Pt/CoO/Co 系におけるスピン軌道トルクの温度依存性

Temperature dependence of spin-orbit torque in Pt/CoO/Co system

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To clarify physics behind the spin-orbit torque (SOT) in ferromagnet/heavy metal heterostructures is one of issues for realizing highly efficient magnetization switching. Previously, we have shown that the SOT in a perpendicularly magnetized Co/Pt system is significantly enhanced by inserting a thin oxidation layer (CoO) into Co/Pt interface [1]. As origins of the enhancement, two possible mechanisms have been suggested; one is efficient spin current transmission across CoO spacer due to its antiferromagnetic nature and the other is enhanced Rashba-Edelstein effect at the Co/Pt interface. In this study, we have investigated the temperature dependence of SOT in Pt/Co systems with antiferromagnetic insulator spacers (CoO or NiO) in order to reveal the correlation between SOT and the antiferromagnetic nature of spacer layer.

We prepared in-plane magnetized Ta/Pt/Co/MgO/Ta layers (Pt/Co system) and Ta/Pt/CoO (NiO)/Co/MgO/Ta layers (Pt/CoO/Co and Pt/NiO/Co systems) on thermally oxidized Si substrates. The blocking temperatures of both CoO and NiO layers were determined to be about 100 K.

If the antiferromagnetic nature of CoO and NiO layers is crucial, temperature dependence of SOT is expected to show some anomalies around Néel temperature [2]. However, SOT in the Pt/CoO/Co and Pt/NiO/Co systems varies monotonically with temperature (see Fig.). In addition, the effect of inserting NiO spacer on SOT is completely different from that of CoO. Therefore, the antiferromagnetic nature of spacer layer does not play a key role in generating SOT and the Rashba-Edelstein effect seems to be important for significantly modulated SOT in the Pt/CoO/Co system.

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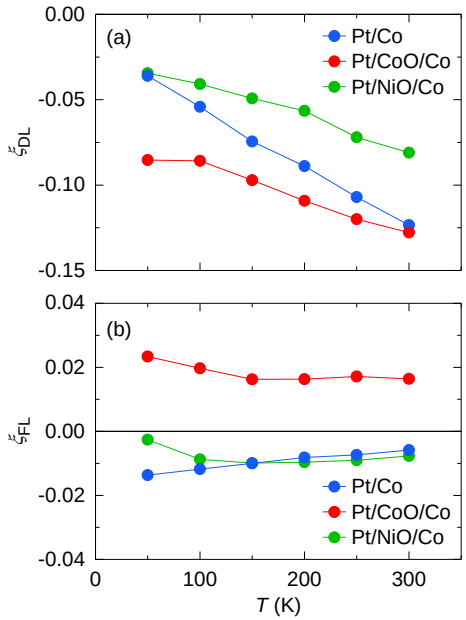

Figure. (a) Temperature dependences of the damping- and (b) field-like SOT efficiencies for Pt/Co, Pt/CoO/Co, and Pt/NiO/Co systems.

[1] K. Hasegawa et al., *Phys. Rev. B* **98**, 020405(R) (2018).

[2] W. Lin et al., *Phys. Rev. Lett.* **118**, 067202 (2017).