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Effects of ferroelectric and ferromagnetic buffer layers in CMR epitaxial films

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Perovskite ferromagnetic and ferroelectric buffer layers on the $LaAlO_3$ (001) substrate for colossal-magnetoresistance (CMR) epitaxial film play an important role for the magnetic and the transport properties. $La_{0.8}Ca_{0.2}MnO_3$ and $BaTiO_3$, were prepared as the buffer layers by the 'soft'-target magnetron sputtering. By using X-ray diffraction and high-resolution electron microscopy, we observed that the out-of-plane uniaxial tensile strains occur in CMR/CMR films, but the strain for a $La_{0.8}Sr_{0.2}MnO_3$ film without the $La_{0.8}Ca_{0.2}MnO_3$ buffer layer is larger than that with the buffer layer. It is shown that the metal-insulator and the ferromagnetic transitions turn out to be shifted to higher temperatures for $La_{0.8}Sr_{0.2}MnO_3$ on $La_{0.8}Ca_{0.2}MnO_3$ compared with the bare $La_{0.8}Sr_{0.2}MnO_3$

However, the metal-insulator transition was not observed in a temperature range of 10 to 300 K in the CMR film on a $BaTiO_3$ buffer layer. The enhanced magnetoresistance and ferromagnetic ordering in the $La_{0.8}Sr_{0.2}MnO_3/La_{0.8}Sr_{0.2}MnO_3$ bilayer are elucidated with the lattice-strain relaxation in the $La_{0.8}Sr_{0.2}MnO_3$ layer. On the other hand, the discovered suppression of contribution from the Jahn-Teller distortion to the ferromagnetic ordering with increasing the lattice mismatch between substrate and film manifests a physical limit of the weak-strain approach in describing the magnetic properties of manganite films.