Structural and magnetic correlations in 3D ordered nanoparticle assemblies

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Self-assembled systems of nanoparticles are candidates for new generation magnetic data storage media [1] or novel materials with tunable magnetic, optical or electronic properties [2,3]. Understanding the magnetic behavior of ordered nanoparticle arrays is an important step towards the controlled design of e.g. novel devices. We have studied γ-Fe_2O_3 nanocubes and nanospheres with a diameter ≈10 nm. Both types of nanoparticles show a high degree of monodispersity (5-6%) and a single-crystalline internal structure [4]. The particles have been deposited on a Si substrate to form highly ordered superstructures (mesocrystals) using a drop casting method. Structural characterization has been carried out using SEM, AFM, TEM and GISAXS. Depending on the shape of the particles, the arrays show mesostructures with bct [5] or fcc symmetry with relatively long structural correlation lengths of 2-10μm.

In order to investigate magnetic inter-particle correlations we have employed grazing incidence neutron scattering experiments in reflectometry mode at the JCNS-instrument TREFF at the FRM II in Garching and in GISANS mode at the Magnetism Reflectometer at the SNS in Oak Ridge and MARIA at FRM II in Garching. These experiments yielded the degree of magnetic correlation for the in-plane and out-of-plane directions at different applied fields.

References

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