Magnetic Properties of Exchange-Biased Three-Layer Films

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Abstract: We study by Monte Carlo (MC) simulations and Green function (GF) method some properties of a system composed of three thin films, from which two outside films are ferromagnetic (FM), while the middle one may be FM or antiferromagnetic (AF). The interface exchange between films is AF. This model simulates the so-called 'exchange-biased' layers. The films have the triangular lattice structure with Isling spins. A uniform magnetic field H is applied along the spin axis, i. e. perpendicular to the film surfaces. At finite temperatures T, we obtained by Monte Carlo simulation a phase diagram in the space (T, H) which shows several interesting behaviors, including a cross-over from the second-order transition to the first-order one at some critical field H_c as shown by the double-peak structure in the energy histogram taken at the transition temperature. The value of H_c depends on the nature of the middle film (FM or AF), on the interface interactions and the film thickness. The hysteresis cycle measured in the transition region by field-heating and field-cooling shows a two-step cycle which may have important practical applications in magnetic recording An analytical calculation by the GF method using an Isling-like model has been performed for the same system. The obtained self-consistent layer magnetizations are in excellent agreement with the MC ones.

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