Properties of single- and multi-core magnetic nanoparticles assessed by magnetic susceptibility measurements

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ABSTRACT

Characterization of structural and magnetic properties of MNP ensembles is crucial in tailoring their performance for biomedical applications. In this work, we evaluate the size distribution of magnetic cores in single- and multi-core nanoparticles in water suspension using transmission electron microscopy (TEM) and static magnetization curve, with the geometrical core size ranges from 8.3 to 40.2 nm. A reasonable core size derived from the magnetization curve is obtained in comparison to the geometrical size from TEM image. The magnetic moment distribution possibly reveals that the reduction of effective magnetic core size is due to the magnetization degradation in cores. The hydrodynamic size and average anisotropy energy ratio obtained from the AC susceptibility response of MNPs from 5 Hz to 100 kHz are also evaluated. The complex distribution of relaxation time is constructed by applying a non-negative least square method to an AC susceptibility model that incorporates the inter- and intra-potential-well contributions. It is found that a log-normal distribution might not be adequate to represent the hydrodynamic size distribution reconstructed from the AC susceptibility responses of the suspended samples. It is demonstrated that the AC susceptibility model used in this study can be used to fairly estimate the average anisotropy energy ratio for MNP ensembles dominated by thermally blocked particles. Moreover, it can be suggested that besides the geometrical core size, the degree of core aggregation also plays an important role in determining the anisotropy energy ratio and effective magnetic moment.

KEYWORDS

Magnetic nanoparticles; Magnetization curve; AC susceptibility; Magnetic anisotropy; Core size distribution; Brownian relaxation; Neel relaxation

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