Ultrathin oxide films in electrochemical energy conversion devices: controlling the internal stress for improved reliability and performance

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Abstract

Various electrochemical energy conversion devices could benefit from decreasing the thickness of their constituting parts. We focus here on solid oxide fuel cells (SOFCs) and solar water splitting cells. In the case of SOFCs, decreasing the electrolyte thickness to ~100 nm allows to decrease the operating temperature.[1] In the case of solar water splitting, using ultrathin films (<10 nm) for electrocatalysts and passivation layers allows to decrease losses associated with light absorbtion and transport of charges through the device. An increase of the internal stress in the GPa range can be expected for such ultrathin films, and could affect the performance as well.
We study the effect of internal stress in yttria-stabilized zirconia thin film electrolytes on the reliability of SOFCs. Varying the synthesis conditions modified the internal stress from –1400 (compression) to +100 MPa (tension). The open circuit potential of the cells, an indication of their reliability, varies with the internal stress and is higher for moderate compressive stress.[2] The effect of internal stress in ultrathin passivating oxide layers on the performance of photoanodes for solar water splitting is also explored. The oxide prevents the degradation of the photovoltaic material by oxidation.[3] The microstructure of the oxide thin film, associated with variations of its internal stress, affects the losses associated with charge transfer between the photovoltaic and the electrocatalyst layer.

Bibliographic References

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