In Situ, Simultaneous Optical and Impedance Measurements of Pr Doped Ceria Thin Films: Nonstoichiometry and Reaction Kinetics

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Many advanced oxides used in solid oxide fuel cells (SOFC) and oxygen permeation membranes experience significant changes in oxygen stoichiometry during operation at elevated temperatures and under reducing/oxidizing conditions. These deviations from stoichiometry can result in major changes in electrical, diffusive, and mechanical properties, which, in turn, impact device performance. The ability to diagnose a material's behavior under operating conditions is therefore of importance. Previously, we introduced a non-contact optical means for *in situ* recording of transient redox kinetics as well as the equilibrium Pr oxidation state and, in turn, the oxygen nonstoichiometry of $Pr_{0.1}Ce_{0.9}O_{2-\delta}$ (10 PCO) thin films, by monitoring the change in absorption spectra upon change in pO_2 or temperature [1, 2]. The oxygen nonstoichiometry of dense oxide thin films can also be examined *in situ* by analyzing the chemical capacitance obtained from impedance spectroscopy (IS) measurements [3]. In this presentation, the simultaneous measurement of *in situ* optical absorption and impedance spectroscopy as a function of temperature and pO_2 on the 10 PCO thin films will be discussed. This novel technique allows direct investigation of 1) nonstoichiometry via capacitance and absorption change and 2) surface exchange reaction kinetics via reaction resistance and absorption relaxation. These results will be compared with data obtained independently from bulk thermogravimetric measurements [4]. Surface chemistry change after long time measurement will be also discussed.

References

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