Spin Wave Resonance in Perpendicularly Magnetized Synthetic Antiferromagnets

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Spin wave polarization, i.e. the rotation direction of magnetic moments around an applied magnetic field, has been attracted much attention for a new freedom degree of spin waves in addition to spin wave amplitude and phase. Unlike ferromagnetic spin waves, antiferromagnetic spin waves in colinear antiferromagnets have both right and left-handed polarizations [1,2]. However, spin waves in crystal antiferromagnets have high resonance frequency of THz regime due to strong exchange coupling, which can cause difficulties in excitation or manipulation of spin waves. In this study, we experimentally demonstrate spin wave resonance in perpendicularly magnetized synthetic antiferromagnets by spectroscopy using a vector network analyzer.

Films of Ta(3.0)/Pt(2.0)/[Co(0.2)/Ni(0.7)]$_5$/Co(0.2)/Ru(0.5)/Co(0.2)/[Co(0.2)/Ni(0.7)]$_5$/Ru(3.0) (thickness in nm) were deposited using dc magnetron sputtering on thermally oxidized Si substrates. The films were fabricated to devices for spin-wave-spectroscopy as shown in Fig. 1 (a). Figure 1 (b) shows a contour plot of spin wave resonance spectra (k = 1.2 μm) generated from Re[S_{11}] spectra measured at a given out-of-plane bias magnetic field. The applied magnetic field swept from +250 mT to –250 mT with a step of 10 mT. Two resonance modes were observed from 130 mT to - 190 mT, where the two magnetic moments were antiferromagnetically aligned. These two resonance frequencies increase and decrease linearly with the bias magnetic field, which indicates excitation of right and left-handed polarized spin waves. In the presentation, we will discuss more details with theoretical analysis based on the equation of motion.

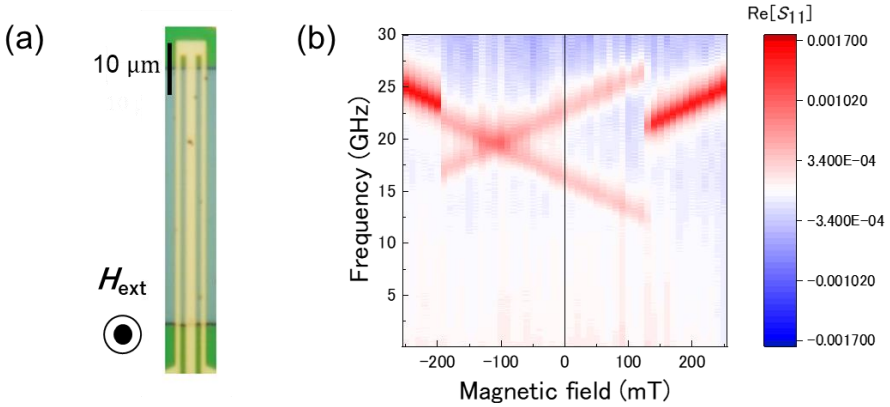

Fig.1 (a) Optical micrograph of the device. (b) Contour plot of Re[S_{11}] spectra.

[1] F. Keffer and C. Kittel, Phys. Rev. **85**, 329 (1952).

[2] F. Keffer, H. Kaplan, and Y. Yafet, Am. J. Phys. **21**, 250 (1953).