Lattice Defects in Ferroelectric Oxides and Their Interactions with Electric Fields

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Lattice point defects in electroceramics dominate the overall electrical properties of the material, and thus great effort is expended on controlling the point defect equilibria via oxygen activity control during processing and/or doping. In device applications, because the lattice defects are typically charged, the applied electric field provides a strong driving force for defect migration. When the electrodes are impermeable to mass transport, the spatio-temporal redistribution of defects can cause time-dependent increases in the leakage current in many electroceramic devices. While this leakage current enhancement is detrimental in devices such as capacitors, the phenomenon of lattice defect migration can be utilized to form novel functional behaviors such as resistive switching in metal-oxides.

Our research into this phenomenon combines electrical transport measurements with electron microscopy analyses to understand the mesoscopic redistribution of point defects as a function of temperature, electric field and time. In systems for which electronic transport is limited by injection at the electrode, we find that the accumulation of the charged defects can modulate the Schottky barrier at the electrodes. At high electrical potentials, the non-stoichiometry in the near-electrode regions can become very large, inducing defect clustering and ordering. The implications of this defect redistribution process and its reversibility are discussed within the context the overall electrical transport characteristics.

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