垂直磁気異方性を有する $SmFe_2$ に作用するスピン軌道トルクの検出

Detection of spin-orbit torque on magnetostrictive $SmFe_2$ thin films with perpendicular magnetic anisotropy for piezoelectronic magnetic tunnel junctions

東工大工　○(M1)佐々木 康宣, 白倉 孝典, (M1)桝田功貴, 高村陽太, 中川茂樹

Tokyo Tech, ○Yasunobu Sasaki, Takanori Sirokura, Katsuki Masuda,

Yota Takamura, Shigeki Nakagawa

E-mail: sasaki.y.bf@m.titech.ac.jp

We have proposed stress-assist magnetization reversal (SAMR) for ultra-low power consumption nonvolatile memories[1]. To realize magnetic memories using SAMR, an understanding of spin injection to a SAMR material is strongly required. However, there is no report on spin injection to a SAMR material despite their novel functionalities. In this study, we detected pure spin current injection to a kind of SAMR material, $SmFe_2$, by measuring second harmonic method[2].

A $SmFe_2$ thin film was sputtered on a Ta-buffered Si/SiO_2 substrate at 200°C and capped with a Ta layer. Subsequently annealing was performed at 450°C in a vacuum for 1 hour. The multilayer was patterned into a Hall bar shape with 200×1000 μm^2 by photolithography and ion-milling, as shown in Fig.1.

Figure 2 shows second harmonic Hall resistances as a function of the azimuth angle φ_H of an external magnetic field, where applied current density was 4.2×10^5 A/cm^2, and the magnetic field strength was set to 1.8 and 9.4 kOe. $R_{xy}^{2\omega}$-φ_H, carves were reproduced by $\cos\varphi_H$, which is originated from the damping-like spin-orbit torque (SOT) and anomalous Nernst effect. The amplitude of the $\cos\varphi_H$ component also depended on the magnetic field strength, which implies the existence of the SOT contribution.

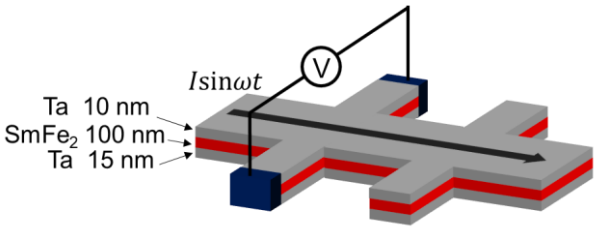

Fig. 1 Structure of a sample

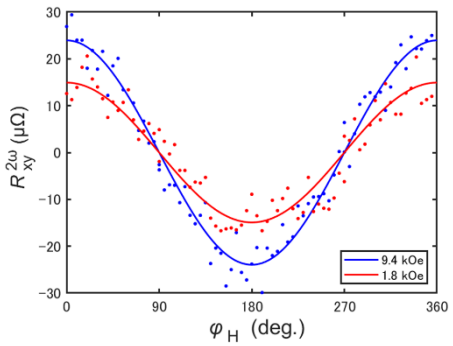

Fig. 2 Second harmonic Hall resistances measured at 1.8 and 9.4 kOe

Acknowledgements: The authors thank Prof. P. N. Hai for help on SOT measurements and ARIM at Tokyo Institute of Technology for help on photolithography processes.

Refs: [1] N. Saito, M. Yamada, S. Nakagawa, J. Appl. Phys. **103**, 07A706 (2008). [2] C. O. Avci, *et al*. Phys. Rev. B **90**, 224427 (2014).