Contribution ID: **16**

Type: **Contributed talk**

Resolving the magnetic structure across interfaces in functional heterostructures

Obtaining detailed information on interface structure and proximity effects in magnetic heterostructures is indispensable for understanding the mechanisms promoting the novel physical properties and functional behavior. We will present recent examples using the high sensitivity of neutron reflectometry to resolve structural and magnetic ordering across interfaces in layer systems and lateral patterns on different length scales.
Magnetic tunnel junctions (MTJ) are an integral component of modern spintronics devices, including the recently commercialized magnetic random access memory. In state of the art MTJs, MgO and CoFeB have become the materials of choice [1]. Typically, a post-growth annealing process is performed to maximize the tunneling magnetoresistance and perpendicular magnetic anisotropy, but the exact processes are far from being understood [2]. High annealing temperatures are favorable leading to improved crystallization of CoFeB and MgO but can be detrimental to the layer structure due to enhanced diffusion [3]. Here, we study W diffusion barriers [3] as a method to stabilize the MTJ's layer structure and compare the diffusion processes to conventional structures. We use co-refinement of polarized neutron (PNR) and x-ray reflectometry (XRR) to elucidate the layer composition, magnetism and interface structure as a function of annealing temperature in thin layers below nanometer length scales. The Ta capping layer is observed to show the largest diffusion. In addition, our analysis shows a substantial Fe diffusion towards the capping layer. The W-spacer layer acts as a barrier for Ta and Fe, leading to an improved magnetic profile up to 450℃ annealing. Our results enable a quantitative understanding of the MTJ performance upon annealing with and without diffusion barriers.
Magnetically patterned domain landscapes function as platforms for various lab-on-a-chip applications, as magnetic sensors and logic elements [4,5]. The stray fields above the thin film surface, emerging at domain boundaries, can be used for positioning and movement of magnetic micro- and nano-objects [6]. We use He-ion bombardment of exchange biased thin films in external magnetic fields to pattern micrometer-sized domains with structurally homogeneous surfaces. Polarized neutron scattering is used to resolve correlation lengths, magnetization directions and disordered moments of the domains. The magnetic evolution is monitored during field cycling, providing a full picture of the magnetic configuration. The measurements reveal crucial details about the magnetic pattern and the ordering of domain walls.
REFERENCES
[1] H. Ohno, M.D.Stiles, B.Dieny., Proc. IEEE 104, 1782 (2016).
[2] Z. Wang et al., Nano Lett. 16, 1530 (2016).
[3] J. Chatterjee et al., Appl. Phys. Lett. 110, 202401 (2017).
[4] T. Ueltzhöffer et al., J. Appl. Phys. 117, 123904 (2015).
[5] A. Gaul et al., J. Appl. Phys. 120, 033902 (2016).
[6] A. Ehresmann et al., Adv. Mater. 23, 5568 (2011).

Primary author: Dr SAERBECK, Thomas (Institut Laue-Langevin)

Co-authors: Dr HUCKFELDT, Henning (University of Kassel, Department of Physics, Kassel, Germany); Prof. EHRESMANN, Arno (University of Kassel, Department of Physics, Kassel, Germany); Dr CHATTERJEE, Jyotirmoy (University Grenoble Alpes, CEA, CNRS, Grenoble-INP, INAC-SPINTEC, Grenoble France); Prof. BERNARD, Dieny (University Grenoble Alpes, CEA, CNRS, Grenoble-INP, INAC-SPINTEC, Grenoble France)

Presenter: Dr SAERBECK, Thomas (Institut Laue-Langevin)