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Inelastic neutron scattering studies of exchange biased core-shell nanoparticles[1]

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Inelastic neutron scattering (INS) measurements of nanoparticle systems are very few, and we report here the first investigation of exchange biased core-shell nanoparticles. We present a study of spin dynamics in core-shell Co/CoO nanoparticles, which display an exchange bias field of 0.6T. We have used INS measurements to determine how the magnetic dynamics are affected, both by the onset of antiferromagnetic (AF) order at 250K and the subsequent onset of the exchange bias effect at 200K. At the highest temperatures, the scattering consists of two quasielastic peaks. The narrower peak is ascribed to superparamagnetic reorientations of the Co core. The broader peak originates with moments in the CoO shell. Surprisingly, their dynamics speed up with decreased temperature, suggesting that the CoO shell absorbs some of the magnetic energy of the core as exchange blocking is approached. Below 200K, the scattering is dominated by an inelastic peak at $\sim$3meV. The integrated spin wave intensity grows when the temperature is reduced below 200K, reaches a maximum near 150K, and nearly vanishes at the low temperatures. We attribute this peak to AF spin waves in the CoO shell, and their lack of dispersion and overall energy scale are consistent with predictions for low energy spin waves in bulk CoO [3,4]. It is remarkable that bulk-like spin wave behavior is observed in the CoO shell, which is only 4 nm thick.

References

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