Voltage-controlled magnetic anisotropy in ultrathin nickel

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Voltage-controlled magnetic anisotropy (VCMA) in 3*d*-transition metals has been intensively studied [1]. Recently, it has been reported that a Co/MgO, where one electron is added to 3*d*-orbitals of Fe, shows larger VCMA (~80 fJ/Vm) than that of Fe/MgO(~30 fJ/Vm) [2]. In this study, we have characterized the VCMA effect and the voltage-induced changes of magnetic moments in a Ni/MgO, where one electron is added to 3*d*-orbitals of Co.

We fabricated magnetic tunnel junction devices with Fe(0.3 nm)/Ni(0.14 nm)/MgO(1.4 nm)/Fe(10 nm) multilayer, and analyzed the VCMA effect. Compared to the VCMA in Fe/MgO system (~30 fJ/Vm), Ni/MgO system shows small (~10 fJ/Vm) but clear VCMA effect. For the characterization of magnetic moments of Ni, a tunnel junction with an Fe(0.3 nm)/Ni(0.14 nm)/MgO(2 nm)/SiO_2(5 nm) was prepared as shown in Fig. 1. We measured X-ray absorption and its X-ray magnetic circular dichroism (XMCD) around Ni-$L_{2,3}$ edges at BL25SU, SPring-8. Figure 2 shows the X-ray absorption and its XMCD spectra measured by partial fluorescence yield methods. We found that bias-voltage changes the XMCD spectra, which suggests that magnetic moments of Ni were modulated by the bias-voltage. A part of this work was supported by JSPS KAKENHI (JP18H03880, JP26103002) and ImPACT program.

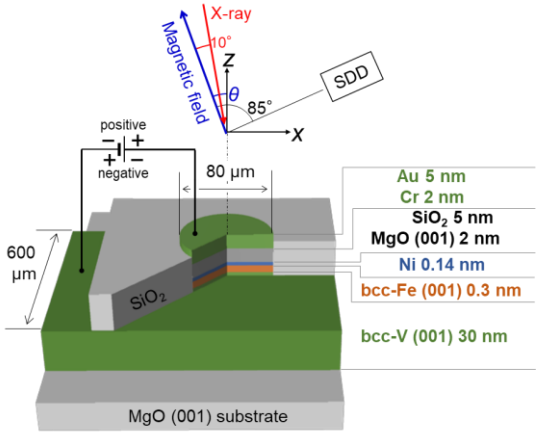

Fig. 1 Sample structure

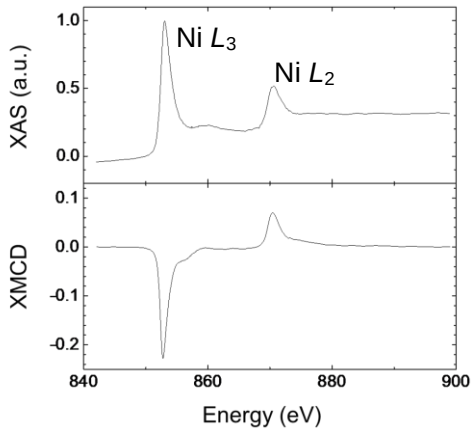

Fig. 2 X-ray absorption and XMCD spectra

[1] T. Maruyama *et al.*, Nature Nanotech. **4** 158 (2009).
[2] T. Kawabe *et al.*, Phys. Rev. B **96** 220412(R) (2017).