Synthesis and self-assembly of iron oxide nanoparticles: looking at details from the atomic level to the mesoscale

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Exchange-coupled magnetic nanoparticles are receiving a great deal of attention due to their potential applications.[1] Where, in recent years, a large number of methods to synthesize both single phase nanoparticles and hybrid nanoparticles comprised of two or more phases have been reported.[2,3] Moreover, the synthesis and self-assembly of non-spherical nanoparticles has been identified as one of the major challenges, and opportunities, for tomorrow's materials.[4]

In this talk the correlation between microstructure and magnetic properties of biphasic core|shell $Fe_{1-x}O|Fe_{3-x}O_4$ nanoparticles during their topotactic oxidation towards single-phase nanoparticles will be presented. We demonstrate that the anomalous magnetic properties of iron oxide core-shell nanoparticles are strongly correlated with defects in their interior which result in reduced saturation magnetization, high-field susceptibility, and exchange bias.[5,6] Varying the synthesis conditions it is possible to adjust their shape and size but also their quality so that they can be used to prepare large arrays.[7] Lastly, it will be shown the types of structures that can be obtained after self-assembling iron oxide truncated nanocubes into well-ordered three-dimensional arrays[8] where, combining detailed information from grazing incidence small-angle scattering (GISAXS) and transmission electron microscopy (TEM) measurements together with other additional techniques allow the reconstruction of the dominant phases, including defects at the mesoscale.[9]

References

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