MA 21: Magnetic Thin Films II

Time: Wednesday 14:00–18:45 Location: H 1012

MA 21.1 Wed 14:00 H 1012

Exchange interactions and critical temperature of ultrathin films MnSi/Si(001) — •Mahbube Hortamani[1,2], Leonid Sandratski[1], Peter Kratzer[3], Ingrid Mertig[1,2], and Matthias Scheffler[4] — [1]MPI für Mikrostrukturphysik Halle — [2]Martin-Luther-Universität Halle-Wittenberg — [3]Universitaet Duisburg-Essen — [4]FHI der MPG Berlin

Epitaxial growth of Mn on Si(001) has been recently studied in the context of spintronics, in order to investigate spin injection through a metal-semiconductor interface. Requirement for an efficient spin injection is to have a high spin polarization of carriers at the Fermi level which retains at room or higher temperature.

Earlier, we had shown that a well ordered layered structure of MnSi can be grown epitaxially on Si(001) substrate under Mn-rich conditions. These films were found to be ferromagnetic with the B2-type lattice structure. The spin moment of interfacial Mn atoms and the spin polarization at the Fermi level are considerable. In order to determine whether or not the thin films remain ferromagnetic above room temperature, we calculate the Curie temperature of ultrathin films MnSi/Si(001).

The Curie temperature is estimated within the multiple sublattice Heisenberg model, applying (i) a mean-field model and (ii) the random-phase approximation. The exchange coupling is obtained from energy differences of various collinear spin configurations. The calculations are performed using DFT with the GGA-PBE functional and the FP-APW+lo method, as implemented in the WIEN2k package.

MA 21.2 Wed 14:15 H 1012

Pulsed laser deposition of epitaxial $Co_2Mn_{1-x}Fe_xSi$ films — •Horst Schneider and Gerhard Jakob — Institut für Physik, Johannes Gutenberg-Universität Mainz

The Heusler compound Co_2MnSi has been predicted to be half-metallic, and recent experiments show a tunneling spin polarization of more than 90% at low temperatures. However, this value decreases rapidly at higher temperatures. It has been shown theoretically that replacing Mn with Fe will shift the Fermi energy of the compound away from the valence band into the center of the half metallic energy gap. This might reduce the temperature dependence of the spin polarization. We report the successful pulsed laser deposition of thin $Co_2Mn_{1-x}Fe_xSi$ films over the whole stoichiometry range $0 \leq x \leq 1$. The films were grown on MgO (100) with and without Cr buffer layer under UHV conditions. The investigated films grow epitaxially and possess the fully ordered $L2_1$ Heusler structure. Furthermore, we present results of bulk magnetometry experiments as well as investigations of the electronic transport of these samples. We discuss these results with respect to the electronic structure of the alloys.

MA 21.3 Wed 14:30 H 1012

Characterization and nanopatterning of Ni_2MnIn Heusler films — •Jan M. Scholtyssek, Jeannette Wulfhorst, Ulrich Merkt, and Guido Meier — Institut für Angewandte Physik und Zentrum für Mikrostrukturforschung, Universität Hamburg, Jungiusstr. 11, 20355 Hamburg

The Heusler alloy Ni_2MnIn is a promising material as spin injector because of its predicted half-metallicity at the interface to InAs. We grow thin films of this Heusler alloy by thermal coevaporation of Nickel and the alloy MnIn. The alloy is grown on Si_3N_4 membranes and amorphous carbon films for transmission-electron microscopy (TEM) as well as on Si and InAs. The degree of the transport spin polarization of the films grown on Si(100), InAs(100) and in-situ cleaved (110) surfaces of InAs is determined by point-contact Andreev reflection spectroscopy (PCAR) [1]. The almost perfect lattice match between InAs and Ni_2MnIn supports highly oriented growth, as we have proven by electron diffraction under grazing incidence [2]. Lateral spin valves with Heusler electrodes are lithographically defined. In view of the temperature-sensitivity of the optical and electron-beam resists, the samples are grown at substrate temperatures of 50 °C and annealed up to 400 °C afterwards. The post-growth annealing process is investigated in situ in the TEM using transmission-electron diffraction on structured samples grown on Si_3N_4 membranes.

[1] L. Bocklage, J.M. Scholtyssek, U. Merkt, and G. Meier, J. Appl. Phys. **101** 09J512 (2007). [2] J.M. Scholtyssek, L. Bocklage, R. Anton, U. Merkt, and G. Meier, J. Magn. Magn. Mat. **316**, e923 (2007).

MA 21.4 Wed 14:45 H 1012

Temperature Dependence of Magnetic Order in Fe/(Ga,Mn)As studied by Monte Carlo Simulations — •Svitlana Polesya[1], Jan Minar[1], Hubert Ebert[1], and Christian Back[2] — [1]LMU München, Dept. Chemie und Biochemie/Phys. Chemie, Butenandtstrasse 11, D-81377 München, Deutschland — [2]Institut für Experimentelle Physik, Univ. Regensburg, Deutschland

The magnetic order of the heterogeneous interface system (GaMn)As/Fe at finite temperatures has been studied by Monte Carlo simulations. The ground state magnetic properties were determined within ab initio electronic structure calculations using the SPR-TB-KKR Green's function method. All calculations have been performed for the semi-infinite system of (GaMn)As with 5 % Mn covered by a 7 ML Fe film. The temperature dependent properties of this system (with and without external magnetic field) have been studied using MC simulation. The exchange coupling within the Fe and (GaMn)As subsystems were found to be dominantly long-range ferromagnetic whereas the coupling of Fe and Mn moments close to the interface is strongly antiferromagnetic. The Monte Carlo simulations lead to a Curie temperature of about 1000 K for the Fe film. Within the (GaMn)As subsystem due to the polarisation induced by the Fe film the average magnetisation at room temperature is still about 70 % of its $T = 0$ value for several layers close to the interface. These results are in full agreement with recent experimental findings.

MA 21.5 Wed 15:00 H 1012

Interface magnetic properties of Al/Heusler films investigated by XAS and XMCD — •Michael Kallmayer[1], Kerstin Hild[1], Tobias Eichhorn[1], Horst Schneider[1], Gerhard Jakob[1], Andres Conca[1], Martin Jourdan[1], Hans-Joachim Elmers[1], Andrei Gloskovskii[2], Stefan Schuppler[3], and Peter Nagel[3] — [1]Johannes Gutenberg-Universität Mainz, Institut für Physik, D-55099 Mainz — [2]Johannes Gutenberg-Universität Mainz, Institut für Anorganische und Analytische Chemie, D-55099 Mainz — [3]Forschungszentrum Karlsruhe, Institut für Festkörperphysik, D-76021 Karlsruhe

The magnetic interface properties of Heusler alloys often deviate from bulk properties, but they greatly determine the functionality of Heusler films in devices. We have investigated magnetic interface properties of $Co_2Cr_{0.6}Fe_{0.4}Al$, Co_2FeSi and Ni_2MnGa films that are capped by an Al layer. X-ray absorption spectroscopy (XAS) reveals a considerable interdiffusion of Al into the Heusler film at elevated temperatures and even at rough interfaces at 320 K. This explains a decreased interface magnetization as observed by x-ray magnetic circular dichroism (XMCD) [1]. Microspectroscopy using photoemission electron microscopy reveals that the reaction proceeds inhomogeneously with reaction nuclei separated on a micron length scale [2].

[1] M.Kallmayer et al., J.Phys.D: Appl.Phys. 40 (2007) 1552.
[2] M.Kallmayer et al., Appl.Phys.Lett. 91 (2007) 192501.

MA 21.6 Wed 15:15 H 1012

Mößbauer study of epitaxial $Co_2Cr_{0.6}Fe_{0.4}Al$ thin films. — •Vadim Ksenofontov[1], Christian Herbort[2], Martin Jourdan[2], and Claudia Felser[1] — [1]Institute of Inorganic and Analytical Chemistry, Johannes Gutenberg - University, 55099 Mainz — [2]Institute of Physics, Johannes Gutenberg - University, 55099 Mainz

Epitaxial thin films of the promising for spintronic applications Heusler half-metallic compound $Co_2Cr_{0.6}Fe_{0.4}Al$ (CCFA) were investigated using conversion electron Mößssbauer spectroscopy (CEMS) in order to get insight into the structural and magnetic properties. Thin films of 100 nm thickness were deposited by rf magnetron sputtering on MgO substrates without and with 10 nm Fe buffer layer. We discuss a correlation between the annealing temperature and the structural disorder and hyperfine fields on Fe atoms measured by Mößbauer spectroscopy. Samples prepared at the optimum annealing temperature as determined by tunneling magnetoresistance measurements show the optimum degree of order on the Fe sites as determined by CEMS. Additionally, we observed evidence for a diffusion of Cr atoms from the CCFA thin film into the Fe buffer layer and the related diffusion of Fe atoms from the buffer into the CCFA film. Thus the thermal treat-