Co/CoO_x/Pt 系におけるスピン軌道トルクの増大

Enhancement of spin-orbit torque in Co/CoO_x/Pt structures

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Enhancement of current-induced torques on magnetization, including spin-orbit torque (SOT) in ferromagnet/heavy-metal bilayer structure, is crucial for magnetic memories operating with an electrical current. Our group has previously reported the enhancement of the field-like (FL) SOT in a Pt/Co system by oxidizing the Co surface (Pt/Co/CoO_x structures) [1]. In this study, the effect of the oxidation was investigated using Co/CoO_x/Pt structures, in which the Pt layer as a spin current source was directly deposited on the oxidized Co surface, to understand the role of the oxidized interface.

Ta(3.0 nm)/Pd(3.0)/Co(t_{Co}) structures were deposited from the bottom side on the thermally oxidized Si substrate. Subsequently, the Co surface was exposed to the air in order to form CoO_x layer (oxidized sample). After that, the 2.7-nm thick Pt layer was deposited onto it. From the measurement of the saturation magnetic moment, the CoO_x thickness in this study was determined to be ~0.8 nm. The similar structure without CoO_x layer (un-oxidized sample) was also prepared as a reference.

SOTs in un-oxidized and oxidized samples with several Co thickness were determined by the harmonic Hall voltage measurement. The thermal effect on the second harmonic voltage was subtracted from the result [2]. The figure shows the longitudinal effective fields ($\mu_0 H_L$) associated with the damping-like torque as a function of a current density injected into the sample for the oxidized and un-oxidized samples with nearly the same areal saturation magnetization. $\mu_0 H_L$ for the oxidized sample was clearly larger than that for the un-oxidized sample even though the CoO_x layer existed between the Co and Pt layers. We also confirmed that the FL torque was larger in the oxidized sample. The enhancement of the SOT by inserting the oxidization layer to the interface of the ferromagnet/heavy-metal bilayer structure is expected to provide a new information on the physics of the SOT.

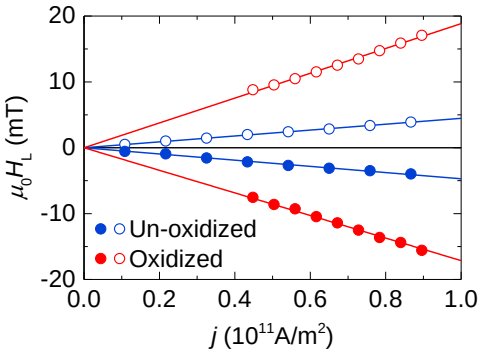

Figure. Longitudinal effective field ($\mu_0 H_L$) for un-oxidized and oxidized samples.

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[2] A. Ghosh *et al.*, *Phys. Rev. Appl.* **7**, 014004 (2017)