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Mechanism of cathodic performance enhancement by cathode/electrolyte interface engineering of solid oxide fuel cells

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Oxygen reduction reaction (ORR) is a sluggish process that causes significant voltage losses for the cathode in low- and intermediate-temperature solid oxide fuel cells (SOFCs). Surface engineering of electrolytes with nanostructures and thin-film interfaces introduced between the cathode and electrolyte can mitigate the voltage losses associated with ORR on the cathode. In this article, we reveal the actual role of the metal oxide interlayer between electrode-electrolyte in the ORR process through a series of electrochemical analysis and surface imaging techniques. We deposited nanocrystalline yttria-doped ceria (YDC) thin film interface layer on yttria-stabilized zirconia (YSZ) electrolyte by spin coating, atomic layer deposition (ALD) and the combination of these two techniques. These tests have been done on a Pt cathode as a pure electron conductor material and lanthanum strontium cobalt ferrite (LSCF) as a mixed electron and ion conductor (MIEC). The interface layer reduced cell polarization resistance substantially. The reduction in the polarization resistance is primarily attributed to the increased interfacial surface area between the cathode and the electrolyte. Moreover, this procedure enhances the adherence of the porous cathode layer to the electrolyte and decreases the electrode-electrolyte interfacial resistance, as confirmed by scanning electron microscopy (SEM). A remarkable change in oxygen partial pressure dependency is also observed indicating a possible change in the oxygen transfer mechanism. In addition, the test demonstrated the benefits of nanofilm interfacial layer in improving the power output of the cell.

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