Spin-torque ferromagnetic resonance in CoFe / Ti / FeNi trilayers

◦Yuya Koike[1,2], Satoshi Iihama[2,3], Shigemi Mizukami[2,3,4]

Tohoku Univ. [1], WPI-AIMR, Tohoku Univ. [2], CSRN, Tohoku Univ.[3],

CSIS, Tohoku Univ.[4]

E-mail: yuya.koike.p8@dc.tohoku.ac.jp

Magnetization switching using spin-orbit torque (SOT) has attracted much attention for high-speed spintronic devices. Conventionally, an in-plane external or effective magnetic field is applied for SOT switching of the out-of-plane magnetization. However, a field-free switching is more desirable and physically possible when an injected spin current has a spin direction perpendicular to a film plane. One of the promising ways is to use ferromagnet (FM) as a spin current source [1]. In addition, it was recently reported that FM/nonmagnet (NM) interface generates such spin current [2]. However, the SOT for such FM/NM/FM trilayer has not been intensively studied. Here, we performed spin-torque ferromagnetic resonance (ST-FMR) measurements in CoFe/Ti/NiFe trilayer to gain insights into the spin current inherent in trilayer system.

Film staking was thermally-oxidized Si substrate/CoFe(5, 10, 20)/Ti(3)/NiFe(4)/Ti(2) (thickness is in nm). We suppose that the bottom CoFe generates spin current which exerts SOT on the top NiFe. Typical result of ST-FMR is shown in Fig. 1(a). The data for each frequency consists of two FMR signals. The FMR signal with a lower and higher resonance field is attributed to that for the CoFe and NiFe layer, respectively. Frequency dependence of the resonance field for the NiFe layer is shown in Fig. 1(b). The experimental data was well fitted to the data calculated with Kittel's formula using reasonable parameter sets. This indicates negligible interlayer coupling between the CoFe and NiFe layers. The evaluation of the SOT from the ST-FMR curves is also discussed.

This study was supported in part by KAKENHI (K19K154300).

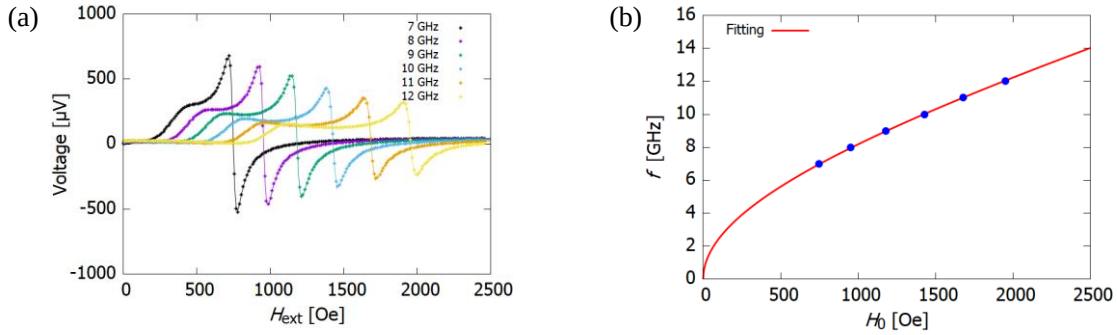

Figure 1 (a)The ST-FMR spectra for CoFe(5)/Ti(3)/NiFe(4) trilayer. (b)The resonance field for the NiFe layer obtained with different frequency of the injected microwave.

[1] T. Taniguchi *et al*. Phys. Rev. Appl. **3**, 044001 (2015), S. Iihama *et al*. Nat. Electro. **1**, 120 (2018)
[2] S. C. Baek *et al*. Nat. Mater. **17**, 509 (2018).