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TEM Study of Epitaxial Growth of $La_{0.65}Pb_{0.35}MnO_3$ on $LaAlO_3$ and Its Relation to Electronic Structure and Spin Polarization

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We showed that the surfaces of ferromagnets differ substantially from the bulk for three different classes of potential half-metallic ferromagnets (metallic in spin majority and insulating in spin minority) as well as an elemental local moment ferromagnet (strained gadolinium). We have been careful to correlate electronic structure, electron spin polarization and structural studies to obtain a more complete picture. We showed that the surfaces of $La_xA_{1-x}MnO_3$ (A= Ca, Sr, Ba, Pb) are dominated by a large surface enthalpy or by surface segregation [1], while CrO_2 surfaces are very unstable [2]. Indeed surface composition has a profound effect upon the measured polarization asymmetry of the unoccupied bands for the $La_xM_{1-x}MnO_3$ (M= Sr, Pb) [3]. In this study, we examine both the microstructure and epitaxial growth of $La_{0.65}Pb_{0.35}MnO_3$ on $LaAlO_3$ using transmission electron microscopy (TEM).

Traditionally, a cross-sectional TEM sample is required to study the epitaxial growth of crystals on a suitable substrate. In this paper we present a method of using a plane-view sample to examine both the microstructure and epitaxial growth of $La_{0.65}Pb_{0.35}MnO_3$ on $LaAlO_3$. Plane-view TEM samples were prepared to examine the microstructure. Ion milling was conducted from the substrate side to view the microstructure. To examine the epitaxy, a part of the sample was covered to preserve the $La_{0.65}Pb_{0.35}MnO_3$ film and the $La_{0.65}Pb_{0.35}MnO_3$ layer in the uncovered part is removed. Thus both the $La_{0.65}Pb_{0.35}MnO_3$ layer and the substrate $LaAlO_3$ have a thin area at the edge. Figure 1 (a) illustrates the specimen configuration. Figures 1 (b) and (c) show the diffraction patterns from the two regions $LaAlO_3$ and $La_{0.65}Pb_{0.35}MnO_3$, respectively. From the alignment of the patterns, the epitaxy relation and the close lattice parameter match is confirmed. Figure 2 shows the HRTEM image of $La_{0.65}Pb_{0.35}MnO_3$. Sub-grain boundaries of a few degrees in the $La_{0.65}Pb_{0.35}MnO_3$ film are observed. This suggests that the formation of $La_{0.65}Pb_{0.35}MnO_3$ is by nucleation at many sites of $LaAlO_3$ and these nuclei grow until eventually touching each other.

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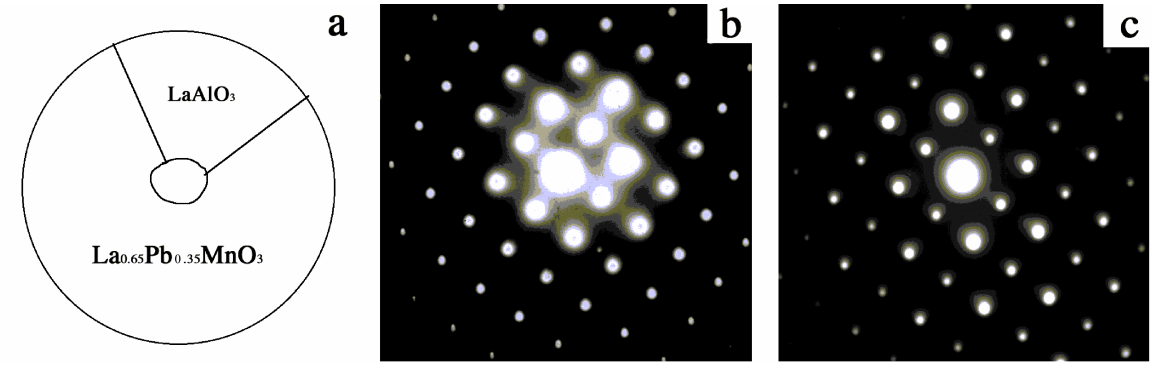

Figure 1. (a) Schematic illustration of TEM specimen for epitaxy observation, (b) diffraction pattern of $LaAlO_3$ and (c) diffraction pattern of $La_{0.65}Pb_{0.35}MnO_3$.

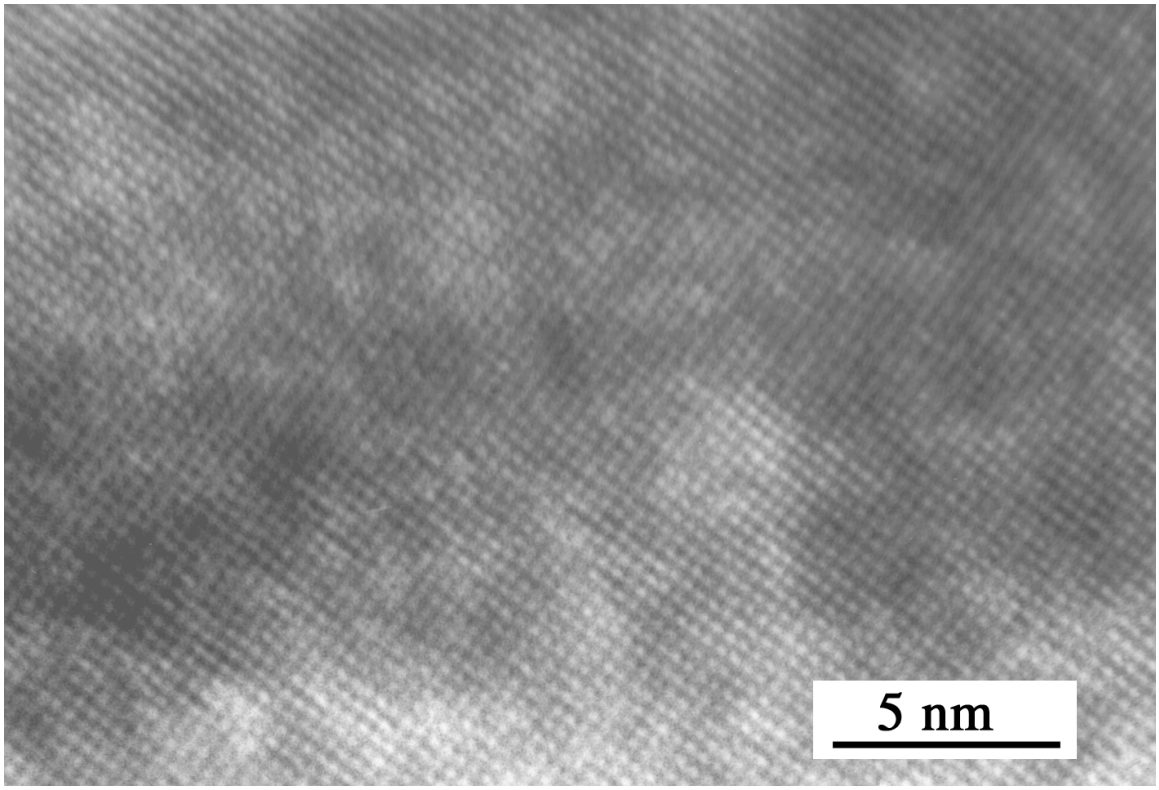

Figure 2. HRTEM of $La_{0.65}Pb_{0.35}MnO_3$.

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