Three-dimensional characterization of magnetic multilayer thin films using resonant soft X-ray scattering

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We report on our progress in developing the technique of resonant soft X-ray scattering for the 3D characterization of magnetic thin film samples. This work forms part of increasingly widespread efforts to achieve such characterization spurred on by the development of diffraction limited synchrotron sources such as MAX IV and SIRIUS [1,2]. Our efforts differ from those of other groups in that we have chosen the approach of scattering studies as opposed to transmission microscopy, with the higher resultant flux permitting higher resolution to be obtained, including with thicker samples.

The experimental geometry is shown in Fig. 1, with X-rays incident on the both stripe and labyrinth domain samples at angles θ up to 80 degrees from the normal. Having started our investigations with qualitative study of flux closure domains in CoPd multilayer samples of up to 160nm thickness [3], we are now focusing our efforts on the quantitative study of interactions between the anisotropic CoPd layers, and isotropic permalloy layers. We report on the general observations from such scattering experiments, the challenges inherent in the task of model fitting, and perspectives for the future, such as progress towards ptychographic experiments using the present sample geometry.

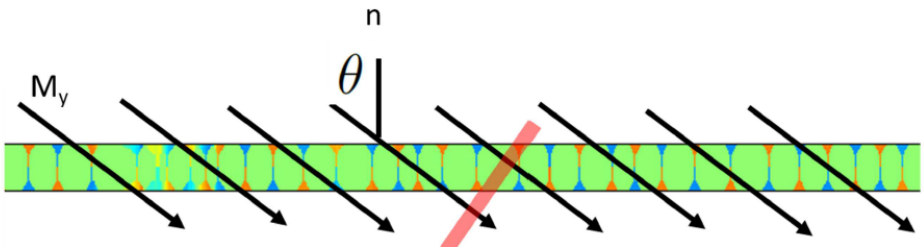

Fig. 1 Schematic experimental geometry, showing X-rays passing through cross section of a magnetic thin film. The film exhibits perpendicular magnetic anisotropy with the color scale representing the in-plane component of the magnetization, noting the small flux closure domains present on the surface.

[1] C. Blanco-Roldán, *et al*, Nat. Commun. 6, 8196 (2015).
[2] R. Streubel, *et al* Nat. Commun. **6**, 7612 (2015).
[3] S. Flewett *et al*. Phys Rev B **95**, 094430 (2017).