垂直磁化した Pt/Co と Pd/Co 系におけるスピン軌道トルクの温度依存性

Temperature dependence of the spin-orbit torque in perpendicularly magnetized Pt/Co and Pd/Co system

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Switching of magnetization direction using the spin-orbit torque (SOT) is intensively studied in the research field of spintronics [1,2]. The SOT effect can be observed in the system of ferromagnetic material/heavy metal (FM/HM) heterostructure. Although the Spin Hall effect in the HM layer is considered to be crucial for the SOT [2], it is also suggested that the interfacial effect at the FM/HM interface such as Rashba effect contributes to the torque [1]. Investigation of temperature dependence of the SOT is expected to be helpful to understand the detailed mechanism. In this work, we investigate temperature dependence of the SOT in perpendicularly magnetized Pt/Co and Pd/Co systems.

The multilayers of Pt/Co and Pd/Co were deposited on the thermally oxide Si substrate using rf sputtering. The SOT effective field was investigated using the harmonic Hall voltage measurement [3, 4]. The measurement was performed in PPMS to control the sample temperature T. The figure shows T dependence of the longitudinal and transverse effective field ($\mu_0 H_L$ and $\mu_0 H_T$) per current density flowing in the HM layer J_N. In both systems, monotonous increase of $\mu_0 H_L$ and $\mu_0 H_T$ with increasing T is observed. In particular, $\mu_0 H_L$ shows a strong T dependence, which differs from the Ta/CoFeB case [4]. The T dependence of the SOT originates from the temperature dependence of the Spin Hall effect in Pt(Pd) or the proximity induced magnetism in Pt(Pd) at the interface of Co [5]. In addition, we observed that in the Pd/Co system, the polarity of the effective field changes with temperature in both longitudinal and transverse component. This might indicates the existence of the strong interfacial effect such as Rashba effect at the Pd/Co interface.

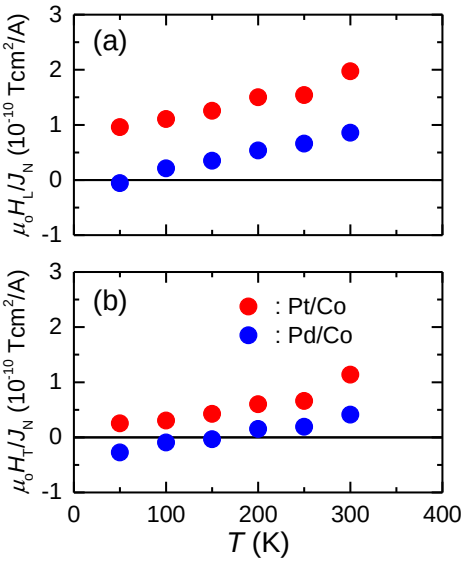

Figure: Temperature dependence of the SOT effective field per unit current density. (a) and (b) shows the longitudinal and transverse component of the effective field respectively.

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