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Names and affiliations of applicants (* indicates experimentalists):

H.A. Dürr, Institut für Festkörperforschung, Forschungszentrum Jülich, Germany

W. Felsch, M. Münzenberg, I. Physikalisches Institut, Universität Göttingen, Bunsenstr. 9 D-37073 Göttingen, Germany

S.S. Dhesi, ESRF

Report:

The magnetisation of periodically stacked layers of Fe and CeH_2 is oriented perpendicular to the layer planes in a multidomain configuration at low temperatures [1]. This is the consequence of a strong interface contribution to the magnetic anisotropy and of the *magnetostatic interaction between the domains* in the Fe layers across the CeH_2 spacer layers which overcome the shape anisotropy. XMCD measurements have shown that the interface anisotropy can be ascribed to strong electronic correlations in the multilayers [2]: The spin-split 3*d* states of Fe induce magnetic order on the Ce 5*d* states by hybridisation, and via intraatomic 5*d*-4*f* exchange also on the 4*f* states of Ce. The strength of the Ce 4*f* magnetisation increases at low temperatures. Due to a crystal-field induced single-ion anisotropy the Ce 4*f* moments at the interfaces point along the layer normal. This orientation is transferred, via the exchange and hybridisation effects to the Fe magnetic moments leading to a spin orientation perpendicular to the layers. The perpendicular magnetisation configuration is considerably stabilised by the magnetostatic interaction between adjacent spin-up and down domains. At a critical temperature T_R, which depends on both sublayer thicknesses and the number of bilayers, the magnetisation changes from the out-of-plane to an in-plane orientation with increasing temperature. The system is unique among rare-earth/iron multilayers in that the reorientation transition occurs rather abruptly in a narrow temperature range.

We probed the magnetic domain structure of the multilayer with x-ray resonant magnetic scattering (XRMS). The photon wavelength was tuned to the Fe L_3 absorption edge (λ=17.5Å). The experimental geometry is shown in the inset of the figure. Circularly polarized light was reflected off a Fe(16Å)/CeH_2(10Å) multilayer sample at an incidence angle of 16°. The magnetic stripe domains with alternating up and down magnetization formed below the spin reorientation transition temperature. The wavevector transfered in the scattering process was oriented perpendicular to the stripes. For that purpose a rectangular aperture was translated through the specular beam parallel to the sample surface. The stripe domain pattern is clearly visible as first and second-order magnetic superstructure peaks. [3] An in-plane magnetization component could be probed by reversing the light helicity of the incident x-rays. The figure demonstrates that the stripe domains with perpendicular magnetization profile disappear by heating the sample across the transition temperature and only and only a magnetization in the layer plane remains.

References

[1] O. Schulte *et al.*, Phys. Rev. B **52**, 6480 (1995).
[2] M. Arend *et al.*, Phys. Rev. B **59**, 3707 (1999).
[3] H.A. Dürr et al., Science **284**, 2166 (1999).