MA 51: Magnetic Half-metals and Oxides II

Time: Thursday 11:00–13:15 Location: HSZ 401

MA 51.1 Thu 11:00 HSZ 401

Spin polarized surface states at the free Co_2MnSi (100) surface — •Roman Fetzer[1], Jan-Peter Wüstenberg[1], Jan Minàr[2], Jürgen Braun[2], Hubert Ebert[2], Takayuki Ishikawa[3], Masafumi Yamamoto[3], Martin Aeschlimann[1], and Mirko Cinchetti[1] — [1]Department of Physis and Research Center OPTIMAS, TU Kaiserslautern, Erwin Schrödingerstr. 46, D-67663 Kaiserslautern — [2]Department Chemie und Biochemie, Ludwig-Maximilians-Universität München, Butenandtstr. 11, 81377 München — [3]Graduate School of Information Science and Technology, Hokkaido University, Kita 14 Nishi 9, Sapporo 060-0814, Japan

Interface states are believed to play a crucial role for the performance of Heusler-based magnetic tunnelling junctions [1]. As a first step towards the investigation of real interfaces, we present a comprehensive study of the free (001) surface of the Heusler alloy Co_2MnSi. We show the presence of minority electron surface states with predominant Δ_1 symmetry at the Fermi energy. Using a combined approach consisting of low energy electron diffraction, Auger analysis and spin-resolved photoelectron spectroscopy, the link between the spin-resolved electronic structure and the surface termination is drawn and substantiated by LSDA+DMFT photoemission calculations using different surface terminations.

[1] T. Ishikawa, N. Itabashi, T. Taira, K. Matsuda, T. Uemura, and M. Yamamoto. J. Appl. Phys. **105**, 07B110 (2009).

MA 51.2 Thu 11:15 HSZ 401

Quadratic MOKE on Co-based Heusler compounds — •Georg Wolf[1], Jaroslav Hamrle[2], Britta Leven[1], Daniel Ebke[3], Andy Thomas[3], Günter Reiss[3], and Burkard Hillebrands[1] — [1]FB Physik and Landesforschungszentrum OPTIMAS, TU Kaiserslautern, 67663 Kaiserslautern, Germany — [2]Institute of Physics, VSB - Technical University of Ostrava, Czech Republic — [3]Thin Films and Physics of Nanostructures, Physics Department, Bielefeld University, Germany

The intensive research on Co-based Heusler compounds revealed that some of these materials show a large quadratic magneto-optical Kerr effect (QMOKE) [1,2]. The presence of QMOKE strongly depends on the electronic band structure. In the case of Heusler compounds the electronic bands can be modified by changing the composition or improving the crystalline structure. This work presents a systematic study on several Heusler compounds (Co_2FeSi, $Co_2Fe_{0.5}Mn_{0.5}Si$, Co_2MnSi and $Co_2FeAl_{0.5}Si_{0.5}$). The amplitude of the QMOKE is investigated as a function of the post deposition annealing temperature, which is known to improve the crystal ordering. We find that the QMOKE is increasing with the annealing temperature. From this we conclude that there is a strong correlation between the presence of QMOKE and the high crystalline ordering in Heusler compounds.

The DFG Research Unit 559, New Materials with High Spin Polarization, and the BMBF project Heuspin are gratefully acknowledged for financial support.

[1] J. Hamrle et al. J.Phys.D **40**, 1563 (2007).
[2] S. Trudel et al. J.Appl.Phys. **107**, 43912 (2010).

MA 51.3 Thu 11:30 HSZ 401

The influence of the disorder on the electronic states of the Heusler compound $Co_2FeAl_{0.3}Si_{0.7}$ studied by ARUPS and tunnelling spectroscopy. — •Elena Arbelo Jorge, Christian Herbort, Michaela Hahn, Gerd Scönhense, and Martin Jourdan — Institute of Physics, Johannes-Gutenberg University, Staudinger Weg 7, 55099 Mainz, Germany

Heusler compounds have attracted much interest based on their half metallic properties predicted by band structure calculations. However, a direct comparison of the theoretical predictions with experiments remains difficult, even if the spin degree of freedom is averaged. Additionally, the influence of atomic disorder on the band structure is of major interest and is in general expected to result in a broadening of the electronic states. We present in-situ spin averaged angular resolved UV-photoemission spectroscopy (ARUPS) of rf-sputtered Heusler thin films. Additionally, tunnelling spectroscopy on planar junctions of Heusler thin films with AlO_x barrier is performed. Samples of the compound $Co_2FeAl_{0.3}Si_{0.7}$ with different degrees of disorder (B2 and $L2_1$) are studied. The ARUPS results at energies close to the Fermi edge are compared to measurements of the bias voltage dependent tunnelling conductivity of $Co_2FeAl_{0.3}Si_{0.7}/AlO_x/Ag$ and $Co_2FeAl_{0.3}Si_{0.7}/AlO_x/CoFe$ junctions. Whereas the ARUPS shows clear correlations with the degree of disorder of the Heusler compound, the interpretation of the tunnelling spectroscopy results in terms of the density of states is challenging.

MA 51.4 Thu 11:45 HSZ 401

Spectroscopy of the electronic states of the Heusler compounds Co_2FeAl and $Co_2Cr_{0.6}Fe_{0.4}Al$ and the influence of oxidation — •Martin Jourdan, Fabian Grosse-Schulte, Michaela Hahn, and Gerd Schönhense — Institut für Physik, Johannes Gutenberg Universität, Staudingerweg 7, 55128 Mainz

Band structure calculations, which predict half metallic properties for several Heusler compounds, initiated great experimental efforts concerning this class of materials. The validation of the calculated electronic properties remains difficult, though. The band structures of the Heusler compounds $Co_2Cr_{0.6}Fe_{0.4}Al$ and Co_2FeAl were investigated in-situ by angle resolved ultraviolet photoemission spectroscopy (ARUPS). The samples were prepared by a sputtering process optimized for tunneling junction preparation, the photoemission process in normal direction of the (001)-oriented thin films was excited by a Helium gas discharge lamp (excitation energies 21.2eV and 40.8eV). The spectra of clean samples are compared with calculations of the total and partial bulk density of states and are evaluated within the three-step model of photoemission. Basic agreement with theoretical predictions of the bulk band structure is concluded. At oxygen exposures of only 1 Langmuir a chemisorption phase with significant changes of the valence-band spectrum near the Fermi-energy is observed. At 10L oxygen the spectra are indicative of beginnig oxide formation within the UPS probing depth.

MA 51.5 Thu 12:00 HSZ 401

Magnetoresistrance and anomalous Hall Effect measurements of Co_2MnGe and Cu_2MnAl Heusler alloy thin film microstructures — •Mohamed Obaida[1,2], Denise Erb[1], Kurt Westerholt[1], and Hartmut Zabel[1] — [1]Institut für Experimentalphysik/Festkörperphysik, Ruhr-Universität Bochum, 44797 Bochum. — [2]National Research Center (NRC), Tahrir Street - Dokki., 12311 Cairo., Egypt.

We study the magnetoresistance and Hall Effect of thin films of the ferromagnetic Heusler compounds Co_2MnGe and Cu_2MnAl prepared by UHV magnetron sputtering at room temperature. In the as-prepared state the Heusler alloy films are non-ferromagnetic (Cu_2MnAl) or weakly ferromagnetic (Co_2MnGe)[1] and the resistivity shows a negative temperature coefficient, indicative of strong disorder renormalization of the electronic density of states. The magnetoresistance and the anomalous Hall coefficient in the as-prepared state are small. The magnetoresistance strongly increases when the ferromagnetism gradually develops after step by step thermal annealing at high temperatures and decreases again when the magnetic moment approaches its saturation value.

[1] D. Erb et al. J. Phys. D: Appl. Phys. 43 (2010).

MA 51.6 Thu 12:15 HSZ 401

Calculation of the Fermi surface of NiMnSb — •Liviu Chioncel — Augsburg Center for Innovative Technologies, University of Augsburg, Germany

Using a combined electronic structure and many-body calculations we revisit the electronic properties of the prototype half-metallic NiMnSb. In particular we discuss changes in the topology of the Fermi surface determined by the presence of electronic correlations beyond the mean-field approach.

MA 51.7 Thu 12:30 HSZ 401

Half-metallic antiferromagnets and their possible device applications — •Nguyen Hoang Long[1,2], Masako Ogura[2], and Hisazumi Akai[2] — [1]Peter Grünberg Institut and Institute for Advanced Simulation, Forschungszentrum Jülich and JARA, 52425 Jülich, Germany — [2]Department of Physics, Graduate School of Science, Osaka University, Osaka 560-0043, Japan

Half-metallic antiferromagnetism is a special case of half-metallic ferrimagnetism where the total magnetization is completely canceled out

(fully spin-compensated). Such materials exhibit half-metallicity with 100% spin-polarized Fermi surface and vanishing magnetization simultaneously. They are especially useful for spintronics devices since they are insensitive to external field and in many cases have a high magnetic transition temperature.

In this work, a new type of half-metallic antiferromagnets are designed by use of the first-principles KKR Green's functions method. The materials consist of transition metals A and B, with the total d-valence electron number of 10, and chalcogens/pnictogens X (with chemical formula ABX_2) or halogens Y (with chemical formula ABY_4). We have found that they are chemically stable and the calculated magnetic transition temperatures are relatively high. The transport properties of the systems are also calculated by the KKR-CPA method combined with the Kubo-Greenwood formula. The results show that those systems can function as spintronics materials if used as components of GMR/TMR and magnetic random access memory cells.

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MA 51.8 Thu 12:45 HSZ 401

Systematic studies of ferromagnetic ordering in EuB_6 — •Adham Amyan[1], Pintu Das[1], Mariano de Souza[1], Michael Lang[1], Peng Xiong[2], Stephan von Molnár[2], Zachary Fisk[3], and Jens Müller[1] — [1]Physikalisches Institut, Goethe Universität, D-60438 Frankfurt (M). — [2]Department of Physics MARTECH, Florida State University, Tallahassee, USA. — [3]Department of Physics, University of California, Irvine, USA.

The ferromagnetic semimetal EuB_6 recently has attracted renewed interest due to its rich transport and magnetic properties. In transport and thermodynamic measurements, two consecutive phase transitions at $\sim$ 12.6 K and 15.3 K are observed, where upon lowering the temperature a charge-localization transition via the overlap of magnetic polarons precede the ferromagnetic ordering. This behavior is discussed in terms of electronic phase separation and a percolative phase transition [1].

In this work, we performed fluctuation (noise) spectroscopy measurements of high-quality single crystals of EuB_6 in order to investigate the dynamics of the charge carriers close to the above-mentioned transitions. In addition, higher-harmonics transport measurements reveal clear signatures of non-linear effects going along with the lower ferromagnetic transition. Furthermore, ultra high-resolution thermal expansion measurements reveal that lattice degrees of freedom are strongly coupled to both low-temperature transitions.

[1] X. Zhang, L. Yu, S. von Molnár, Z. Fisk and P. Xiong, PRL 103,106602 (2009)

MA 51.9 Thu 13:00 HSZ 401

A study of the Verwey transition in epitaxial magnetite thin films by Raman spectroscopy and SQUID-magnetometry — •Mehrdad Baghaie Yazdi[1], Dirk Wulferding[2], Choi Kwang Yong[2,3], Peter Lemmens[2], and Lambert Alff[1] — [1]Technische Universität Darmstadt — [2]Technische Universität Braunschweig — [3]Chung-Ang University, Seoul, Korea

The origin of the Verwey transition, despite decades of research, remains a heavily debated fundamental property of magnetite. Its understanding involves concepts such as charge ordering which are essential in transition metal oxides. For this work, epitaxial thin films of magnetite (Fe_3O_4) have been grown, using reactive rf-magnetron sputtering, on single crystal (100) MgO (magnesium oxide) and c-cut Al_2O_3 (sapphire) substrates. The phase purity and orientation was analyzed using high resolution X-ray diffraction. The Verwey transition was studied by both Raman spectroscopy and SQUID-magnetometry. The Raman spectra of the magnetite grown on Al_2O_3 show an earlier onset of the transition at around 150 K with a definite change at T_V = 130 K, which corresponds to the data obtained by SQUID. As for the films grown on MgO, the transition is close to the literature value of 120 K.