Controlling Exchange Stiffness in Recording Media

Erol Girt[1)], W. Huttema[1)], C. Eyrich[1)], E. Montoya[1)], B. Heinrich[1)], O. Mryasov[2)], O. Karis[4)]

[1)] Department of Physics, Simon Fraser University, 8888 University Drive, Burnaby, Canada V5A 1S6, [2)] Department of Physics, University of Alabama, Tuscaloosa, AL 35487, USA, CA 94538, USA, [4)] Department of Physics and Astronomy, Uppsala University, SE-751 05 Uppsala, Sweden

Recording media consists of epitaxial sub-10-nanometer-diameter magnetic grains surrounded by an insulating oxide matrix. The composition along the growth direction of the grains is varied on the atomic scale, allowing for a directional variation of magnetization, anisotropy and exchange stiffness *within* a single grain. This can create a non-uniform reversal of magnetic moment in the grains reducing the field required for magnetization reversal without affecting the thermal stability of the grains [1,2]. Stiffness, A_{ex}, is the key parameter controlling transition from uniform to non-uniform reversal. We developed a new method for measuring A_{ex} on the bases of the spiral formation in two ferromagnetic films antiferromagnetically coupled across a non-magnetic spacer layer. The method was used to measure the exchange stiffness for a series of Co(Cr, Ru, Pt) thin film alloys. The results show that the exchange stiffness of Co alloys does not scale with the alloy magnetization and that it decreases at the rate of 4.9 %, 3.3 %, and 1.3 % per addition of one atomic percent of Ru, Cr, and Pt, respectively. These results can be understood by combining measurements of localized magnetic moments of Ru, Cr, and Pt in Co using X-ray magnetic circular dichroism (XMCD) and the first principal calculation. We will show that the understanding of the origin of exchange stiffness in these alloys is critical for designing magnetization reversal in future recording media.

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