Figures of Merit for Magnetic Recording Media

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Since the first nucleation-field calculations for hard-soft nanostructures with multilayered [1] and arbitrary [2] geometries, exchange-spring magnets have attracted much attention in various areas of magnetism, including magnetic recording. Ultrahigh storage densities correspond to the strong-coupling limit, realized on small length scales and described by volume-averaged anisotropies. Second-order perturbation theory yields finite-size corrections that describe a partial decoupling of the phases. Since soft phases reduce the nucleation field, nanostructuring can be used to reduce the coercivity $H_c$ while maintaining the energy barrier $E_B$. However, the ratio $E_B/H_c$ is an ill-defined figure of merit, because the comparison with the Stoner-Wohlfarth model requires the introduction of a particle volume, as contrasted to an area. By using elongated particles with a continuous anisotropy gradient, it is possible to reduce the coercivity by a factor scaling as the bit size divided by the domain-wall width of the hard phase. However, with decreasing bit size this effect becomes less pronounced. In the strong-coupling limit, thermal stability yields a maximum storage density of order $\gamma/k_B T$, where $\gamma$ is the domain-wall energy of the hard phase. - This research is supported by NSF MRSEC, INSIC, and NCMN. [1] S. Nieber and H. Kronmüller, phys. stat. sol. (b) 153, 367 (1989). [2] R. Skomski and J. M. D. Coey, Phys. Rev. B 48, 15812 (1993).

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