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スピンポンピングを用いたナノサイズ面内構造素子上におけるスピン注入

Spin injection in a nanometer-sized lateral device by spin pumping

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[Introduction] Spintronics is a technology utilizing the properties of electron spins, which provides with spintronic devices having some attractive features such as high-speed data processing, non-volatility,and low-energy consumption. Although many spintronic devices have been proposed, there still exist some obstacles for actual applications. One of the key issues is to establish a method for effective spin injection into nonmagnetic materials at room temperature. Spin pumping is a way for the spin injection into into a nonmagnetic material [1]: where the magnetization precession in a ferromagnet emits a pure spin current into an adjacent nonmagnetic material through the interface. In contrast to other electrical spin injection methods based on the electric current flow, the use of which are strongly limited due to the impedance mismatch problem [2], the spin current generated by the magnetization dynamics does not require the flow of net charge current, which provides a powerful methods for spin injection. In this study, we investigated the enhancement of Gilbert damping in lateral devices consisting of a Permalloy (Py) element, a Cu wire, and a Pt wire, which were located on a coplanar waveguide (CPW) in order to examine the spin pumping effect in well-controlled nanometer-sized devices.

[Experiment] Figure 1 shows the optical microscope images of the microfabricated lateral device. Thin films were prepared on a thermally oxidized Si substrate. The thin films were patterned into the shape of the device structure through the use of electron beam lithography and Ar ion etching. The RF magnetic field was applied to the Py element by injecting the RF power into the coplanar waveguide, and the resonant linewidth of ferromagnetic resonance spectra (Δf) was evaluated employing a vector network analyzer. In this study, the distance between the Py element and the Pt wire (d) was changed in the range from 100nm to 2 μm (edge to edge). Compared with the device without a Pt wire, the enhancement of Δf was observed for device with d < 400 nm, which is interpreted in a scenario that the spin accumulation in the Cu wire driven by spin pumping, was changed by the spin absorption due to the existence of the Pt wire.

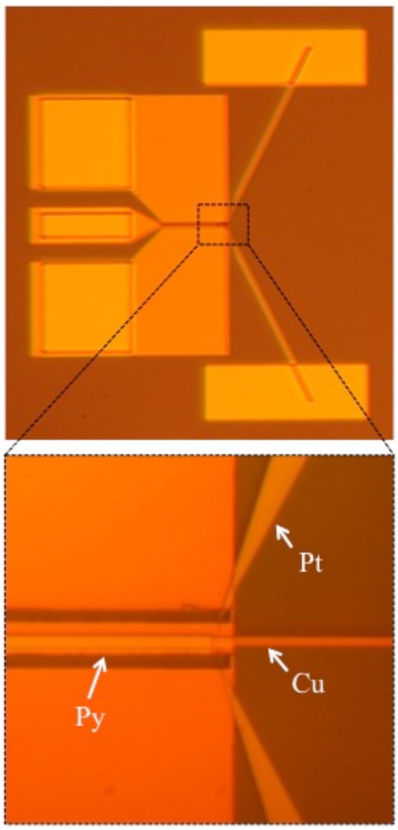

Fig. 1 Optical microscope images of the microfabricated lateral device.

[1] Y. Tserkovnyak *et al.*, Phys. Rev. Lett. **43**, 117601 (2002)
[2] E. I. Rashba *et al.*, Phys. Rev. B. **62**, R16267 (2000)