Structure and Interlayer coupling of NiFe/Ir superlattices

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The study of magnetic superlattices is one of the most important advances in material sciences and condensed matter physics in recent years, opening new avenues for fundamental studies and practical applications of magnetism. A superlattice is a structure made up of alternating layers of different materials. By stacking such thin materials together, the properties of the individual materials blend together in unexpected ways. The properties of the magnetic superlattices can be tailored by varying the layering sequence and are strongly affected by the structure of the individual layers and the interfaces. Interlayer coupling can be complicated by surface and interface roughness, primarily due to growth conditions.

We studied the properties of NiFe/Ir superlattices to investigate the interfacial-roughness effects on interlayer coupling. For structural characterization, small angle x-ray reflectivity measurements are done to get information on the total superlattice thickness, the fluctuations of the layer thickness, electron density profile within the superlattice, critical angle, and the correlation of interface roughness. Interference fringes are observed which correspond to the thickness of the repeated structures in the superlattice [1-3]. Computer simulations are performed to get a good fit of the experimental X-ray reflectivity patterns.

Magnetic coupling between ferromagnetic layers through nonmagnetic spacer layers is studied with a focus on the effects of biquadratic exchange on the magnetic behavior. Biquadratic coupling creates a zero-field alignment of adjacent layer magnetizations of less than 180º, resulting in a nonzero remnant magnetization. The observed remnant moment in some samples is attributed to biquadratic exchange energy proportional to $\cos^2\theta$ where θ is the angle between the magnetization vectors of adjacent layers. These subtle effects occur when biquadratic coupling is introduced via interfacial roughness in the antiferromagnetically coupled NiFe/Ir superlattices.

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References

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