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Numerical Study of the Exchange Bias properties of $MnFe_2O_4$/γ-Fe_2O_3 core/disordered shell nanoparticles

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Abstract: The structure and the low-temperature magnetic properties of non-textured diluted frozen dispersions of single 3.3 nm sized nanoparticles (NPs) consisted of a soft $MnFe_2O_4$ core protected by a disordered maghemite shell have been experimentally investigated [1,2].We use Monte Carlo simulations technique to study the exchange bias behaviour of these systems [3,4] in an atomic scale.
The model assumes spherical ferrimagnetic soft core/hard disordered shell nanoparticles with Heisenberg exchange interaction between the spins. We consider uniaxial anisotropy along the z-axis in the core and at the interface and random anisotropy in the shell and at the surface. To take into account the random distribution of the NPs in the ferrofluid, the cooling field has been applied in different directions and the hysteresis loop is calculated by averaging on the hysteresis loops along each magnetic field direction. Our simulations have been performed for several cooling field sizes and they show that the optimum exchange bias field is achieved for a cooling field of the order of the anisotropy field. Higher cooling fields lead to the decrease of the exchange bias value. Our numerical results reproduce well the experimental findings confirming that the NPs consist of a well-ordered ferrimagnetic core surrounded by a disordered spin glass-like surface layer [1,2].

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