Simulation System

We have simulated a system of lateral dimension 160x160 nm with periodic boundary condition along x and y. We have used a log-normal distribution of anisotropy field for the RL. Mean value $H_k = 11.5$ kOe. Dispersion $\sigma(H_k) = 0.4$ (corresponds to a FWHM of ~9 kOe). We also used a Gaussian distribution of easy axis for the RL with a FWHM of about 13°.

Pulsed Field and Response Magnetization

A trapezoidal pulse with rise and fall time of 0.5 ns is applied along the $-z$ direction. The system usually switches within a few ns.

Effect of Pulse Demagnetization

- The dependence of $H_{cr}$ on the initial remanent state is different if the initial demagnetization is achieved by a field pulse.
- The high Zeeman energy is converted into spin wave energy which increases the local spin temperature.
- Low coercivity grains destabilizes its higher coercivity neighbors.

Landau-Lifshitz Equation

We have solved the Landau-Lifshitz equation with the total field as

$$\frac{dM}{dt} = -\gamma M \times H - \alpha \gamma M \times (M \times H)$$

with the total field as

$$H = H_{\text{exch}} + H_{\text{anis}} + H_{\text{stat}} + H_{\text{rand}}$$

Damping constant $\alpha = 0.02$

Anisotropy Dispersion

We have used a log-normal distribution of anisotropy field for the RL. Mean value $<H_k> = 11.5$ kOe. Dispersion $\sigma(H_k) = 0.4$ (corresponds to a FWHM of ~9 kOe). We also used a Gaussian distribution of easy axis for the RL with a FWHM of about 13°.

Remanent Coercivity

We note the remanent magnetization $M_r$ a few nanoseconds after the pulse ends. A high value of $KV/kT$ (~170) ensures a negligible probability of switching after the field becomes zero. Remanent coercivity ($H_{cr}$) is the field which produces $M_r = 0$.

Distribution of Unswitched Grains

- A pulse demagnetization process switches grains over the entire range of $H_k$.
- A DC demagnetization process switches grains with the lowest values of $H_k$.
- Hence it is more difficult to switch a DC demagnetized sample than a pulse demagnetized one.

Role of Initial Remanence

- The counter intuitive dependence of $H_{cr}$ on $M_i$ is reproduced.
- The time scale of initial demagnetization process is unattainable in the simulation, hence an initial state is artificially prepared by selectively switching lowest $H_k$ cells. The process mimics DC demagnetization.
- The simulated value of $H_{cr}$ is within 10% of the experimental value.

Conclusions (Parts 1 & 2)

- $H_{cr}(t)$ in the range 2.3-62 ns is measured. Within the experimental error the data agree with the extrapolation of a long time data using Sharrock’s formula.
- $H_{cr}(t)$ in the nanosecond regime depends on the initial remanent state.
- Simulations show that the effect is sensitive to the time scale of the initial demagnetization process.

Future Work

- Study the dependence of switching field on remanent states with $M_i$ achieved by a pulsed field.
- Check the dependence on the pulse width.
- Study the role of low-coercivity grains – nucleate switching (May lower coercivity without thermal instability).

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