. Besides, hysteresis of MSMA actuator has the characteristics of multi-valued-mapping, asymmetrical and rate-dependent. For researching the hysteresis of the MSMA actuator, hysteresis modeling method takes on even more importance [2]. In this paper, a hysteresis model based on Pi-Sigma neural network (PSNN) with a modified backlash-like operator is proposed to capture the dynamic hysteresis of the MSMA actuator. To solve multi-valued-mapping and asymmetrical problems, a modified backlash-like operator is proposed based on backlash-like structure with the exponential and polynomial function. The unknown parameters of the modified backlash-like operator are first identified using the shuffled frog leaping algorithm. To overcome the rate-dependent issue, we adopt the PSNN to express the rate-dependent property of MSMA actuator due to its advantages of the fast learning and strong nonlinear processing ability. The schematic diagram of the proposed model for the MSMA actuator is shown in Fig.1.

In the simulation, the different frequency current signals (i.e. 1Hz, 5Hz, 10Hz) are used as input driving signals to build the dynamic hysteresis model. When the frequencies are 1Hz, 5Hz and 10Hz, the root-mean-square (RMS) error after stability are 0.1772μm, 0.3438μm and 0.9936μm, which are improved by 1.96 times, 1.06 times and 0.13 times compared with the results based on KP model in [3]. Next, we use the variable amplitude current signal as the driving signal to further verify performance of the proposed model. The RMS error and mean absolute (MA) error are 0.2889μm and 0.1561μm. Compared with the results in [3], they are improved by 1.08 times and 1.34 times. It is obvious that the modeling precision of the proposed model is greatly increased.

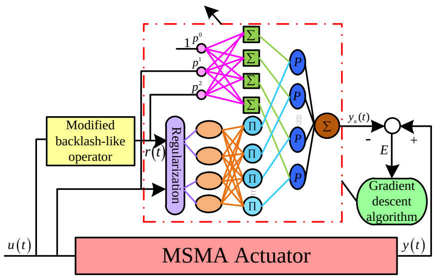

Fig. 1. Schematic diagram of the proposed hysteresis model for the MSMA actuator.

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O9-05

MONITORING OF THERMAL DAMAGE AFTER DEPOSITION OF COATINGS VIA BARKHAUSEN NOISE TECHNIQUE

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This paper deals with monitoring of thermal damage of hardened steel 100Cr during deposition of coatings via magnetic Barkhausen noise. This study investigates influence of the different deposition regimes when the samples of the different hardness are coated. Hardness of the matrix before and after deposition is correlated with Barkhausen noise features extracted from the raw Barkhausen noise signal. Results indicate that Barkhausen noise technique is suitable for monitoring surface overtempering initiated during coating deposition. Moreover, position of the Barkhausen noise envelope maximum correlates with hardness of the sample more that conventional effective value.

O9-06
Withdrawn

P9-01

INFLUENCE OF SAMPLE SIZE AND MAGNETIZING VOLTAGE ON BARKHAUSEN NOISE DURING BENDING AND UNIAXIAL TENSILE TESTS

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This paper reports about influence of sample thickness and magnetizing voltage on Barkhausen noise emission during bending as well as uniaxial tensile tests. This study demonstrates that Barkhausen noise in the tensile stress loading for the low sample thickness and low magnetizing voltage decreases. Such behaviour is considered to be a result of predominating the stress anisotropy whereas the crystal anisotropy influence is only minor (or missing). For this reason, the conventional effective value of Barkhausen noise signal cannot be employed for non-destructive monitoring of stress state in such a case and the magnitude of exerted stresses should be calibrated via the width of Barkhausen noise envelope. It was also found that the sample thickness as well as the manner of exerted loading also play significant roles since Barkhausen noise tends to increase with increasing tensile stresses especially for the higher magnetizing fields.

P9-02

MONITORING OF RAIL SURFACE DAMAGE VIA MAGNETIC MEASUREMENTS

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This paper reports about magnetic non-destructive evaluation of the rail surface exposed to the long-time cyclic plastic deformation. Long-tiem severe plastic deformation and superimposing friction heating initiate paerlite matrix defragmentation and the corresponding refinement of magnetic domain structure. This paper discusses potential of Barkhausen noise as well as tangential magnetic field techniques for such purpose. The paper analyses correlation between the thickness of the near surface white layer and magnetic parameters. This study would contribute to a possible concept for preventing unexpected rails deformation (or cracking) due to their thermal dilatation via non-destructive magnetic techniques.

P9-03

MAGNETOMETRY AS AN EFFECTIVE TOOL FOR KINETICS EVALUATION IN MECHANOCHEMICAL SYNTHESIS OF CHALCOPYRITE $CuFeS_2$

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Chalcopyrite $CuFeS_2$ has been synthesized from elemental precursors by high-energy milling. The presence of chalcopyrite phase was proved by the Rietveld analysis performed on the measured XRD patterns. Product of mechanochemical synthesis consists of crystallites less than 20 nm in size. For determination of iron consumption during the solid state reaction magnetometry has been applied. Based on magnetization data reflecting time dependent integration of elemental iron into chalcopyrite nanostructure the kinetics of the reaction was evaluated. From the kinetics data the rate of the reaction as well as conversion degree R were determined. The high conversion degree of mechanochemical synthesis performed in a laboratory mill (R=100%) as well as in an industrial mill (R=96%) offers the possibility to scale-up the process of synthesis in preparation of this perspective magnetic semiconductor.

This work was promoted by the Slovak Research and Development Agency under the contract No. APVV-14-0103. The support through the Slovak Grant Agency VEGA (projects 2/0044/18, 2/0065/18) is also thankfully acknowledged.

P9-04

MAGNETIC RESONANCE CONTRAST IMAGING OF FERRITIN AND MAGNETOFERRITIN AT 7 T

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Disruption of ferritin homeostasis in human cells is associated with several pathological processes, including neurodegenerative disorders, inflammation, etc [1]. Structural changes in the mineral core of ferritin lead to significant hypointensive artifacts in magnetic resonance imaging (MRI) [2]. Our goal is to develop a MRI methodology for the contrast imaging and differentiation of physiological and pathological ferritin (magnetoferritin) for noninvasive diagnostics in clinical practice. MRI measurements were performed at 7 T BRUKER system using longitudinal (T_1) and transversal (T_2) relaxation time mapping protocols. Relative contrast and relaxation time of native ferritin and magnetoferritin with different loading factor were analysed and compared. The results clearly show a significant difference between native ferritin and magnetoferritin in T_2-weighted protocol (Fig. 1), and less significant change in T_1-weighted protocol (Fig. 2).

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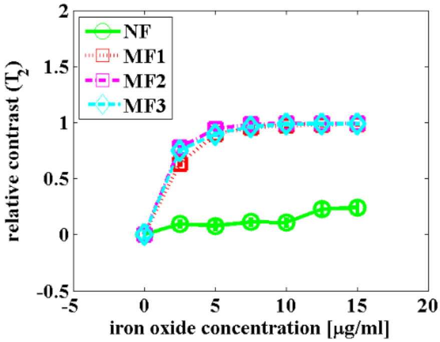

Fig. 1

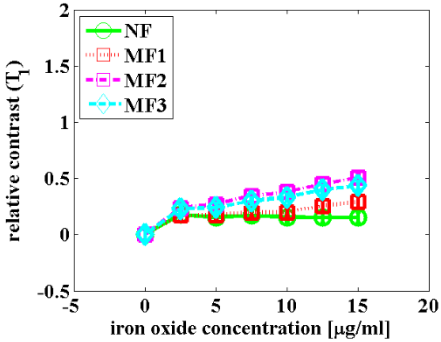

Fig.2

P9-05

COMPARISON OF MAGNETIC AND NON-MAGNETIC NANOPARTICLES AS SONOSENSITIZERS IN ULTRASONIC HYPERTHERMIA

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Ultrasonic waves have been used to induce the temperature rise in human tissues e.g. in hyperthermia supporting chemotherapy and radiotherapy or in thermal ablation. In order to increase the efficiency of ultrasonic heating, supplementary materials can be added to the medium. As a result, using the same acoustic power it is possible to obtain higher absorption of ultrasonic waves and higher temperature rise in desirable place.

Magnetic nanoparticles Fe_3O_4 were explored to be sonosensitizers, mainly due to the opportunity to combine heating induced by absorption of ultrasonic waves and effects in AC magnetic fields [1,2]. Here, we want to provide another results for both magnetic and non-magnetic nanoparticles and discuss their efficiency in improving the ultrasound thermal effect.

We investigated the temperature rise caused by ultrasonic waves in agar-based tissue-mimicking phantoms doped with laponite, silicone dioxide and magnetite nanoparticles. The results indicate the differences in hyperthermia efficiency between different types of nanoparticles.

This work was supported by a Polish National Science Centre grants: NCN/2015/17/B/ST7/03566 and NCN/2017/27/N/ST7/00201.

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P9-06

INFLUENCE OF SEA WATER CORROSION ON STRUCTURE AND MAGNETIC PROPERTIES OL52 STAINLESS STEEL

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Marine corrosion causes significant loss to global economy. Number of industries has no alternative to use a corrosion-resistant steels and alloys based on iron [1-3]. Therefore, it is very important to study a mechanism of corrosion and simulate properties of materials during long-term use in seawater to find a way to increase the time of life and reliability of structures.

In this work we report study of the sea (Mediterranean, Black and Aegean) waters corrosion action on structure and magnetic properties OL52 stainless steel. Crystal structure was characterized by X-ray diffraction (XRD) using X-ray diffractometer with Cu-K_α-radiation (λ = 0.154 nm) at room temperature. Temperature dependences of the specific magnetization were studied in the temperature range of 77 - 1100 K by the ponderomotive method in the field of 0.86 Tesla. Corrosion behavior of OL52 stainless steels was monitored by the gravimetric method. A weight index or corrosion rate (V_{corr}) is a change in sample mass (Δm), as a result of corrosion, per unit surface area (S) per unit time (t): $Vcorr = \Delta m / (S \cdot t)$, which is expressed usually in g / m2·h.

It is noted that mass loss increases with exposure time for all studied sea waters, and the corrosion rate becomes approximately constant after > 1500 hours of immersion in all three sea types. Corrosion penetration for all studied sea is about 0,06 μm/year. It revealed, that crystal structure and specific magnetic characteristics of OL52 stainless steels are resistant to corrosion action of Mediterranean, Black and Aegean sea waters.

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P9-07

BROWNIAN MOTION OF CHARGED PARTICLES IN A BATH RESPONDING TO AN EXTERNAL MAGNETIC FIELD

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The Brownian motion of particles is effectively described by the stochastic Langevin equations of motion that, along with external forces, contain forces originating from random impacts of surrounding molecules. The case when the time scale of the molecular motion is not very much shorter than that of the Brownian particle (BP) corresponds to the generalized Langevin equation (GLE). Kubo [1] derived for this equation the so called second fluctuation-dissipation theorem (FDT). So far, all versions of the GLE and the associated FDT are limited by the assumption that the bath particles surrounding the BP are unaffected by the external field.

In the present contribution, we develop the theory, in which not only the observed BP but also the bath particles respond to the external field. The charged bath particles are regarded as harmonic oscillators interacting with the BP. The system is placed in a constant magnetic field. For the BP equations of motion are derived. Along the vector of magnetic induction, when there is no effect of the field on the particles' motion, the same GLE is obtained as it follows from the Caldeira-Legget theory [2]. For the motion across the field two coupled stochastic equations are obtained. They have the form of stochastic integro-differential equations of the GLE type for the projections of particle velocity on the plane perpendicular to the field. The retarded effect on the frictional forces is determined by the coupling between the particle and the bath oscillators and depends on the spectral distribution of the oscillators' eigenfrequencies and their cyclotron frequencies. The stochastic forces are, in general, colored. Under the condition of stationarity, we derive the autocorrelation functions for the velocity projections of the BP. They are determined by its cyclotron frequency and the memory functions. Finally, the second FDT is proven. It has the familiar form, but now the generalized memory function depends on the magnetic field.

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P9-08

HYSTERESIS MODELING FOR MAGNETICAL SHAPE MEMORY ALLOY ACTUATOR BASED ON T-S FUZZY NEURAL NETWORK

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Magnetical shape memory alloy (MSMA) is a new class of smart metallic materials, which has excellent characteristics of huge strain and fast response. These characteristics make MSMA-based actuator as a potential alternative to replace traditional actuators in the high-precision positioning applications. However, the MSMA-based actuator has not found its way into micro positioning field due to the obvious hysteresis behavior that exhibits in the MSMA [1-2].

In this paper, we present the prototype of the MSMA-based actuator and analyze the complex hysteresis nonlinearity phenomenon in MSMA-based actuator. A suitable hysteresis modeling is needed to describe the hysteresis characteristic. Thus, Takagi-Sugeno (T-S) fuzzy neural network is firstly utilized to construct an online rate-dependent hysteresis model of MSMA-based actuator. T-S fuzzy neural network is a fuzzy-logic based neural network system, which has the capability of approximating nonlinear mapping and self-tuning [3]. Experimental investigations are performed in the MSMA-based actuator to confirm the effectiveness of the proposed hysteresis model based on T-S fuzzy neural network. Experimental results clearly indicate that the proposed modeling method can fit the hysteresis curve satisfactorily.

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P9-09

SANS STUDY OF LIQUID CRYSTAL DOPED WITH $CoFe_2O_4$ NANOPARTICLES

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Liquid crystals combine crystalline solid properties and liquid properties in a phase called mesophase. In a nematic liquid crystal, elongated molecules forming the liquid crystal are aligned into the same direction defined by the unit vector, so called director. Unlike the anisotropy of the dielectric permittivity, the anisotropy of the liquid crystal magnetic permeability is very low. Therefore, large magnetic field (a few T) is required to reorient the director. Addition of magnetic nanoparticles allows increase of the liquid crystal sensitivity to magnetic field.

We report about experimental observations on liquid crystal and magnetic nanoparticles suspension obtained by small-angle neutron scattering (SANS). The investigated liquid crystal suspension is based on 4-n-pentyl-4′-cyanobiphenyl (5CB) liquid crystal and spherical cobalt ferrite $CoFe_2O_4$ nanoparticles (MNPs). To prevent aggregation, the MNPs were coated with mesogenic ligands (ML). SANS measurements were performed on the pure liquid crystal and the liquid crystal doped with the ML coated $CoFe_2O_4$ nanoparticles with two concentrations 0.0854 wt. % (OA) and 0.0623 wt. % (OB). Firstly, reference measurements were carried out in zero magnetic field, then magnetic field up to 2.2 T was applied during measurements. Results showed that the samples were oriented in the cells in zero magnetic field and at 0.5 T the samples were aligned by field. Moreover, sample OB was measured with smaller magnetic field steps, and it was already aligned at 0.01 T. Corresponding averaged intensities in direction parallel and perpendicular to magnetic field showed a presence of elongated objects in the samples.

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P9-10

IDENTIFICATION OF MAGNETIC PHASES IN NATURAL OCHRES BY MÖSSBAUER SPECTROSCOPY

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Mössbauer spectroscopy is one of few analytical techniques that provide information on the investigated system both from the viewpoint of its structural arrangement and also magnetic order. Here, we demonstrate how ^{57}Fe Mössbauer spectroscopy can contribute to identification of magnetic phases in rather ordinary Fe-containing material like natural ochres.

Fe-ochre precipitates were collected at abandoned antimony deposit in East Slovakia. Three sets of samples were studied: (i) as-collected, (ii) ochres sterilized at 95°C for 30 min, and (iii) Fe-ochre precipitates which were after sterilization exposed to fungal bioleaching. Mössbauer spectra from all three batches were recorded at 300 K, 80 K and 5 K. Presence of magnetic phases was revealed only at the lowest temperature. At higher temperatures, all samples show significant relaxation of magnetic moments which indicates that the crystalline grains are very small and exhibit superparamagnetic behaviour.

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P9-11

MBN & PALS CHARACTERIZATION OF MODEL RPV STEELS IN AS-RECEIVED STATE

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A large spectrum of model ferritic steels with a parametric variation of alloying elements was developed in order to understand the role and influence of Ni, Mn, Si, Cr and Mo as alloying elements and certain impurities as Cu and P on the properties of reactor pressure vessel (RPV) steels during irradiation. In the present paper, we discuss the results obtained by Magnetic Barkhausen noise complemented with Positron annihilation Lifetime spectroscopy data. In later stage these data will be compared with those obtained on model steels irradiated in the High Flux Reactor –Lyra irradiation facility in Petten/the Netherlands up to neutron fluence of about 2.5×10^{19} n. cm^{-2}.

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P9-12

EVALUATION OF THE OPERATIONAL STATE OF A SMALL TURBOJET ENGINE USING VARIATIONS IN ITS NEAR MAGNETIC FIELD

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Different parameters, which are obtained using classical sensors, are nowadays used to determine the technical state of turbojet engines. In order to expand and to improve this evaluation a novel idea in is explored in the article that variations in the near magnetic field of an operational turbojet engine can contain valuable information about its state. It was proven that variations in the measured magnetic field near a running small turbojet engine can provide some information related to its situational state [1]. This idea is further expanded in the article, providing a relation between the measured variations of the engine's magnetic field in laboratory conditions and its technical state. Two basic state parameters of the engine are investigated and their influence on the near magnetic field. These are the rotational speed of the engine and its exhaust gas temperature. Using a three channel magnetic sensor, data analysis of a running engine in different operational states is presented describing its near magnetic field and variations in it, which are created by a running small turbojet engine iSTC-21v in laboratory conditions. It was shown in the previous work that frequency spectrum of the magnetic field contains the most important information about the technical state of the engine [1]. A detailed analysis is performed in order to determine how the rotational speed and the exhaust gas temperature can be related to changes in frequency spectrum of the near magnetic field of a turbojet engine. A predictive model to describe this relation is also designed and the results show how this model can be used to determine the technical state, in order to perform non-invasive diagnostics or be used to improve full authority digital engine control systems. The presented results and ideas can be considered as a novel approach in the field of diagnostic and control algorithms implemented in electronic turbojet engine control units.

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P9-13

ESTIMATION OF MAGNETIC MICROWIRE MECHANICAL PROPERTIES BY FEM MODELING

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Composite materials have become popular also for the aerospace applications and nowadays an increasing number of such materials are being developed. In addition to the development of these modern materials there is a requirement to monitor mechanical properties inside composite material between particular layers during their lifetime.

The article is focused on the development of a methodology for the magnetic microwire finite element model creation, which have bright prospect in terms of the mechanical stress monitoring inside the composite materials. [1-2] The finite element model is based on a real geometry of a particular magnetic microwire. The glass coat of the magnetic microwire was mechanically removed and the information about the geometry was obtained by the microscope. It is possible to create a 3D model of a magnetic microwire, the geometry of which was extracted from the microscope photos. Based on the 3D geometry the mesh of the magnetic microwire and the finite element model with boundary conditions were developed. The advanced methodology of magnetic microwire finite element modeling was used. The model consists of two parts; first part is the metal core which was modeled using the hybrid meshing, thus hexa and tetra elements. Second part of the model is the glass coat, which consists of hexa mesh elements.

Other and probably the most important part of the submitted work deals with the modelling of the magnetic microwire contact surfaces and with the development of their finite element mesh. Once the finite element model is done all properties for the static stress analysis are applied. In this context, the static stress analysis is performed and the results from the ANSYS APDL are presented in the submitted article. The article summarizes the new approach in magnetic microwire mechanical properties investigation. The proposed finite element model of the magnetic microwire can be applied for the investigation of magnetic and other properties using the finite element analyses in the future.

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P9-14

INFLUENCE OF STATIONARY AND TIME-VARYING PERIODICAL INTERFERENCE ON THE NOISE ANALYSIS OF MAGNETIC SENSORS USING ALLAN VARIANCE

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Noise analysis of inertial sensors can be performed using many methodologies. One of the advantageous methods supported also by the IEEE is the noise analysis using Allan variance. This method is based on the analysis of a data sequence in the time domain and can also be used to determine the noise types as a function of the averaging time. Currently many optimization methods have been researched [1], [2]. We proved that the theory is very properly applicable also for magnetic sensors [3], which are nowadays together with accelerometers and gyroscopes a common part mainly of the small inertial measurement units. Furthermore, during the noise analysis it is necessary to consider the characteristics resulting from the time-varying noise amplitude [4], [5]. And even though the Allan variance is the most common time domain measure, for the application of the noise analysis using the Allan variance it is advantageous to apply the proposed methodology for revealing the periodical interference during the noise analysis even in the cases if the periodical interference is non-stationary.

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P9-15

RELAX-TYPE MAGNETOMETER WITH DIRECT OPTOCOUPLER RELAXATION

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The article deals with the new simplified relax-type magnetometer design, which uses the measurement of the transient effects time intervals of the sensor after periodical saturation of the magnetic core in the sensor. The presented work is based on the previously published papers [1-3], but uses simplified electronics suitable for future on-chip integration.

The proposed design uses unipolar power supply for whole measurement chain compared to the VEMA-04 magnetometer, from which the design was derived. The relaxation circuits consist only from digital two-channel optocouplers and a few passive components as the primary transducer of the measured magnetic field into the time intervals. The excitation circuitry was also modified and uses the full bridge made from the MOSFETs powered from a precise current source. The excitation control, time intervals measurements and primary signal processing is carried out by the small FPGA connected to the ARM Cortex-M7 microcontroller.

The testing results show that although the presented design is cheap and simple, the achievable sensitivity is better than 5 nT/LSB and the noise is less than 800 pT/√Hz at 10 Hz in the measurement range ±80 μT, whereas the simultaneous sampling frequency is 1000 Hz. These parameters are sufficient for wide range of applications.

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P9-16

INVESTIGATION OF IRON WEAR COMING FROM MILLING MEDIA IN MECHANOCHEMICAL SYNTHESIS OF COPPER SULFIDE-SULFUR COMPOSITE USING MAGNETOMETRY

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The mechanochemical synthesis of covellite (CuS) was realized in the over-stoichiometry of sulfur in order to prepare CuS-S composite. The kinetics of this reaction was evaluated using Soxhlet analysis determining the amount of free sulfur and by X-ray diffraction. The results suggested rapid consumption of both sulfur and copper. After 15 minutes of treatment, the peaks of Cu were no longer identified in the XRD pattern, while only those belonging to CuS and S could be identified. It was impossible to pursue the progress of the reaction through magnetometry, as both reactants and products are diamagnetic, but as the synthesis was realized in a stainless steel milling chamber, the wear coming from milling balls and chamber could be identified also at very low quantities. With increasing milling time, magnetization values also increased, always showing diamagnetic slope until 15 minutes of milling. After 30 min, the saturation magnetization of 0.166 emu/g was detected, which corresponds to 0.076% of iron in reaction mixture. This is far below the detection limit of X-ray diffraction. Therefore, magnetometry could be used for possible identification of wear in reactions performed using stainless steel media, which are most commonly used in mechanochemistry.

P9-17

INFLUENCE OF PARAMETERS OF LASER ABLATION ON MAGNETIZATION FERROMAGNETICS

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Laser technologies are more and more widely used in various branches of the economy, including for drilling, cutting, welding, ablative surface cleaning, engraving and marking [1-3]. Various construction materials, including ferromagnetic, are subjected to laser treatment.

During the laser treatment of ferromagnetic there is a clear impact of the parameters of the laser beam interaction with the material (including duration and power of laser pulses, exposure time, number of passes, etc.) on the change of magnetization of the material, which results from changes in the material is internal energy, thermal and mechanical stresses, vibrations and wave effects and phase transformations of the structure. The above observation can be used to control the quality of laser processing using cheap magnetic methods.

The article will be present selected results of magnetic measurements carried out during and after the laser ablation process - the evaporation of corrosion products from the surface of the cleaned steel sample, with or without slight evaporation of the material being cleaned. Based on laboratory tests [4], including magnetic field measurements and verification of surface quality on an optical microscope, it was found that there are reliable quantitative and qualitative relationships between the parameters of the laser ablation process and the parameters of the material magnetization.

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P9-18

APPLICATION OF NON DESTRUCTIVE TESTING TO DEFECT BY USING MAGNETIC PARTICLE METHOD

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Magnetic particle inspection is a method for detecting cracks, lumps, subsurface holes, and other surface or subsurface discontinuities in ferromagnetic materials. Non-destructive testing of materials by the magnetic particle method uses the tendency and efficiency of magnetic forces or fluxes applied to ferromagnetic materials. The defect on or near the surface of a metal dislocate the distribution of magnetic fluxes so part of the flow is forced to pass through the surface. The magnetic field force increases in the area of crack and the opposite magnetic poles are formed on both sides of the material defect. The soft magnetic particles applied to the damaged part of the material are attracted to these areas and form a pattern around the crack. The particle pattern gives us a visual indication of the defect. When mentioned inspection method, perform the control of ferromagnetic particles (iron and steel) are magnetized in the external magnetic field. The subject of our contemplation is the sliding part of the main landing gear of the Fokker 100, the consistency is made of steel. The result of the detailed analysis is the use of the most convenient non-destructive testing method. From the point of view of our object of investigation, the best way is to implement a magnetic particle method. The implementation of the inspection is based on the application of magnetic parts to the sliding member cracks in the radius of the wheel axles of the main landing gear of the A/C Fokker 100. In our study, we are using the non-destructive testing. We identify the damaged part and take the necessary steps to detect damaged components by using magnetic fluxes. Our main objective is to demonstrate the effectiveness of non-destructive testing using a magnetic particle inspection.

P9-19

MAGNETIC NON-DESTRUCTIVE TESTING OF ROPES

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In transport equipment (overhead cranes, cranes, elevators, hoisting machines and belt conveyors), steel ropes of various diameters and constructions are used. During their exploitation there are various degradation processes resulting from: cyclic loads (stretching, bending, twisting), friction between neighboring wires and strands, dynamic overloads and the impact of adverse environmental conditions, e.g. high humidity and salinity - sources of chemical corrosion. The progressive degradation of the rope reduces the level of device operation safety and is a challenge for the diagnostician.

Wire cracks, local losses in cross-sectional area of the rope and strong corrosion are the source of magnetic anomalies which is used in Non-Destructive Testing (NDT) to diagnose surface and internal defects of the rope using magnetic methods [1].

The article presents three basic methods of magnetic rope research: 1) MRT (Magnetic Rope Testing) method [1, 2] based on strong longitudinal rope magnetization; 2) the passive MMM method (Metal Magnetic Memory) [1, 3] based on the measurement of the existing magnetization of the rope produced by magneto-mechanical effects (operation history) and the earth's magnetic field; 3) hybrid method [1] based on the measurement of the existing magnetization of the rope after it is previous re-magnetization by the magnetizing head. A common diagnostic symptom of the above methods are magnetic anomalies detected near the rope by the measuring head - a system of coils or vector magnetometers. The topics discussed will be illustrated with examples including the results of comparative studies of the active and passive methods on the real object [1, 4].

On the example of compacted ropes with dense packing of wires and strands (used especially in mining) it was shown that new rope construction solutions generate new diagnostic challenges despite over 100 years of operational experience of magnetic non-destructive testing methods.

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P9-20

MAGNETISM IN CoCrFeMnNi BASED HIGH ENTROPY ALLOYS

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The high entropy alloys (HEA) represent promising materials for industrial application thanks to the variability of their properties. In comparison to classical alloys HEAs are composed from a higher number of constituents, which not only offers the possibility to tune the properties, but also brings the stabilization of the alloys by the high entropy in high temperatures, in general.

In our study we are focusing on ground state properties of CoCrFeMnNi so-called 'Cantors alloy', the well known example of HEA. Since we are pointing out especially on its magnetic behavior, we studied its derivatives based on the non-magnetic substitution by molybdenum as well. It helped us to explore the relations between constituting elements and resulting magnetic properties.

We show how the non-magnetic substitution in parent alloy and crystal structure influence the ground state properties and the preferred magnetic state in particular. Furthermore, by calculating the exchange interactions and with respect to the chemical disorder we discuss the contribution of the each constituent element to the magnetic behavior. Finally we try to suggest a route to stabilize the particular alloy and its magnetic ordering.

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P9-21

USING THE EARTH'S MAGNETIC FIELD IN PARACHUTE JUMPING

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The Earth's magnetic field is used in navigation since 2000 years [1]. The dynamic development of other magnetic applications occurred only in XX century along with the development of the knowledge on magnetism, magnetic materials, modern measuring technologies (analogue and digital) as well as cheap scalar and vector magnetometers. Currently, the weak magnetic field of the Earth is used, e.g. in non-destructive testing, geology, UXO detection, medicine and quality control of food products.

The modern digital magnetometers constructed in MEMS technology have dimensions not exceeding 3.0x3.0x1.0 mm and A/D conversion depth to 24-bits. Triaxial magnetometers (3D) are usually integrated into one housing with 3D accelerometer and 3D gyroscope creating 9 DOF platforms. Such miniature test platforms are used, e.g in movement monitoring systems.

The article presents the application of the Earth's magnetic field and 9 DOF platform equipped with the pressure sensor (10 DOF platform) [2] to monitor quick spatial movements of parachutists during fall with a closed parachute [3, 4].. The obtained information may be used to evaluate the training process of parachutists and verify the correctness and quality of performing individual acrobatic movements during sports competitions. Dynamic features of the parachutists (research problem), minimum metrological conditions, prototype measurement path, the theoretical basis of the analysis of measurement data and model research results were demonstrated.

The analysis of the research task and the initial resulting test results [4] indicate the possibility to use the magnetic field in parachute jumping. However, the usefulness of extending the measurement system was emphasized to include the teletransmission path of measurement data.

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P9-22

RADIO FREQUENCY RESPONSE OF MAGNETIC NANOPARTICLE-DOPED YARN

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The research of electrospun nanofibers in various fields of science and their use in engineering applications is increasing rapidly. The commercial use of nanofibre technology is intensively investigated mainly in the field of water treatment and environmental remediation, health and biomedical engineering, and energy production and storage. Therefore, a wide range of materials has been used to synthesize nanofibers with various physical properties. This paper presents the results of experiments on the shielding effectiveness against electromagnetic fields using yarns. The yarns were produced using AC electrospinning based on a needleless spinning-electrode. The optimal frequency of 50 Hz and a high voltage of 40 kV were used to generate the yarn. The poly(vinyl butyral) was chosen as a polymer. Nanoparticles of Fe_3O_4 were used as the filler. Transmission electron microscopy confirmed good compatibility of the nanoparticles with polymeric nanofibres. The presence of the magnetic dopant in the nanofibers was also reflected in measured magnetization curves. Measurements of Fe_3O_4 nanoparticle-doped yarn shielding effectiveness in the frequency range from 700 MHz to 3 GHz confirmed a slight shielding effect.

P9-23

THE USE OF MEASUREMENTS OF THE RESIDUAL MAGNETIC FIELD IN THE ASSESSMENT OF TECHNICAL CONDITION OF STEEL WIRE ROPES

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Anomalies of the residual magnetic field are used to identify imperfections of steel wire ropes such as broken wires, deformations, wear and corrosion. The most common method of non-destructive testing of steel wire ropes is the active magnetic method, which uses imperfections leaked by a strong, formatted by an external source, magnetic field. Unfortunately, this method is ineffective in case of flaw detection of modern compacted ropes. Research has been undertaken to analyze the possibilities of using residual magnetic field as a result of local changes in the electromagnetic properties of the rope material. In this kind of examination , the magnetization from an external source of magnetic field is not required to assess the technical condition of wire ropes.

Remanence appears in the rope at the stage of wires production and its value changes during their turning into strands. The values of residual induction change as a result of the work of rope, i.e. its bending, stretching or twisting. The value of the induced magnetic field in the rope is also affected by the damage occurring. Under the influence of cyclically changing work loads, due to the effects of magnetomechanics, changes in electromagnetic properties occur both in the wires and in the entire line.

As part of this work, measurements of the own (residual) magnetic field of scattering of the rope subjected to axial stretching were presented. Observations of changes in magnetic field induction occurring in laboratory conditions were verified on the real object. Using the AICHI magnetic strip consisting of 16 magneto-impedance sensors, the measurement was carried out on a passenger lift installed in the laboratory of the Department of Rope Transport of the AGH University of Science and Technology in Kraków. The linear arrangement of the sensors allowed for simultaneous observation of magnetic changes taking place in all lifting ropes of the passenger lift as well as for observation of changes in one line over a given length.

P9-24

SELF MAGNETIC FLUX LEAKAGE AS A DIAGNOSTIC SIGNAL IN THE ASSESSMENT OF ACTIVE STRESS – ANALYSIS OF INFLUENCE FACTORS

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On the macroscopic scale, there are close relations between the mechanical and magnetic properties of ferromagnetics. Under the influence of mechanical stress in a ferromagnetic occur to deformation, accompanied by change of magnetization. Stresses and strains change the interaction of exchange forces between adjacent atoms and lead to a change in the magnetization distribution in domains, which results is a change in magnetic properties. Generally, these phenomena are called magnetomechanical effects.

As part of this research, specimens of X10CrMoVNb9-1 under the designation EN 10216-2 standard were tested, which were subjected to various heat treatment processes affecting their microstructure. The samples were subjected to periodic pulsing tensile cyclic loads with different values of the active stress created in the part of the sample in which the measurements were made.

The aim of the research was to determine the effect of the maximum stress value in the cycle on changes in the self-magnetic flux leakage component value parallel to the load direction. A flux-gate transducer sensor was used to measure the components of the magnetic field strength.

On the basis of the obtained results, the influence of the structure and parameters of the cycles on the self magnetic flux leakage of the samples at their surface was found. For each of the tested combinations of stresses and structures, different magnetization change curves were obtained, although similarities were noticed between them. The biggest changes in the value of the magnetization of the samples were visible for the initial load cycles. Differences in the magnetization process between samples with different internal structures were observed. The possibility of determining the active stress in the sample cross-section based on the self-magnetic flux leakage value was analyzed.

P9-25

LOW FREQUENCY MAGNETIC FIELDS AND SAFETY

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Magnetic fields in environment can have the natural or technical origin. Their impact to the human organism is confirmed by the multiple scientific studies. The standards for staying of persons in places with increased intensity of magnetic fields can have the influence on the psychical performance of person, or chemical reactions running in organism. The present valid health and safety standards do not take the knowledge of these studies into account reasonably.

The presented article describe the present state of the international and national health and safety standards. There are presented the results of the studies referring the impact of the low frequency magnetic field on human organism and processes in it. The main part of the magnetic fields induced into the organism are the fields generated by the movements of the organism in non-homogeneous magnetic field. The most of the standards do not take this fields into account. Their impacts are many times higher than the impact of the stationary sources of magnetic fields.

The measurements of the low frequency magnetic fields induced by the movement in the Earths magnetic field are presented in the article. The measured values are confronted with tie valid health and safety standards. At the end of the article we describe the methodology for the limitation of staying in the places with low frequency magnetic fields based on the clinical studies.

P9-26

MAGNETIC CHARACTERIZATION AND MÖSSBAUER SPECTROMETRY OF FOREST TOPSOILS AND ARABLE LAYERS NEAR VARIOUS POLLUTION SOURCES

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Various technological processes typical for definite branches of industry are a source of very specific forms of technogenic magnetic particles (TMPs) [1, 2] being deposited on the topsoils and arable layers. Magnetic methods applied to the soils samples are a quick way of gaining information on iron-bearing minerals content. It depends both on the primeval geogenic origin of soil and on the exposition to TMPs sources. In this work several magnetic techniques were utilized in order to determine such parameters as: magnetic susceptibility (κ), temperatures of magnetic transitions (T_c), saturation magnetization (M_s), saturation remanence (M_{rs}), coercivity (H_c) and remanence coercivity (H_{cr}).

The Day plot, relating the ratio M_{rs}/M_s to the ratio H_{cr}/H_c, has allowed to estimate the average size of magnetic grains. The transmission ^{57}Fe Mössbauer spectrometry at room temperature has been applied in order to identify iron-containing phases and to determine their percentage contribution. All soil samples before measurements were magnetically concentrated.

In the most soils samples the dominating ferrimagnetic mineral is multidomain, stoichiometric magnetite. However, in the case of soil close to iron mine in Bjørnevatn (Norway) one observes also a presence of titanomagnetite and magnesium ferrite [3]. In the forest topsoils and arable soils collected close to Pb-Zn wastes in Piekary Śląskie (Upper Silesia, Poland) and Ni-Cu smelter from Nikel (Kola Peninsula, Russia) the noticeably finer fraction of TMPs has been observed. They contain strongly defected (oxidized) magnetite and hematite, goethite - FeO(OH) and sulfides (mostly pyrrhotite). The obtained results convince, that TMPs content strongly depends on pollution source.

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P9-27

LATTICE DYNAMICS OF W-Cr ALLOYS FROM FIRST PRINCIPLES

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Elemental tungsten exhibits a large melting temperature and has exceptional mechanical properties for fuse reactor first wall applications but is unfortunately very susceptible to oxidation when exposed to an environment with very high temperature (above 500°C) [1]. For this reason, Tungsten alloys are being looked into, and it had been hypothesized that W-Cr alloys could be used as coating for nuclear fusion reactors [2] keeping much higher resistance to oxidation [1]. In this contribution we have investigated the enthalpy formation as well as lattice dynamics and elastic properties within binary immiscible W-Cr alloy from first principle calculations. We utilized the VASP code using the generalized gradient approximations for the exchange-correlation effects for two concentrations, namely 50-50 and 70-30 W-Cr to optimize the atomic positions and to obtain the Hellman-Feynman forces in order to calculate phonons using supercell and direct method. Using quasi-harmonic approximation for the lattice dynamics the effect of temperature and concentration on enthalpy formation is discussed in details.

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P9-28

THE FINITE ELEMENTS MODEL OF STANDARD MAGNETIC SHIELDED ROOM (MSR) AS A TOOL FOR ASSESSMENT OF SYSTEMS OF COMPENSATION OF EARTH MAGNETIC FIELD

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The introduction of the new, high sensitivity atomic magnetic transducers in the place of the traditional SQUID sensors creates the strong need for the significant improvements of the compensation of the earth magnetic field inside of a Magnetically Shielded Room (MSR). The two basic methods of compensation are: passive e.g. by shielding construction of MSR and active with use of the coils reducing the earth magnetic field.

The passive compensation system applied in SQUID labs consists of at least two layers of Mumetal nickel alloy and one highly conductive eddy current layer of aluminum. The active compensation is realized by coil systems powered by high stability DC current supply units. The MSR built with two Mumetal layers and one Aluminum layer reduces the Earth magnetic field to about 20 nT. The attenuation factor of external magnetic fields for such MSR is from 500 for DC to 10000 for 100Hz. This level of shielding is not sufficient for sensing of the very small magnetic field in the range below 1pT with the atomic transducers. Therefore we designed, built and tested two systems of modified Helmoholz coils, a global one covering for whole MSR volume and local for the immediate surroundings of the sensor, each consisting of three sets of coils dedicated for x, y, z axes.

Paper presents the results of finite elements method modelling of magnetic shielded room. The model was implemented in open-source ELMER [1] software considering Whitney edge elements equations [2]. On the base of the model, the efficiency of the shielding was assessed. The results of modelling was compared with the result of measurements to elaborate the guidelines for efficient use of the developed magnetic shielded room as well as to minimize the influence of less efficient compensated areas.

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P9-29

SHAPE OPTIMIZATION OF THE RACE-TRACK CORE FOR FLUXGATE SENSOR

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Intensive development of thin layer based fluxgate sensors produced as printed board circuits creates needs of tools for modelling its functional characteristics. To avoid problems with thin layer modelling with finite elements method [1, 2], paper presents the application of the method of moments [3, 4] utilizing uniform square meshes [5]. As a result, magnetostatic modelling of thin layers may be carried out on the base of solution of the set of linear equations.

Presented results of modelling indicate, that the sensitivity of race-track shaped fluxgate sensor strongly depends on the width of the track whereas the influence of the width of the core on the fluxgate sensitivity is about 3 %. This information is very important for development of PCB-based fluxgate sensors with racetrack-shaped cores, as it can lead to significant reduction of the sensor's perpendicular dimension. As a result the racetrack-shaped core fluxgate sensors can fit in smaller probes without significant reduction of sensitivity. Thus PCB sensors may be optimized for application in the area of nondestructive testing of ferromagnetic materials or in industrial automation.

Presented in the paper approach, based on the method of moments utilizing uniform mesh, opens new possibilities of modelling thin film magnetic devices, such as magnetic concentrators, whilst optimization of their shape was not possible on the base of finite elements method (FEM).

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P9-30
MODELLING THE FLUXGATE SENSORS WITH MAGNETIC FIELD CONCENTRATORS

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Since the thirties of twenty century, fluxgate sensors are one of the most commonly used magnetic field sensors. Due to their sensitivity, stability and simple construction, fluxgate sensors are used in the industry for non-destructive testing as well as for the Earth's magnetic field anomaly detections in archaeology and geology.

Due to such wide range of applications, fluxgate sensors are constantly developed. The most promising area of development is application of amorphous alloys for the cores of fluxgate sensors [1]. Amorphous alloys are produced in the form of thin ribbon. Later, the core of fluxgate sensor is produced in the process of photolithography and chemical etching such processes enables development of sophisticated shapes of the cores, radically pushing the limits connected with production of the cores made of bulk materials.

As a result, cores for fluxgate sensors with magnetic concentrators were proposed [2]. This is interesting idea for increasing the fluxgate sensor sensitivity; however, the efficiency of such magnetic concentrator was not verified. Presented paper is filling this gap.

The core of fluxgate sensor made of thin amorphous ribbon was modelled with the finite elements method. The model was implemented using ELMER FEM open source software [3] together with NETGEN applied for tetrahedral meshing process. Finally the influence of the different shapes of magnetic field concentrator on the sensitivity of fluxgate sensor was quantified.

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P9-31

INSTRUMENT DEVELOPMENT FOR MEASURING MAGNETIC PROPERTIES OF THIN FERROMAGNETIC RIBBONS

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Accurate measurement of magnetic properties of ferrous materials in the development process of improved electric motors is a crucial task. New generation amorphous materials show better performance in terms of magnetic properties, however forming and cutting of these materials decreases these excellent magnetic properties. It happens because of the mechanical and/or thermal stress caused by the cutting technology.

In order to allow development of the adequate cutting technology for amorphous materials, the effect of the cutting process on the magnetic properties need to be determined. This can be done by developing a specialized instrument that is capable to accurately measure magnetic properties of small sized amorphous ribbons. This paper introduces a custom instrument that is developed from scratch to make these specialized measurements possible. Generation of strong magnetic field for the excitation of the specimen is required while small B field is measured in the same place and in the same time, which makes the system quite sensitive to design, building accuracy and calibration. The instrument consists of (i) a solenoid, that is used to create the excitation field for BH curve measurement, (ii) a power supply, that is capable to provide several voltage levels with high output power as needed, (iii) a pair of magnetic field sensor, that is able to measure the weak B field in the presence of enormous H field, (iv) a constant current driver to precisely drive the solenoid and produce controlled H field, and (v) a microcontroller based control unit, that controls the measurement process and communicate with PC.

The paper also describes the test and calibration methods and results that are carried out to set the instrument up for scientific measurements and to determine the accuracy of the system. Calibration tests show, that the instrument is able to repeatable determine the BH curve of amorphous samples with good accuracy.

P9-32

USE OF ACTIVE MAGNETIC METHOD IN DIAGNOSTICS OF STEEL ELEMENTS

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Maintenance of steel structures is important to guarantee structural security and integrity. An important role in the safe and economically justified use of steel structures is played by non-invasive diagnostic methods. Such methods include active magnetic methods that use an external magnetic field to introduce the ferromagnetic material into a condition that give the opportunity to assess the degree of material degradation. All ferromagnetic steels change magnetic properties under the influence of applied loads, accumulation of load history and progressive degradation of the structure. Material fatigue, exceeding the permissible stresses or the occurrence of plastic deformation induces a qualitative and quantitative change in the magnetic properties of the materials.

The paper presents new approach to magnetic Barkhausen noise signal processing for assessment of material fatigue and plastic deformations in carbon steel. Magnetic properties of two kinds of test-pieces were tested: samples with different plastic deformations and samples subjected to different number of tensile load cycles. A special measuring system was built to measure the magnetic properties of investigated test-pieces. A new diagnostic approach using the method of Barkhausen signal filtration was investigated, which allowed obtaining more useful diagnostic symptoms than those received from the raw signal. The innovative proposal also concerns the exploration of the possibility of diagnostic use of analysis of the intensity of an electric current that generates an external magnetic field.

The developed method of diagnosing steel elements, based on the use of an external magnetic field creates a good possibility of evaluation of material fatigue and plastic deformations in mechanical constructions built of carbon steel and provide a good detectability and precision of assessment.

P9-33

DIAGNOSTICALLY ORIENTED MAGNETOMECHANICAL EFFECTS ANALYSIS IN QUASI STATIC LOW MAGNETIC FIELD

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The technical condition of the construction material issue and its effort state, despite many proposals approaching to asset of this knowledge, is still the subject of intense research. [1, 2]. Although there are already models, able to provide parameters associated with changes in magnetic strength of key features of the material [3, 4] is still the application of these models is very difficult. Therefore, methods are still being sought that, based on new, more pronounced symptoms, will allow us to make a reliable diagnosis of the technical condition of the construction material. The article presents the concept of decomposition of information contained in the magnetic field observed on the surface of tested samples made of typical construction steel. The aim of the work was to try to separate two information: related to the magnetization of the material and the change of its magnetic permeability. These two parameters, in accordance with the adopted model, are associated with reversible and irreversible magnetomechanical effects present in the material degradation process. For extracting the material features, stimulation was performed using a slow-changing magnetic field with a value close to the natural field of the earth. For the observation field on the sample surface was used an original matrix of triaxial magnetic field sensors. Several measuring series were made for various construction steels for various load stages, both for the area of elastic and plastic deformation. The obtained results were also compared with the variant of the absence of artificial stimulation which corresponds to the tests according to the assumptions of the passive state observer. The proposed approach together with the results from the conducted research allowed for a better identification of the magnetomechanical effects that carry diagnostic information about the material.

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P9-34

ELECTROMAGNETICALLY COUPLED CHARGING FOR MONITORING DEVICES NEAR 110kV HIGH-VOLTAGE TRANSMISSION LINE

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The possibility and efficiency of wireless electromagnetic charging near 110kV high-voltage transmission line is studied in this paper.

For monitoring devices that are used to measure, acquire and transmit various physical parameters near transmission lines or in electrical substations it is necessary to provide sufficient power supply according to device specifications. Usually this is accomplished by photovoltaic panels in combination with built-in batteries, as there is no possibility to connect the power supply of the device to supply network.

In some cases it is necessary to use additional back-up charging as photovoltaic panels do not provide enough power to charge the built-in battery pack through the day especially in winter season due to the short time sunshine period. One of possible additional methods of back-up charging is the wireless electromagnetic charging.

We propose a design of such charging system and we study the efficiency of the system as the parameter of design and distance from the transmission line. We studied the possibility to use the core material type N87 with μ_e=1590 and B_S=320mT. The number of coil windings was 2000. The distance above the ground was in the range between 10cm and 200cm for our experiments. The orientation of the coil and its core was another parameter with influence on the charging system was analyzed. We studied the influence of the pole construction on which the charging system is fastened, i.e. insulated grounding line pole or standard single grounding line.

A model of such charging system is provided and modelled situation is verified by experimental measurements at power distribution network frequency of magnetic field used as input parameters for design and placement of the system achieving maximum efficiency of the magnetically coupled charging system.

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P9-35

SHIELDING EFFECTIVENESS OF THE ELECTROMAGNETIC FIELD BY SPECIALLY DEVELOPED SHIELDING COATING

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Electric lines, mobile phones, computers, radio and TV transmitters, and many other sources of electromagnetic waves produce an unhealthy environment. These type of devices cause electromagnetic pollution. The term electrosmog refers to all electromagnetic waves surrounding our environment. Every year the amount and type of radio waves and microwaves in the environment are increasing. The presence of Electromagnetic Interference (EMI) signals, which sometimes overlap in the frequency spectrum has been causing problems for television and radio broadcasting, military, aerospace, and medical applications. Many scientists are focusing on the development of materials and elements that have the capability to prevent the penetration of electromagnetic waves. One of the possibilities to protect human health from electrosmog is to prevent the penetration of electromagnetic waves from the external environment into the indoor environment of buildings. Glass windows, roofs, specially developed bricks and shielding coatings on the outer and inner walls of buildings are using for this purpose.

This article aims to present the results of the measurements of the electromagnetic waves penetration through the building element with a specially developed shielding coating. Shielding coating represents dispersed powder in semiconducting liquid. The powder represents the complex oxides of $La_{0.7}Sr_{0.3}MnO_3$ (LSMO), $ZnFe_2O_4$ and $NiFe_2O_4$ composition and were prepared by self-combustion method using corresponding metal nitrates in required molar ratio and glycine as fuel. Measurements were made for different powder concentrations (5 g, 10 g and 15 g), which were then compared to the zero powder concentration. Measurements were performed in the frequency range from 0,9 GHz to 9 GHz. The measurement results show the electromagnetic wave shielding effectiveness of the building material using shielding coating.

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APPLICATION OF MAGNETIC MATERIALS IN INDUCTIVE SENSORS FOR PARTIAL DISCHARGE ACTIVITY MONITORING

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The measurement and monitoring of partial discharge activity is one of the commonly used methods to determine the status of insulation system in high voltage power devices.

For such monitoring there are various methods involving direct galvanic coupled measurement, acoustic method or measurement by inductive method.

Inductive measurement of partial discharges uses inductive sensors which sense the partial discharge pulses occurring in high voltage circuit. The sensitivity of such sensors depends on their design, construction and materials used for sensor core. The choice of magnetic material is very important to achieve optimal values of sensor sensitivity.

We have constructed experimental sensors using different magnetic materials and different construction. In our experiments we have selected two magnetic material types: magnetic material based on Fe-Ni (Permalloy) and magnetic material based on $MO.Fe_2O_3$. We have made the analysis in frequency range up to 10MHz of the Dirac pulse response. We were able to examine the optimal construction type and magnetic material of sensor core for these sensors. The minimum acceptable sensitivity of the sensors were determined by equivalent measuring sensitivity when using direct galvanic method.

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P5-18 **SYNTHESIS AND MAGNETIC PROPERTIES OF HYDROPHILIC AND HYDROPHOBIC HYBRID NANOCOMPOSITE**
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6 RARE-EARTH AND 5f-SYSTEMS

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P6-11 **DEPRESSION OF MANY-BODY STATES IN NARROW BAND SEMICONDUCTOR $Sm_{1-x}Yb_xB_6$**
M. Anisimov, V. Zhurkin, A. Azarevich, *A. Bogach*, V. Krasnorussky, V. Voronov, S. Demishev, S. Gavrilkin, K. Mitsen, N. Shitsevalova, A. Levchenko, A. Dukhnenko, V. Filipov, S. Gabáni, G. Pristáš, K. Flachbart, N. Sluchanko and V. Glushkov

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G. Pristáš, J. Bačkai, P. Diko, Mat. Orendáč, K. Flachbart, S. Gabáni, E. Gažo, N. Shitsevalova and K. Siemensmeyer

P6-14 **CORRELATION OF MAGNETIC PROPERTIES AND CRYSTAL STRUCTURE OF PRASEODYNIUM-ORGANIC FRAMEWORK CONTAINING TPPS LIGAND**
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7 STRONGLY CORRELATED ELECTRON SYSTEMS, SUPERCONDUCTING MATERIALS

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A. Bogach, A. Azarevich, S. Demishev, V. Glushkov, A. Samarin, N. Shitsevalova, V. Filipov, S. Gabáni, K. Flachbart and N. Sluchanko

P7-03 **STUDY OF MISFIT SUPERCONDUCTOR $LaSe_{1.14}$ $NbSe_2$**
O. Šofranko, T. Samuely, J. Kačmarčík, P. Szabó and P. Samuely

P7-04 **COEXISTENCE OF FERROMAGNETISM AND SUPERCONDUCTIVITY IN Ni_2NbSn HEUSLER ALLOY**
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P7-05 **MAGNETIC PHASE DIAGRAM OF $Tm_{1-x}Yb_xB_{12}$ ($x < 0.1$) ANTIFERROMAGNETS WITH DYNAMIC CHARGE STRIPES AND Yb VALENCE INSTABILITY**
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P7-06 **SUPERCONDUCTING PHASE DIAGRAM OF LuB_{12} AND $Lu_{1-x}Zr_xB_{12}$ ($x \leq 0.20$) DOWN TO 60 mK**
J. Bačkai, K. Flachbart, S. Gabáni, E. Gažo, M. Orendáč, G. Pristáš, N. Sluchanko, A. Dukhnenko, V. Filipov and N. Shitsevalova

P7-07 **LOCAL MAGNETOMETRY OF SUPERCONDUCTING Mo_8Ga_{41} AND Mo_7VGa_{41}: VORTEX PINNING STUDY**
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P7-11 **EFFECT OF TiO_2 FIBERS ON PROPERTIES OF SINGLE-GRAIN BULK GdBCo SUPERCONDUCTORS**
P. Hajdova, I. Shepa, M. Rajnak, J. Dusza and P. Diko

P7-12 **SPECIFIC HEAT MEASUREMENTS OF HEAVY FERMION SUPERCONDUCTOR $CeCoIn_5$**
M. Marcin, *J. Kačmarčík*, Z. Pribulová, C. Marcenat, T. Klein, Y. Fasano, P. Pedrazzini, V. F. Correa and P. Samuely

P7-13 **OXYGENATION TEMPERATURE DEPENDECY ON THE CRITICAL TEMPERATURE AND THE CRITICAL CURRENT OF THALLIUM BASED SUPERCONDUCTORS**
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P7-14 **MAGNETIC CONTRIBUTION TO HEAT CAPACITY OF $YbNi_4Si$**
M. Zapotoková, M. Reiffers, A. Kowalczyk, M. Falkowski and T. Toliński

P7-15 **INVESTIGATION OF Co-DOPED GdFeAsO-BASED MAGNETIC SUPERCONDUCTORS**
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P7-16 **MEAN-FIELD STUDY OF THE AMPEREAN PAIRING STATE**
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P7-17 **UNCONVENTIONAL DENSITY OF STATES ABOVE THE UPPER CRITICAL FIELD IN HOMOGENEOUSLY DISORDERED SUPERCONDUCTING Mo_2N FILMS**
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V. A. Ulitko, A. A. Chikov, Yu. D. Panov, K. S. Budrin and A. S. Moskvin

P7-20 **MAGNETIC GROUND STATE AND PHASE DIAGRAM OF γ_{II}-Li_2FeSiO_4**
M. Jonak, C. Neef, W. Hergett, S. Spachmann, F. Billert, N. Bouldi, M. Haverkort, C. Ritter, B. Bryant, S. Wiedmann and R. Klingeler

8 MULTIFUNCTIONAL MAGNETIC MATERIALS (MULTIFERROIC, MAGNETOELASTIC, SHAPE MEMORY, ...)

O8-01 **TUNABLE EXCHANGE BIAS IN THE MULTIFERROIC $BiFe_{0.5}Sc_{0.5}O_3$ PEROVSKITE**
E. L. Fertman, A. V. Fedorchenko, V. A. Desnenko, V. V. Shvartsman, D. C. Lupascu, S. Salamon, H. Wende, D. D. Khalyavin, A. I. Vaisburd, N. M. Olekhnovich, A. V. Pushkarev, Yu. V. Radyush and A. N. Salak

O8-02 **EFFECT OF DRIVE SIGNAL AND TEMPERATURE ON HYSTERESIS OF MAGNETICAL SHAPE MEMORY ALLOY-BASED ACTUATOR**
M. Zhou, Y. Yu, C. Zhang and S. Wang

O8-03 **Withdrawn**

O8-04 **MICROSTRUCTURAL AND MAGNETIC PROPERTIES OF SORBENTS BASED ON CERIUM DIOXIDE**
J. Luňáček, O. Životský, Y. Jirásková, P. Janoš and J. Buršík

P8-01 **MAGNETIC PROPERTIES OF $Gd_xMn_{1-x}Se$ SELENIDES**
A. Zhyvulka, V. Dziamidzenka, A. Galyas, K. Yanushkevich and S. Aplesnin

P8-02 **THE EFFECT OF Co-DOPING ON MAGNETIC PROPERTIES OF BISMUTH FERRITE**
I. Makoed, V. Prigodich, K. Yanushkevich, A. Zhivulko, *V. Zhivulko*, A. Galias, O. Demidenko and D. Krivchenya

P8-03 **STRUCTURAL AND MAGNETIC CHARACTERIZATION OF GLASS-COATED MICROWIRES OF Ni_2FeGa HEUSLER ALLOY**
L. Frolova, T. Ryba, J. Kopecek, L. Fekete, T. Kmjec, O. Heczko, Z. Vargova and R. Varga

P8-04 **MARTENSITIC STRUCTURAL VARIANTS RECOVERED BY THE MAGNETIC FIELDS IN Fe_2MnGa HEUSLER ALLOYS**
R. Vidyasagar, T. Ryba and R. Varga

P8-05 **SPECTROSCOPIC AND THERMODYNAMIC INVESTIGATION OF THE NEW ALTERNATING CHAIN SYSTEM $Fe(Te,Se)_2O_5Cl$**
K. Denisova, D. Wulferding, P. Lemmens, P. Berdonosov, E. Kozlyakova and A. Vasiliev

P8-06 **MAGNETISM OF $GdMn_{1-x}Fe_xO_3$ ($0 \leq x \leq 1$) NANOPARTICLES**
M. Mihalik jr., M. Vavra, M. Šestáková, J. Briančin and M. Mihalik

P8-07 **MAGNETIC PROPERTIES OF $(La_xDy_{1-x})_2Ti_2O_7$**
R. Jacko, K. Csach, M. Mihalik jr., M. Zentková and *M. Mihalik*

P8-08 **DISCOVERY OF THE PIEZOMAGNETOELECTRIC EFFECT IN $LiCoPO_4$**
M. P. Kolodyazhnaya, K. R. Zhekov, I. V. Bilych, G. A. Zvyagina and V. D. Fil

P8-09 **MAGNETIC AND STRUCTURAL TRANSITIONS IN $Pb_{1-x}Ba_x(Fe_{0.5}Nb_{0.5})O_3$ FROM MÖSSBAUER, MAGNETIC AND XRD STUDIES**
T. Kmječ, J. Plocek, K. Závěta, J. Kohout, M. Veverka and M. Dopita

P8-10 **COMPLEX HALL EFFECT IN HEUSLER $Ni_{48}Mn_{39}Sn_{13}$ ALLOY**
J. Kamarád, J. Kaštil, J. Hejtmánek and Z. Arnold

P8-11 **CHARACTERISATION OF 'MULTIPIEZO' Pb_2MnO_4**
P. R. Kloihofer, D. Pesquera, M. A. Carpenter and J. P. Attfield

9 APPLICATIONS AND OTHER MAGNETIC MATERIALS NOT INCLUDED IN 1-8

O9-01 **TUNING ELECTRONIC PHASE SEPARATION IN $CaFe_3O_5$ BY DOPING**
B. V. Hakala, K. H. Hong and J. P. Attfield

O9-02 **THE FINITE ELEMENTS MODEL OF ACTIVE COMPENSATION OF EARTH MAGNETIC FIELD AND MAGNETIC ENVIRONMENTAL NOISES IN MAGNETIC ATOMIC SENSORS**
K. Peczalski and A. Ostaszewska-Liżewska

O9-03 **MAGNETIC-FIELD-INDUCED TRANSITIONS IN BISMUTH**
B. Camargo, P. Gierlowski, M. Sawicki and K. Gas

O9-04 **DYNAMIC HYSTERESIS MODELING FOR MAGNETIC SHAPE MEMORY ALLOY ACTUATOR VIA A PI-SIGMA NEURAL NETWORK WITH A MODIFIED BACKLASH-LIKE OPERATOR**
W. Pan, R. Xu, Y. Yu, C. Zhang and *M. Zhou*

O9-05 **MONITORING OF THERMAL DAMAGE AFTER DEPOSITION OF COATINGS VIA BARKHAUSEN NOISE TECHNIQUE**
M. Čilliková, J. Uríček, *M. Neslušan*, V. Ballo and A. Mičietová

O9-06 **Withdrawn**

P9-01 **INFLUENCE OF SAMPLE SIZE AND MAGNETIZING VOLTAGE ON BARKHAUSEN NOISE DURING BENDING AND UNIAXIAL TENSILE TESTS**
J. Šrámek, M. Neslušan, F. Bahleda, K. Zgútová and P. Schenk

P9-02 **MONITORING OF RAIL SURFACE DAMAGE VIA MAGNETIC MEASUREMENTS**
K. Zgútová, *M. Neslušan*, P. Minárik, P. Kejzlar and J. Šrámek

P9-03 **MAGNETOMETRY AS AN EFFECTIVE TOOL FOR KINETICS EVALUATION IN MECHANOCHEMICAL SYNTHESIS OF CHALCOPYRITE $CuFeS_2$**
P. Baláž, M. Baláž, E. Dutková, M. Hegedus, M. Rajňák, M. Achimovičová and J. Briančin

P9-04 **MAGNETIC RESONANCE CONTRAST IMAGING OF FERRITIN AND MAGNETOFERRITIN AT 7 T**
M. Mihalikova, L. Balejcikova, P. Kopcansky, D. Dobrota and O. Strbak

P9-05 **COMPARISON OF MAGNETIC AND NON-MAGNETIC NANOPARTICLES AS SONOSENSITIZERS IN ULTRASONIC HYPERTHERMIA**
K. Kaczmarek, *R. Bielas*, M. Siluk, S. Porzak, T. Hornowski and A. Józefczak

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