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Magnetization and Hysteresis of Dilute Magnetic-Oxide Nanoparticles[1] RALPH SKOMSKI, B. BALAMURUGAN, D.J. SELLMYER, Department of Physics and Astronomy & NCMN, University of Nebraska — Real-structure imperfections in dilute magnetic oxides tend to create small concentrations of local magnetic moments that are coupled by fairly long-range exchange interactions, mediated by p-electrons. The robustness of these interactions is caused by the strong overlap of the p orbitals, as contrasted to the much weaker interatomic exchange involving iron-series 3d electrons. The net exchange between defect moments can be positive or negative, which gives rise to spin structures with very small net moments. Similarly, the moments exhibit magnetocrystalline anisotropy, reinforced by electron hopping to and from 3d states and generally undergoing some random-anuisotropy averaging. Since the coercivity scales as $2K_1/M$ and M is small, this creates pronounced and — in thin films — strongly anisotropic hysteresis loops. In finite systems with N moments, both K_1 and M are reduced by a factor of order $N^{1/2}$ due to random anisotropy and moment compensation, respectively, so that that typical coercivities are comparable to bulk magnets. Thermal activation readily randomizes the net moment of small oxide particles, so that the moment is easier to measure in compacted or aggregated particle ensembles.

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D. J. Sellmyer
Department of Physics and Astronomy & NCMN,
University of Nebraska

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