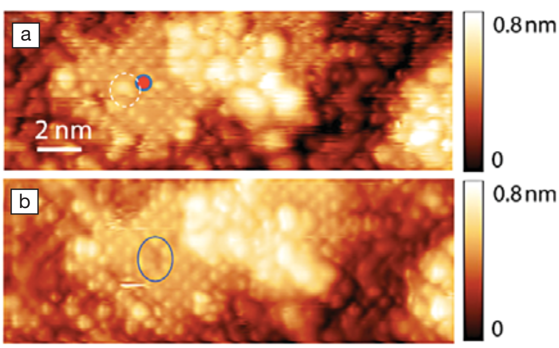
SPM scans the chemical landscape of manganite oxides

Manganite oxide thin films exhibit a dazzling array of properties, ranging from ferroelectricity to ferromagnetism. They are used in applications as diverse as sensors, data storage, and battery electrodes, but a full description of these materials has eluded scientists.



In situ mapping of $La_{0.625}Ca_{0.375}MnO_3$ surface morphology before (a) and after (b) an electrochemical reaction. The white and blue circles mark the formation of an oxygen vacancy. Reprinted with permission from *Appl. Phys. Lett.* **106** (2015), 143107. © 2015 AIP Publishing LLC.

The properties of oxides are extremely sensitive to atomic structure, chemistry, and defects and because of this they often behave in unexpected ways. The situation is even more complicated for electrochemical reactions, which operate at tiny length scales under harsh conditions. Now, Rama Vasudevan and his colleagues at Oak Ridge National Laboratory (ORNL) have begun to unravel the mysteries of these electrochemical reactions using scanning probe microscopy (SPM).

Vasudevan, a posdoctoral research associate working with Sergei Kalinin in the Scanning Probe Microscopy Group at the Center for Nanophase Materials Sciences at ORNL, explains, "Manganite surfaces are poorly understood because atomic resolution studies are very uncommon. In our study, we introduce a method that will allow for much greater insight into the reactions and movement of oxygen on these surfaces through atomic-resolution imaging and manipulation."

Writing in the April issue of *Applied Physics Letters* (DOI:10.1063/1.4917299), the team describes a unique form of *in situ* scanning tunneling microscopy (STM). In traditional STM, a small, electrically biased tip is brought to less than a nanometer from a material's surface. Quantum mechanical tunneling occurs between the tip and surface; this tunneling depends on the local structure and the density of states, making it an exquisitely sensitive probe of surface chemistry. The Oak Ridge group took this a step further, tuning the bias to both initiate and monitor an electrochemical reaction at the atomic level. This method allowed the group to study a thin film of $La_{0.625}Ca_{0.375}MnO_3$ (LCMO) and observe the formation of oxygen vacancies on the film's surface. The group's approach offers significant insight into the electrochemical properties of oxides that will guide other researchers in the field.

Steven Spurgeon

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