Computer Simulations on Depinning Transition of Magnetic Domain Wall

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Recently considerable attentions have been paid to domain-wall dynamics in magnetic materials in order to achieve high coercivity. Here we investigate the domain-wall dynamics under driving field in a thin film of permanent ferromagnet by computer simulations on the two-dimensional Ising model with dipole-dipole interactions and random fields. At zero temperature, there is a critical driving magnetic field, below which the system is pinned by random pinning potentials, whereas above which the domain wall acquires a finite velocity. This sharp depinning transition point defines the coercive force. However, at finite temperatures velocity is non-zero even below the critical field due to thermal activations. We have found a scaling relation among the velocity, temperature and driving field. Interestingly, the domain-wall motion derived from the scaling function and critical exponents is a non-Arrhenius-type one. In this way, we have formulated a systematic way for analyzing experimental results at finite temperatures.