Surface spin disorder and exchange bias in hollow and core-shell magnetic nanoparticles

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Abstract

Exchange bias (EB)-like behavior in magnetic nanoparticles has been observed and reported in a number of systems. However the origin is not well understood and the results have often been misinterpreted in numerous reports in the literature. Large horizontal and vertical shifts in the M-H loops as well as enhanced coercivity, which are taken as signatures of EB, could result from minor loops, improper field cooling protocol, lack of supplementary information about the surface and core spin structure and incomplete understanding of the physics of freezing of the spins in the core and shell of nanoparticles. We have recently done systematic experiments to investigate these intriguing phenomena using a range of probes such as DC and AC magnetometry, RF transverse susceptibility in hollow maghemite (γ-Fe_2O_3), core-shell (Fe-γFe_2O_3) and Co-CoO nanoparticle systems. Our studies have provided insights into intrinsic EB, tuning surface anisotropy by changing shell thickness and its influence on EB, the distinction between freezing of core and shell spins and a detailed analysis of the spin glass behavior observed below the blocking temperature. In addition to magnetometry, preliminary Small Angle Neutron Scattering (SANS) has been done to probe the surface and core spin ordering. In this talk we will emphasize the need for systematic experimental studies to understand the origin and physics of exchange bias in magnetic nanoparticles.

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