HiPIMS deposition of oxide thin films for solid oxide fuel cells

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Abstract

In this work, we have deposited Y2O3-stabilized ZrO2 (YSZ) and Gd2O3-doped CeO2 (GDC) thin films by HiPIMS in an industrial-scale batch coater. Both YSZ and GDC are ceramic ion-conducting coatings used in solid oxide fuel cells (SOFCs) as electrolytes and barrier coatings, respectively. Therefore, depositions are carried out on YSZ fuel cell electrodes as well as Si(001) substrates. The thin films were deposited by reactive sputtering from Zr0.84Y0.16 and Ce0.9Gd0.1 alloy targets in an Ar-O2 atmosphere. Inherent to the HiPIMS technique is a high fraction of ionization of the sputtered material. This favors the growth of dense films which is of the highest importance in the production of thin films for SOFC applications. The deposited films were characterized by scanning electron microscopy and X-ray diffraction. Films deposited on Si(001) were generally textured but by increasing the HiPIMS peak power or the substrate bias voltage, in order to increase the energy flux of ions bombarding the growing film, the crystallinity of the films was decreased. When depositing on YSZ electrodes, dense and featureless films could be obtained at an intermediate energy flux. Too low or too high peak power or substrate bias voltage was not suitable. At a low energy flux the resulting films were columnar and contained voids. At too high energy flux the ion bombardment disrupted the film growth and caused film porosity. To test the properties of the HiPIMS coatings as SOFC electrolytes, samples were prepared for cell testing in a fuel cell setup.

Keywords: HiPIMS, Solid oxide fuel cells, YSZ, GDC

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