The dependence on carrier density, Co content, and thickness of magnetic domain structure in anatase (Ti,Co)O_2 thin films

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Room temperature ferromagnetism in (Ti,Co)O_2 was controlled at room temperature via electrostatic and chemical carrier doping [1]. Although the observation of microscopic magnetic domain structure has been difficult, it is an important technique to observe electrical manipulation of magnetic domain [2]. Previously, we observed the magnetic domain structure in (Ti,Co)O_2 at room temperature with magnetic force microscope (MFM) [3]. In this study, we investigate systematically the dependence of magnetic domain structure in anatase (Ti,Co)O_2 on both carrier density and Co content.

Anatase $Ti_{1-x}Co_xO_{2-\delta}$ (001) epitaxial thin films (x = 0.01, 0.03, 0.05, and 0.10) with TiO_2 epitaxial buffer layer were grown on atomically flat $LaAlO_3$ (001) substrates by pulsed laser deposition. The carrier density (n) was varied by oxygen pressure during film growth. The total film thickness was typically 45 nm. The magnetic images were measured by MFM in vacuum of 10 Pa at room temperature without external magnetic field. The clear magnetic images suggested that the size of magnetic domain was a monotonically increasing function of x at high carrier density. Figure 1 shows carrier dependence of magnetic structure in $Ti_{0.90}Co_{0.10}O_{2-\delta}$ films with ferromagnetic transition around at n~2.0×10^{19} cm^{-3}, indicating good coincidence with bulk magnetization measured by a SQUID magnetometer. From the MFM images, micromagnetic parameters were also evaluated as functions of carrier density and Co content. The thickness dependence of magnetic domain structure will be also discussed.

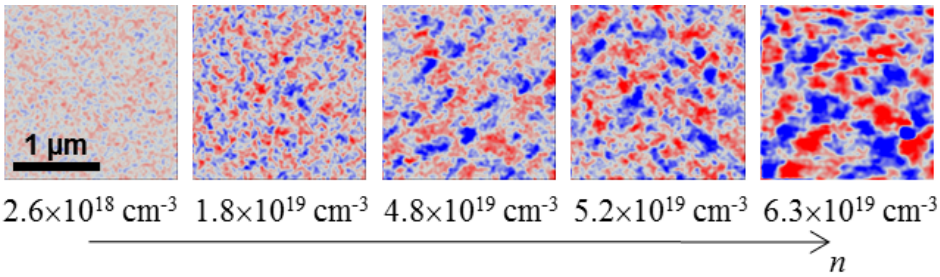

Figure 1 Magnetic images of anatase $Ti_{0.90}Co_{0.10}O_{2-\delta}$ (001) films with different carrier density at room temperature.

References

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