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Direct Observation of Virtual Electrode Formation Through a Novel Electrolyte-to-Electrode Transition DAVID SIEGEL, FARID EL GABALY, NORMAN BARTELT, KEVIN MCCARTY, Sandia National Laboratories — Novel electrochemical solutions to problems in energy storage and transportation can drive renewable energy to become an economically viable alternative to fossil fuels. In many electrochemical systems, the behavior of a device can be fundamentally limited by the surface area of a triple phase boundary, the boundary region where a gas-phase species, electrode, and electrolyte coincide. When the electrode is an ionic insulator the triple phase boundary is typically a one-dimensional boundary with nanometer-scale thickness: ions cannot transport through the electrode, while electrons cannot be transported through the electrolyte. Here we present direct experimental measurements of a novel electrolyte-to-electrode transition with photoemission electron microscopy, and observe that the surface of an ionically conductive, electronically insulative solid oxide electrolyte undergoes a transition into a mixed electron-ion conductor in the vicinity of a metal electrode. Our direct experimental measurements allow us to characterize this system and address the mechanisms of ionic reactions and transport through comparisons with theoretical modeling to provide us with a physical picture of the processes involved. Our results provide insight into one of the mechanisms of ion transport in an electrochemical cell that may be generalizable to other systems.

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