Memory of frozen and rotatable antiferromagnetic spins in epitaxial CoO(111)/Fe and NiO(111)/Fe bilayers.

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We combined XMLD, XMCD and in-situ MOKE techniques to follow the magnetic properties of epitaxial CoO(111)/Fe(110) [1] and NiO(111)/Fe(110) [2,3] bilayers. We find that in both studied cases ferromagnetic (FM) sublayer plays a dominant role and determines the magnetic state of the neighboring antiferromagnet (AFM), however different interaction mechanisms are involved. In CoO/Fe bilayers the AFM spins are frozen and their orientation is imprinted by magnetization of Fe layer when the system passes the Neel temperature of CoO. Once the Fe layer grafts the particular magnetic anisotropy (MA) into the CoO overlayer, it later remains frozen and insensitive to external factors like external magnetic field or Fe magnetization direction [1]. Specifically, choice of particular magnetic state of Fe sublayer, when passing Néel temperature of CoO, determines both the axis and direction of interfacial antiferromagnetic spins after the sample is cooled and allows for imprinting their +/- 90° and 0/180° alignment within the sample plane. For example, particular direction of frozen AFM spins determines the corresponding sign of the shift field of exchange biased magnetic hysteresis loop (Fig.1, left). For NiO/Fe bilayers, the AFM spins are rotatable and always follow the reorientation of Fe magnetization that can be controlled by external magnetic field or via the temperature and thickness driven SRT of Fe(110). In a uniform thickness NiO(111)/Fe(110) system, two magnetic states with orthogonal spin orientations can be stabilized in AFM NiO and field-free, reversible switching between these two AFM states was demonstrated [2]. Additionally, tuning the thickness of Fe sublayer allows to tailor the critical temperature of SRT in AFM NiO and provides possibility to cover wide temperature window ~ (250 – 380 K) for switching of AFM spins [3]. Nanoscale AFM vortex states in individual self-organized NiO/Fe nanostructures will be also presented (right panel of Fig.1).

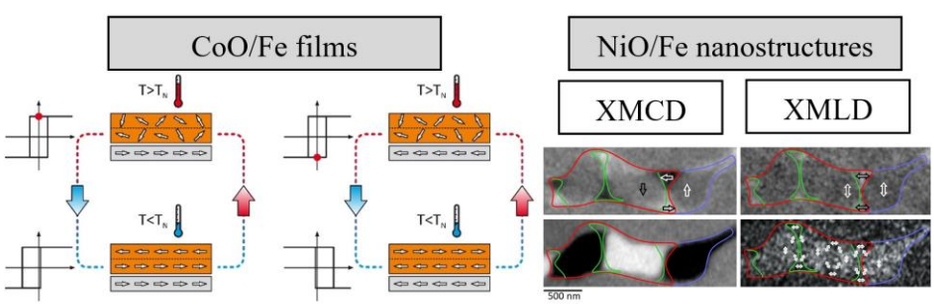

Figure 1. (left) Memory of frozen AFM spins in CoO(111)/Fe bilayer. (right) XMCD- and XMLD-PEEM images of NiO/Fe self-organized nanostructures for two sample geometries.

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References

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3. M. Ślęzak et al., Phys. Rev. B 104 (2021) 134434