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Numerical Study of the effect of the Antiferromagnetic matrix on the Exchange Bias properties of diluted nanoparticle system

G. Margaris[1], K. N. Trohidou[1], M. Vasilakaki[1], D. Peddis[2], D. Fiorani[2]
[1] *Institute of Nanoscience and Nanotechnology,NCSR Demokritos,Aghia Paraskevi,Greece*
[2] *Institute of Structure of Matter, Area della Ricerca,Via salaria km 29,500, P.B. 10-00016, Monterotondo Scalo, Roma, Italy*

Abstract: Monte Carlo simulations of the static and dynamical magnetic properties of fine ferromagnetic (Co) particles dispersed (at 5 % volume filling fraction) in an antiferromagnetic film matrix (Mn) are reported and compared with the experimental results [1,2]. The model, assuming Co nanoparticles randomly placed on the nodes of a simple cubic lattice, accounts the significant degree of Co-Mn alloying, as shown by EXAFS measurements, responsible for a very small magnitude of the Co moment, as shown by XMCD measurements, and the Mn granularity, as shown by X-ray diffraction measurements, responsible for uncompensated magnetic moments in the antiferromagnetic matrix. Simulations replicate the zero-field-cooled and field-cooled low field susceptibility curves, providing an evidence of super spinglass freezing (SSG), the stop-and-wait effect in the ZFC curve (memory effect) and the observed Exchange Bias behaviour.
The results indicate that the observed super spinglass features in such a diluted nanoparticle system, unlike the dense ones as in usual SSGs, come from the interplay of dipolar interparticle interactions, transmitted through the uncompensated grain moments of the matrix which are also exchange coupled, and the non-uniform exchange interactions at the Co/Mn interface.

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