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Nanomagnetic Simulations of Recording Media[1]

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The optimization of ultra-high density recording systems requires the joint simulation of the recording head, the data layer and the soft underlayer. This talk presents micromagnetic simulations of recording processes in perpendicular and patterned media. The numerical technique for the multiscale simulation combines the finite element method with an accelerated boundary method. The use of hierarchical matrices and FFT methods significantly speeds up the computation time for the magnetostatic interactions between the head and the data layer. In addition to dynamic magnetization processes, energy barriers of recording media are calculated using a nudged elastic band method. The rise time of the write field was found to depend significantly on vortex motion in the pole tip of the head. The shortest field rise time was obtained for intermediate values of the Gilbert damping constant. Under the influence of the write field, magnetization reversal in composite perpendicular media occurs by the nucleation and expansion of reversed domains. However, thermally activated switching in composite media shows reversal by quasi-uniform rotation. Therefore it is possible to keep a high energy barrier while reducing the switching field in composite media, where a soft magnetic layer is exchange coupled to the hard magnetic layer. The energy barrier of composite media was calculated as a function of the applied field. The results show that the extrapolation of barriers measured at high fields underestimates the zero-field energy barrier. The calculated energy barrier of an island of a patterned media is smaller than the anisotropy constant times the island volume. This result shows that thermally activated magnetization reversal in patterned islands is non-uniform. The energy barrier of a square island with a size of only 20 nm was found to be 17% lower than the barrier expected for uniform rotation.

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