Further application on the BYCZ-based P-SOFC cell performance evaluation will be conducted.

(ICACC-S3-P012-2018) Ionic Conductivity and Phase Stabilization in Zirconia-Scandia-Europia

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Zirconia-8 mol% yttria is widely used as electrolyte in solid oxide fuel cells, due to its high ionic conductivity and good mechanical and chemical properties. Nevertheless, scandia-stabilized zirconia is recognized as exhibiting the highest ionic conductivity among zirconia-based solid electrolytes. Stabilization of the high symmetry and high ionic conductivity cubic phase in this system is non-trivial. Introduction of a second additive (or dopant) is a usual strategy to overcome that constraint. In this work, europium oxide has been added to 10 mol% scandia-stabilized zirconia (10ScSZ) aiming full stabilization of the cubic structure at room temperature. The influence of europia addition (up to 1.25 mol%) on phase stabilization and ionic conductivity of 10ScSZ was investigated by differential scanning calorimetry and impedance spectroscopy. The higher is the fraction of europia into solid solution the lower is the temperature of the endothermic event due to phase transition. The cubic phase is fully stabilized at room temperature for 1 mol% europia addition. The grain and total ionic conductivity show typical Arrhenius behavior. The magnitude of the total conductivity increases with increasing europia addition.

(ICACC-S3-P013-2018) Influence of Calcium Addition on the Electrical Conductivity of Samarium Doped Ceria

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Ceria-based ceramics have been proposed to be used as solid electrolyte in solid oxide fuel cells operating at intermediate (500-750°C) temperatures, due to their high ionic conductivity. Samarium ion is recognized as one of the most reliable dopants for cerium oxide because of its lower association energy with oxygen vacancies. One challenge posed to ceria-based solid electrolytes is how to improve sinterability, avoiding high temperatures to attain good densification. Thermal treatments at high temperatures may reduce Ce^{4+} to Ce^{3+}, favoring electron transport and generation of micropores in the sintered electrolyte. Introduction of a second additive is a usual approach to overcome these constraints. In this work calcium ion was chosen as the second additive. $Sm_{0.2-x}Ca_xCe_{0.8}O_{1.9-x/2}$ compositions, with x = 0, 0.025, 0.05, 0.1, 0.15 and 0.2, were prepared by solid-state reaction, and the influence of the additive content on densification and ionic conductivity was investigated. All compositions were found to have cubic fluorite-type structure. The optimal composition was $Sm_{0.175}Ca_{0.025}Ce_{0.8}O_{1.888}$, which showed a relative density of 97%, single phase and higher ionic conductivity than the $Sm_{0.2}Ce_{0.8}O_{1.9}$ parent electrolyte.

(ICACC-S3-P014-2018) Aerosol Deposition of barium-based perovskites as solid electrolyte film for fuel cells

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Solid oxide fuel cells (SOFC) are of interest for clean and reliable energy conversion technologies. State of the art SOFCs based on ScSZ or YSZ (scandia or yttria stabilized zirconia) electrolytes that conduct oxide ions. Typically, they require high temperatures above 800 °C. In contrast, barium- or strontium-based perovskites are receiving increased attention due to their potential use as proton conducting membranes that could already be operated at temperatures of 500 °C and even below. However, a major drawback of these materials limiting their commercial use is the high sintering temperature of 1500 °C to 1700 °C. To overcome the necessity of sintering, we intended to form dense and well-adhering perovskite films by Aerosol Deposition (AD). The unique feature of this spray coating technique is the possibility to form dense, nanocrystalline ceramic films directly from the ceramic powder without the need for a heat treatment during or after deposition. Three different compounds were synthesized, namely barium zirconate ($BaZrO_3$), barium cerate ($BaCeO_3$) and barium stannate ($BaSnO_3$). Each compound was doped with 10 % and 20 % yttrium, respectively. Resulting films are dense and between 2 µm and 10 µm thick. The crystal structure of the powder was retained during coating and was still present in films. Especially $BaZrO_3$ and $BaCeO_3$ films feature high conductivities of up to 10^{-2} S/cm at 800 °C.

(ICACC-S3-P015-2018) Residual Stress Measurement of 8 mol % YSZ Coating for SOFC Application

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As for SOFC application, 8 mol% YSZ coating usually is fabricated by using wet ceramic or physical deposition route. In contrast with wet ceramic method, physical deposition route such as PLD and plasma spraying, leaves residual stress because of difference in temperature and material properties of coating-substrate during deposition process. By knowing changes in residual stress, deposition condition, material properties, and defects inside a coating, it is possible to explain how the defects were formed, therefore the desired dense, crack-free YSZ coating can be fabricated. We tried to quantify residual stress inside PLD deposited 8 mol% YSZ by $\sin^2$ psi XRD and raman method. As for XRD method, by using (422)-cubic YSZ, respectively, we are able to quantify the residual stress inside the deposited film. However, as for raman method, one has to know the raman peak shift with variation of stress inside material, so that by measuring how much a raman peak is shifting, one can quantify the residual stress that is contained inside of material.

(ICACC-S3-P016-2018) Reactive Spray Deposition Technology (RSDT): A flamed-based process for SOFC diffusion blocking layer and cathode

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An important focus for SOFCs is the improvement of cell lifetime and reduction in materials costs by developing cells capable of running in an intermediate temperature range (773-923K). In this range, LSCF ($La_{0.6}Sr_{0.4}Co_{0.2}Fe_{0.8}O_{3-\delta}$) is a promising cathode material due to its good electronic and ionic conductivity. A GDC ($Ce_{0.9}Gd_{0.1}O_{1.95}$) blocking layer must be applied between the YSZ ($Zr_{0.92}Y_{0.08}O_{2-\delta}$) electrolyte and the LSCF cathode to prevent the formation of $SrZrO_3$. The presence of $SrZrO_3$ leads to resistive losses. RSDT is used to deposit a GDC diffusion blocking layer and a LSCF cathode layer on half cells with NiO,YSZ anode support, NiO,YSZ anode functional layer, and YSZ electrolyte. The RSDT process uses inexpensive solvents and precursors (i.e. toluene and metal 2-ethylhexanoates) in open atmosphere. With RSDT, a dense GDC layer with good adhesion is achieved at a relatively low temperature (~1273K) without sintering. This leads to decreased production costs and limits the inter-diffusion of the YSZ and GDC. The cathode is deposited using a slurry of pre-synthesized LSCF nanoparticles, which, in some experiments is mixed with LSCF nanoparticles directly from the RSDT flame. Test data suggest that RSDT cathodes with this mixture of LSCF nanoparticles have better performance (1.4 W/cm^2) than RSDT cathodes made from only the LSCF slurry.