

# Spin Textures in Synthetic Antiferromagnets

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Synthetic antiferromagnets make use of indirect exchange coupling across spacer layers to achieve an antiferromagnetic ground state in a magnetic multilayer. Here we report on studies of synthetic antiferromagnets based on the repeat unit [Pt(8)/ CoB(16)/ Ru(7)/ Pt(8)/ CoFeB(10)/ Ru(7)], with layer thicknesses in Å. The CoB and CoFeB layer thicknesses have been chosen so that their moments are equal and cancel owing to the coupling through the Ru spacers. They thus form the sublattices of an antiferromagnetic structure. The Pt layers ensure that the magnetic layers are perpendicularly magnetised and possess an interfacial Dzyaloshinskii-Moriya interaction.

We have studied the magnetisation process of a multilayer with 5 repeat units. Conventional magnetometry shows a low magnetisation regime (SAF alignment) up to ~40 mT, with saturation occurring at ~80 mT. Phase coexistence of antiferromagnetic and ferromagnetic regions is observed in the intermediate regime by MFM, as shown in Figure 1. The lack of spin textures in the AF regions was confirmed by PEEM imaging of the top layer only. When they exceed a certain size ~150 nm, the FM regions break up into worm domains and skyrmions, as seen by MFM in real space and small angle soft x-ray scattering in reciprocal space.

Nanoscale devices formed from a similar multilayer were studied by scanning x-ray transmission microscopy. Correlated SAF domain wall motion at current densities as low as 0.3 TA/m<sup>2</sup> was observed in both sublattices by tuning to the Co and Fe L<sub>3</sub> edges. Motion at velocities up to 40 m/s was observed at current densities ~0.6 TA/m<sup>2</sup>, markedly less than required to drive domain walls in a conventional chiral multilayer where Ir replaces the Ru.

The currents were injected from a finger-shaped electrode with radius of curvature at the tip of 250 nm. Under appropriate conditions, skyrmion nucleation in the SAF state can occur. In Figure 2 we show a SAF skyrmion nucleated by a 10 ns long, 0.37 TA/m<sup>2</sup> current pulse.

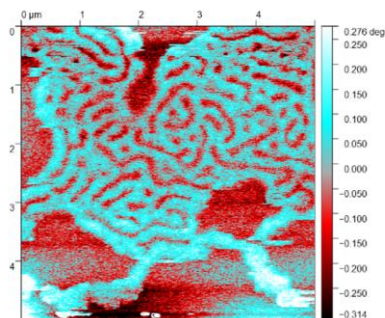


Figure 1. MFM image acquired at 42.7 mT showing AF aligned regions of featureless contrast and FM aligned regions showing worm domains and skyrmions.

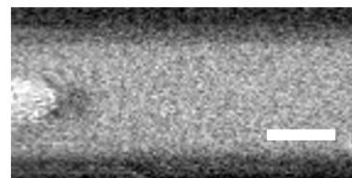


Figure 2. STXM image of a 2  $\mu\text{m}$  wide multilayer wire acquired at the Co L<sub>3</sub> edge, showing region of dark contrast at the tip of a Cu injector electrode. 1  $\mu\text{m}$  scale bar.

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