FORC DIAGRAMS AS A DIAGNOSTIC TOOL FOR EVALUATING NANOPARTICLE COATING

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The use of magnetic nanoparticles has become important in a wide range of biomedical and polymer nanoparticle applications. Particles are frequently coated to improve thermal stability and functionality but also clustering and therefore retention of superparamagnetic (SP) behavior. The effectiveness of coating is often evaluated using electron microscopy and magnetic hysteresis loops. First-order reversal curves (FORC) allow for a more rigorous evaluation of effective particle size and interaction. Predominantly γ-Fe_2O_3 particles with low amounts of α-Fe_2O_3 were produced by scalable flame technology and the resulting aerosol was *in situ* coated with SiO_2 by oxidation of hexamethyldisiloxane (HMDSO) vapor (cf., Teleki et al., 2009, Chem. Mater., doi: 10.1021/cm803153m). The individual Fe_2O_3 grains were encapsulated by thin SiO_2 films and the coating thickness was controlled by the HMDSO concentration in the reactor. The mean particle size obtained from TEM images is 22.4 nm for uncoated and slightly higher for coated particles, although particle size can vary from about 10 to 80 nm. Particles were also produced by co-oxidizing Fe and Si precursors in the flame reactor. Co-oxidation reduces the γ-Fe_2O_3 grain size to about 8 nm and results in particles segregated in crystalline γ-Fe_2O_3 and amorphous SiO_2 domains. FORC analysis shows that co-oxidized particles with 7– 46 wt% SiO_2 display predominantly SP behavior due to the small γ-Fe_2O_3 grain size. The uncoated Fe_2O_3 and 7 – 23 wt% SiO_2-coated particles show a broader coercivity spectrum and therefore a larger spectrum of effective particle size; there is also a broader range of interaction fields. The FORC diagrams for samples with higher wt% SiO_2 coating and thus higher coating thickness suggest SP behavior with a narrow grain size spectrum and low degree of particle interaction. FORC diagrams are a powerful tool for assessing the effectiveness of coating treatment in the production of non-interacting SP nanoparticles.

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