PHYSICS OF CONDENSED MATTER

Preparation and study of physical properties of magnetic material with reduced Dimension.
supervisor: Mgr. Vladimír Komanický, PhD. (vladimir.komanicky@upjs.sk)
study form: full time
Annotation: Low dimensional materials are materials with at least one dimension small enough for the physical properties of the material lay somewhere between that of individual atoms and the bulk material. A physical constraint can give rise to unique effects as a result of new surface states and/or demonstration of quantum effects. A number of unexpected and fascinating phenomena such as Ising behaviour, oscillating antiferromagnetic coupling, perpendicular magnetic anisotropy have been demonstrated in magnetic materials characterised by a reduced dimensionality [1]. Magnetic thin films, multilayers, and nanomagnetic structure arrays are the most typical representatives of such materials.
Thin film deposition techniques such as evaporation, magnetron sputtering, atomic layer deposition, molecular beam epitaxy are techniques of choice to prepare magnetic thin films and multilayers. On the other hand ordered arrays of magnetic dots, antidots and wires in the submicrometric range can be prepared by using various lithographic techniques [2]. When thin film deposition technique such as magnetron sputtering is combined with flexible e-beam lithography one has almost unlimited possibilities to design material geometry, structure and periodicity on the nanoscale level in both horizontal and vertical direction. This gives endless variability to engineer novel magnetic materials and explore many unique effects and phenomena.
Ciele EN: The aim of this dissertation is preparation of magnetic materials with reduced dimensionality, establishing relation between structure and morphology on preparation conditions and study of physical properties of these materials.
References:
[1] M. Gibertini, M. Koperski, A.F. Morpurgo, K. S. Novoselov. Magnetic 2D materials and heterostructures. Nat. Nanotechnol. 14, 408-419 (2019).
[2] J.I. Martín, J. Nogués, K. Liu, J.L Vicent, I.K. Schuller. Ordered magnetic nanostructures: fabrication and properties. J. Magn. Magn. Mater. 256, 449-501 (2003).

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Phase diagrams of $RA_{1-x}Cr_xO_3$ (R = rare earth metal, A = Mn,Fe) substitutional system.
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consultant: RNDr. Marián Mihalik, CSc.
study form: full time
Annotation: Transition metal oxides are intensively studied due to their high application potential as cathodes for fuel cells, sensors for the detection of various gases (CO_2, methanol, ethanol ...) and, last but not least, as components with strong magneto-electrical coupling for electronics. Our laboratory has been dealing with this topic for a long time, mainly with compounds of the $RMn_{1-x}Fe_xO_3$-type (R = rare earth metal). Preliminary results show that $RA_{1-x}Cr_xO_3$ (A = Mn, Fe) systems can also exhibit very interesting properties with high application potential.

The aim of the PhD. study will be the synthesis of new materials with the chemical composition $RMn_{1-x}Cr_xO_3$, the study of their properties with emphasis on magnetism, magneto-electrical coupling and the optimization of these materials for practical use. The student will be guided through the preparation and characterization of samples, experiments, data analysis and presentation of the results. This will ensure that the person who completes this study will have a broad view in the field of experimental physics and will be able to pursue a career in basic or applied research.
Requirements for the applicant: good basics on the field of magnetism, or inorganic chemistry.

Unconventional spin dynamics of artificial magnetic systems.

supervisor: prof. Ing. Martin Orendáč, DrSc.
consultant: doc. RNDr. A. Zeleňáková, PhD.
study form: full time

Annotation: The thesis will deal with the experimental investigation of static and dynamic magnetic properties of selected “man-made” magnetic assemblies. The proposed assemblies will predominantly consist of magnetic nanoparticles with appropriate surfactants, which will be investigated as agglomerates, located into polyethylene matrix, or deposited on polyethylene substrate. The attention will also be devoted to selected magnetic ions located in glassy matrix or selected coordination compounds. Systematic tuning of the composition and structural parameters will enable tailoring single-ion and single-particle anisotropy, respectively, as well as tuning magnetic interactions. Static properties will be investigated by analyzing thermodynamic quantities and electron-spin resonance spectra. Dynamic response will be studied by adopting standard protocols in a wide range of temperatures, magnetic fields and excitation frequencies. The combined analysis of static and dynamic properties will enable to clarify the mechanisms of magnetic relaxation. More specifically, the conditions of the formations of (super)spin-glass state and their utilization in the design of the assembly appropriate for thermal memory cell will be addressed in detail.