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Stability of Proton-Conducting Solid Oxide Electrolyzers for Hydrogen Production and Energy Storage

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Abstract

Proton-conducting solid oxide electrolyzers (H-SOEs) provide promising opportunity to produce pure and dry hydrogen in steam electrolysis at relatively low operating temperatures (550-700˚C) utilizing electricity and heat generated from renewable energy sources. Compared to traditional high temperature

(750-1000˚C) oxygen-conducting solid oxide electrolyzers (O-SOEs), lower operating temperature of H-SOE offers ease of thermal management, active stack and BOP materials cost reduction and reduction in chromium evaporation from metallic components. Like O-SOEs, preserving the long-term stability of H-SOEs is one of the technical challenges for large-scale hydrogen production. In this technical contribution, results of experimental evaluation of H-SOEs under real-world operating conditions are presented. As fabricated and posttest cells have been characterized using operando electrochemical impedance spectroscopy, X-ray diffraction, focused ion beam-transmission electron microscopy and other bulk and surface characterization techniques to examine bulk, surface and interface stability of electrochemically active components. Phase and morphological changes, compositional uniformity and interfacial reaction products formation have been examined. Electrolyte/electrode materials stability, cell and gas seal fabrication processes, and gaseous impurities affecting long-term electrochemical performance will be discussed. H-SOE electrochemical performance model based on cell materials and operating conditions has been proposed and validated based on single cell testing data.

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