Effect of weak dipolar interaction between Ni nanoparticles on energy barrier distribution

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The effect of dipolar interaction between Ni nanoparticles on the energy barrier (E_a) was extracted from *ac* magnetic susceptibility (χ_{ac}) measurements performed under zero dc magnetic field, an excitation field of 1 Oe, and driving frequencies (f) varying over five decades, or more appropriately from 0.033 to 9999 Hz. The nanocomposites of Ni:SiO_2/C were prepared through a modified sol-gel process, based on a polymeric precursor method with Ni concentrations x = 1.9, 2.7, 4.0, 7.9, and 12.8 % wt.[1] The Ni nanoparticles of all samples display a nearly spherical shape, with mean diameter of d_{TEM} ~ 5 nm and narrow particle size distribution, well described by a log-normal function inferred by transmission electron microscopy (TEM) measurements. The barrier energy E_a distribution as a function of x has been determined by using $T \ln(t/\tau_0)$ scaling plots of $\chi_{ac}(T, f)$.[2] The major observed changes are related to the systematic increase of the mean value of E_a with x. We have observed that E_a varies from 213 K for the sample with x = 1.9 % wt. to 735 K for the one with x = 12.8 % wt. Contributions to E_a can originate from intrinsic anisotropies of the nanoparticles or interparticle interaction. Therefore, the increase of the mean value of E_a is certainly due to the increase of dipolar interactions between Ni nanoparticles with x, provided that all samples have quite similar average diameter and size distribution width. Besides this, the increase in E_a is not accompanied by an appreciable change in the width of E_a distribution which is similar to the ones observed in TEM. We finally argue that the increase in the magnitude of E_a may be used for quality control of devices constituted of magnetic nanoparticles used in magnetic recording media where the role of dipolar interaction determines their physical properties.

Work supported by CAPES, CNPq and FAPESP.

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Key words: Dipolar interaction; Magnetic nanoparticles; Nanocomposite; Nickel; Superparamagnetism