STRUCTURAL AND MAGNETIC STUDIES ON IRON OXIDE NANOPARTICLES IN HYBRID AND POLYMERIC MATRICES

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We report the structure and the magnetic properties of iron oxide and iron oxide hydroxide nanoparticles grown in organic-inorganic hybrids and polymer matrices. In particular, the controlled growth of ferrihydrite, in di-ureasil matrices [1], and maghemite in poly(vinylpyridine) (PVP) [2] is presented. Di-ureasils are siliceous networks to which oligopolyoxyethylene chains with different molecular weight are grafted by means of urea cross-links. Maghemite nanoparticles are formed after the incorporation of different amounts of a $FeBr_2/FeBr_3$ solution in PVP, followed by a basic treatment. Small-Angle X-ray Scattering studies show that the size of the nanoparticles increases linearly with the iron content [3]. Ferrihydrite nanoparticles are formed at low pH on the siliceous surface, where the carbonyl groups act as nucleation points. This implies an heterogeneous nucleation, where the nanoparticles size depend on the amount of iron (in the 1 to 6% wt range) and the nanoparticles concentration is constant. The ferrihydrite nanoparticles have antiferromagnetic and uncompensated/canted moments, responsible for linear and saturation components in the dependence of the magnetization with field, respectively [4]. These components can be separated by a scaling method here presented and an accurate dependence of the magnetic moment with temperature determined [5]. Using the scaling method we conclude that the linear component is not relevant in the description of the magnetization of maghemite. The dynamic magnetic properties of ferrihydrite were studied by ac susceptibility, relaxation and Mossbauer measurements. These studies allowed the determination of the evolution of the dipolar interactions with the iron content and the determination of the anisotropy energy barrier distribution in cases where such interactions are negligible. Comparing the energy barrier distribution with the size distribution allowed to conclude that the uncompensated moments are randomly distributed in volume. This conclusion is based on a new method here presented, that uses distributions to investigate the power law relation between physical quantities.

References:

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