Electron tunneling through perpendicularly magnetized cobalt ferrite films grown on metallic TiN layers

Nagoya Inst. Tech.[1], Kyoto Univ.[2], Kansai Univ.[3]

○Masaaki Tanaka[1], Katsuyoshi Naruse[1], Kosuke Nomura[1], Kodai Kutsukake[1], Takaya Okuno[2], Syuta Honda[3], Teruo Ono[2], and Ko Mibu[1]

It is reported that magnetic insulator $CoFe_2O_4$ (CFO) films grown along the [001] direction with in-plane tensile strain have large perpendicular magnetic anisotropy (PMA) [1]. If CFO films with PMA are grown on nonmagnetic metal layers, they can be applied for spin-filtering devices using tunneling electrons. In this study, we investigated PMA and electron tunneling characteristics of CFO films on nonmagnetic metal layers.

$Co_xFe_{3-x}O_4$ ($0<x<1$) films of 20 nm were grown on MgO (001) substrates with metallic TiN buffer layers using pulsed laser deposition technique at the substrate temperature of 300°C. Magnetic hysteresis loops were measured using a superconducting quantum interference device magnetometer at 300 K. The tunneling property was investigated for Au/Cr/$Co_{0.54}Fe_{2.46}O_4$/TiN and CoFe/MgO/$Co_{0.54}Fe_{2.46}O_4$/TiN tunnel junctions with the junction diameter of 10 μm.

Figure 1(a) shows the Co composition dependence of the squareness ratio (remanence magnetization with respect to saturation magnetization) of the out-of-plane hysteresis loops. The high squareness ratio of more than 0.8 was realized for the $Co_xFe_{3-x}O_4$ layers (x = 0.1~0.5). We have succeeded in fabricating perpendicularly magnetized $Co_xFe_{3-x}O_4$ films on nonmagnetic metal TiN films [2]. The voltage–current curves of the tunnel junctions (Fig. 1(b)) show typical tunneling characters. The perpendicularly magnetized $Co_xFe_{3-x}O_4$ films applicable for the spin-filtering devices were thus realized on nonmagnetic metals.

References

[1] H. Yanagihara *et al.*, J. Appl. Phys. 109, 07D122 (2011).

[2] K. Naruse, M. A. Tanaka *et al.*, J. Magn. Magn. Mater. 475, 721 (2019).

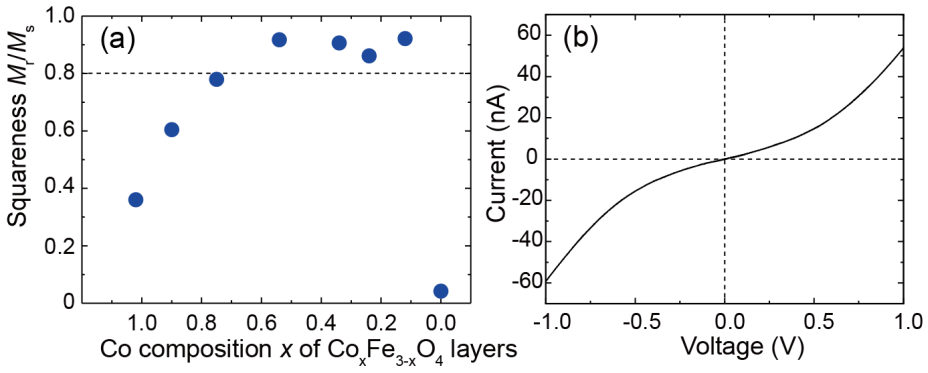

Fig. 1 (a) Co composition dependence of the squareness ratio in out-of-plane hysteresis loops.
(b) Voltage - current curve of the Au/Cr/$Co_{0.54}Fe_{2.46}O_4$/TiN tunnel junction at 300 K.