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RETRIEVAL OF FUNDAMENTAL PARAMETERS OF MAGNETIC NANOPARTICLES FROM THE MAGNETIZATION RELAXATION CURVES

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We have proposed the original method of retrieval of the magnetocrystalline anisotropy constant and the saturation magnetization of non-interacting superparamagnetic nanoparticles from the magnetization relaxation curves measured with SQUID magnetometer. The objects of study are the ensembles of spherical colloidal Fe_3O_4 nanoparticles dispersed in the rigid polymer matrix (polyvinyl alcohol + chitosan) preventing nanoparticles from the agglomeration. The Transmission Electron Microscopy (TEM) is used to determine the size distribution of magnetic nanoparticles and to control the homogeneity of their spatial distribution in the matrix (Fig. 1). High sensitivity of SQUID microscope enables to study samples at low contents of magnetic component (0.1–0.5 vol %) magnetized in low magnetic field (~ 10^{-4} T) produced by low-inductance coil with short switching time (20 μs). Low content of magnetic component provides the absence of interparticle dipolar interactions that simplifies significantly the theoretical description of magnetization relaxation process. The detection of magnetization relaxation starts after the external magnetizing field is switched off and proceeds for the several minutes. A series of samples with mean size of nanoparticles in the range 5–8 nm possessing relaxation times less than 5 min was measured at a temperature of 77 K (Fig. 2). The calculation formula based on the Stoner–Wohlfarth model of single-domain particles with the size distribution determined from the TEM images was applied to measured relaxation curves in order to obtain reliable data on the fundamental parameters of Fe_3O_4 nanoparticles studied.