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Atomically-resolved imaging of surfaces of complex oxide thin films grown by laser-MBE

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Complex oxides exhibit a large spectrum of phenomena ranging from superconductivity and colossal magnetoresistance to high ionic mobility and catalytic activity. The rich variety of phenomena inherent to these compounds lead to intense research in the past two decades in order to understand and harness this complexity to obtain novel functionalities for applications, in particular, in electronics, spintronics, energy conversion, and chemistry, especially in the form of thin films and thin film heterostructures. Still, the role of the film growth dynamics in the formation of the surface structure, roles of oxygen stoichiometry, atomic defects and vacancies on the surface properties and atomic-scale processes in these oxides remains largely unexplored. We used Laser Molecular Beam Epitaxy to grow thin films of $SrRuO_3$ (SRO) and $La_{5/8}Ca_{3/8}MnO_3$ (LCMO) and performed *in-situ* Scanning Tunneling Microscopy (STM) imaging of the film surfaces with atomic resolution. The atomically resolved images of the metallic SRO films revealed remarkable linear surface reconstructions identified as formed by adsorbed oxygen atoms. In turn, atomic structure of the semiconducting LCMO surface is strongly dependent on the film termination with reconstructions signaling the unexpected presence of the charge-ordered state on the surface. Furthermore, using the LCMO films, we demonstrate the ability to both perform and monitor surface electrochemical processes at the atomic level, including formation of oxygen vacancies, disruption of the overlying layers, and removal and deposition of individual atomic clusters. These experiments open the door to better understanding and control of atomic-scale processes and surface reactions of complex oxides.

Biography

Alexander Tselev received PhD in Materials Sciences from Dresden University of Technology, Germany. He spent terms at University of Maryland, College Park, Georgetown University, and Duke University before joining the Center for Nanophase Materials Sciences at ORNL, where his research is primarily focused on near-field microwave microscopy and complex oxide thin films. He has published more than 70 papers in refereed journals.

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