Controlling Structural Characteristics in AMnO$_3$ Thin Films and Superlattices

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The physicochemical properties of the AMnO$_{3-x}$ system (A= rare-earth or alkaline-earth) are well known to be a strong function of the crystal structure along with the composition and/or long range order on the A and O sites. We have been interested in designing specific structural characteristics into AMnO$_{3-x}$ systems using parameters that can be well controlled during thin film growth, such as temperature, pressure, substrate, orientation, composition, and composition alternations. In this talk I will describe our research into understanding of how the substrate, orientation, and oxygen pressure play a role in determining the crystal structure of the end-member compounds as well the structural characteristics of LaMnO$_3$/SrMnO$_3$ and PrMnO$_3$/SrMnO$_3$ superlattices. The magnetic and resistive properties of various systems will also be discussed, especially focusing on the effects of the nature of the superlattice ordering and the oxygen activity used during growth. More recently we have focused on understanding the surface of epitaxial (La,Sr)MnO$_3$ films, since they should play a strong role in the interfacial characteristics of such films, as a function of temperature and pressure in the film growth regime. Using synchrotron x-ray techniques at the Advanced Photon Source of Argonne National Laboratory, we have studied the surface structure and chemistry of La$_{0.7}$Sr$_{0.3}$MnO$_3$ films that were deposited on several perovskite substrates as a function of film thickness, temperature, and oxygen pressure. It will be shown that strontium segregation to the surface is observed to be thermodynamically favorable for nearly all processing conditions relevant to thin film growth.