A New Twist to Interface Magnetism

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On beamline I06 at Diamond Light Source (UK) electron microscopy combined with polarised X-ray spectroscopies allows high-resolution imaging of strain and electrical effects on nanomagnetism. In this talk, recent results using PhotoEmission Electron Microscopy (PEEM) combined with X-Ray Magnetic Linear Dichroism (XMLD) and X-Ray Magnetic Circular Dichroism (XMCD) will be presented.

Antiferromagnetic spintronics aims to exploit zero net magnetic moment materials as efficient generators, detectors and transmitters of spin current. PEEM, with magnetic contrast arising from XMLD, has been employed to directly image changes in the antiferromagnetic domain structure of CuMnAs [1,2] after electrical rotation of the magnetic moments. The XMLD-PEEM images are correlated with *in situ* Anisotropic Magnetoresistance transport measurements [3].

XMLD-PEEM imaging has also been used to directly visualise the antiferromagnetic domain structure of epitaxial (111)-oriented $BiFeO_3$ (BFO) films. Angle-dependent XMLD-PEEM images are combined to reveal a sub-micron network of antiferromagnetic domains (see Figure 1) that are coherently coupled to monoclinic domains. The magnetoelastic coupling is found to stabilise the antiferromagnetic domain structure, providing a possible pathway towards strain-engineering multiferroic domains in (111)-oriented BFO films [4].

Finally, I will explore electrical switching of Ni films grown on PMN-PT substrates. XMCD-PEEM maps of the in-plane magnetization reveal a shear-strain mediated magnetoelectric effect [5].

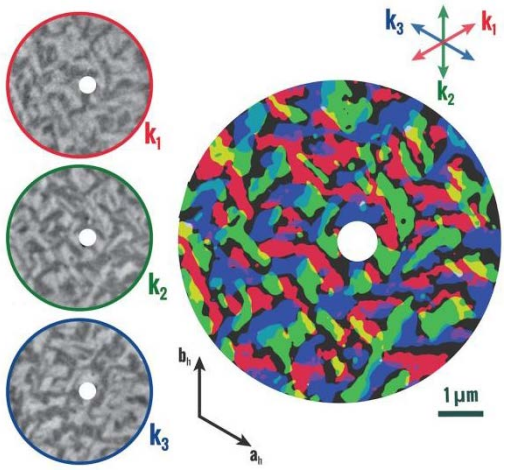

Figure 1: A full spatial threshold map of cycloidal domains in $BiFeO_3$ (right image) constructed by appropriately combining XMLD-PEEM images collected at multiple angles (left 3 images). The contrast is consistent with the sample surface comprising an equal number of the 3 **k**-domains.

References

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[2] - P. Wadley *et al.*, Nat. Nanotechnol. **13**, 362 (2018).
[3] - M. J. Grzybowski *et al.*, Phys. Rev. Lett. **118**, 057701 (2017).
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[5] - M. Ghidini *et al.*, Nat. Mater. **18**, 840 (2019).