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Talk Invited Invited Talk

A Monte Carlo Study of the dynamical behavior of cluster assembled magnetic nanostructures

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There is a growing realization of the enormous potential of cluster assembled films in the production of high-performance magnetic materials. Increasingly attention has been focused on the effect of interactions in cluster deposits that can occur between the clusters, the clusters and substrate, and clusters and coating materials [1]. In this context the exchange interaction is of great importance, since the exchange length is significant compared to the cluster diameter and in interacting cluster films, it is the dominant mechanism [2]. This mechanism produces a number of interesting and technically useful effects. We give two examples of systems where the intercluster interactions determine their magnetic behavior.

First we model the growth process and the evolution of the magnetic behavior of Co clusters on Au surfaces in the case of low temperature co-deposition of Co and Au atoms. The magnetic structure is obtained by a Monte Carlo simulation, which includes exchange and magnetostatic intercluster interactions and perpendicular anisotropy for each Co cluster. The dynamic evolution of the magnetic properties is described by our simulations and it is correlated with the interparticle coupling and the annealing conditions. Our results are in very good agreement with experimental findings.

The magnetization dynamics of a dense cluster assembly has also been modeled using the Monte Carlo simulation technique. The role of the internal characteristics of the assembly (inter-cluster interactions, anisotropy axes distribution, particle size distribution, substrate coverage) and the external parameters (temperature, applied field) has been studied. In very dense Fe cluster films, the frustration resulting from the inter-particle exchange interaction and the randomly oriented intra-cluster anisotropy produces a correlated super-spin glass ground state that is magnetically soft. Clearly a faster magnetization reversal is observed with increasing coverage in agreement with the experimental observation and is attributed to the growing size of the clusters of the exchange-coupled nanoparticles that reverse collectively under the applied field.

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[1] M. Vasilakaki and K.N. Trohidou, *Phys. Rev B* **79**, 144402 (2009).

[2] C. Binns, M.J. Maher, Q.A. Pankhurst, D. Kechrakos and K.N. Trohidou, *Phys. Rev. B* **66**, 184413 (2002).