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Magnetization Dynamics in Ultrahigh-Density Magnetic Recording[1] R. SKOMSKI, J. ZHOU, D. J. SELLMYER, Department of Physics and Astronomy and Center for Materials Research and Analysis, University of Nebraska, Lincoln, NE — Thermally activated magnetization reversal is a key consideration in the development of magnetic recording materials with ultrahigh densities. We consider the onset of magnetization reversal (nucleation) and describe the magnetization by a Langevin model, where the magnetization dynamics is realized by random thermal forces. The exchange, anisotropy, and Zeeman energies are expanded into powers of a small perpendicular magnetization component, and the dynamics reduces to a time-dependent superposition of normal modes. In the Stoner-Wohlfarth (SW) model, the approach reproduces the Arrhenius-Néel-Brown law $\tau = \tau_o \exp(E_a \backslash k_B T)$ with an approximate energy barrier E_a and a particle-size dependent constant τ_o. The same is true for the micromagnetic approach, where the local micromagnetic parameters such as $K_1(\mathbf{r}) = <K_1(\mathbf{r})>$ give rise to nonuniform magnetization modes in inhomogeneous and interacting particles. However, both the coercivity H_c and the energy barrier E_a are smaller than the SW predictions. A further reduction of H_c and E_a is obtained by taking into account local anisotropy fluctuations of the type $<K_1(\mathbf{r})^2>$ - $K_1(\mathbf{r})^2$. This reduction corresponds to fluctuating energy barriers, and establishes a particle-shape and materials-dependent upper limit to energy barriers in very small particles.

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