Growth of Fe_4N/Cu/Fe_4N tri-layer structure for current-perpendicular-to-plane giant magnetoresistance devices

Institute for Materials Research, Tohoku Univ. [1], CSRN, Tohoku Univ. [2]

○Keita Ito[1,2], Takahide Kubota[1,2], Koki Takanashi[1,2]

E-mail: itok@imr.tohoku.ac.jp

Anti-perovskite type 3*d* transition metal ferromagnetic nitrides are promising candidates for a new spintronics material. Fe_4N, one of these compounds, is theoretically predicted to have a large negative spin-polarization of electrical conductivity (P_σ = –1.0) [1]. In addition, a large tunnel magnetoresistance effect is theoretically expected due to coherent tunneling in a Fe_4N/MgO/Fe_4N magnetic tunnel junction with perpendicular magnetic anisotropy [2], and voltage control of magnetocrystalline anisotropy in Fe_4N/MgO is predicted by theoretical calculations [3]. On the other hand, we consider that the large $|P_\sigma|$ and relatively high electrical resistivity of Fe_4N are suitable for application to a current-perpendicular-to-plane giant magnetoresistance (CPP-GMR) recording head of a next generation hard disk drive [4]. In this work, we grew Fe_4N/Cu/Fe_4N tri-layer structure by molecular beam epitaxy toward fabrication of Fe_4N-based CPP-GMR devices.

Fe_4N(20 nm)/Cu(5 nm)/Fe_4N(7 nm)/Au(7 nm) layered structure was grown on a $SrTiO_3$(STO)(001) single crystal substrate. The top and bottom Fe_4N layers were grown at 450 °C by supplying Fe and radio-frequency N_2 plasma, simultaneously. The Cu spacer and Au capping layers were formed at room temperature. The grown layered sample was characterized by reflection high-energy electron diffraction (RHEED) and out-of-plane (ω-2θ) x-ray diffraction (XRD).

Figure 1 shows the RHEED patterns during the growth of the sample. Streaky patterns are observed in each layer. Figure 2 shows the ω-2θ XRD pattern of the sample, and the diffraction peaks of Fe_4N 001, 002, and Cu 002 are clearly observed. From these results, the epitaxial growth of Fe_4N/Cu/Fe_4N structure on STO(001) is confirmed. As a next step, we are trying to grow the Fe_4N/Cu/Fe_4N tri-layer structure on a thick Cu_3Au metallic buffer layer, and fabricate CPP-GMR devices, the results of which will be shown in the presentation.

[1] S. Kokado *et al.*, Phys. Rev. B **73**, 172410 (2006). [2] B. Yang *et al.*, Phys. Rev. Appl. **9**, 1054019 (2018). [3] Z. R. Li *et al.*, Appl. Phys. Lett. **113**, 132401 (2018). [4] M. Takagishi *et al.*, IEEE Trans. Magn. **46**, 2086 (2010).

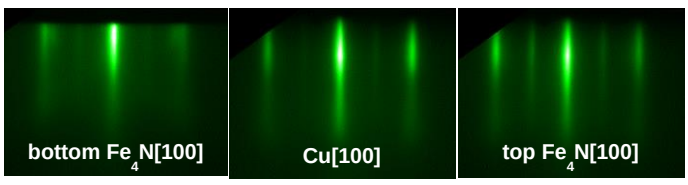

Fig. 1 RHEED patterns of the sample.

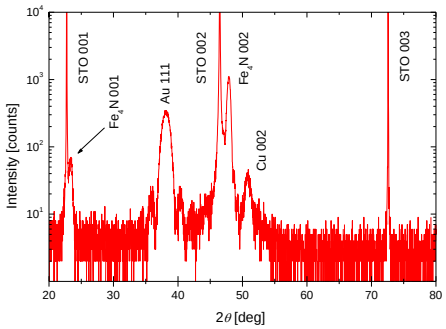

Fig. 2 The ω-2θ XRD pattern of the sample.