ZERO FIELD VISCOSITY IN PERPENDICULAR MEDIA

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The thermal relaxation of magnetic media is a topic of considerable importance. The stability is typically characterized by measuring the time dependence of the coercivity or by measuring the magnetization decay rate as a function of applied reverse field. For large thermal stability factors (KV/kT), the magnetization decay in zero applied field is considered to be negligible. This is not necessarily the case, however, in state-of-the-art media with KV/kT less than 100. We have recently reported on measurements of the decay of remanence in zero applied field for a series of longitudinal thin film and particulate media [1,2] and for self-assembled L_0 FePt nanoparticles [3]. Here we report on the measurement and calculation of zero-field relaxation in a film with perpendicular anisotropy. For illustration we have used a CoCrPtB film with a coercivity of 1900 Oe. The decay of magnetization was measured at zero applied field after the application of a saturation-reverse field sequence for different reverse fields, and the initial viscosity coefficient, $S_0 = dm_r/d\log(t)$, was measured as a function of the initial remanent magnetization (Fig. 1). Depending on the initial remanence, over the time scale of the measurement (600 s) the magnetization was observed to either monotonically increase or decrease, or to increase at short times and then decrease at longer times. The shape of the curve in Fig. 1 is quite different from what was previously observed for films with in-plane anisotropy and is strongly affected by the demagnetization field. The solid curve in the figure represents a calculation based on a Stoner-Wohlfarth, Arrhenius-Néel model that included a mean-field interaction (demagnetization) term of the form $h = h_{\text{applied}} + \alpha m_r$, where $h = H/H_i$ and $m_r = M_r/M_{rs}$. A log-normal volume distribution was used and the easy axes were assumed to be aligned perpendicular to the film. The fit is excellent over most of the remanence range. The discrepancy at high m_{r0} values and the difference between the fit value ($KV_m/kT = 38$) and that determined from the dynamic coercivity ($KV_m/kT = 54$) is attributed to the sensitive dependence of the S_0 on the shape of the volume distribution for small volumes.

Fig. 1. Dependence of zero-field viscosity on initial remanence.

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A NEW METHOD FOR INTRINSIC VISCOSITY MEASUREMENTS ON PERPENDICULAR RECORDING MEDIA

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In the case of perpendicular media, it is hard to measure the magnetic viscosity S (from the relaxation curve) because the internal field (H_i) is continuously changing with time due to the change in the demagnetizing field. Correction for this effect using an analytical formula [1] fails in principle to provide accurate results in case S varies largely with field. In this paper, we introduce a new method that allows to measure directly the intrinsic viscosity (S) using a VSM. The measurement is carried out in a number of measurement steps. In each step, the applied field (H_a) behavior with time is gradually adjusted according to the change in H_i calculated from the relaxation behavior measured from the previous measurement step. Eventually, during the last step, H_i is kept constant by appropriately changing H_a . The ultimate viscosity obtained from the last step is the intrinsic viscosity at this constant H_i . Automatic measurements were carried out on two samples: a sputtered CoCrPtB perpendicular media and a Co-filled alumite media (see Fig. 1 for example). Commonly, the ultimate S for these types of samples can be obtained after 4 to 6 steps. Throughout the steps, the deviation of H_i (from that at the start of the relaxation) goes asymptotically to zero and the viscosity increases and saturates at the ultimate value (Fig. 2). The viscosity obtained using our method is believed to reflect better the real intrinsic viscosity of perpendicular media. Moreover, we proposed a model that allows to simulate the measurements. The simulation fits quite well with our observations. With the model, we can understand and predict the behaviors of samples during the measurements. Using this model, we proposed a way to make a "shortcut" in the real measurements. By using this "shortcut", even with high susceptibility samples, the ultimate viscosity value can still be obtained after a few steps. Reference: [1] A. Lyberatos and R. W. Chantrell, J. Phys.: Condens. Matter. 9 (1997), 2623.

Fig. 1. Extrinsic viscosity vs. H_a and intrinsic viscosity vs. H_i measured by our new method, as compared to that calculated by the analytical method (CoCrPtB media sample).

Fig. 2. An example of a measurement: after 6 successive measurement steps, viscosity approaches the ultimate value while the deviation of the internal field is vanishing.

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