Influence of viscosity on dynamic magnetization of thermally blocked iron oxide nanoparticles characterized by a sensitive AC magnetometer

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ABSTRACT

In this work, we show that the viscosity of carrier liquid affects the dynamic magnetization of thermally blocked multi-core iron oxide nanoparticles. The core size of the nanoparticles was determined from the magnetization curve measured by a specially developed high-T_c SQUID magnetometer and calculated to be 11.7 nm. Using an AC magnetometer developed based on induction coils, the dynamic magnetization of the multi-core iron oxide nanoparticle solution was measured from 3 Hz to 10.48 kHz. Later, we reconstructed of the hydrodynamic size distribution of the particles by assuming a log-normal distribution of particle size in an AC susceptibility model by Shliomis and Stepanov, which accounts for anisotropic directions of the easy axes of magnetic nanoparticles with respect to the excitation field direction. The reconstructed hydrodynamic sizes showed an average diameter of 130 nm and agreed with the size determined by dynamic light scattering method. In the case of increasing viscosity of the carrier liquids from 0.89 to 8.11 mPa s, the dynamic magnetization peaks of the imaginary component have shifted to a lower frequency region. We showed that the harmonics ratio and phase delay upon the magnetic field excitation at 30 Hz could also be used to determine the viscosity of carrier liquid independently.

KEYWORDS

Brownian relaxation; Dynamic magnetization; Iron oxide nanoparticles; Magnetometer