Pt/Cu/Co 系における一方向性スピンホール磁気抵抗の増大

Enhanced unidirectional spin Hall magnetoresistance in Pt/Co system with Cu spacer

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Magnetoresistance is a central theme in spintronics and its enhancement is a critical issue. Recently discovered unidirectional spin Hall magnetoresistance (USMR) is completely different from common magnetoresistances because of its distinctive property; it is odd in current and magnetization direction [1]. The modulation of interface resistance induced by spin accumulation is one of the mechanisms, in analogy to giant magnetoresistance [1,2]. In this study, we have investigated the USMR in Pt/Cu/Co system, where Cu/Co interface has strong spin-dependent scattering potential, to clarify the role of interface structure.

We prepared in-plane magnetized Ta(1.0 nm)/Pt(3.0 nm)/Cu(t_{Cu})/Co(2.5 nm)/MgO(2.8 nm)/Ta(0.7 nm) layers on thermally oxidized Si substrate by rf sputtering (Pt/Cu/Co system). We also prepared similar structures with Au(t_{Au}) spacer as references (Pt/Au/Co system). Second harmonic resistance that represents USMR was measured while rotating external magnetic field of 4 T in xy-plane (Fig. (a)). Fig. (b) shows the angle dependences of normalized second harmonic resistance in Pt/Co system (t_{Cu}=0 nm) and Pt/Cu(1.5 nm)/Co system. USMR in Pt/Cu/Co system is about 1.5 times larger than that in Pt/Co system. This result demonstrates the interfacial origin of the enhanced USMR. Fig. (c) shows the $t_{Cu(Au)}$ dependence of USMR, where $\Delta R_{2\omega}^{USMR}/R = \left|R_{2\omega}^{USMR}(90°) - R_{2\omega}^{USMR}(270°)\right|/R$. USMR initially increases with t_{Cu}, then decreases for t_{Cu}>1.5 nm due to current shunting into Cu layer. In contrast, USMR in Pt/Au/Co system monotonically decreases with t_{Au}, indicating that appropriate choice of material is important to achieve enhancement through interface engineering.

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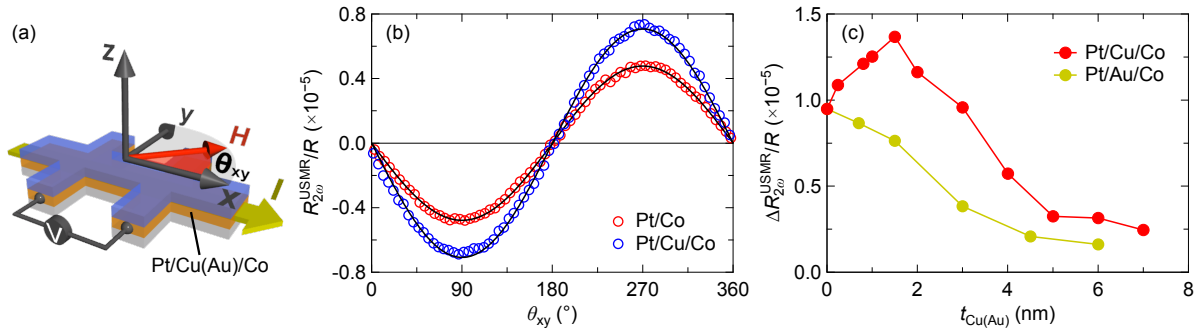

Figure. (a) Schematic illustration of the experimental setup and coordinate system. (b) Angle dependence of second harmonic resistance at current density of 1×10^{11} A/m^2. Solid lines are sine curve fits. (c) Cu (Au) thickness dependence of USMR.

[1] C. O. Avci et al., *Nat. Phys.* **11**, 570 (2015). [2] C. O. Avci et al., *Phys. Rev. Lett.* **121**, 087207 (2018).