MAR13-2012-020284

Abstract for an Invited Paper
for the MAR13 Meeting of
the American Physical Society

Spin Mechanics in Ferromagnet/Ferroelectric Hybrid Structures

SEBASTIAN GOENNENWEIN, Walther-Meissner-Institut, Bayerische Akademie der Wissenschaften, Garching, Germany

In most ferromagnets, magnetic and elastic degrees of freedom are coupled – as evident, e.g., from the hum of a transformer. In the “spin mechanics” scheme, one intentionally exploits magneto-elastic coupling (inverse magneto-striction) to control the magnetization of ferromagnetic films. On the one hand, I will briefly review spin mechanics in the static limit, taking ferromagnetic nickel thin film/piezoelectric actuator hybrid structures as prototype examples [1]. In these hybrids, the application of an electric field to the actuator results in a uniaxial strain, which is transferred into the Ni film. Due to magneto-elastic coupling, the voltage-controlled strain modifies the magnetic anisotropy and thus induces a magnetization reorientation. This allows for a voltage-controlled, fully reversible magnetization orientation manipulation within a range of approximately 90 degrees at room temperature in these hybrids. On the other hand, I will show that the spin mechanics scheme also is operational at GHz frequencies. In the corresponding experiments, we use surface acoustic waves (SAWs) propagating in Ni/$LiNbO_3$ hybrid devices for the all-elastic excitation and detection of ferromagnetic resonance (FMR). Our SAW magneto-transmission data are consistently described by a modified Landau-Lifshitz-Gilbert approach [2], in which the magnetization precession is not driven by a conventional, external microwave magnetic field, but rather by a purely virtual, internal tickle field stemming from radio-frequency magneto-elastic interactions. This causes a distinct magnetic field orientation dependence of elastically driven FMR, observed in both simulations and experiment. Last but not least, I will address perspectives for spin mechanics experiments, e.g., the study of magnon-phonon coupling, or acoustic spin pumping [3] in normal metal/ferromagnet hybrid structures.

[1] M. Weiler *et al.*, New J. Phys. **11**, 013021 (2009).
[2] M. Weiler *et al.*, Phys. Rev. Lett. **106**, 117601 (2011).
[3] M. Weiler *et al.*, Phys. Rev. Lett. **108**, 176601 (2012).