Magnetic domain formation of $La_{0.6}Sr_{0.4}MnO_3$ epitaxial thin films observed by XMCD-PEEM

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Spin tunnel junctions with half-metallic manganites have attracted great attention because of the application to the magnetoelectronic devices using their huge magnetoresistance. In order to determine the magnetic structure directly, we have performed the observation of the magnetic domain formation of the ferromagnetic $La_{0.6}Sr_{0.4}MnO_3$ (LSMO) epitaxial thin films grown on the stepped $SrTiO_3$ (001) substrates. The magnetic domains were imaged using the PEEM with x-ray magnetic circular dichroism (XMCD) which is installed at BL25SU of SPring-8. Figure 1 shows the magnetic images of the LSMO thin films with the thickness of 20 and 120 nm. We have found that the magnetic domains show a stripe structure elongated along the step directions, which is ascribed by the uniaxial magnetic anisotropy induced by the step structures. In the thicker films, however, we have observed not only the stripe magnetic domains but also the domains with the magnetizations along a different axis from the step direction, as shown by the arrows in Fig. 1(b). These domains are considered to exhibit the biaxial anisotropy which originates from magneto-crystalline anisotropy with easy axes along the [110] direction. These results suggest that the step-induced magnetic anisotropy arise at the surfaces and/or the interfaces, since the relative contribution of the step-induced magnetic anisotropy decreased with increasing film thickness.

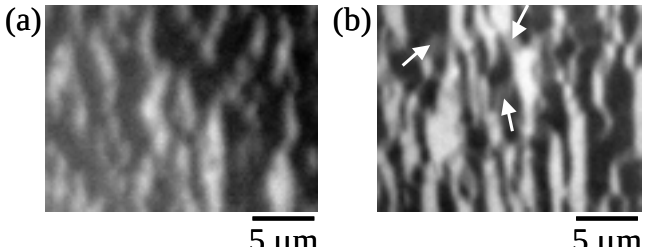

Figure 1. The magnetic images of the $La_{0.6}Sr_{0.4}MnO_3$ thin films. The thicknesses are (a) 20 nm and (b) 120 nm, respectively.