Giant spin-orbit torque and magnetothermal effects in sputtered BiSb/CoFeB bilayers

The Univ. of Tokyo[1], NIMS[2]
°(D)Zhendong Chi[1,2], YongChang Lau[1,2], Masamitsu Hayashi[1,2]
E-mail: z.chi@qspin.phys.s.u-tokyo.ac.jp

Spin-orbit torques (SOT) in heavy metals/ferromagnet heterostructures has attracted particular attention for its high potential in manipulating the magnetization of a ferromagnet in nano-scale. SOT acting on a ferromagnet can be quantified by measuring the change of the Hall resistance with respect to currents and magnetic fields. Recently, using this protocol, giant room temperature SOT was reported in sputtered $Bi_{1-x}Sb_x$ [1] and MBE grown BiSb topological insulator thin films [2]. However, it has also been pointed out that the strong ordinary Nernst effect (ONE) in these Bi-based alloys, in addition to other magnetothermal effects (anomalous Nernst effect (ANE), spin Seebeck effect (SSE), etc.) may give rise to signal that interferes with the electrical quantification of SOT based on Hall resistance measurements [3].

In this work, using the second harmonic Hall resistance ($R_{2\omega}$) technique, we systematically studied the SOT and the magnetothermal effects in BiSb/CoFeB bilayers prepared by magnetron sputtering. The $R_{2\omega}$ signals of the bilayers with two different BiSb thicknesses are plotted as a function of external field azimuthal angle in Fig. 1. The sign change of the amplitude of $R_{2\omega}$ with varying external field strength is attributed to competition between the SOT-induced $R_{2\omega}$ that decays with field and the ONE induced $R_{2\omega}$ that increases linearly with fields. The distinct field dependence allows unambiguous separation of the magnetothermal contributions from $R_{2\omega}$ and accurate quantification of the giant SOT in BiSb/CoFeB bilayers. The BiSb thickness, temperature and BiSb alloy composition dependence of $R_{2\omega}$ results will be discussed in the presentation.

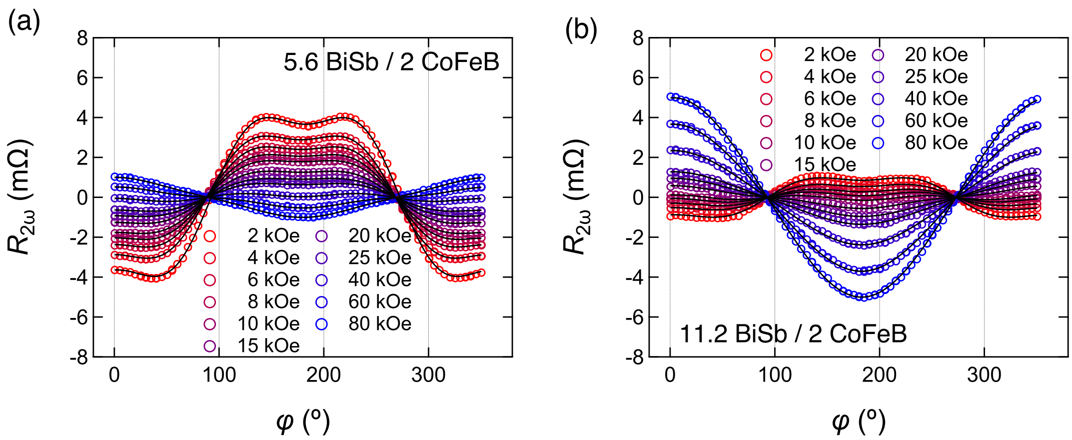

Fig. 1 $R_{2\omega}$ of 5.6 nm BiSb/2 nm CoFeB (a) and 11.2 nm BiSb/2 nm CoFeB (b) bilayers plotted as a function of external field azimuthal angle of varing strength.

Reference

[1] Mahendra DC *et al.*, Nat. Mater. **17**, 800-807 (2018).
[2] N. Khang *et al.*, Nat. Mater. **17**, 808-813 (2018).
[3] N. Rochewsky *et al.*, arXiv:1810.05674 (2018).