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Fingerprinting Magnetic Nanostructures by First Order Reversal Curves[1]

KAI LIU, University of California - Davis

Realistic systems of magnetic nanostructures inevitably have *inhomogeneities*, which are manifested in distributions of magnetic properties, mixed magnetic phases, different magnetization reversal mechanisms, etc. The first order reversal curve (FORC) method [1-3] is ideally suited for "fingerprinting" such systems, both qualitatively and quantitatively. Here we present recent FORC studies on a few technologically important systems. In arrays of Fe nanodots [4], as the dot size decreases from 67 to 52nm, we have observed a vortex state to single-domain transition. Despite subtle changes in the major hysteresis loops, striking differences are seen in the FORC diagrams. The FORC method also gives quantitative measures of the magnetic phase fractions and vortex nucleation and annihilation fields. Furthermore, with decreasing temperature, it is more difficult to nucleate vortices within the dots and the single domain phase fraction increases. In exchange spring magnets [3], we have investigated the reversibility of the soft and hard layers and the interlayer exchange coupling. In FeNi/polycrystalline-FePt films, the FeNi and FePt layers reverse in a continuous process via a vertical spiral. In Fe/epitaxial-SmCo films, the reversal proceeds by a reversible rotation of the Fe soft layer, followed by an irreversible switching of the SmCo hard layer. As the SmCo partially demagnetizes, the Fe layer still remains reversible, as revealed by second order reversal curves (SORC). The exchange coupling between the two layers can be extracted as a function of the SmCo demagnetization state. These results demonstrate that FORC is a powerful method for magnetization reversal studies, due to its capability of capturing magnetic inhomogeneities, sensitivity to irreversible switching, and the quantitative phase information it can extract. Work done in collaboration with J. E. Davies, R. K. Dumas, J. Olamit, C. P. Li, I. V. Roshchin, I. K. Schuller, O. Hellwig, E. E. Fullerton, J. S. Jiang, S. D. Bader, J. Wu, C. Leighton, H. G. Katzgraber, C. R. Pike, R. T. Scalettar, G. T. Zimanyi, and K. L. Verosub.

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