Exploiting 4D-STEM for In-Situ TEM Strain Mapping during Metal Corrosion.

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Abstract:

Metal oxidation, a prominent concern in metal utilization, can lead to issues like surface degradation, corrosion, and reduction of mechanical properties. A comprehensive understanding of strain anisotropy at various reaction stages is crucial for the development of oxidation mechanism theory. Here we have chosen to study the oxidation of Zr, which is used as the cladding material in nuclear reactors. An in-situ strain mapping with a large field of view is developed by integrating four-dimensional scanning transmission electron microscopy (4D-STEM), micro-electromechanical systems (MEMS) gas-cell, precession electron microscopy, and direct electron detector. The key to successful 4D-STEM strain mapping lies in optimizing Bragg peak detection quality and quantity in the nano-beam electron diffraction patterns. Strategies for MEMS sample preparation, enhancement of in-situ 4D-STEM strain mapping accuracy, and effectively pausing reaction evolution will be discussed. Our approach facilitates nanometer-resolution strain mapping across a large field of view during zirconium oxidation. This proposed method sheds light on the characterization of chemo-mechanical evolutions and holds vast potential for corrosion studies.