Nanoscale physics

Phase transitions and coercivity of blocked superparamagnetic and superferromagnetic states in the ensemble of Stoner-Wohlfarth particles. The Monte Carlo simulation.

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The magnetization reversal of the ensemble of Stoner-Wohlfarth (SW) particles with ferromagnetic-like exchange interaction was investigated with Monte-Carlo (MC) modeling. The modification of MC algorithm with procedure of forced turnover of magnetic moments of all particles, at reaching the value of critical field of stability of the ensemble as a whole, was proposed. Such modification made possible the simultaneous turnover of all particles of the ensemble. In the realization of traditional MC with Metropolis algorithm, for the optimization of the direction of each particle, the solutions with overturn of all particles of the ensemble, which should be realized according to physical analysis of the process, requires practically unrealizable processing time.

The calculations have shown, that in the range of low temperatures, in the ensemble of exchange-interacting SW particles, the coercive force was determined by the loss of the stability of the direction of mean magnetic moment of the system. Thus, the value of the coercive force was equal or close to the value of critical anisotropy field.

At higher temperatures (but less than the critical temperature of superferromagnetic (SFM) state), the magnetization reversal occurred in the critical field of the complete loss of SFM state stability. In this case, this critical field was less than the critical anisotropy field.

It was shown, that even in the case, when the exchange field surpasses the anisotropy field, the coercive force, which occurs in the SFM state, in the area $T_{red\_b}<T_{red}<T_{red\_SF}$ is proportional to $T^{1/2}$. This dependence is similar to the Néel-Brown formula, but does not contain the characteristic blocking temperature, which depends on the measurement time.