Zero Field Relaxation in Magnetic Recording Media

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Magnetization Decay

• Thermal relaxation of the magnetization is a critical issue in ultra-high density recording media.

• The thermal stability is typically characterized by measuring the time dependence of the coercivity or by measuring the magnetization decay as a function of the reverse field after saturation.

• The relaxation is usually given in terms of a magnetic viscosity coefficient given by \( S = \frac{dm}{d\log(t)} \).

• The viscosity is usually greatest near the coercivity, and for large thermal stability factors, \( KV/kT \), it is usually very small in zero applied field.
Zero-Field Relaxation Measurements

• Relaxation of remanence in zero applied field may be important in state-of-the-art media in which $KV/kT$ is often much less than 100.

• Zero-field relaxation measurements have been recently reported for thin film media, granular films, and tapes:


• We report here new zero-field relaxation measurements for perpendicular media and for synthetic antiferromagnetic (SAF) media. We have also successfully modeled the measurements for perpendicular media.
Zero-Field Relaxation Measurements

1 → 2: $H_{\text{sat}} \rightarrow -H$

2 → 3: magnetization decay at $-H$

3 → 4: $-H \rightarrow 0$

4 → 5: measure relaxation of remanent magnetization (zero field relaxation)
Remanent state after partial dc demagnetization

\[ V_c = \frac{kT}{K} \ln(t_0t) \]
Initial ZF Viscosity in CoPtCrB film with Perpendicular Anisotropy

- Measurements have been successfully modeled using a Stoner-Wohlfarth, Arrhenius-Néel model that includes a mean field: $\Delta E = KV(1 \pm \alpha M_r)^2$

$$H_n < 4\pi M_s$$

![Graph showing initial ZF viscosity measurement](image)
ZF Viscosity in Co/Pd Multilayer Films with Perpendicular Anisotropy

- Large perpendicular anisotropy significantly affects zero field viscosity

\[ H_n \sim 4 \pi M_s \]
ZF Viscosity in Synthetic Antiferromagnetic (SAF) Films

- When $H_{ex} > H_C$ of bottom layer, zero field viscosity curve is similar to single-layer film.

$H_{ex} > H_C$ (bottom)
ZF Viscosity in Synthetic Antiferromagnetic (SAF) Films

- When $H_{ex} < H_C$ of bottom layer, zero field viscosity curve is similar to perpendicular film with $H_n < 4\pi M_s$.

$$H_{ex} < H_C \text{ (bottom)}$$
ZF Viscosity in SAF - Top Layer Only

- Zero field viscosity is similar to bilayer film with $H_{ex} > H_C$ of bottom layer.
Summary and conclusions

• Zero field viscosity measurements have been made in a variety of thin film media – longitudinal, tapes, perpendicular, SAF.

• Measurements depend strongly on demagnetization state and on nature of the interparticle interactions.

• Zero field viscosity measurements can provide additional insight, along with ordinary viscosity measurements and dynamic coercivity measurements, for assessing long-term storage capabilities of magnetic media.