Magnetic properties of Co Core/CoO Shell and Hollow CoO NPs

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We present an experimental study of the effects of progressive oxidation on the magnetic structure of exchange biased Co/CoO core-shell nanoparticles. Transmission electron microscopy measurements reveal that oxidation creates a Co-CoO interface which is highly directional and epitaxial in quality. Neutron diffraction measurements find that below a Neel temperature of ~ 230 K the magnetization of the CoO shell is modulated by two different wave vectors, q1=($\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$) 2π/a and q2=(100) 2π/a. The large magnitude of the latter, relative to bulk CoO, is consistent with the presence of a tetragonally distorted interface region in the CoO shell, where the distortion magnitude and the related induced moment both increase with oxidation. We propose that the large exchange bias effect results from the highly ordered nature of the interface between the Co core and CoO shell, and by the enhanced core-shell coupling enabled by the uncompensated interface moment.