Observation of mode splitting by magnon-magnon coupling in synthetic antiferromagnets

ICR, Kyoto Univ. [1], CSRN, Kyoto Univ.[2], ○Daiju Hayashi[1], Yoichi Shiota[1,2], Mio Ishibashi[1], Ryusuke Hisatomi[1,2], Takahiro Moriyama[1,2], Teruo Ono[1,2]

E-mail: hayashi.daiju.67s@st.kyoto-u.ac.jp

Interlayer exchange-coupled synthetic antiferromagnets (SAFs) have been attracting attention because their magnetization can be easily controlled by external fields maintaining the advantages of antiferromagnetic dynamics. It is known that the magnons on in-plane magnetized SAFs have two resonance modes: an acoustic mode and optical mode, corresponding to the in-phase and out-of-phase precession in two magnetizations, respectively [1]. In our recent study, it was found that the hybridization of two modes, called magnon-magnon coupling, can be realized due to the dynamic dipolar interactions [2]. Those results were measured by the electrical spin wave spectroscopy technique with the microwave reflection occurring from the coplanar waveguide. In this study, we measured the magnon propagation on SAFs using a heterodyne-magneto-optical Kerr effect (MOKE) technique [3] and obtained magnon dispersion relation which is important to understand the properties of magnons.

The SAF structures of Ta(3)/Ru(3)/$Fe_{60}Co_{20}B_{20}$(15)/Ru(0.6)/$Fe_{60}Co_{20}B_{20}$(15)/Ru(3) (thicknesses in nm) were fabricated using dc magnetron sputtering on thermally oxidized Si substrates. The films were micro-fabricated to spin wave devices, as presented in Ref. [3]. Magnons were excited by applying microwave current to the antenna from the port 1 of a vector network analyzer (VNA). Then the magnetization precession dynamics were detected using a focused laser beam in the polar MOKE geometry, which enable to detect only acoustic magnon, and the optical heterodyne signal was send to the port 2 of the VNA. In this measurement, the intensity and phase of the propagating magnon were obtained. Figure 1 shows the experimentally obtained dispersion relation of the acoustic magnons from the complex fast Fourier transformation of the obtained signals under the in-plane magnetic field of 38.1 mT to 45° away from the direction of the magnon propagation direction. A pronounced mode splitting was observed in negative-*k* region, indicating the anticrossing of magnon dispersion relations between acoustic and optical magnons. Further investigation, such as the dependences on magnetic field strength and angle, will be discussed in the presentation.

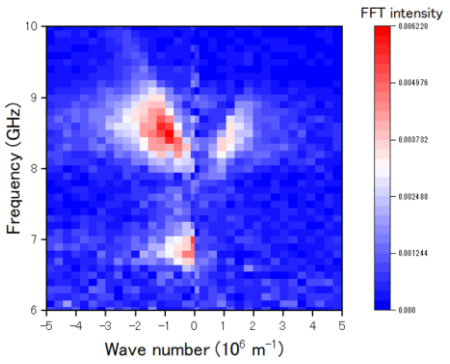

Fig. 1　Dispersion relation of acoustic magnons on SAFs.

[1] Z. Zhang *et al., Phys. Rev. B.* **50,** 6094–6112(1994). [2] Y. Shiota *et al., Appl. Phys. Lett.* **116,** 192411(2020). [3] Y. Shiota *et al., Phys. Rev. Lett.* **125,** 017203 (2020)