Investigation of spin configurations in FM/AF/FM trilayers by PNR

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FM/AF/FM (FM = ferromagnet, AF = antiferromagnet) trilayers exhibit intriguing spin configurations in the AF depending on its thickness. Possible interlayer exchange mediated by the AF has been investigated by polarized neutron reflectivity. The non spin-flip (NSF) and spin-flip (SF) reflectivities of the FM at saturation and during the magnetization reversal are reproduced by model calculations. From the obtained layer resolved magnetization profile we conclude that partial domain wall formation in the AF is responsible for the observed magnetization behaviour of the trilayers.

FM/AF multilayers, are well known for the exchange bias phenomenon, intriguing interface magnetic structure and their technological applications. Further, in a more complex FM/AF/FM trilayer, a possible interlayer exchange coupling (IEC), accommodated by a twist of the AF spins has been proposed from macroscopic magnetization measurements [1]. The twist angle between the FM layer magnetizations is found to depend linearly on the AF thickness until180° where the domain wall width (DW) of the AF is reached. In this project, we investigate the AF thickness dependence of the spin configurations in these trilayers by PNR which is well known for unravelling layer resolved magnetization. The samples Ti(5 nm)/FeCoV (20 nm) / NiO (*t* nm)/ FeCoV (20 nm)/Ti(5 nm) [*t* = 0.9 - 100 nm] were sputter deposited on glass substrates at the TIPSI sputter unit, LNS, PSI.

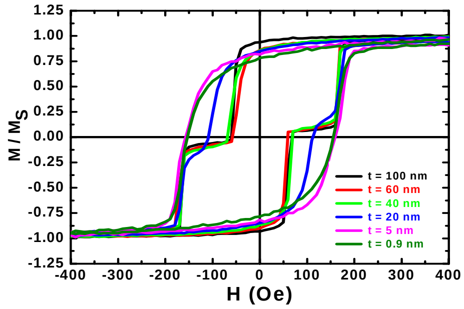

Fig. 1: DC magnetization of the FM/AF/FM trilayers. For *t* < 10 nm, the magnetization reversal takes place via a single gradual process while for *t* ≥ 20 nm, it occurs via a two step process creating a plateau region of zero net magnetization.

PNR with full polarization analysis was performed at the TOF reflectometer AMOR on selected samples, tuned to desired magnetic states (using an electromagnet) prior to the experiments. A Q range of 0.1-1 nm^{-1} was covered by measuring the reflected TOF spectrum at two angles of incidence (0.5°and 1.4°). The spin dependent reflectivities were analysed by the code '*simulreflec*'[2] after corrections for background and finite polarization efficiency of the polarizer and analyzer supermirrors. PNR at magnetic saturation and at selected fields during the reversal are measured for *t* = 1.5, 5, 20, 60 nm. Fig. 2 shows the results of the analysis during the magnetization reversal.

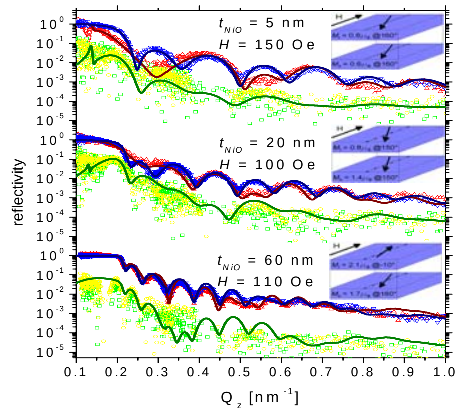

Fig. 2: PNR of selected samples during the magnetization reversal. Each sample was saturated at -5000 Oe prior to the experiment. The experimental data are represented by the symbols (Δ R^{++}, ∇ R^{--}, □ R^{+-}, ○ R^{-+}) and the computed reflectivities are represented by the lines, respectively.

The analysis indicates a coupled rotation of the FM layer magnetizations for thinner AF spacer layers, whereas a 180° twist in the FM layer magnetization gradually develops as t is increased to 40 nm. These observations corroborates the recent theoretical prediction of the formation of partial domain walls (DW) in the AF and agrees well with our observation of 180° DW for t ~ 40 nm. The results are being published in our forthcoming publications[4,5].

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Work fully performed at SINQ
Proposal-number: II/03-S23
Instruments: AMOR