Independent Measurement of Magnetic Properties of the Soft Underlayer and Hard Recording Layer of Perpendicular Magnetic Recording Media Using an Anomalous Hall Effect Magnetometer

Jeffrey R. Lindemuth[1], and Brad C. Dodrill[1]
[1]Lake Shore Cryotronics, 575 McCorkle Blvd., Westerville, Oh., 43082 USA

Conventional magnetometry methodologies (e.g., VSM) are unsuited to the task of characterizing the magnetic properties of double layer perpendicular magnetic recording media (PMRM). In a conventional magnetometer the signal response is dominated by the soft underlayer, rendering it virtually impossible to deconvolute the magnetic properties of the recording layer. The anomalous Hall effect (AHE) has been recognized as a useful tool for measuring the magnetic hysteresis M(H) loops of PMRM[1,2], and provides for independent measurement of the magnetic properties of both the soft underlayer and recording layer. The Hall voltage contains three terms. The first is proportional to the perpendicular component of the magnetization and is called the anomalous Hall effect (AHE). The second is proportional to the square of the component of magnetization in the plane of the film, and perpendicular to the current, and is called the planar Hall effect (PHE). The third is proportional to the perpendicular component of the B field and is called the ordinary Hall effect (OHE). Measurements of the hall voltage with different current directions allows the in plane and perpendicular magnetization components to be separated. We have measured the AHE and PHE in double layer PMRM and compared the results with measurements using a VSM. To achieve maximum sensitivity from high conductivity samples, an AC current methodology was used[3]. This technique also eliminates errors due to thermal EMF voltages. To eliminate residual resistance voltages from the Hall measurements, geometry averaging techniques commonly employed in conventional Hall effect measurements on semiconductors were used. For full M(H) loop measurements however, a modified form of field reversal must be used where the Hall voltage from positive fields on the descending curve is averaged with the Hall voltage at negative fields on the ascending curve. We demonstrate that the anomalous and planar Hall effects, when coupled with measurements at multiple angles, provides a simple and fast method to characterize the magnetic properties of both the soft underlayer and hard recording layer in PMRM.

[1] S. Haan et al., J. Mag. Soc. Jap. 15 (1991) 349
[2] S. Das et al., Poster presented at Joint [NA]PMRC 2003
[3] J Lindemuth et al, Poster presented at ICM2003