Influence of alkali halide insertions on magnetic anisotropy at the Fe/MgO interface

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Perpendicular magnetic anisotropy (PMA) is essential for magnetic tunnel junctions as it leads to device miniaturization. Recently, Nozaki *et al*. reported that an ultrathin LiF insertion at the Fe/MgO interface considerably enhances PMA while keeping the tunnel magnetoresistance [1, 2]. Motivated by this finding, in the present study, we inserted various alkali halide layers at the Fe/MgO interface and examined the contribution of electronegativity and spin-orbit interaction of anion atoms to PMA [3].

We fabricated epitaxial Fe/alkali halide (LiF, NaCl, or CsI)/MgO multilayers by molecular beam epitaxy [Fig. 1(a)]. The crystallinity of each layer was examined by reflection high energy electron diffraction, and the magnetic properties were characterized by using the polar magneto-optical Kerr effect. The normalized out-of-plane magnetization curves of LiF-, CsI-, and NaCl-inserted samples are shown in Figs. 1(b), 1(c), 1(d), respectively. We find that the LiF layer insertion up to 0.4 nm enhances interfacial PMA, but thicker LiF insertion weakens it. For the CsI and NaCl cases, interfacial PMA energy decreases monotonically with CsI or NaCl thickness. Our results suggest that high electronegativity is more important for PMA than the spin-orbit coupling of the anion atom. Nevertheless, the contribution from the spin-orbit interaction of the alkali halide layer remains elusive as the magnetic dead layer is formed between Fe and CsI or NaCl layers probably because of their inter-mixing.

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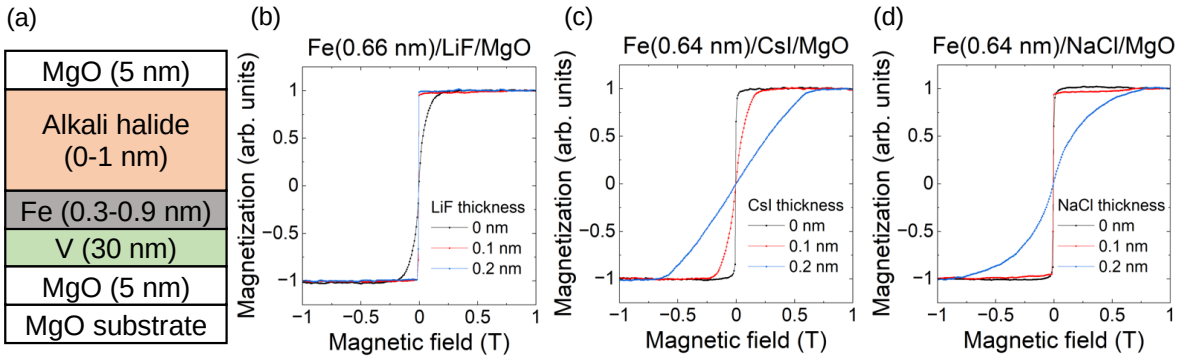

Fig. 1. (a) Schematic sample structure. Normalized out-of-plane magnetization curves for (b) LiF-, (c) CsI-, and (d) NaCl-inserted samples.

[1] T. Nozaki *et al*., NPG Asia Mater **14**, 5 (2022). [2] S. Sakamoto *et al*., Phys. Rev. B **106**, 174410 (2022). [3]. J. Chen *et al*., submitted.