18a-C15-1

MgO/Co_2FeAl 界面における垂直磁気異方性の電界変調

Electric-field modulation of perpendicular magnetic anisotropy at MgO/Co_2FeAl interface

東北大 CSIS[1]，東北大 RIEC[2]　○辻川　雅人[1]，森　大樹[2]，三浦　良雄[2,1]，白井　正文[2,1]

CSIS, Tohoku Univ.[1], RIEC, Tohoku Univ.[2],

○Masahito Tsujikawa[1], Mori Daiki[2], Yoshio Miura[2,1], Masafumi Shirai[2,1]

E-mail: t-masa@riec.tohoku.ac.jp

Recently, the large perpendicular magnetic anisotropy (PMA) is found at the interfaces between ferromagnetic metals and oxides such as MgO/CoFeB [1]. The large PMA is also reported for the interfaces between MgO and Heusler alloy Co_2FeAl (CFA) [2], or $Co_2FeSiAl$ [3]. These Heusler alloys are promising candidates for applications in spintronics due to the high spin polarization and low dumping constant. Moreover, the magnetic anisotropy at the insulator/ferromagnet interface can be controlled by the electric field [4, 5]. This electric-field effect is a key technology for realizing the ultra-low energy consumption magnetization switching. In this work, we reveal the origin of the PMA at the MgO/CFA interface and explore the potential for the electric-field control of the PMA.

We have carried out first-principles electronic structure calculations based on the projector augmented-wave with plane wave basis set by using the Vienna ab initio simulation package [6]. We investigated magnetic anisotropy and its electric-field modulation in the MgO/CFA/Au junction. The magnetic anisotropy energy (MAE) is evaluated by using the force theorem.

The MAE is estimated to be 1.28 and -0.78mJ/m^2 for the MgO/CFA/MgO junctions with Co- and FeAl-terminated interfaces, respectively. The Co-terminated (FeAl-treminated) interface has the perpendicular (in-plane) anisotropy. In MgO/CFA/Au junctions with both the Co- and the FeAl-terminated interfaces, the PMA is increased linearly with increasing negative electric field, which shows the same tendency with the experimental result in MgO/FeCo and MgO/CoFeB junctions [4, 5]. The variation of the MAE with respect to the electric field is 22fJ/Vm and 11fJ/Vm for the Co- and the FeAl-terminated interfaces, respectively. The variation is in the same order of magnitude with that in the MgO/Fe/Au junction.

This work was supported by JSPS though the FIRST Program initiated by the CSTP and a Grant-in-Aid for Scientific Research (Grant No. 22360014) from JSPS.

[1] S. Ikeda *et al.*, Nature Mater. **9**, 721 (2010). [2] Z. Wen *et al.*, Appl. Phys. Lett. **98**, 242507 (2011). [3] W. Sheng *et al.*, Chin. Phys. B, **22**, 057305 (2013). [4] T. Nozaki *et al.*, Appl.Phys. Lett. **96**, 022506 (2010). [5] M. Endo *et al.*, Appl. Phys. Lett. **96**, 212503 (2010). [6] G. Kresse *et al.*, Phys. Rev. B **49**, 14251 (1994).