Nonequilibrium phase transition properties and frequency dispersions of hysteresis curves of a cubic core/shell nanoparticle system: A Monte Carlo Simulation study

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Abstract

Monte Carlo simulation based on Metropolis algorithm has been used to study dynamic phase transition properties of a cubic core/shell nanoparticle system under a time dependent oscillating magnetic field source. The ferrimagnetic Heisenberg nanoparticle is described on a simple cubic lattice with spin-3/2 ferromagnetic core which is surrounded by a spin-1 antiferromagnetic shell layer. An antiferromagnetic spin-spin interaction between core and shell spins is used at the interface of the particle. Our simulation findings indicate that dynamic phase transition temperature of the system gradually decreases when value of the external field amplitude increases. Moreover, particular attention has been devoted the hysteresis treatments of the system. For the first time, frequency dispersion of hysteresis loop area curves have been categorized into three distinct types in Ref. (1) for kinetic Ising model for infinite systems. Results obtained in our study suggest that this type of a classification is also valid and possible for the present finite core/shell system, namely, frequency dispersions can be categorized into three groups for a fixed temperature, which are labeled as type-I, -II and -III, respectively. The curves in type- I correspond to the dynamically ordered phase and their corresponding hysteresis loops are asymmetric treatment around the origin for all the studied frequencies. In type-II, the hysteresis curves change their shapes from symmetric one to asymmetric one with increasing field frequency for the selected values of external field amplitudes. Finally, in type-III, the system exists in the dynamically paramagnetic phase and the hysteresis curves present symmetric shape around the origin. Hence, corresponding dynamic loop area curves as a function of field frequency have a single peak for considered values of the applied field amplitude.

References:

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