27p-PB2-4

ナノサイズ面内構造素子におけるスピンポンピング効果の評価

Characterization of a spin pumping effect in nanosized lateral devices

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[Introduction] Spintronics, which simultaneously utilizes the charge and the spin of electrons, provides us with a solution to essential problems for existing electronic devices, such as the limitation of integration and high energy consumption for the device operation. In order to develop high performance spintronic devices, it is necessary to understand the spin transport properties in ferromagnetic and nonmagnetic materials. There are several ways to inject spin current into a material, and to evaluate its spin diffusion length. Spin pumping is an effective way to inject pure spin current into not only a nonmagnetic metal[1] but also a nonmagnetic semiconductor[2] because this method is free from the impedance mismatch problem between the metal and the semiconductor. Although previous studies reported the spin-injection by means of spin pumping in the stacked thin films, the spin pumping effect has not been examined in well-controlled nanosized devices, which is important to design an actual spintronic device structure. In this study, we characterized the spin pumping effect in the lateral devices consisting of a Permalloy (Py) element, a Cu nanosized wire, and a Pt wire, which were located on a coplanar waveguide (CPW).

[Experiment] Figure 1 shows a schematic illustration for the nanosized 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 milling. The RF magnetic field was applied to the Py element by injecting the RF power into the CPW, and the resonant linewidth of ferromagnetic resonance (FMR) spectra was evaluated employing a vector network analyzer. For the devices without a Pt wire, a clear single peak structure was observed in the FMR spectra, and the magnetic field dependence of peak frequency was interpreted by the Kittel's relationship. However, the peak structure was significantly changed when the Pt wire was attached with the Cu wire. This change in the spectral shape might be due to the spin pumping effect into the Cu wire attached with Pt.

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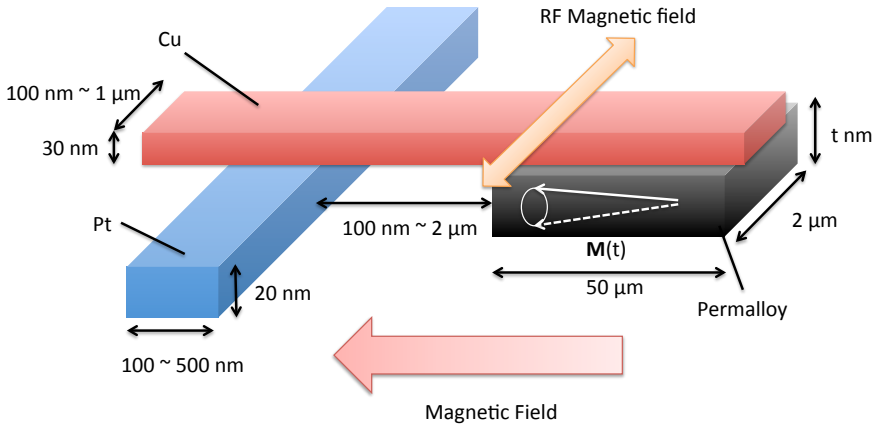

Figure 1　　A schematic illustration for the nanosized lateral device.