Magnetic Trilayer Systems: Static and Dynamic Properties

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Modern recording devices contain a stack of two thin magnetic layers separated by a non-magnetic spacer layer. Magnetic stray fields are an important mechanism for their operation. With the aim of studying the effect of these stray fields on the magnetic coupling through the non-magnetic spacer we have imaged 4nm $Fe_{81}Ni_{19}$/Cu/20nm Co trilayer microstructures with sizes in the range of 5x5 to 10x20 µm² and with varying Cu thickness, using x-ray magnetic circular dichroism (XMCD) as magnetic contrast mechanism. The images were acquired at the UE49-PGMa at BESSY, a microfocus beamline with an Elmitec photoelectron emission microscope (PEEM, resolution ~30 nm).
The magnetic domains of the two ferromagnetic layers are coupled parallel, via exchange interaction and orange-peel coupling. For $t_{Cu} > 1.5$ nm, a non-parallel alignment of the magnetization in the domain walls (DW) of the two magnetic layers becomes favorable due to magnetostatic stray fields (Fig. 1). Similar behavior has been observed previously in 180° and head-on walls [1], where the wall coupling is anti-parallel in the two magnetic layers. Here we find a perpendicular coupling: In 90° walls the magnetization inside a wall in the FeNi layer first turns opposite to the Co layer before it turns back (Fig. 1b).
The experimental results are successfully contrasted to micromagnetic simulations (Fig. 1c). Dynamic measurements show the response of such systems to ultrashort magnetic field pulses in the ps time regime.

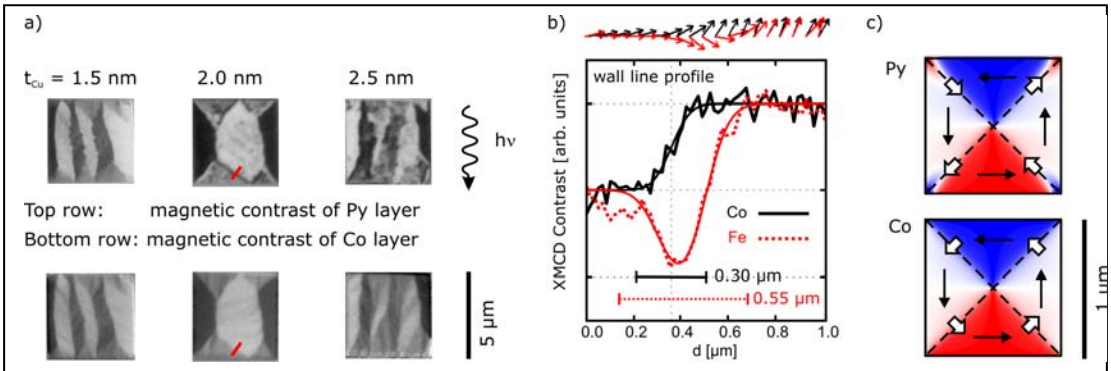

Fig 1: Static images of FeNi/Cu/Co trilayer microstructures. For a thickness of the Cu spacer layer of 2.0 nm a 90° coupling of the two magnetic layers is observed inside the domain walls and compared to micromagnetic simulations. a) Domain patterns for different Cu thicknesses. b) Line profile of a domain wall in a structure with t_{Cu} = 2.0 nm along the red line in Fig. 1 a. c) Micromagnetic simulation for t_{Cu} = 2.0 nm

References

[1] J. Vogel *et al.*, *Layer-resolved imaging of domain wall interactions in magnetic tunnel junction-like trilayers*, J. Phys.: Condens. Matter **19**, 476204 (2007)

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