Influence of Pd layer insertion at Fe/MgO interface on spin-wave dynamics

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Spin-wave can be used as a characterization method of interfacial perpendicular magnetic anisotropy (PMA) and Dzyaloshinskii-Moriya interaction (DMI). Previously, voltage inductions of PMA and DMI have been successfully demonstrated in Fe/MgO multilayer proved by the spin-wave spectroscopy [1]. In this study, to enhance the modulation, we insert the Pd layer which has large spin-orbit interaction, at the Fe/MgO interface.

The structure of sample is depicted in Fig. 1. The epitaxial multilayer stacks MgO(001) substrate/MgO(5 nm)/V(20 nm)/Fe(20 nm)/Pd(t_{pd}=0-1 nm)/MgO(5 nm) was fabricated using the molecular beam epitaxy under ultrahigh vacuum. The MgO (5 nm) and the V (20nm) were deposited at 150°C. The V and Fe layer were post-annealed at 500°C for 30 minutes and 250°C for 15 minutes, respectively. After that, the sample was encapsulated by sputtering of 50 nm SiO_2. Micro-sized antennas were prepared onto it to generate and detect spin-waves. An in-plane external magnetic field is applied normal to the spin-wave propagation direction to excite magneto-static surface spin-wave (MSSW). Using a vector network analyzer, the resonant frequency of MSSW in the Fe was characterized by using S_{11} measurement. Figure 2 shows an effective magnetic field from interface PMA in the system (H_{int}), which is estimated from the resonant frequency of MSSW. By increase the Pd thickness the interfacial magnetic anisotropy field H_{int} increase rapidly and then decline as the thickness continue to increase. The critical thickness of the Pd, which maximize the H_{int} was about 0.2 nm (around 1ML thick of Pd). Our result trend agrees with previous work with sputter-deposited Co/Pd/MgO system [2], but the critical thickness of the Pd was different (around 1.7 nm in Ref. 2). In the presentation, voltage induction of the PMA and DMI will be discussed. This work was partially supported by ImPACT program and JSPS KAKENHI (No. 26103002)

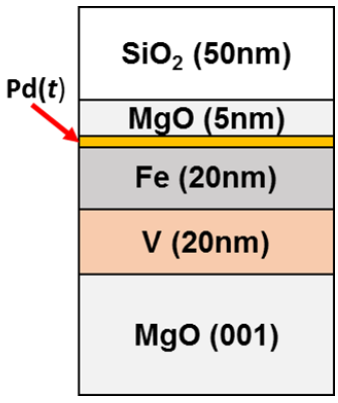

Fig. 1. Schematic of sample structure

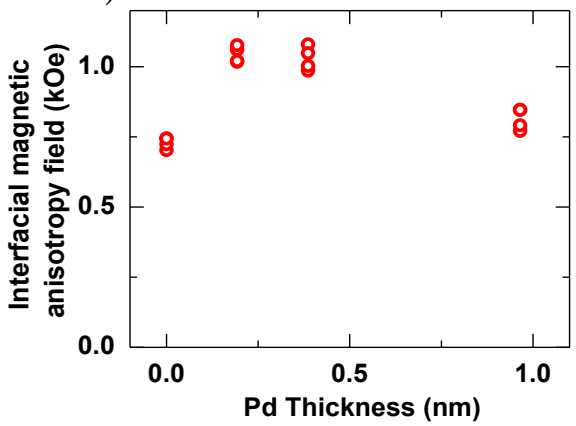

Fig. 2. Pd thickness dependence of interfacial magnetic anisotropy field

[1] K. Nawaoka *et al.*, APEX 8, 063004 (2015). [2] Y. Hibino *et al.*, APEX 8, 113002 (2015).