Chirality in Thin Films and Multilayers probed by Soft X-ray (Coherent) Scattering

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Many current forthcoming applications of magnetic materials involve heterostructures or alloys containing magnetic and non-magnetic elements. X-ray Resonant (Coherent) Scattering is the technique of choice to probe such phenomena thanks to its element-selectivity and spatial sensitivity.

In this presentation I will introduce the experimental set-up that we developed at SOLEIL and illustrate their capabilities. SEXTANTS [1] is a beamline of the SOLEIL synchrotron, covering the 50-1700eV energy range dedicated to soft x-ray scattering. The resolving power exceeds 10^4 and maximum flux on the sample ranges from 1×10^{14} (100 eV) to 2×10^{13} (1000 eV) ph./s/0.1% bw. The beamline main objective is the investigation of the electronic and magnetic properties of solids using three scattering techniques: resonant inelastic x-ray scattering (RIXS), x-ray resonant magnetic scattering (XRMS) and coherent x-ray scattering (CXS), the last one including also imaging via Fourier transform holography (FTH) [2].

In the second part, several recent results obtained at SEXTANTS beamline will be presented, and in particular I will show that XRMS is the tool to study magnetic chirality as illustrated with two systems: on one hand, I will briefly introduce the approach using prototype Pt/Co multilayers in which Dzyaloshinskii-Morya interaction (DMI) is induced by the inversion symmetry breaking at the interfaces [3,4] and on the other hand, an investigation we have done of $BiFeO_3$ thin epitaxial layers in which the "bulk" DMI plays a major role in its magnetic configuration and in particular in the stabilization of the antiferromagnetic cycloid. Combining real space [5] and reciprocal space [6] approach we reveal the presence of periodic chiral AFM objects along the ferroelectric (FE) domain walls.

In the last part I will present the latest development of resonant scattering and in particular how the use of the x-ray coherence available at modern light source allow nowadays to image the sample with a spatial resolution of few tens of nanometers and a time resolution ranging from ns down to few ps timescale.

References

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