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Improved magnetization in (Ti,Co)O_2 with non-magnetic capping layer

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Recently, the electric-field induced ferromagnetism in (Ti,Co)O_2 has been reported via electric double layer transistor [1]. For further development of the electric field effect, all-solid-state type transistor is more suitable. Such transistor usually requires the thinner channel because of the limited amplitude of electric field. However, the surface magnetization of (Ti,Co)O_2 was found to be suppressed significantly from x-ray magnetic circular dichroism measurements, representing the presence of magnetically dead layer [2], which leads to the difficulty of realizing the transistor with thin channel. In order to reduce the magnetically dead layer, capping and/or annealing magnetic layer is known to be an effective method [3]. In this study, we developed non-magnetic capping layer for anatase (Ti,Co)O_2 epitaxial thin film and investigated the effects of the capping layer on the magnetic properties.

Anatase $Ti_{0.95}Co_{0.05}O_{2-\delta}$ (001) epitaxial thin films with TiO_2 epitaxial buffer layer were grown on atomically flat $LaAlO_3$ (001) substrates by pulsed laser deposition, followed by the deposition of non-magnetic TiO_2 epitaxial capping layers. The total film thickness was typically 40 nm. Both in-plane and out-of-plane magnetizations of the films with/without the capping layer were measured by a SQUID magnetometer. Figure 1 shows magnetization curves at 300 K for the films with different thickness of capping layers. The out-of-plane magnetization was increased from 1.1 μ_B/Co to 2.4 μ_B/Co with increasing the thickness of capping layer from 0 nm to 2 nm, while in-plane magnetization was almost unchanged, representing that only two unit cells of the capping layer was quite effective to improve the out-of-plane magnetization. This result suggests that the capping layer reduced the magnetically dead layer at surface. In this presentation, we will also discuss the possible roles of the capping layer.

References

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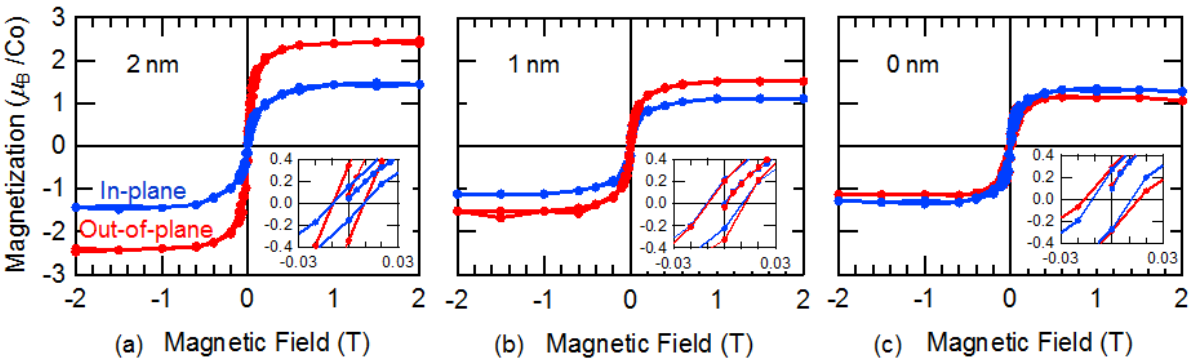

Figure 1 Out-of-plane (red) and in-plane (blue) magnetization curves at 300 K of anatase $Ti_{0.95}Co_{0.05}O_{2-\delta}$ epitaxial thin films with different thickness of capping layers (a) 2 nm, (b) 1 nm, and (c) 0 nm.

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