Ionic-gate tuning of spin-torque ferromagnetic resonance in nanometer-thick platinum

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Platinum (Pt) possesses large spin-orbit interaction (SOI) and is often selected as a material to study the spin-charge conversion, namely the spin Hall effect (SHE) and its inverse effect (ISHE). A previous study [1] showed that the ionic-gate tuning of the resistance and the ISHE in Pt, and these effects were prominent when the thickness of Pt was thinner than 3 nm. Given that the SHE and the ISHE are interconnected by Onsager reciprocity, detection of the reciprocal effect of the gate-tunable ISHE in a nanometer-thick Pt, i.e., a gate-tunable SHE, can be expected. Here, we demonstrate an ion-gate tuning of the spin-torque ferromagnetic resonance (STFMR) by using a Pt/NiFe (Py) bilayer film.

Figure 1 shows the experimental scheme of the ionic-gate tuning of the STFMR. A Pt(1.2 nm)/Py(3.0 nm) bilayer was deposited on a MgO substrate by electron-beam evaporation. An RF current was injected into the bilayer and a static magnetic field was applied along 45° to the longer direction of the bilayer. Figure 2 shows the gate voltage dependence of the Gilbert damping parameter of Py, α. The Gilbert damping parameter decreased with increasing gate voltage, and this result can be explained by the ion-gate tuning of the SOI and the SHE in Pt.

[1] S. Dushenko *et al*., Nature Communications **9**, 3118 (2018).

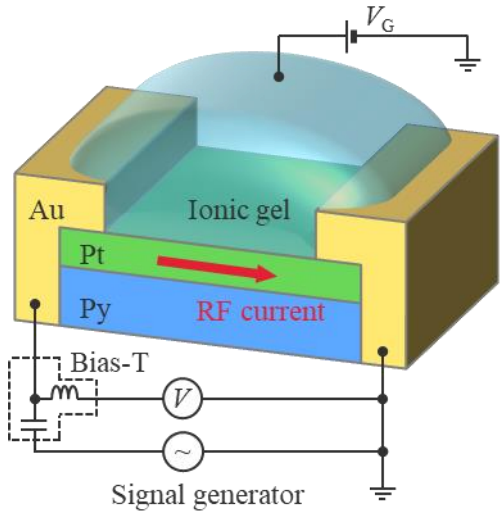

Fig. 1 Experimental setup

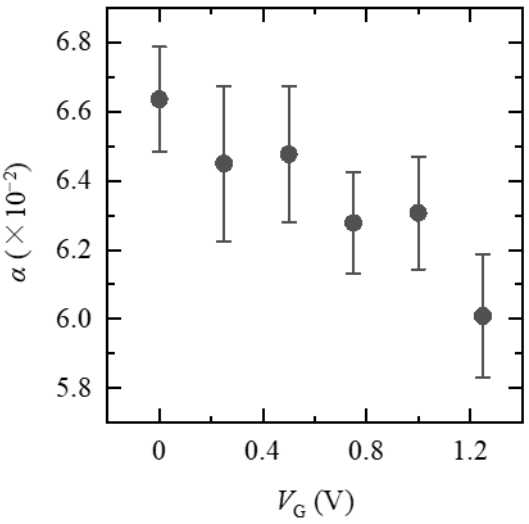

Fig. 2 Gate voltage, V_G dependence of the Gilbert damping parameter of Py, α.