MA 13: Magnetic Materials II

Time: Monday 17:00–19:00 Location: HSZ 401

MA 13.1 Mon 17:00 HSZ 401

Evidence of a new magnetic configuration in ferrimagnets RCo_2 — •Julia Herrero-Albillos[1], Marcela Bonilla[2], Luis Miguel García Vinuesa[2], Fernando Bartolomé[2], Celia Castán[2], Noelia Marcano[2], and Irene Calvo[2] — [1]Helmholtz-Zentrum Berlin, Albert Einstein strasse 15, 12489 Berlin (Adlershof), Germany — [2]Departamento de Física de la Materia Condensada, Instituto de Ciencia de Materiales de Aragón, CSIC-Universidad de Zaragoza, Pedro Cerbuna 12, 50009 Zaragoza, Spain.

Different experimental techniques allowed us to identify a new magnetic configuration within the paramagnetic phase of ferrimagnet $ErCo_2$. In this new magnetic ordering, coined as parimagnetism,[1] the Co net magnetic moment is aligned antiparallel to the Er and to the applied field at temperatures well above T_C and below certain flipping temperature. Magnetic short-range correlations of Co atoms within the parimagnetic state have been also established by means of small angle neutron scattering measurements. Thermopower and μSR spectroscopy measurements give also evidence about the existence of these strong correlated magnetic entities. Recently analysis carried on X-ray magnetic circular dichorism (XMCD) spectra taken in $HoCo_2$ and $DyCo_2$ have showed also the antiparallel arrangement of Co net magnetic moment respect to the rare earth in both compounds. The XMCD measurements allow us to propose a new magnetic phase diagram, for $ErCo_2$, $HoCo_2$ and $DyCo_2$. These results suggest that parimagnetism is a more general phenomenon among this ferromagnetic family. [1] J. Herrero-Albillos, et al., Physical Review B 76, 2007.

MA 13.2 Mon 17:15 HSZ 401

Magnetic properties of $Fe_{1-x}Tb_x$ thin films — •C. Schubert[1], B. Hebler[1], A. Liebig[1], F. Radu[2], M. Daniel[1], and M. Albrecht[1] — [1]Chemnitz University of Technology, Institute of Physics, Germany — [2]Helmholtz Zentrum Berlin, Department of Magnetization Dynamics, Germany

Amorphous ferrimagnetic rare earth-transition metal alloys with high perpendicular magnetic anisotropy (PMA) at room temperature (RT) are suitable for the use as pinning layers in spin valve sensor systems or in hard drive disks to overcome the superparamagnetic limit [1]. In this regard $Fe_{1-x}Tb_x$ thin films are promising candidates since their ferrimagnetic properties with respect to a chosen temperature can be well controlled depending on the Tb content.

Here we present an investigation of the structural and magnetic properties of 20 nm thick amorphous $Fe_{1-x}Tb_x$ alloy films in the composition range from x = 0.19 to 0.26. The magnetic layers are embedded in Pt seed and capping layers with a thickness of 5 and 3 nm respectively to prevent them from oxidation. All depositions were realized through magnetron sputtering on thermally oxidized Si(100) wafers. A compensation point above RT, as verified through the temperature dependence of the remanence and the coercivity, was achieved at x = 0.24. Interestingly, the magnetization reversal process changes towards lower temperatures and shows an exchange spring behavior due to an anisotropy gradient in the film. Furthermore first results on nanostructured $Fe_{1-x}Tb_x$ thin films will be presented.

[1] Fullerton et al., Appl. Phys. Lett. **77**, 23 (2000)

MA 13.3 Mon 17:30 HSZ 401

Switching processes and thermal activation in a hard magnetic FePt film — •Christian Behler, Volker Neu, Ludwig Schultz, and Sebastian Fähler — IFW Dresden, P.O. Box 270116, D-01171 Dresden, Germany

In order to understand the switching behaviour of a granular FePt film we examined the angular dependence of the switching field and studied the thermal activation of the switching process via magnetisation relaxation measurements. The investigated film with a nominal thickness of 5 nm is grown epitaxially in $L1_0$-ordered structure. The coercive field, measured parallel to the easy axis, reaches a value of 7.4 T, which is about 70 % of the anisotropy field (10.8 T). The angular dependent switching field is in good agreement with the Stoner-Wohlfarth-Model when the above observed reduction in coercivity is included. We conclude that the switching behaviour approaches Stoner-Wohlfarth, but the nucleation starts at defects with reduced magnetic anisotropy. This result is supported by the size of the activation volume, which was determined from viscosity measurements. Compared with the grain volume the smaller activation volume also indicates that the switching process is initiated by inhomogeneous domain nucleation.

MA 13.4 Mon 17:45 HSZ 401

Magnetization reversal of interaction domains in fine-grained textured Nd-Fe-B — •Juliane Thielsch, Ulrike Wolff, Volker Neu, Ludwig Schultz, and Oliver Gutfleisch — IFW Dresden, Institute for Metallic Materials, P.O. Box 27 01 16, D-01171 Dresden, Germany

Textured nanocomposite magnets attract a lot of interest due to their potential of exhibiting higher energy products than those of currently existing rare earth-transition metal permanent magnets. In such nanostructured materials interaction domains are expected in contrast to classical magnetic domain structures that are commonly known from e.g. sintered magnets. Domain structures of this kind occur due to the magnetic coupling between grains whose sizes are about equal or smaller than the expected single-domain grain size. For hot-deformed samples made of melt-spun Nd2Fe14B-type ribbons the existence of interaction domains due to magnetostatic coupling has been reported. We choose this system to investigate the magnetic microstructure in dependence of a magnetic field along the initial magnetization curve. Images taken with Magnetic Force Microscopy are correlated to global hysteresis measurements. We show for the first time how interaction domains evolve in a bulk magnetic system from the thermally demagnetized state to a field of 6T. The growing/shrinking of the interaction domains happens from the domain border to the inside. Hardly any reversal within one domain is visible which affirms the collective nature of those domains. At high magnetic fields domains are left that are in the range of the grain size which implies a grain by grain switching.

MA 13.5 Mon 18:00 HSZ 401

Magnetocaloric effect and thermal stability of hydrogenated melt spun $La(Fe,Si)_{13}$-compounds — •Maria Krautz, Konstantin Skokov, James D. Moore, Jian Liu, Ludwig Schultz, and Oliver Gutfleisch — IFW Dresden, Institute for Metallic Materials, P.O. Box 270116, D-01171 Dresden

3d-metal based alloys with a $NaZn_{13}$-structure are of high interest for magnetic refrigeration as they show a large magnetocaloric effect by undergoing a first-order phase transition. Since only $LaCo_{13}$ is stable as a binary, the $LaFe_{13}$-phase must be stabilised by additional elements such as Al or Si. In pseudobinary $La(Fe,Si)_{13}$ alloys the magnetic transition temperature can be tuned by inserting interstitial hydrogen. In this work, almost single phase $La(Fe,Si)_{13}$ alloys produced by melt spinning and subsequent short time annealing are hydrogenated at elevated temperatures. In view of application, the hydrogen content was adjusted to cover a range of Curie temperatures. A systematic study of different particle sizes on the hydrogenation was carried out. The influence of hydrogen on the magnetocaloric properties was studied by direct adiabatic temperature change measurements and indirect methods to determine the magnetic entropy change. Finally, the stability of the hydrogenated samples is assessed.

MA 13.6 Mon 18:15 HSZ 401

HDDR - An efficient way to produce highly coercive, anisotropic Nd-Fe-B powders — •Konrad Güth, Thomas George Woodcock, Juliane Thielsch, Ludwig Schultz, and Oliver Gutfleisch — IFW Dresden, Institut für Metallische Werkstoffe, Postfach 270016, D-01171 Dresden, Germany

Nd-Fe-B sintered magnets have the highest energy product, $(BH)_{max}$, of any commercially available hard magnetic material (typically 300-400 kJ/m^3). Disadvantages of Nd-Fe-B sintered magnets are the relatively high cost and their machinability. One promising approach to achieve relatively high performance with lower material cost is to process the Nd-Fe-B powder using a hydrogen treatment at elevated temperature. This method is known as the HDDR (hydrogenation, disproportionation, desorption, recombination) process. HDDR has been shown to be an effective route to produce a $Nd_2Fe_{14}B$ powder with a highly refined grain size (about 300 nm) compared to that of the starting material (typically tens of μm). Coercivity has been shown to increase with decreasing grain size. A further, very specific advantage of the HDDR process is the texture-memory effect. This means that the refined grains within a particle exhibit a texture which is derived

from the orientation of the original, coarse grain. Strong texture is necessary to maximize the remanence, yielding anisotropic polymer bonded magnets. In the current work, microstructural investigation based on SEM and XRD of different stages of the HDDR process will be given. The magnetic properties in dependence on the hydrogen pressure during processing are studied by VSM.

MA 13.7 Mon 18:30 HSZ 401

The AC transport properties of iron whiskers at 4.2 K — •Matthäus Langosch, Haibin Gao, and Uwe Hartmann — Institute of Experimental Physics, Saarland University, Postfach 151150, D-66041, Saarbruecken, Germany

Iron single crystals (iron whiskers) were grown as specific samples to investigate the magneto-impedance (MI) effect at low temperature. MI measurements on iron whiskers with <100> growth direction were first carried out at room temperature. The MI effect of the whiskers was observed as a function of driving current and frequency. Calculations based on the standard skin effect formalism provide the complex values of the effective circumferential permeability. Furthermore, MI measurements at low temperature were employed to investigate the AC transport properties. In addition, DC measurements were carried out to extract magneto-resistance (MR) effects from the MI data. At room temperature, the change of the impedance is about 150 % and mainly due to the skin effect. At low temperature, MR effects are taken into account.

MA 13.8 Mon 18:45 HSZ 401

Magnetic Main Group Impurities in CdS — •Pedro Bedolla-Velazquez, Peter Mohn, and Christoph Gruber — Technische Universität Wien (Computational Materials Science) Wien, Austria

With the development of magnetic semiconductors, the role of the magnetism of impurities came again into the focus of research. For d- and f-electron impurities, the situation seems to be rather clear. A new field appears when one starts to study magnetism produced by vacancies or by atoms, which usually do not carry any magnetic moments in a bulk solid. Starting from the magnetism of carbon vacancies in graphene we will present a study of CdS where S is replaced by main group elements. On the basis of ab-initio supercell calculations employing density functional theory (DFT) we investigate the behaviour of impurities (B,N,C,O,F,Al,Si,P,Ga,Ge) in wurtzite (w) and zincblende (zb) CdS lattices. It is found that the impurities prefer the sulfur position and most of them, depending on the concentration exhibit magnetic order. We find that for small concentrations (64zb/72w and 32zb atom supercells) a half metallic ferromagnetic behaviour is found. For a 16 atom supercell for both zb- and w-structure partly also unsaturated magnetic moments occur. For Si, Ge and P impurities a metamagnetic behaviour appears, which is found for the first time in p-electron systems. A field dependence of the magnetic moments in these materials may lead to new technological applications in these magnetic semiconductors as tunable spin injection materials.