MM 25: SYM Thin Film Magnetic Materials: Microstructure, Reaction and Magnetic Coupling IV

Time: Wednesday 16:00–17:50 Location: H 1058

Invited Talk MM 25.1 Wed 16:00 H 1058

Magnetic thin film materials tailored by ion irradiation — •Jürgen Fassbender — Forschungszentrum Dresden-Rossendorf, Institute of Ion Beam Physics and Materials Research, Bautzner Landstrasse 128, 01328 Dresden, Germany

In recent years the tailoring of magnetic properties by means of ion irradiation techniques has become fashionable. Since the magnetic properties of multilayers depend sensitively on the mutual interfaces a modification of these interfaces by ion irradiation leads to a local modification of the magnetic anisotropy, the exchange bias or the interlayer exchange coupling [1,2]. Also structural phase transitions can be induced by ion irradiation. If these are accompanied by magnetic phase transformations ferromagnetic regions can immediately be written with a focused ion beam. In addition to pure radiation effects also doping effects can be exploited to achieve a pure magnetic patterning. Finally ion erosion of semiconductor substrates can be used as periodically modulated substrates which modify the magnetic anisotropies of subsequently deposited magnetic films. Examples of all different approaches will be presented in order to demonstrate the large viability of ion beam technology to tailor magnetic materials.

Refs.: [1] J. Fassbender, D. Ravelosona, Y. Samson, J. Phys. D 37, R179 (2004). [2] J. Fassbender, J. McCord, J. Magn. Magn. Mater. 320, 579 (2008).

MM 25.2 Wed 16:30 H 1058

Magnetic microstructures produced by local ion irradiation induced interfacial mixing — •Thomas Strache[1], Jörg Grenzer[1], Jürgen Fassbender[1], Wolfhard Möller[1], Rainer Kaltofen[2], and Ingolf Mönch[2] — [1]Forschungszentrum Dresden-Rossendorf, Institute of Ion Beam Physics and Materials Research, Bautzner Landstrasse 128, 01328 Dresden, Germany — [2]Leibniz-Institut für Festkörper- und Werkstoffforschung IFW Dresden, Institute for Integrative Nanoscience, P. O. Box 270116, 01171 Dresden, Germany

Ion irradiation of $Ni_{80}Fe_{20}/Ta$ multilayers induces an interfacial mixing of these two materials, which subsequently leads to a suppression of the ferromagnetic properties. In order to quantify the structural change grazing incidence x-ray reflectometry has been used. The ion irradiation induced intermixing has been studied by means of TRIDYN simulations. The broadening of the interfaces due to intermixing causes an enrichment of Ta in $Ni_{80}Fe_{20}$ and finally an amorphization of $Ni_{80}Fe_{20}$ above a Ta concentration of 10 to 20 percent [1]. Consequently the ferromagnetic properties are altered or even suppressed completely for high enough ion fluences. It is observed that the critical ion fluence for a complete suppression of the ferromagnetism depends sensitively on the number of interfaces. It is demonstrated that pure magnetic microstructures can be easily fabricated by local ion irradiation without changing the substrate topography.

[1]J. Fassbender *et al.*, Nucl. Instr. and Meth. in Phys. Res. B 248, 343 (2006).

MM 25.3 Wed 16:50 H 1058

Influencing the magnetic properties of NiMn/Co exchange bias system by pulsed laser irradiation — •Senthilnathan Mohanan[1], Ulrich Herr[1], Ralf Diebolder[2], and Raimund Hibst[2] — [1]Insitut für Mikro- und Nanomaterialien, Universität Ulm, 89081 Ulm — [2]Institut für Laseranwendungen in der Medizin und Meßtechnik, Universität Ulm, 89081 Ulm

NiMn with L10 ordered structure is a promising antiferromagnetic material that can be used to achieve exchange bias in giant magnetoresistive spin valve sensors. However, as-deposited NiMn exhibits the paramagnetic fcc phase and has to be annealed at an elevated temperature to obtain the L10 ordered antiferromagnetic fct phase. We present a study on the influence of ns pulsed laser irradiation using a Nd-YAG laser on the structural and magnetic properties of NiMn/Co exchange bias system [1]. X-ray diffraction spectra revealed that upon laser irradiation there is an improvement of the (111) texture of NiMn accompanied by grain growth, but no structural phase transformation. As-prepared and laser irradiated samples were subsequently annealed at different temperatures, and we observed increased exchange bias fields for the laser irradiated samples as compared to those of the as-prepared samples. Since no difference in the degree of ordering was found between as-prepared and laser irradiated samples after annealing, we attribute the observed increase in the exchange bias fields to the modified microstructure.

1. S. Mohanan, R. Diebolder, R. Hibst, and U. Herr, J. Appl. Phys. (accepted)

MM 25.4 Wed 17:10 H 1058

Strain effect on spin reorientation of epitaxial Nd-Fe-B films — •Ah-Ram Kwon[1], Volker Neu[1], Vlakimir Matias[2], Jens Hänisch[2], Ruben Hühne[1], Bernhard Holzapfel[1], Ludwig Schultz[1], and Sebastian Fähler[1] — [1]IFW Dresden, P.O. Box 270116, D-01171 Dresden — [2]Los Alamos National Laboratory, Mail Stop T004, Los Alamos NM 8545 USA

Nd-Fe-B is the best permanent magnetic materials known to date. Thin film applications such as magnetic microactuators and motors as well as the study of intrinsic properties require well textured Nd-Fe-B films. Here a new approach to study the influence of strain on the intrinsic magnetic properties, especially spin reorientation transition is demonstrated. Hastelloy, which has high ductility, is used as substrate to reach a strain up to 2% by conventional mechanical elongation. Prior to elongation, MgO(001) had been deposited by ion beam assisted deposition. As a next step Mo and Nd-Fe-B are deposited at 450 °C by pulsed laser deposition. Mo grows epitaxially with a (001) orientation and Nd-Fe-B films onto this buffer possess the desired (00l) out-of-plane orientation. Elongation breaks the symmetry compared to the as-deposited state, resulting in an elliptical shape of the cone opening during spin reorientation. By this novel approaches high strains are obtained which allows to examine highly anisotropic materials where magnetostriction can usually be neglected.

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Ion damage during FIB-milling of nanostructures into magnetite thin films — •Anjela Koblischka-Veneva[1] and Michael R. Koblischka[2] — [1]Institute of Functional Materials, Saarland University, P. O. Box 151150, D-66041 Saarbrücken, Germany — [2]Institute of Experimental Physics, Saarland University, P. O. Box 151150, D-66041 Saarbrücken, Germany

Nanostructures are prepared into magnetite (Fe3O4) thin films grown on (0 0 1) MgO substrates by means of focused ion beam (FIB) milling. The resulting ion damage is analyzed using the electron backscatter diffraction (EBSD) technique enabling the determination of crystal orientation with a spatial resolution of about 40 nm. Depending on the ion currents and radiation dose applied during the FIB milling, different types of damage are observed. Only at relatively low ion currents, the nanostructures can be created without causing damage to the surrounding magnetite film. This enables the creation of e.g., markers in order to relocate a given sample section in different experiments like EBSD and magnetic force microscopy (MFM). At high ion currents, an entire ring area around the fabricated nanostructure is affected by the ion beam. The EBSD analysis reveals that new, small grains with a distinct, different orientation pattern are created within the ring area. This could be used to create sample areas with a distinct orientation with respect to the remainder of the magnetite film.