SINGLE-DOMAIN PARTICLE WITH RANDOM ANISOTROPY

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Uniform magnetization is known to be the ground energy state of a usual ferromagnet, the low-lying energy states being small magnetization deviations from the ground state. However, the structure of the low-lying energy states in nanocrystalline magnetic materials is unclear. To describe macroscopic properties of FINEMET type material a numerical simulation is carried out for a system of exchanged coupled single-domain nanograins with diameter D = 10 - 12 nm, having randomly distributed easy anisotropy axes. The important parameters of the model are the number of the interaction grains, N, and the interaction strength ratio, ξ = J/KV, where J is the exchange interaction energy between closest nanograins, K is the anisotropy constant and V is the grain volume. It is shown that there is a critical number of interacting grains, $N_c(\xi)$, so that for $N < N_c(\xi)$ the cluster has well defined single ground state with a probability $P \approx 1$. The behaviour of the cluster resembles that of single-domain particle. Interestingly, the cluster preserves uniaxial or cubic type of magnetic anisotropy depending on the type of magnetic anisotropy of the nanograins, though for the case of cubic anisotropy the degeneracy of the energy minima is lifted. The effective anisotropy constant of the cluster is highly reduced. The distribution functions for the effective anisotropy constants, as well as $N_c(\xi)$ numbers are calculated for clusters of different topology having. 2, 4 and 6 exchange links per grain. It corresponds to 1D case (line), 2D case (layer) and 3D case, respectively.