MA 3.7 Mon 11:45 HSZ 103

How many crystalline interface layers are necessary to create high TMR? — •Christian Heiliger, Peter Zahn, and Ingrid Mertig — Martin Luther University, FB Physik, FG Theorie, D-06099 Halle, Germany

Recent experiments [1-3] based on epitaxially grown Fe/MgO/Fe samples shed light on the subject of tunneling magnetoresistance (TMR). First of all, the obtained TMR ratios exceed the predictions by Julliere's model. Second, the measured bias voltage characteristic shows features which could be related to the electronic structure of the system. The high crystallinity of the samples [1-3] seemed to be the reason. New experiments [5], however, demonstrate that even amorphous electrodes attached to a crystalline MgO barrier show a TMR of more than 230%. The question that is addressed in this talk is: How many crystalline metal layers close to the interface are necessary to obtain high TMR?

A screened Korringa-Kohn-Rostoker (KKR) method based on density functional theory was applied to calculate the electronic and magnetic structure of the different junctions self-consistently. The Landauer conductance of planar junctions was calculated using the Baranger-Stone scheme by means of Green's functions in the limit of coherent tunneling.

The results demonstrate that only a few crystalline ferromagnetic layers cause a significant spin-polarisation and TMR.

[1] J. Faure-Vincent et al., Appl. Phys. Lett. **82**, 4507 (2003)
[2] S. Yuasa et al., Nature Materials **3**, 868 (2004)
[3] S.S.P. Parkin et al., Nature Materials **3**, 862 (2004)
[4] K. Tsunekawa et al., Appl. Phys. Lett. **87**, 072503 (2005)

MA 3.8 Mon 12:00 HSZ 103

Tunneling Magneto Resistance in Co-Fe-B/Al-Ox Magnetic Tunnel Junctions — •Oliver Schebaum[1], Andy Thomas[1], Hubert Brückl[2], and Günter Reiss[1] — [1]Bielefeld University, Nano Device Group, Universitätsstrasse 25, 33615 Bielefeld — [2]ARCS research GmbH, Division "Nano System Technology", Tech Gate Vienna, Donau-City-Strasse 1, 1220 Vienna, Austria

We investigated the effect of Co-Fe-B as the free and the pinned magnetic layer in magnetic tunnel junctions (MTJs). The lower electrode was exchange-bias coupled to MnIr and Al-Ox was used as a tunnel barrier. The samples were prepared by dc/rf-magnetron sputtering in a UHV chamber with a base pressure of 1×10^{-7} mbar. The metallic Aluminum was oxidized utilizing electron cyclotron plasma oxidation in a pure Oxygen.

We measured the influence of different B compositions of the electrodes using sputter-targets with 5% and 12% of B [Co 70%/Fe 25%/B 5%; Co 62%/Fe 26%/B 12%]. Furthermore, we optimized the samples yielding high TMR ratios by varying the thickness of the Al-Ox barrier.

The TMR effect of the samples prepared with a 5% B target decreased (38% @ RT) compared with standard MTJs consisting of Co-Fe and Ni-Fe electrodes (52% @ RT). However, the 12% B electrodes raised the TMR ratio to 72% at RT when reducing the Al thickness (before oxidation) to 1.2nm (compared to 1.4nm in our standard MTJs). Low temperature measurements showed a TMR value of 114% at 21K and possible explanations for this behavior are discussed.

MA 3.9 Mon 12:15 HSZ 103

Interfacial microstructure of Fe/AlOx/Fe-magnetic tunnel junctions in high resolution — •Holger Schmitt[1], Jens Ellrich[1], and Horst Hahn[1,2] — [1]Forschungszentrum Karlsruhe GmbH, Institute for Nanotechnology, Hermann-von-Helmholtz-Platz 1, 76344 Eggenstein-Leopoldshafen, Germany — [2]Technische Universität Darmstadt, Joint Research Laboratory Nanomaterials, Petersenstrasse 23, 64287 Darmstadt, Germany

Tunneling Magneto Resistance (TMR) systems were prepared by deposition of a Ta-buffered Fe-AlO_x-Fe-trilayer on a thermally oxidized Silicon wafer. In order to investigate the influence of the different Fe-oxides on the TMR effect, a ^{57}Fe tracer was deposited at the lower barrier interface. Using Conversion Electron Mössbauer Spectroscopy (CEMS) the chemical, structural and magnetic changes were followed from the as-prepared state and after several annealing steps. The nuclear probe technique can resolve different phases at the interface with submonolayer resolution. In addition, Transmission Electron Microscopy and X-Ray Reflectivity have been applied to complete the insight into the interfacial structure and to correlate to magnetoresistance of the trilayers. The results indicate the formation of a spinel-like phase and a spinel (Hycernite), in expense of the pure iron oxide Fe_2O_3, produced by a slight overoxidation of the barrier during its preparation. The changes at the interface are correlated to the changes of the TMR effect during annealing.

MA 3.10 Mon 12:30 HSZ 103

Induced magnetic anisotropy effects on the transport properties of magnetic tunnel junctions — •Voicu Popescu and Hubert Ebert — Department Chemie/Physikalische Chemie, University of Munich, Butenandtstr. 5-13, 81377 Munich, Germany

We report results of calculations on the electronic, magnetic and transport properties of Fe/GaAs/Fe and Fe/GaAs/Au/Fe magnetic tunneling junctions (MTJs) that have been obtained using the tight-binding Korringa-Kohn-Rostoker Green function method in a spin-polarised fully relativistic formulation (TB-SPR-KKR). This approach, by coupling the electron spin and orbital degrees of freedom, allows one to properly account for the changes induced in the electronic transport when different magnetic configurations, e.g., in-plane and out-of-plane, are considered.

Recent experimental work on MTJs based on diluted magnetic semiconductors have shown that, while keeping the orientation of the magnetisation in the plane of the junction but varying its azimuthal angle, a measurable dependence of the resistance with respect to this angle can be observed. This phenomenon is now commonly termed as Tunneling Anisotropic Magnetoresistance (TAMR).

We have performed analogous theoretical investigations on MTJs based on metallic (ferromagnetic or non-magnetic) leads. Our results show that a similar dependence is obtained also for such systems and it can be related to the spin-orbit coupling induced magnetic anisotropy at the metal/semiconductor interface. This, in turn, is shown to vary for different terminations (As or Ga) of the semiconductor, revealing the role of the covalent bonding at the interface.

MA 3.11 Mon 12:45 HSZ 103

Anisotropic magnetoresistance and spin-valve effect in all-metal mesoscopic spin-valve devices — •Alexander van Staa, Ulrich Merkt, and Guido Meier — Institut für Angewandte Physik und Zentrum für Mikrostrukturforschung, Jungiusstraße 11, 20355 Hamburg

Only in a few experiments all-electrical spin injection and detection in normal metal structures has been demonstrated [1]. We investigate all-metal lateral spin-valve devices with and without tunneling barriers. The devices consist of two permalloy electrodes and an interconnecting aluminum strip. The micromagnetic behavior of the device has been imaged with a magnetic-force microscope in external magnetic fields at room temperature. During a single cooling cycle at temperatures between 2 and 120 K we have measured the anisotropic magnetoresistance of both electrodes and the magnetoresistance of the entire device. In the latter we can clearly identify the contributions of the anisotropic magnetoresistance and the mesoscopic spin-valve effect [2].

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