スピン渦度結合によりPtで励起される交流スピン流の温度依存性

Temperature Dependence of Alternating Spin Current Generated in Pt by Spin-Vorticity Coupling

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In 2013, Matsuo *et al*. theoretically proposed a method to produce an alternating spin current in nonmagnetic materials through the coupling of spin and lattice rotation (spin-vorticity coupling, or SVC)[1]. According to the theory, the magnitude of the spin current generated by SVC would depend on both the electrical conductivity and the spin diffusion length of the material. Kobayashi *et al*. succeeded in developing a device in which an alternating spin current was generated through SVC in which the macroscopic rotation was produced by Rayleigh surface acoustic waves (R-SAWs)[2]. However, the magnitude of the spin current as a function of the various parameters of the material has not yet been quantitatively analyzed. In this study, we gauged the dependence of the magnitude of the spin current on conductivity and spin diffusion length by varying these parameters through temperature.

An optical photograph of the SAW device is shown in Fig 1. The device was patterned on a $LiNbO_3$ substrate, a piezoelectric material often used for SAW devices. Electrodes in a comb-like pattern called interdigital transducers (IDTs) that generate and detect SAW were fabricated on a piezoelectric substrate. A rectangular NiFe/Pt bilayer film was deposited between the IDTs. Here, the SAW generates an alternating spin current in the Pt layer, which is then injected into the Py layer. The spin current provides a spin-transfer torque. Consequently, spin wave resonance (SWR) can be induced at a resonant magnetic field. In SWR, the energy of the R-SAW is absorbed at the resonance frequency, leading to its attenuation. We measured the magnitude of this attenuation to determine the magnitude of spin current generated by SVC. Fig. 2 shows an example of the spin current absorption by the Py layer as functions of the external magnetic field and the frequency of the R-SAW. We will examine the temperature dependency of the absorption signal and discuss the contributions from conductivity and spin diffusion length.

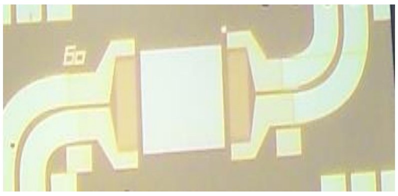

Figure 1: SAW device.

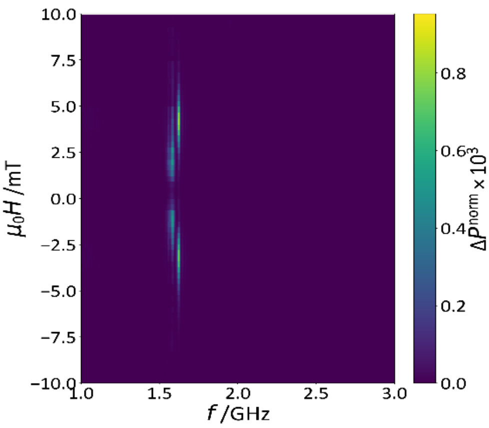

Figure 2: Color plot of SAW absorption through SWR.

[1] M. Matsuo *et al.*, Phys. Rev. B **87**, 180402 (2013).

[2] D. Kobayashi *et al.*, Phys. Rev. Lett. **119**, 077202 (2017).