Characterization of Dy/Y superlattices with neutron scattering techniques

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The Dy/Y superlattices were initially designed for the study of spin wave dispersion relations by inelastic neutron scattering, which requires a large amount of magnetic material. Dysprosium was chosen for this experiment due to its large local magnetic moment (10.6 μ_B), which gives a correspondingly greater magnetic scattering strength. Yttrium was selected in order to match the lattice structure and spacing of Dysprosium [1]. Since it is unavoidable that the crystal defects accumulate during film deposition and eventually destroy the epitaxy, our approach was to stack a few multi-layers with less repeats but higher quality. However, only encouraging preliminary results were presented in the inelastic neutron scattering experiment.

In the past two years, 20 Dy/Y superlattices have been made with 40 to 80 repeats, and these samples have been thoroughly characterized by X-ray and magnetometer techniques in order to determine the quality of every individual sample. Some interesting questions were raised during these characterizations. At low temperatures, the magnetic structure in the Dy layers is a helical antiferromagnet, where in the bulk the material is ferromagnetic. Recently, none-zero average chirality throughout the Dy/Y system has been reported as induced by the applied magnetic field [2, 3]. In order to study the mechanism of field induced chirality in Dy/Y system, polarized neutron reflectivity were also performed on two of the samples to provide information for the in-plane magnetic correlation of domains consisting of lateral areas with different helical magnetic structures in the superlattice structure.

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