Damping in exchange bias structures


*MINT Center, The University of Alabama*

This project was funded by NSF grant DMR 0804243

**Introduction:**

- Increased linewidth in exchange bias structures well known since Parkin et al PRB 38, 6847 (1988)
- Two-magnon model commonly used to explain origin: Arias & Mills PRB 60, 7895 (1999) and Rezende PRB 63, 214418 (2001)
- No data on frequency dependence of linewidth

**Sample series:**

- NiFe/FeMn - antiparallel
- NiFe(tF)/FeMn(100 nm)
- NiFe/FeMn - parallel
- NiFe(tF)/Cu(10 nm)/FeMn(100 nm)

**Data collection & analysis:**

- Shorted waveguide FMR & coplanar waveguide FMR
- Frequency range up to 70 GHz
- Fully automated data collection & analysis
- Determination of resonance field and linewidth as a function of microwave frequency

**Extrinsic linewidth contribution in biased samples:**

\[ \Delta H_{\text{extrinsic}} = \Delta H_{\text{exchange}} + 2 \alpha \gamma \Delta f \]

Results consistent with model based on two-magnon scattering contribution due to interface roughness

S. M. Rezende et al., PRB 63, 214418 (2001)

**Frequency dependence of linewidth:**

- Linewidth vs. frequency well described by \[ \Delta H_0(\gamma) = \Delta H_0 + \beta \gamma \]
- Large extrinsic & intrinsic contribution to damping in biased samples
- Measured at 90° with respect to bias direction

**Intrinsic damping constant \( \alpha \):**

- \( 1/\alpha \) damping increase in decoupled and unbiased samples agree within error margins
- Caused by spin-pumping from ferromagnet into ideal spin-sink FeMn
- Additional increase in biased samples is unidirectional

**Antiferromagnetic thickness dependence:**

- Damping constant follows the antiferromagnetic thickness dependence of the exchange bias field

**Summary:**

- Spin-pumping contributes significantly to the damping in magnetic multilayers containing antiferromagnets with short spin-diffusion length – this is a non-local effect
- Damping in biased structures is further increased by a unidirectional contribution