Search for induced ferromagnetic moment in the antiferromagnetic layer of Fe/CoO exchange biased bilayer.

F. Radu[1], G. Nowak[1], M. Gupta[2], Th. Gutberlet[2], and H. Zabel[1]
[1]Ruhr-Universität Bochum, 44780 Bochum, Germany
[2]Laboratory for Neutron Scattering, ETH Zürich & PSI, CH-5232 Villigen PSI, Switzerland

The interaction between the ferromagnetic and anntiferromagnetic layers across their common interface give rise to a shift of the hysteresis curve. We focus for the present study on the antiferromagnet itself, trying to detect ferromagnetic contributions induced in the antiferromagnetic layer by the proximity of the ferromagnetic layer.

The exchange bias phenomenon was discovered more that 50 years ago [1]. At its very basics it can be qualitatively understood by the coupling between a ferromagnet and an antiferromagnet when they share a common interface. During the cooling down procedure through the Néel temperature of the antiferromagnet the uncompensated spins at the interface (belonging to the AF layer) will be effectively coupled to the ferromagnet. Due to high anisotropy of the AF layer the interface spins will resist the remagnetization of the F layer. This causes the the shift of the hysteresis loop of the FM layer. Besides the uncompensated interfacial spins one could expect that in the bulk part of the AFM layer there are uncompensated spins, as well. They could appear from several sources like: magnetic domains in the AF layer, structural inhomogeneities, nonstoichiometric growth, etc. Their mere observation could play an important role for some of the theoretical approaches trying to explain in the EB effect. We focuse our experiment on observing those uncompensated spins in the AF layer and follow their behavior as function of temperature.

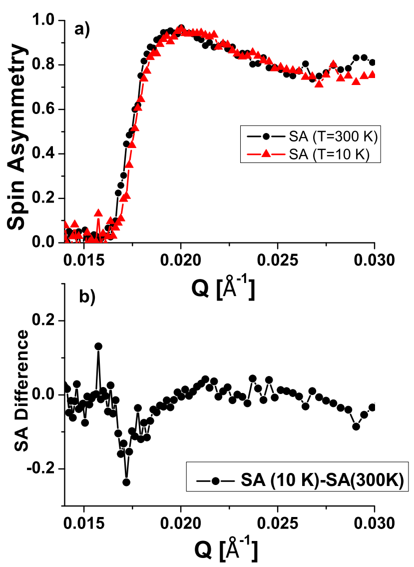

Figure 1: a)The Spin Asymmetry measured at T=300 K and at T=10 K after cooling the system in a field of +4000 Oe. b)The difference between SA measured at 10 K and SA measured at 300 K: SA(10 K)-SA(300K). The down peak close to the critical edge is directly related to the presence of the ferromagnetic component in the antiferromagnetic layer.

The sample we used for the present investigation was a Fe(150Å)/CoO(Å) exchange biased bilayer. The Néel temperature of CoO is 291 K. We have measured the spin asymmetry (SA) for different temperatures. Typical curves measured in an applied field of 4000 Oe are shown in Fig. 1a for 300 K, and 10 K. By comparing the SA(T) measured at 300 K with the SA(T) measured at lower finite temperatures we are able to directly observe relative changes of the induced ferromagnetic moment in CoO. Such curve is shown in Fig. 1b where the difference between SA(10 K) and SA(300 K) (SA(10 K)-SA(300K)) is plotted as function of the wave transfer vector (Q).The difference appears as a down peak located close to the critical edge. Its position and maximum value is related to the magnitude of the induced ferromagnetic moment in the antiferromagnet. Its orientation (down) indicates that the ferromagnet is oriented parallel to the ferromagnetic component of the CoO.

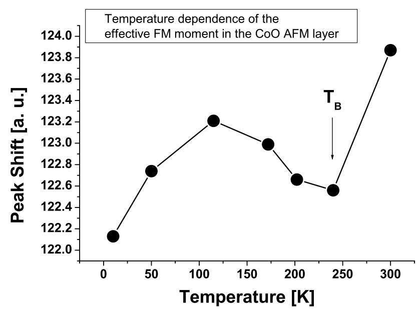

Figure 2: Temperature dependence of the effective ferromagnetic moment in the CoO. The shift of the peak close to the total reflection region would have to be converted in the effective magnetic moment per atom after the numerical analysis.

We also measured the position of the peak as function of temperature. The data is shown in Fig. 2. The shape of the curve is related to the behavior of the ferromagnetic moment magnitude in CoO. We observed that it has a minimum at the blocking temperature.

[1] W. Meiklejohn and C. P. Bean, Phys. Rev. **102**, 1413 (1956) ; **105**, 904 (1957).

Work partially performed at SINQ
Proposal-number: I/02 S-45
Instruments: AMOR