MA 52: Magnetic Thin Films III

Time: Thursday 11:00–13:15 Location: HSZ 403

MA 52.1 Thu 11:00 HSZ 403

Electronic structure of fully epitaxial Co2TiSn thin films — •Markus Meinert[1], Jan-Michael Schmalhorst[1], Hendrik Wulfmeier[1], Günter Reiss[1], Elke Arenholz[2], Tanja Graf[3], and Claudia Felser[3] — [1]Dünne Schichten und Physik der Nanostrukturen, Fakultät für Physik, Universität Bielefeld, 33501 Bielefeld, Deutschland — [2]Advanced Light Source, Lawrence Berkeley National Laboratory, CA 94720, USA — [3]Institut für Anorganische Chemie und Analytische Chemie, Johannes-Gutenberg-Universität, 55128 Mainz, Deutschland

We report on the properties of thin films of the full Heusler compound Co2TiSn prepared by DC magnetron co-sputtering. Fully epitaxial, stoichiometric films were obtained by deposition on MgO (001) substrates at substrate temperatures above 600°C. The films are well ordered in the $L2_1$ structure, and the Curie temperature exceeds slightly the bulk value. They show a significant, isotropic magnetoresistance and the resistivity becomes strongly anomalous in the paramagnetic state. The films are weakly ferrimagnetic, with nearly $1\,\mu_B$ on the Co atoms, and a small antiparallel Ti moment, in agreement with theoretical expectations. X-ray absorption spectra on the Co $L_{3,2}$ edges, including circular and linear magnetic dichroism are compared with ab initio calculations of the x-ray absorption and circular dichroism spectra. We infer that the electronic structure of Co2TiSn has essentially non-localized character. Spectral features that have not been explained in detail before, are explained here in terms of the final state band structure.

MA 52.2 Thu 11:15 HSZ 403

First principles investigation of the influence of excess Fe and Si(Al) on the magnetic properties of Co_2FeZ (Z = Si,Al)/MgO(001) — •Heike Herper and Peter Entel — Faculty of Physics, University of Duisburg-Essen, Lotharstr. 1, 47048 Duisburg, Germany

Ferromagnet/semiconductor spintronic devices make high demands on the magnetic material, i.e., high spin polarization and Curie temperature are prerequisites. Heusler alloys such as Co_2FeSi fulfill the requirements in their $L2_1$ bulk phase. However, in thin films the spin-polarization (P) is often smaller which seems to be related to structural disorder and formation of off-stoichiometric alloys. Furthermore, the Heusler alloys experience lattice strain if grown on MgO(001) which can also change the magnetic properties.

We investigate the influence of off-stoichiometry, disorder, and strain on the magnetic properties in bulk-like Fe-Co-Si(Al) systems and thin films on MgO(001) within density functional theory using VASP [1]. Exchange parameters and magnetic transition temperatures are obtained from KKR[2] calculations.

Our investigations show that the polarization depends on the interplay between composition, e.g., Fe excess can reduce P, and strain which increases P in case of excess Fe. Additional Co on the Fe sublattice improves the magnetic properties of the system.

[1] G. Kresse and J. Furthmueller, Comput. Mater. Sci. 6, 15 (1996).
[2] The Munich SPR-KKR package, version 3.6, H. Ebert et al.

MA 52.3 Thu 11:30 HSZ 403

X-ray diffraction studies of $Mn_{3-x}Ga$ Heusler thin films — •Patrick Thomas, Daniel Ebke, Manuel Glas, and Günter Reiss — Thin Films and Physics of Nanostructures, Physics Department, Bielefeld University, Germany

Perpendicular magnetized thin films have attracted a lot of attention, because of the possible higher storage densities in comparison to common magnetic memory devices. In contrast to multilayered thin films like Co/Pd for inducing a perpendicular anisotropy, we have investigated the crystal structure of the tetragonal distorted Heusler lattice $Mn_{3-x}Ga$. In this work we will discuss the crystal growth properties of the Heusler thin films for different substrates and buffer layers as a function of deposition temperature and film thickness.

MA 52.4 Thu 11:45 HSZ 403

Structural and magnetic ordering of Cu_2MnAl on MgO(001) studied by XAS and XMCD — •Bernhard Krumme[1], Heike Herper[1], Denise Erb[2], Claudia Weis[1], Anne Warland[1], Carolin Antoniak[1], Kurt Westerholt[2], Peter Entel[1], and Heiko Wende[1] — [1]Faculty of Physics and CeNIDE, University of Duisburg-Essen, D-47048 Duisburg, Germany — [2]Faculty of Physics IV, Ruhr-University Bochum, D-44801 Bochum, Germany

Since many Heusler compounds are predicted to be halfmetallic ferromagnets, these materials are very promising candidates for ferromagnetic electrodes in spintronic devices. However, in ferromagnet/insulator hybrid structures used for these devices, the magnetic properties of the Heusler compounds strongly depend on the structural quality of the films and their interfaces. Therefore, we investigate the influence of chemical order on the electronic structure as well as the magnetic properties element-specifically by means of X-ray absorption and X-ray magnetic circular dichroism (XMCD) spectroscopy at the $L_{2,3}$ absorption edges of Cu and Mn, respectively. Due to the element-specificity of these techniques, we are able to monitor the disorder-order transition at both the Cu and Mn sites and to identify a small, induced magnetic moment of $0.045\ \mu_B$ per Cu atom, which is in reasonable agreement with our SPR-KKR calculations [1].

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[1] The Munich SPR-KKR package, version 3.6, H. Ebert et al.

MA 52.5 Thu 12:00 HSZ 403

Anisotropic magnetorestistance and magnetic anisotropy of Heusler compound thin films — •Matthias Althammer[1], Alexander T. Krupp[1], Franz D. Czeschka[1], Matthias Opel[1], Inga-Mareen Imort[2], Günter Reiss[2], Andy Thomas[2], Rudolf Gross[1], and Sebastian T. B. Goennenwein[1] — [1]Walther-Meißner-Institut, Bayerische Akademie der Wissenschaften, Garching, Germany — [2]Fakultät für Physik, Universität Bielefeld, Bielefeld, Germany

Magnetic anisotropy is of fundamental importance in ferromagnets, as it strongly influences their properties. Using anisotropic magnetoresistance (AMR) measurements, we investigate the magnetic anisotropy of the ferromagnetic Heusler compound Co_2FeAl. Thin Co_2FeAl films grown on (001)-oriented MgO substrate were patterned into Hall-bar mesa structures via optical lithography and etching. To quantify the magnetic anisotropy, we recorded the angle dependent magnetoresistance (ADMR), i.e., the AMR as a function of magnetic field *orientation* for different magnetic field magnitudes $|H|$. From the ADMR data taken at high $|H|$, the resistivity coefficients are obtained. The magnetic anisotropy is then extracted from ADMR taken at lower $|H|$. We will quantitatively compare the resistivity coefficients and the magnetic anisotropy in Co_2FeAl thin films with thicknesses of 20 nm, 50 nm, 80 nm, 100 nm, as a function of temperature from 5 K to 350 K.

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MA 52.6 Thu 12:15 HSZ 403

Magnetic domain patterns in Co2MnGe-Heusler nanostripes — •Katherine Gross, Philipp Szary, Oleg Petracic, Kurt Westerholt, and Harmut Zabel — Festkörperphysik, Ruhr Universität Bochum, D-44780 Bochum, Germany

We have investigated the magnetic domain patterns of Co2MnGe-Heusler microstructures resulting from the interplay between the magneto-crystalline, growth induced uniaxial, and shape anisotropies. Before patterning, thin films of ferromagnetic Co2MnGe Heusler alloys grown on Al2O3 a-plane substrates exhibit, besides a small cubic anisotropy, a dominant in-plane uniaxial anisotropy parallel to the Al2O3 -c-axis. On submicron wide slabs prepared by electron beam lithography we analyzed the influence of the slab geometry (width,length and thickness) on the magnetic domain configurations by magnetic force microscopy (MFM) and SQUID Magnetometry. In the remanent state with the uniaxial anisotropy axis perpendicular to the long axis of the slabs we observed perfectly regular multidomain patterns with the magnetization direction perpendicular to the slab axis and the domain width varying approximately as the square root of the slab width. For an oblique orientation between the slab axis and the uniaxial anisotropy axis ($0°<\alpha<90°$) the magnetization switches from a multidomain configuration to a single domain dipole state below a critical angle αC, which depends on the width of the stripes. The essential features of the domain patterns that we have imaged by MFM could well be reproduced by OOMMF micromagnetic simulations.

MA 52.7 Thu 12:30 HSZ 403

Co_2FeGa Heusler nanoparticles at the interface of physics, chemistry and materials science. — •Changhai Wang, Frederick Casper, Benjamin Balke, Gerhard H. Fecher, and Claudia Felser — Institute of Inorganic and Analytical Chemistry, Johannes Gutenberg - University, 55099 Mainz

This work reports on the chemical synthesis and characterizations of the ternary Heusler Co_2FeGa nanoparticles. Specifically, the role of particle size in affecting the long and short range order and magnetic properties of the Heusler nanoparticles is investigated. The formation of the $L2_1$ Co_2FeGa phase is confirmed by anomalous X-ray diffraction (AXRD), extended X-ray absorption fine structure (EXAFS), Mössbauer spectroscopy, and magnetic measurements. The degrees of long and short range order of Co_2FeGa nanoparticles decrease for smaller particles. The population of superparamagnetic particles increases with decreasing particle size. The correlation of the TEM-derived particle size and Mössbauer spectroscopy specifies the critical size of Co_2FeGa nanoparticles bridging superparamagnetism and ferromagnetism. It is found that stoichiometric Co_2FeGa phases can be obtained under nonstoichiometric conditions. Pure Co_2FeGa phases are formed at precursor compositions of low Co/Fe ratio, nominal Co and excess Fe. A microscopic study reveals that the size of Co_2FeGa nanoparticles is dependent on the size and morphology of silica supports.

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MA 52.8 Thu 12:45 HSZ 403

Tuning the magnetic anisotropy in $Mn_{3-x}Co_xGa$ Heusler compounds for spintronic applications — •Vajiheh Alijani, Jürgen Winterlik, Benjamin Balke, Gerhard H. Fecher, and Claudia Felser — Institute of Inorganic and Analytical Chemistry, Johannes Gutenberg - University, 55099 Mainz

Heusler compounds such as tetragonal phase of $Mn_{3-x}Ga$ are currently receiving increased interest due to their benefits for applications, especially in the research field of spintronics. Our current research is particularly focused on Mn_2-based Heusler compounds. These compounds are of exceptional importance due to their large diversity of adaptive magnetic properties and their tunability by variation of several physical parameters such as temperature, magnetic field, or electron-doping. The materials $Mn_{3-x}Co_xGa$, i. e. substitution of Mn atoms by Co, exhibit very interesting features. While the Mn-rich alloys are very similar to Mn_3Ga as they crystallize in the identical tetragonal structure and show comparable hard-magnetic properties, the Co-rich samples show the cubic Heusler structure, soft-magnetic hysteresis loops, and perfect Slater Pauling behavior. This facilitates the tuneability of the magnetic anisotropy by varying the Co concentration. This work is supported by the Deutsche Forschungsgemeinschaft through the ASPIMATT projects TP 1.2-A (CH 952/1-1) and TP 2.3-A (FE 633/11-1).

MA 52.9 Thu 13:00 HSZ 403

Towards stretchable magnetoelectronics — •Michael Melzer, Denys Makarov, and Oliver G. Schmidt — Institute for Integrative Nanosciences, IFW Dresden, Helmholtzstraße 20, 01069 Dresden

Magnetic multilayer stacks revealing giant magnetoresistance (GMR) are crucial components of magnetic sensor devices. Currently, GMR sensors are fabricated on rigid substrates. In this respect, successful operation of GMR devices on stretchable and flexible substrates can open up a variety of new applications for magnetic sensors due to arbitrary surface geometries possible after fabrication.

Here, we present a study of the magnetic and structural properties of GMR elements fabricated on free-standing elastic Poly(dimethylsiloxane) (PDMS) membranes. 40 μm thick PDMS films were spin-coated onto silicon wafers comprising an anti-stick layer, which allows for easily pealing the PDMS film off. GMR stacks consisting of 50 bilayers of Co/Cu as well as $Ni_{81}Fe_{19}$/Cu were grown on the elastic PDMS surfaces using magnetron sputter deposition. The GMR ratio measured on the multilayers grown on the elastic PDMS is found to be comparable to values obtained on rigid substrates. The optimization of the sensitivity of the resulting GMR elements with respect to sensing of low magnetic fields was performed by tuning the coupling between the magnetic layers. Furthermore, the performance of these magnetic sensor elements upon stretching will be in the scope of the presentation.

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