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Magnetism and Magnetic Materials

October 22-23, 2018 | Rome, Italy

Special Session

Day 1

Magnetic Materials 2018

Rafał Michalski, Res. Rev. J Mat. Sci. 2018, Volume 6
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3rd International Conference on

Magnetism and Magnetic Materials

October 22-23, 2018 | Rome, Italy

Rafał Michalski

Atomic Systems Ltd., Poland

Simulated thermomagnetic properties of $DyAl_2$, $HoAl_2$ and $ErAl_2$ compounds calculated by atomic matters MFA computation system

We present the results of calculations of magnetic properties of three compounds from Laves phase C15 family: $DyAl_2$, $HoAl_2$ and $ErAl_2$ performed with a new computation system called atomic matters MFA. We compare these results with the recently published results for $TbAl_2$, $GdAl_2$ and $SmAl_2$. The calculation methodology was based on the localized electron approach applied to describe the thermal evolution electronic structure of rare-earth R^{3+} ions over a wide temperature range and to compute magnetocaloric effect (MCE). Thermomagnetic properties were calculated based on the fine electronic structure of $4f^9$, $4f^{10}$ and $4f^{11}$ configurations of the Dy^{3+}, Ho^{3+}, Er^{3+} ions, respectively. Our calculations yield the magnetic moment value and direction; single-crystalline magnetization curves in zero field and external magnetic field applied in various directions of $m(T, B_{ext})$; the $4f$-electronic components of specific heat $c_{4f}(T, B_{ext})$; and temperature dependence of the magnetic entropy and isothermal entropy change with external magnetic field $-\Delta S(T, B_{ext})$. The cubic CEF parameter values used for $DyAl_2$ calculations are taken from earlier research of A.L. Lima, A.O. Tsokol and recalculated for universal cubic parameters (A^m_n) for the RAl_2 series. Our studies reveal the importance of multipolar charge interactions when describing thermomagnetic properties of real $4f$ electronic systems and the effectiveness of an applied self-consistent molecular field in calculations for magnetic phase transition simulation.

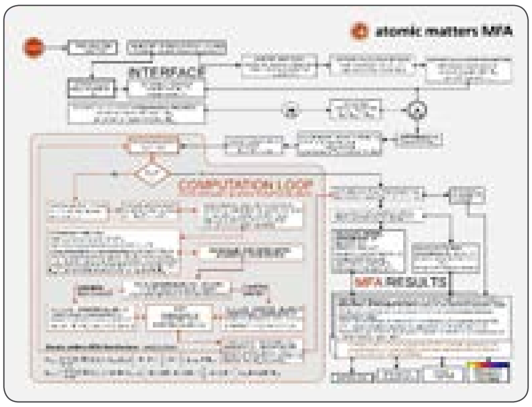

Figure 1: Atomic Matters MFA, calculation algorithm.

Recent Publications

1. Rafał Michalski and Jakub Zygadło (2018) Predictions of thermomagnetic properties of Laves Phase compounds: $TbAl_2$, $GdAl_2$ and $SmAl_2$ performed with atomic matters MFA computation system. Journal of Magnetism and Magnetic Materials 452:415–426.
2. Rafał Michalski, Jakub Zygadło and Marek Karaś (2017) Effective methodology for calculation of magnetic properties of atomic systems in ordered state and around phase transition temperature. WSEAS Transactions on Computers 16:69-75.

3. Rafał Michalski and Jakub Zygadło (2017) Spin and orbital moment compensation in $SmAl_2$. Calculations performed with atomic matters MFA computation system. International Journal of Applied Physics 2:11-17.
4. Rafał Michalski and Jakub Zygadło (2017) Predictions of thermomagnetic properties of $HoAl_2$ and $ErAl_2$ performed with atomic matters MFA computation system. WSEAS Transactions on Circuits and Systems 16:22-34.
5. Rafał Michalski and Jakub Zygadło (2017) Thermomagnetic properties of $DyAl_2$ single crystal, calculated by atomic matters MFA computation system. WSEAS Transactions on Applied and Theoretical Mechanics 12:69-77.

Biography

Rafał Michalski graduated in 1996 from the Pedagogical of University Krakow, Poland in the department of Physics, Mathematics and Computer science. He worked in the Institute of Physics and Computer Science as an Assistant Professor (1996-2001) and then in 2001 he gained a PhD in physics in the department of Nuclear Physics and Solid State Physics at Krakow University of Mining and Metallurgy (AGH). Subsequently, he became an associate professor. His PhD Thesis was "*Calculations of the thermal evolution properties of 4f-electron compounds with the use of the self-consistent methods*". In 2001, dr R. Michalski become a leader of a Polish Scientific Research Committee project (no 1463/P03/2002/22) entitled "The Effects of crystalline symmetry in ThCr2Si2 type Rare Earth compounds". The project ended 31.12.2002. Simultaneously, he worked at the Center for Solid State Physics with prof R.J. Radwański (1996-2006) and published around 30 papers about Crystal Field (CEF) and spin-orbit coupling (SO) effects in materials. At the same time, R. Michalski created two free access computing packages: BIREC (Basic Interactions in Rare-Earth Compounds) and CEF for 3d ions (Crystal Electric Field for 3d ions) to simulate the fine electronic structure and examine the consequences of such a structure on properties of solids as a function of temperature. In 2006-2011 R. Michalski cooperated with a consulting company providing services for industry research projects and deployment of innovative technologies. During this time he invented some commercial technologies protected by 5 patent applications in the EU and the USA. In 2012, he set up and worked for a Light Source Photometry Laboratory for MILOO Electronics. In 2008, R. Michalski started his own commercial scientific activity and developed a project co-financed by European Union resources of the regional development fund (UDA-POIG.01.04.00-12-069/10-00) entitled: "Creation of tools for comprehensive analysis of magnetic properties of elements". The result of this project was an application called Atomic Matters, which simulates the influence of crystal lattice charge surroundings on any atom/ion from the periodic table (www.atomicmatters.eu). Atomic Matters is designed to calculate, simulate and visualize the most relevant properties of materials which are determined by the fine electronic structure of contained ions or atoms in defined conditions. After completing this project, R. Michalski lead a team of programmers in the creation of ATOMIC MATTERS MFA software. ATOMIC MATTERS MFA is an extension of Atomic Matters for magnetic phase transition simulation by self-consistent calculations according to Mean Field Approximation methodology. The synergy of both applications makes it possible to predict the macroscopic properties of materials in user-defined temperature region by using the physical properties of atomic electron systems under the influence of an external magnetic field. The visual form of the results of calculations (including full 3D interactive CEF potential visualization), intuitive interface and tools, and comparative data makes the application extremely efficient and easy for new users. The premiere presentation of ATOMIC MATTERS MFA software was at Thermag VII, the Seventh IIF-IIR International Conference on Magnetic Refrigeration at Room Temperature, Torino Italy, 11-14 September 2016. R. Michalski has managed and participated in about 20 scientific projects. He is has authored more than 40 articles published in international journals and conference proceedings.

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Notes:

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Scientific Tracks & Abstracts

Day 1

SESSIONS

Magnetism | Electromagnetism | Spintronics | Materials Science

Chair: **Fedor Pudonin,** P.N. Lebedev Physical Institute of RAS, Russia
Co-Chair: **Karine Chesnel,** Brigham Young University, USA

SESSION INTRODUCTION

Title: **Critical behavior of GaMnAs diluted magnetic semiconductors near the Curie temperature**
Shavkat U Yuldashev, Dongguk University, South Korea

Title: **Potential of the NMR-in-magnetics technique in the study of local structure of various magnetic materials**
Vladimir V Matveev, Saint Petersburg State University, Russia

Title: **A step towards magnetic separation of rare earth ions**
Liubov Lukina, KU Leuven, Belgium

Title: **Enhancement of germination in maize (*Zea mays variety*: Ganga safed) by magnetic field signal transduction**
K N Guruprasad, Shri Vaishnav Institute of Science, India

Title: **Low temperature properties of low-dimensional exactly solvable spin models with impurities**
Elena V Ezerskaya, VN Karazin Kharkiv National University, Ukraine

Title: **Condensed matter physics in 100 – 1000 T ultrahigh magnetic fields**
Yasuhiro H Matsuda, University of Tokyo, Japan

Title: **Toward addressing the stability challenge of solution processed organic solar cells**
Zhe Li, Cardiff University, UK

Title: **Enhanced magnetization in the $BiFeO_3$-$RMnO_3$ thin films**
Lahmar Abdelilah, University of Picardie Jules Verne, France

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Shavkat U Yuldashev, Res. Rev. J Mat. Sci. 2018, Volume 6
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3rd International Conference on
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Critical behavior of GaMnAs diluted magnetic semiconductors near the Curie temperature

Shavkat U Yuldashev
Dongguk University, South Korea

GaMnAs have been studied intensely over the last few decades and have become a model system for diluted ferromagnetic semiconductors. At present, it is accepted that the Curie temperature of GaMnAs with metallic type of the conductivity coincides well with the maximum of the temperature derivative of the resistivity dρ/dT, similar to the ferromagnetic metals like Ni and Fe, whereas, for samples with low concentration of free carriers, the T_C coincides with the resistivity maximum. The critical behavior of GaMnAs near the Curie temperature was experimentally studied by using the temperature dependencies of the resistivity, the specific heat, and the magnetization of GaMnAs. It is shown that the determination of T_C from the maximum of the temperature derivative of the resistivity is valid only for the samples with a high concentration of free carriers. For the samples with low concentration of free carriers, the T_C coincides with the resistivity maximum. The magnetic specific heat for $T > T_C$ demonstrates the crossover from the one dimensional to the three dimensional critical behavior when temperature become closer to the Curie temperature. This is explained by the existence of Mn-Mn dimers oriented along one direction at the beginning of the formation of the ferromagnetic phase on the paramagnetic side of the phase transition.

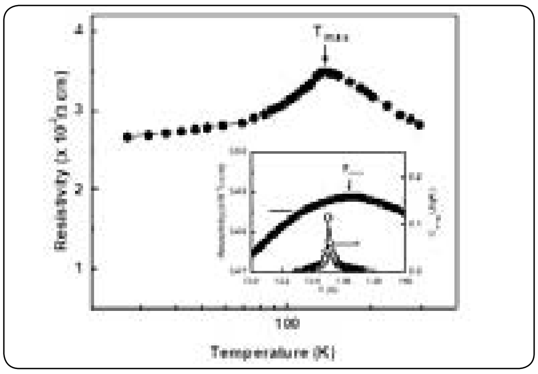

Figure 1: Temperature dependencies of the resistivity for the GaMnAs with 8% of Mn, annealed at low temperature. Inset shows the enlarged picture of the resistivity behavior near the maximum and the magnetic specific heat, respectively.

Recent Publications

1. Z A Yunusov, Sh U Yuldashev, Y H Kwon, D Y Kim, S J Lee, et al. (2018) Band gap engineering of ZnMnO diluted magnetic semiconductor by alloying with ZnS: Journal of Magnetism and Magnetic Materials 446:206–209.
2. Sh U Yuldashev, Z A Yunusov, Y H Kwon, S H Lee, R Ahuja, et al. (2017) Critical behavior of the resistivity of GaMnAs near the Curie temperature: Solid State Communications 263:38-41.
3. Sh U Yuldashev, V Sh Yalishev, Z A Yunusov, Y H Kwon and T W Kang (2016) Magnetic phase transitions in ZnO doped by transition metals: Physica Status Solidi C 13: 559–563.
4. Sh U Yuldashev, V Sh Yalishev, Z A Yunusov, S J Lee, H C Jeon, et al. (2015) Magnetoelectric effect in GaMnAs /P(VDF-TrFE) composite multiferroic nanostructures: Current Applied Physics 15:S22–S25.
5. Sh U Yuldashev, Kh T Igamberdiev, Y H Kwon, S H Lee, X Liu, et al. (2012) Crossover critical behavior of Cd1-xMnxAs: Phys. Rev. B 85: 125202:1–5.

Biography

Shavkat U Yuldashev has completed his PhD in the year 1983 from A.F. Ioffe Institute, Saint-Petersburg. He is the Professor at the Department of Physics of Dongguk University, Seoul, South Korea. He has published more than 175 papers in reputed journals. His expertise is in diluted magnetic semiconductors and spintronics.

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Vladimir V Matveev, Res. Rev. J Mat. Sci. 2018, Volume 6
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Potential of the NMR-in-magnetics technique in the study of local structure of various magnetic materials

Vladimir V Matveev
Saint Petersburg State University, Russia

The lecture is devoted to nuclear magnetic resonance (NMR) in the magnetically ordered state of matter. The technique is also known as NMR in magnetics or spin echo, or FNR. This method possesses a considerable potential for effective investigation and testing of various magnetic materials, especially in the nanocrystalline and/or in nanocomposite state. In the first part of the lecture an introduction is done to basic physics of pulse NMR in magnetics together with a brief description of the method development since its appearance, about 60 years ago. The method was successfully applied to a lot of magnetics such as metallic cobalt and cobalt-containing materials, including films, multilayers and nanoparticles; various ferro- and ferrimagnetic compounds, Heusler alloys, intrinsically inhomogeneous perovskite-like CMR manganites etc. A number of works of different years demonstrate that NMR technique was the useful addition to well known diagnostic methods of magnetic materials and allowed one to get unique information. In the second part of the lecture we review applications of the technique to some novel magnetic structures/materials during the last few decades. In particular, we describe a determination of the core-shell structure of bimetallic FeCo nanoparticles, an observation of ferromagnetic clusters in spin-glass manganites far above Curie temperature, molecular magnets i.e., array of molecular complexes with several 3d-metal ions, Mn-doped magnetic semiconductors, and a detection of zero-field ^{13}C NMR signal in so-called magnetic carbon i.e., in carbon-based magnetic materials free from metallic elements.

Recent Publications

1. Matveev V V et al. (2007) ^{139}La NMR detection of ferromagnetic clusters far above the Curie temperature in $La_{0.7}Ca_{0.3}Fe_{0.09}Mn_{0.91}O_3$ spin-glass manganite. Journal of Physics Condensed Matter 19(22):226209.
2. Matveev V V et al. (2014) ^{13}C NMR relaxation and reorientation dynamics in imidazolium-based ionic liquids: revising interpretation. Physical Chemistry Chemical Physics 16:10480-10484.
3. Matveev V V et al. (2017) Investigation of melts of polybutylcarbosilane dendrimers by ^{1}H NMR spectroscopy. Scientific Reports 7:13710.
4. Markelov D A, Matveev V V et al. (2015) Determination of the hyperfine magnetic field in magnetic carbon-based materials: DFT calculations and NMR experiments. Scientific Reports 5:14761.
5. Markelov D A, Shishkin A N, Matveev V V et al. (2016) Orientational mobility in dendrimer melts: molecular dynamics simulations. Macromolecules 49:9247-9257.

Biography

Vladimir V Matveev has completed his PhD from Semenov Institute of Chemical Physics of USSR Academy of Sciences. He is a Senior Researcher of Department of Nuclear-Physics Investigation Techniques of Saint Petersburg State University, Russia. He has published more than 25 papers in reputed journals and made a lot of reports/lectures at international conferences.

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Liubov Lukina, Res. Rev. J Mat. Sci. 2018, Volume 6
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A step towards magnetic separation of rare earth ions

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KU Leuven, Belgium

Rare earth metals are critical elements for many high-tech applications, e.g. electric vehicles, wind power generators and electronics. Due to the scarcity of rare earth metal supplies in Europe, it is clear that new efficient, environmentally friendly and cheap methods for separating rare earth metals from electronic and mining waste are needed. Currently used solvent extraction process is time-consuming and not efficient. In this context, magnetic separation of rare earth ions looks promising. Magnetic separation is a well-established method used in ore processing, food industry, biomedical diagnostic etc. The method of magnetic separation is based on the fact that REM have different magnetic susceptibilities: some of the rare earth ions are strongly paramagnetic (Dy^{3+}, Ho^{3+}), which means that they move towards the magnet; the other rare earth ions are diamagnetic (Sc^{3+}, Y^{3+}, Lu^{3+}), hence they will move away from the magnet. Particles, cells and molecules easily undergo separation in a magnetic field. However, magnetic separation of ions has not been reported since 1950s. In this work, magnetomigration of rare earth ions was investigated using a separation device. The separation device featured a 2.5 ml^3 cell where rare earth solution was enclosed and circulated due to natural convection. Magnetic field was applied to the device using a magnetic yoke setup. Enrichment of paramagnetic Dy^{3+} ions in the paramagnetic fraction was achieved. Simulation of the experimental system in Comsol 5.2 is allowed to verify the observed fluid flow and temperature patterns. Magnetomigration is the first step to magnetic separation of rare earth ions.

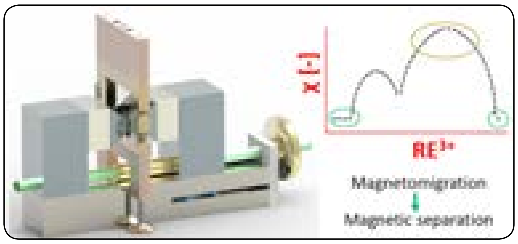

Figure 1: Left: magnetic separation device and magnetic yoke; Right: graph of magnetic susceptibilities of rare earth ions.

Recent Publications

1. Yang X et al. (2014) Magnetic separation of paramagnetic ions from initially homogeneous solutions. IEEE Transactions on Magnetics 50:1–4.
2. Pulko B et al. (2014) Magnetic separation of Dy (III) ions from homogeneous aqueous solutions. Applied Physics Letters 105(23):232407.
3. Ji B et al. (2016) Segregation behavior of magnetic ions in continuous flowing solution under gradient magnetic field. Chinese Physics B 25:074704.
4. Rodrigues I R et al. (2017) Magnetomigration of rare-earth ions triggered by concentration gradients. The Journal of Physical Chemistry Letters 8:5301–5305.
5. Lei Z et al. (2017) Evaporation-assisted magnetic separation of rare-earth ions in aqueous solutions. The Journal of Physical Chemistry C 121:24576–24587.

Biography

Liubov Lukina obtained her Engineer diploma from the National Mineral Resources University in Saint Petersburg, Russia in 2015. Subsequently, she completed the Master program in Chemical Engineering in Lappeenranta University of Technology, Finland in 2016. Since her Master thesis work concerned separation of rare earth metals, she decided to pursue researching this direction. Currently, she is working on her Doctoral thesis on the border of Chemistry, Physics and Engineering in University of KU Leuven in Belgium. She hopes that her work will help developing green methods for rare earth metal recycling from electronic and mining waste.

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K N Guruprasad et al., Res. Rev. J Mat. Sci. 2018, Volume 6
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Enhancement of germination in maize (*Zea mays* variety: Ganga safed) by magnetic field signal transduction

K N Guruprasad and **Pinke Patel**
Shri Vaishnav Institute of Science, India

Maize (*Zea mays* variety: Ganga safed) seeds treated with static magnetic field (SMF) strength of 200 mT showed enhanced germination and seedling vigor. This stimulation leads to better growth of plants and improves the yield of the plant under field conditions. The initial biochemical events soon after treatment of seeds with SMF have been analyzed. SMF treatment induces production of reactive oxygen species (ROS) and nitric oxide (NO) besides enhancing the activity of amylase enzyme. Inhibitors of NO like sodium tungstate (ST) and N-nitro-L arginine methyl ester hydrochloride (L-NAME) inhibit the promotion of seedling growth by SMF. Similarly diphenyleneiodonium (DPI), an inhibitor of NADPH-oxidase enzyme which generates ROS, also inhibits SMF promoted seedling growth. On the contrary, sodium nitroprusside (SNP), a donor of NO, promotes SMF stimulated growth. The biochemical signal transduction of SMF for the promotion of germination and seedling growth is through the production of ROS and NO. ROS can directly degrade the stored food materials like starch in the seeds. NO is a known germination stimulator and an activator of amylase enzyme. The receptors of the magnetic field in the seeds which stimulate the production of these radicals are yet to be ascertained.

Recent Publications

1. Sunita Kataria, Lokesh Baghel and K N Guruprasad (2017) Pre-treatment of seeds with static magnetic field improves germination and early growth characteristics under salt stress in maize and soybean. Biocatalysts and Agricultural Biotechnology 10:83-90.
2. Sunita Kataria, Lokesh Baghel and K N Guruprasad (2017) Alleviation of adverse effects of ambient UV stress on growth and some potential physiological attributes in soybean (*Glycine max*) by seed pre-treatment with static magnetic field. Journal of Plant Growth Regulation 36:550–565.
3. A Fatima, S Kataria, L Baghel, K N Guruprasad, A K Agrawal, B Singh, P S Sarkar, T Shripathi and Y Kashyap (2017) Synchrotron-based phase-sensitive imaging of leaves grown from magneto-primed seeds of soybean. Journal of Synchrotron Radiation 24:232–239.
4. Pinke Patel, Guruprasad Kadur Narayanaswamy, Sunita Kataria and Lokesh Baghel (2017) Involvement of nitric oxide in enhanced germination and seedling growth of magneto primed maize seeds. Plant Signaling and Behaviour 12(12):e1293217.
5. M B Shine, S Kataria and K N Guruprasad (2017) Enhancement of maize seeds germination by magneto priming in perspective with reactive oxygen species. Journal of Agriculture and crop Research 5(4):66-76.

Biography

K N Guruprasad is a Director of Shri Vaishnav Institute of Science, SVVV, Indore, Madhya Pradesh, India. He has worked in the area of photobiology and magneto-biology for over 30 years and has published over 85 research papers in journals of international repute. His work on improvement of crop yields by magnetic field treatment is gaining importance in the field of agriculture as a non-invasive physical method that can enhance the performance of crop plants.

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Notes:

Elena V Ezerskaya, Res. Rev. J Mat. Sci. 2018, Volume 6
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Low temperature properties of low-dimensional exactly solvable spin models with impurities

Elena V Ezerskaya
VN Karazin Kharkiv National University, Ukraine

This work is devoted to the theoretical study of quantum stationary states and thermodynamics of some exactly solvable quantum models based on spin-1/2 XX-chain. Low-dimensional spin models occupy special place in quantum theory of magnetism. Some of these systems may have exact analytical solutions. In our study we consider the spin chains with defects: infinite XX-chain with impurity fragment, finite linear XX-chain with an additional ZZ (Ising) bond, two finite XX-chains, connected through an additional ZZ spin, finite spin-1/2 XX-chain closed by one zz (Ising) bond and open ends XX-chain with two zz-impurities at the both ends. For infinitive spin-1/2 XX-chain with impurity fragment in longitudinal magnetic field the exact energy spectrum is found. This spectrum consists of the energy band, set of discrete levels, and may contain from one up to four bound states localized on the boundaries of impurity fragment and main chain. We studied the critical behavior of local static thermodynamic characteristics and time dependence of dynamical longitudinal correlation functions at different temperatures. For finite XX-chain with Ising defects the localized levels near the impurity spin may exist in the spectrum. The conditions for their appearance were found. The field and temperature dependences of some thermodynamic characteristics of the models are studied. It is shown that the localized levels may effect noticeably on local thermodynamic characteristics.

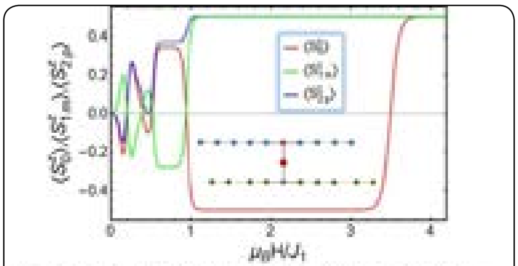

Figure 1: Unstable behavior of field dependences of local spin z-projection of additional Ising spin and its nearest neighbors for two finite XX-chains, connected through ZZ spin at low temperature.

Recent Publications

1. Cheranovskii V O and Ezerskaya E V (2013) U=∞ Hubbard model for 1D frustrated magnets. Croatica Chemica Acta 86:431-434.
2. Cheranovskii V O and Ezerskaya E V (2015) Magnetic properties of the infinite U Hubbard model on one-dimensional frustrated lattices. Journal of Superconductivity and Novel Magnetism 28:773-776.
3. Ezerskaya E V (2017) The energy spectrum and thermodynamics of spin-1/2 XX chain with Ising impurities. Acta Physica Polonica A131:928-930.
4. Cheranovskii V O, Ezerskaya E V, Klein D J and Tokarev V V (2017) Lowest energy states of Hubbard ladder model with infinite electron repulsion. Computational and Theoretical Chemistry 1116:112–116.
5. Cheranovskii V O, Ezerskaya E V, Klein D J and Tokarev V V (2018) Finite size effects in anisotropic u = ∞ Hubbard ladder rings. Journal of Superconductivity and Novel Magnetism 31:1369–1373.

Biography

Elena V Ezerskaya has completed her PhD in the year 1985 from VN Karazin Kharkiv National University. She is Associate Professor at the Theoretical Physics Department of VN Karazin Kharkiv National University. She has published more than 30 papers in reputed journals. She is experienced university teacher and researcher in field of Theoretical Physics for more the 30 years, supervisor of MS and PhD students.

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Yasuhiro H Matsuda, Res. Rev. J Mat. Sci. 2018, Volume 6
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Condensed matter physics in 100 – 1000 T ultrahigh magnetic fields

Yasuhiro H Matsuda
University of Tokyo, Japan

Ultrahigh magnetic field in the range of 100-1000 T opens new research fields in condensed matter physics. The spin Zeeman energy of a free electron reaches 1350 K (0.116 eV) at 1000 T that is large enough to change electronic as well as structural properties of matter. Various kinds of phase transitions can be induced by such ultrahigh magnetic fields and the novel high-field phase is regarded as a kind of new material. Destructive ways are only available for generation of the 100-1000 T fields and thus the time duration of the pulsed-fields is in the microsecond range, which requires us to develop special measurement techniques to overcome this severe condition. For magnetic field generation, the single-turn coli and the electromagnetic flux compression techniques have long been developed in our institute (the Institute for Solid State Physics (ISSP)) and can generate up to 300 and 1000 T, respectively. Various kinds on intriguing phenomena such as the structural phase transition of solid oxygen, magnetic phase transitions in low dimensional magnets, novel spin-state transitions in cobalt-oxides, and the insulator-metal transition in a Kondo material are recently discovered in ultrahigh magnetic fields. Such recent physical achievements as well as developments of magnet technology are presented.

The coil-clamping part of the magnetic-field generator with electromagnetic flux compression technique using 2 MJ capacitor bank.

Recent Publications

1. K Nomura, Y H Matsuda, Y Narumi, K Kindo, S Takeyama, Y Hosokoshi, T Ono, N Hasegawa, H Suwa and S Todo (2017) Magnetization process of the S = 1/2 two-leg organic spin-ladder compound BIP-BNO. Journal of the Physical Society of Japan DOI: 10.7566/JPSJ.86.104713.
2. T Nomura, Y H Matsuda and T C Kobayashi (2017) H-T phase diagram of solid oxygen. Physical Review B 96:054439.
3. A Ikeda, T Nomura, Y H Matsuda, S Tani, Y Kobayashi, H Watanabe and K Sato (2017) High-speed 100 MHz strain monitor using fiber Bragg grating and optical filter for magnetostriction measurements under ultrahigh magnetic fields. Review of Scientific Instruments 88(8):083906.

Biography

Yasuhiro H Matsuda completed his PhD in the year 1996 from Tohoku University. He is the Associate Professor of The Institute for Solid State Physics, The University of Tokyo. He has published more than 100 papers in reputed journals. He is expertise in high-magnetic-field science and condensed matter. His discoveries of novel field-induced phases shed new light on condensed matter physics.

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Lahmar Abdelilah, Res. Rev. J Mat. Sci. 2018, Volume 6
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Enhanced magnetization in the $BiFeO_3$-$RMnO_3$ thin films

Lahmar Abdelilah
University of Picardie Jules Verne, France

The monolithic $BiFeO_3$ (BFO) is claimed to be multiferroic at room temperature, but only a weak magnetization and moderate polarization are observed. The co-doping of BFO is a way to improve electrical properties as well as magnetization. Thin films of the $BiFeO_3$-$RMnO_3$ (R = rare earth) system affords an interesting combination of good ferroelectric polarization and magnetization properties at room temperature that are a prerequisite for intrinsic multiferroism. Particularly, the addition of $GdMnO_3$ leads to a substantial increase in magnetization that experimentally allows the determination of Néel temperature (TN). The origin of magnetization improvement will be discussed in terms of Gd substitution effects on octahedral distortion and tilting.

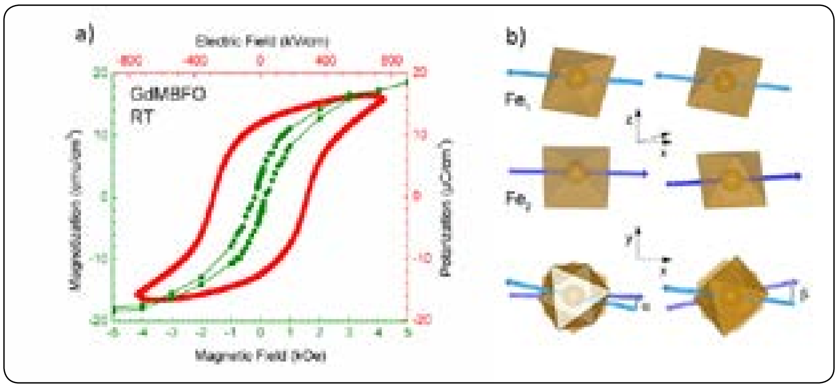

Figure: (a) Simultaneous presence of ferroelectric and magnetic properties in GdMBFO. (b) Simple representation of how motion of oxygen cages would lead to rotation of octahedra and increase in the octahedral angle from α angle for pure BFO to β angle for GdMBFO.

Recent Publications

1. Lahmar A (2017) Multiferroic properties and frequency dependent coercive field in $BiFeO_3$-$LaMn_{0.5}Co_{0.5}O_3$ thin films. Journal of Magnetism and Magnetic Materials 439:30–37.
2. Lahmar A and Es Souni M (2015) Sequence of structural transitions in $BiFeO_3$-$RMnO_3$ thin films (R= rare earth), Ceramics International 41(4):5721–5726.
3. Lahmar A, et al. (2009) Effect of rare earth manganites on structural, ferroelectric and magnetic properties of $BiFeO_3$. Applied Physics Letters 94(1):012903.

Biography

Lahmar Abdelilah received his Doctorate in Science in Materials Chemistry in 2007 from University of La Rochelle (France)/University Mohammed V (Morocco). Subsequently he worked at the Institute for Materials and Surface Technology (IMST) in Kiel (Germany) until 2012. Then he moved to Amiens, in Laboratory of Condensed Matter Physics, where he obtained his Habilitation thesis in 2017. His research interests encompass a broad range of multifunctional materials (multiferroic, electrocaloric, and magnetoelectrics). He has published more than 50 papers published in peer reviewed journals and contributed to numerous international conferences.

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Scientific Tracks & Abstracts
Day 2

SESSIONS

Magnetoelectronic Materials | Magnetization Dynamics | Hard Magnetic Materials | Soft Magnetic Materials | Structured Materials | Special Magnetic Materials | Superconductivity and Superfluidity | Geomagnetism | Novel Magnetic Materials and Device Applications

Chair: Consiglia Mocerino, Sapienza University of Rome-MIUR, Italy
Co-Chair: Dmytro A Bozhko, Universität Kaiserslautern, Germany

SESSION INTRODUCTION

Title: Nanoisland magnetic films: Technology and possible applications
Fedor Pudonin, P.N. Lebedev Physical Institute of RAS, Russia

Title: Efficiency of nanotechnologies in the high performance of buildings
Consiglia Mocerino, Sapienza University of Rome—MIUR, Italy

Title: Macroscopic dynamics of ferrofluids
Victor V Sokolov, MIREA— Russian Technological University, Russia

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Title: Photo-induced magneto-optical phenomena in magnetic semiconductors: Europium chalcogenides
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Title: Process, characterization and physical properties of 3D transition ion doped-tetrahedrite compounds
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Nanoisland magnetic films: Technology and possible applications

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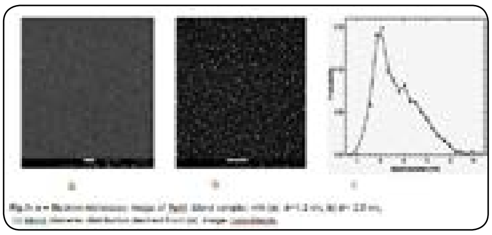
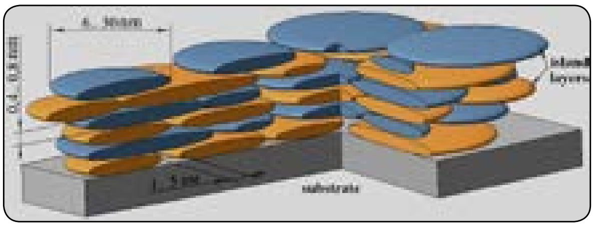
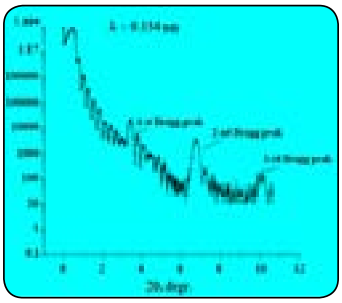
Now there has been a significant interest in the technology of obtaining and studying magnetic nanoisland films. This is due both to the enormous applied potential of these objects. We used the RF-sputtering method to obtain nanoisland films of magnetic materials such as FeNi, Co, Ni, etc. In this report we will present the results of our work on obtaining magnetic nanoisland films and some applied aspects of these structures. Since the deposition rate is a stable value at constant technological parameters, we deposit thin films whose effective thickness was determined by the time of deposition. There is a critical thickness d*(percolation threshold) below which the films are nanoisland, and films with effective thickness d>d* become continuous. To determine the d* value, we have grown several series of FeNi films with effective thicknesses from 0.5 to 3.0 nm with thickness steps Δ~0.07 nm. The standard polished ceramic plates (sitall), crystalline silicon, silicon nitride, glass, as well as thin Al_2O_3 layers deposited on silicon were used as substrates. Figure 1 shows an image of some island FeNi films. To determine d*, the dependences of the permittivity ε(ω) and conductivity σ on the thickness were studied. It was found that Re ε(ω) and δ=[σ (T=300 K) - σ(T=77 K) simultaneously change sign at d~1.6-1.8 nm, which indicates the presence of a percolation transition at d*~1.6-1.8 nm. Thus, FeNi films with an effective thickness d<1.6 nm are island. We have shown that photoconductivity in the range 500-1500 nm, anomalous conductivity in weak electric fields, giant dielectric constant, and other unusual properties are observed in nanoisland films of FeNi and other metals. We proposed to use nanoisland FeNi films in which the effect of anomalous conductivity is observed as labels that can serve as a protection for various documents and securities and other products. Nanoisland films can also be used to create sensors of superweak magnetic fields at room temperature. For this, we fabricated multilayer island structures such as $[FeNi/Co]_N$ in figure 2. With the help of X-ray studies it was shown that in such systems the island layers do not mix and they really are periodic structures. It was found that these structures are capable of detecting (changing their resistance) magnetic fields $H<10^{-11}$ T. This is a great result and we hope to improve it.







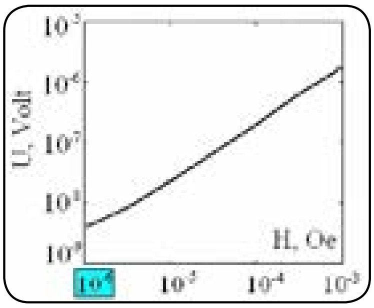


Figure 2: Multilayer structure (FeNi-Co)N

Figure 3: Angular dependence of the X-ray reflection I from the multilayer island structure [ZnTe(1.5 nm)–Ti(0.9) nm]10.

Figure 4: The dependence of the voltage U on the structure (FeNi-Co)20 on the magnetic field H.

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Biography

Fedor Pudonin is the Head of Laboratory in P.N.Lebedev Physical Institute Russian Academy of Science, Russia. He is the chief researcher in the Laboratory of Heterogeneous Systems Physics.

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Consiglia Mocerino, Res. Rev. J Mat. Sci. 2018, Volume 6
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Efficiency of nanotechnologies in the high performance of buildings

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New research in the field of technological innovation, with nanotechnologies and nano-structured eco-active materials, smart materials that change according to meteorological and atmospheric flows, with new adaptive and smart models, etc. identify new processes in the efficient building of infrastructures in cities and territories, with low environmental impact and reduction of CO_2. Objectives of innovation and sustainability with use of functional materials that mainly focus on optical, magnetic, electrical properties, such as those of semiconductor, magnetic materials, etc. with the dematerialized technologies and high performance in the building and use of sustainable materials with high solar transmittance, lightness, air quality and low thermal conductivity. So methodologies with the application of efficient nanostructured materials including silica aerogels, the doped materials by epoxy resins with carbon nanotubes (CNT), much stronger than steel, intelligent bio phase change materials (PCM), bioplastics, etc. Application of advanced materials such as aerographite, based on carbon nanotubes, with characteristics of resilience, strength, flexibility and durability, aimed at different uses in the building sector of the construction industry, for super-light energy accumulators, for purification devices of air and water. Distinguishing materials by environmental quality since recyclable, renewable and biodegradable, linked to chemical/physical, mechanical and technological, while denouncing criticality and application limits for the protection of human health. High performance requirements of architectural beauty even through transparency and surface gloss, with nanostructured materials ecoactive high performance, glassy and light-sensitive materials, iridescent and translucent colors, from thermal comfort with use of minimum thickness. The challenge is in the application of advanced materials in the emerging areas of digital fabrication for environmental sustainability and in the efficient, intelligent and sustainable building sector.

Recent Publications

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3. Mocerino C (2016) Integration of the energy and building technologies. Journal of Civil Engineering and Architecture (JCEA) 10(12):1934–7367.
4. Mocerino C (2016) Technology innovation in digital architecture processes. Journal of Civil Engineering and Architecture (JCEA) 10(8):1934–7367.

Biography

Consiglia Mocerino, graduated cum laude with a Master of Science degree in Architecture, PhD in Urban Recovery and Regeneration and specialist in Restoration of monuments, has held at the Faculty of Architecture, Sapienza University of Rome, teaching and research collaboration and teaching assignments, as a contract professor, in Architectural Technology. In the same Faculty she obtained the nomination of subject expert in the discipline of Technology of Architecture and Industrial Design. She is an expert in research on issues related to innovation and technological experimentation of systems and products in efficient, intelligent, low impact, environmentally friendly architectures, innovative materials and the application of third generation nanotechnologies.

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Macroscopic dynamics of ferrofluids

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Ferrofluids (magnetic fluids, magnetic nanofluids) are ultrastable colloidal suspensions of magnetic nanoparticles in non-polar and polar carrier liquids. The most striking feature of a ferrofluid is that it is a liquid with strong magnetic properties. The macroscopic dynamics of ferrofluids remains a subject of interest. Here we concentrate mainly on the two limiting cases. One corresponds to the assumption about equilibrium magnetization of ferrofluids i.e., under dynamic perturbations of the ferrofluids, the relaxation time of a magnetic field strength to its equilibrium value is infinitely small. Another limiting case corresponds to the assumption of frozen-in magnetization. The relaxation time of a magnetic field strength to its equilibrium value is infinitely large. The physical grounds for introducing this limiting case were descriptions of dynamic processes, in particular, ultrasound propagation in ferrofluids. The obtained expression for the velocity of fast magnetosonic waves describes the existing experimental data on the anisotropy of ultrasound wave propagation in ferrofluids. The previous theories could not describe the propagation of ultrasound waves in magnetic fluid under external magnetic field. The prediction concerning the existence of new waves, namely slow magnetosonic wave and Alfvén-type wave in ferrofluids seems very important and requires an experimental verification. We believe these waves would prove a most prolific area of experimental research.

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Biography

Victor V Sokolov is a Professor at MIREA-Russian Technological University, Russia. His activities and awards include the Russian Government Premium in Education (2013), Honoured Worker of Higher Education of the Russian Federation (2003), Certificate of Soros's Associate Professor of Physics (1998). He is a Member of the Russian National Committee on Theoretical and Applied Mechanics. His research interests lie in macroscopic theory of continuum with frozen-in magnetization and Hamiltonian dynamics of complex fluids.

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The electron correlation effect on the magnetic properties of quasi-one dimensional-materials on the base of graphitic nanoclusters with embedded transition metals

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It is well known, the phase diagrams of the nanostructured magnetic materials demonstrate a variety of low-spin and high-spin states. The switch ability of these states is the central point to potential applications in molecular spintronics and high-density magnetic data storage. In this work, we studied the energy spectrum and thermodynamics of quantum Heisenberg spin model for graphitic nanoribbons with periodically embedded heteroatoms and model chain magnets formed by triangular graphitic clusters. The exact diagonalization study, density matrix renormalization group and Quantum Monte-Carlo method based on stochastic series expansion approach were used for this purpose. We found that clusters with frustrated interactions could exhibit spin switching when the corresponding coupling parameters are changed. For several carbon nanoribbons, we found macroscopic ground state spin and intermediate magnetization plateau. We also studied the exact thermodynamics of infinite distorted nanoribbons described by the special case of Heisenberg-Ising model. Special attention was given to the doped systems described by single-band Hubbard model with strong electron repulsion at partial electron filling. Here we used cyclic spin permutation formalism to derive the corresponding low-energy lattice Hamiltonians. We found numerically the possibility of the spin switching with the change of model parameters. We also demonstrated that the correlated hopping terms, which are present in our Hamiltonians, may change significantly the lowest energy spectra of the corresponding magnets in comparison with the similar description within the framework of the t-J model.

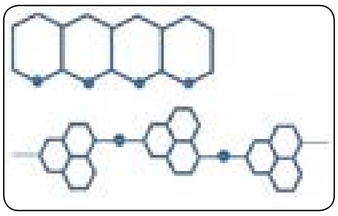

Figure 1: Graphitic clusters with embedded heteroatoms

Recent Publications

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Biography

Vladyslav O Cheranovskii has completed his Doctor of Sciences in the year 1994 from Institute for Single Crystal. He is the Professor of V.N.Karazin Kharkiv National University, Department of Chemistry. He has published 49 papers recognized by Scopus and Web of Science databases. He is working in field of Solid State Physics and Quantum Chemistry. His main subject of interests includes strongly correlated electron system quantum theoretical simulation of electron structure and thermodynamics of nanomagnets.

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Photo-induced magneto-optical phenomena in magnetic semiconductors: Europium chalcogenides

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Europium chalcogenides EuX (X = O, S, Se, Te) are a compact group of magnetic semiconductors with unique electronic, magnetic, optical and magneto-optical properties. The physical properties of the europium chalcogenides EuX are determined by the electronic structure of the Eu^{2+} ions, which have strongly localized $4f^7$ electrons with a large spin S = 7/2. A photo-induced Faraday effect (FE) was studied in the chalcogenides EuTe and EuSe by the optical pump-probe technique using continuous lasers and a broadband light source. The photo-induced FE was investigated as a function of the intensity of light, magnetic field, and temperature. Figure 1 shows field dependences of the photo-induced FE in EuTe at various optical pumping intensities. It has been established that resonant excitation of the $4f^7 5d^0 \rightarrow 4f^6 5d^1$ optical electric-dipole transition in EuTe produces magnetic polarons with a quantum efficiency of about 10% and a magnetic moment exceeding 600 μB for EuTe and 6000 μB EuSe at low temperatures. A quantum mechanical model has been developed for calculating the photoinduced FE associated with the formation of giant magnetic polarons in EuTe. The developed theory describes well the experimentally observed dependencies. The optical pump-probe technique with a femtosecond time resolution was used to study ultrafast dynamics in EuTe near the absorption band gap. A magnetic-field-induced crossover from the inverse FE to the optical orientation was observed. In conclusion, a number of new photo-induced optical effects in magnetic semiconductors EuX were observed.

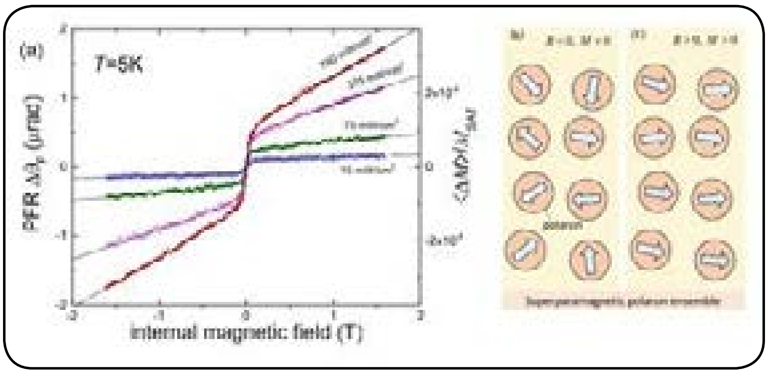

Figure 1: (a) Field dependences of the photo-induced FE in EuTe at various optical pumping intensities. (b) Photo-induced polarons form a paramagnetic ensemble: in the zero magnetic field each polaron has an arbitrary orientation, the average magnetic moment is zero. (c) Due to the large magnetic moment of the polaron a small magnetic field is needed to align all polarons at low temperature.

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Biography

Victor Pavlov has completed his PhD in the year 1993 and second PhD in the year 2007 at the Ioffe Institute, St Petersburg, Russia He is the laboratory head of optical phenomena in magnetic and semiconductor crystals He has published more than 80 papers on linear and nonlinear magneto-optical phenomena in bulk magnetically ordered materials and nanostructures.

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Process, characterization and physical properties of 3D transition ion doped-tetrahedrite compounds

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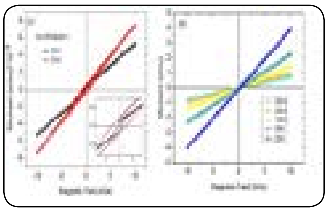
[2]Gebze Technical University, Turkey
[3]Kazan E.K. Zavoisky Physical-Technical Institute of RAS, Russia

The demand on new and waste energy potential increases with decreasing energy sources in the world. This situation brings new attitudes globally on using waste energy and discovering new energy sources. Among the main types of waste renewable energy, thermoelectricity which is converted electric energy from waste heat play a very important role on science and with its applications on industry. Among the many sulphate salts, the group of tetrahedrite/tennantite has potential interest in physics in many ways are widely used in thermoelectric and photovoltaic applications. The importance of the thermoelectric researches is coming from neglecting the high material costs and long-termed synthesizing procedures. On the other hand, the properties of cheapness, accesibility, minimized risk factor in the usage of thermoelectric materials make important for technological applications in scientific studies. Recently, tetrahedrite $Cu_{12}Sb_4S_{13}$ material doped with different dopant elements exhibits important thermoelectric properties. Tetrahedrite, $Cu_{12}Sb_4S_{13}$, is emerging as a promising phase in thermoelectrics. It exhibits an intrinsically low lattice thermal conductivity ($\kappa L = 0.4 Wm^{-1}K^{-1}$ at 700 K) due to unique features in its crystal structure. At the same time, the defect zinc-blende lattice ensures a good crystalline pathway for electron transport. At the same time, tetrahedrites are one of the most abundant TE minerals on Earth. In this study, main material $Cu_{12}Sb_4S_{13}$ tetrahedrite doped with 3d ions such as Sb and As were synthesized using solid state reaction method. The annealing procedure was optimized for Sb and As doped -$Cu_{12}Sb_4S_{13}$ tetrahedrite samples. Structural characterization was done by X-ray diffraction method (XRD). Scanning electron microscope (SEM) and an *in-situ* electron dispersive spectroscopy (EDS) were used for particle size and elemental compositions respectively. The compositions were also analyzed by electron spin resonance (EPR) and vibrating sample magnetometer (VSM) tools as shown in images.



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Biography

Adil Guler, Lecturer, now is a Researcher in Marmara University, Ataturk Faculty of Education, Department of Computer and Instructive Technology Teacher. He completed his BSc degree in Physics and Specialist in Magnetic and Superconductive materials. He got his PhD at Marmara University, Department of Physics. He works in the research group of Prof. Dr. Arunava Gupta as a Research Scientist in Alabama State University. He also makes projects with Assist. Prof. Dr. Cihat Boyraz on superconductivity and magnetism. His magnetic superconductivity group has been working on Fe-based superconductors for 5 years.

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