Investigation of magnon absorption from $Y_3Fe_5O_{12}$ into metals

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Magnon has a potential to be a new information carrier because of its Joule-heating-less and long-distance propagation in ferromagnets [1]. Recently, Das *et al.* demonstrated that magnon in $Y_3Fe_5O_{12}$ (YIG) is absorbed into an adjacent ferromagnet, Ni-Fe alloy (Py), and the absorption can be modulated by the magnetization direction of the Py [2]. Although this study makes a progress toward a realization of magnonic device, a detailed principle of magnon absorption into metals has not been sufficiently clarified yet. Here, we study magnon propagation with several metallic middle strips (MSs), Py, Co, and Pt, to explore the mechanisms of magnon absorption into metals.

Figure 1 shows a schematic of the fabricated device. Ti (3 nm)/Au (150 nm) coplanar wave guides antennas with the center-to-center distance of 210 μm and a metallic MS with a width of 100 μm were fabricated on a YIG substrate (5 μm) using RF magnetron sputtering and electron-beam deposition. An external magnetic field (***B***) applied to the device was swept from 50 mT to 140 mT. AC current with the power of 0 dBm and frequencies from 3 to 7 GHz was injected into the antenna using vector network analyzer and magnons were excited by the induced AC magnetic field. Magnons propagating in YIG were partially absorbed by the MS and detected by the other antenna as an induced AC magnetic field. We measured the S_{21} parameter as an index of the amount of the propagating magnons and calculated $\Sigma|S_{21}|$, which is defined as $\Sigma|S_{21}| = \int_{50}^{140} |S_{21}|\, dB$ to compare the amounts of the propagating magnons among the different devices. Figure 2(a) shows the |S21| from the device with Py-MS and from the device without MS. Figure 2(b) shows the MS-thickness (t) dependences of $\Sigma|S_{21}|(t)$ normalized by $\Sigma|S_{21}|(0)$ for each metal. The absorption with Py- and Co-MSs was larger than that with Pt-MS, indicating that magnetism in MS plays an important role in the absorption. We will discuss a possible mechanism of magnon absorption in the presentation.

[1] A. V. Chumak *et al.*, Nature Physics **11**, 453 (2015).
[2] K. S. Das *et al.*, Physical Review B **101**, 054436 (2020).

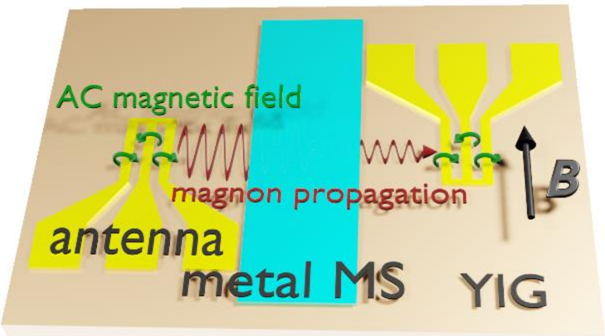

Fig.1 A schematic of device structure for demonstration of magnon absorption.

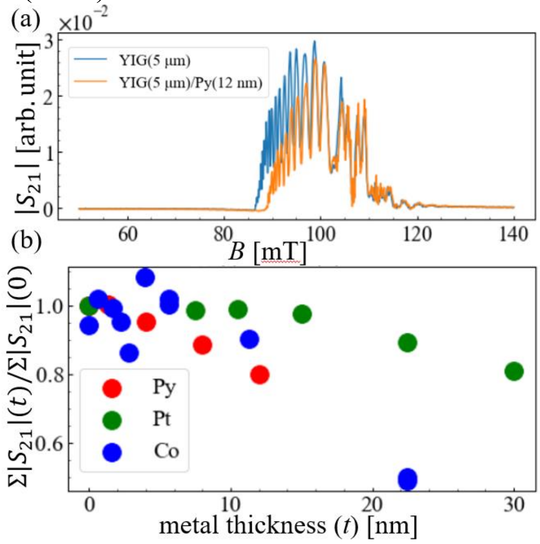

Fig.2 (a) the comparison of propagating magnons between the devices with or without Py-MS.
(b) MS-thickness dependence of Σ|S21|(t)/ Σ|S21|(0).