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Peering inside a functioning $Pt/TiO_2/Pt$ bipolar resistance switching device JOHN PAUL STRACHAN, MATTHEW PICKETT, JIANHUA YANG, JULIEN BORGHETTI, Hewlett-Packard Labs, A. L. D. KILCOYNE, ANDREAS SCHOLL, Advanced Light Source, Lawrence Berkeley Labs, SHAUL ALONI, The Molecular Foundry, Lawrence Berkeley Labs, GILBERTO MEDEIROS-RIBEIRO, R. STANLEY WILLIAMS, Hewlett-Packard Labs — Many transition-metal oxides exhibit electrical polarization-dependent resistance changes. Direct observation of the physical changes induced during this switching has been limited, due to challenges in observing subtle material changes occurring in a small volume. We use x-ray absorption spectromicroscopy and transmission electron microscopy (TEM) in order to determine the chemical and structural identity of the switching region in a functioning $Pt/TiO_2/Pt$ device, fabricated on a thin transparent window. These transmission techniques allow probing of the physical properties of the switching layer between/during the application of an electrical bias. We directly observed the formation of a conductive channel following an electroforming process. The conductive channel is identified to be a nanoscale metallic suboxide (TiO_{2-X}), a phase generated within the TiO_2 matrix by the creation and ordering of oxygen vacancies. Besides shedding light on long-standing questions regarding the physical changes, we show how this work has informed new device engineering.

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