Inkjet printing of 8% Y2O3-stabilized ZrO2 (YSZ) thin films is achieved by designing a novel water-based reactive ink for Drop-on-Demand (DoD) inkjet printing. The ink formulation is based on a novel chemical strategy that consists of a combination of metal oxide precursors (zirconium alkoxide and yttrium salt), water and a nucleophilic agent, i.e. n-methyl-diethanolamine (MDEA). This chemistry leads to metal–organic complexes with long term ink stability and high precision printability. Ink rheology and chemical reactivity are analyzed and controlled in terms of metal–organic interactions in the solutions. Thin dense nanocrystalline YSZ films below 150 nm are obtained by low temperature calcination treatments (400–500 °C), making the deposition suitable for a large variety of substrates, including silicon, glass and metals. Thin films and printed patterns achieve full densification with no lateral shrinkage and high ionic conductivity.
Effect of spherical porosity on co-fired dense/porous zirconia bi-layers cambering

Geometrical instability leading to cambering is recorded during co-sintering of zirconia dense/porous bi-layered planar structures. Sintering strain in the bi-layers rises mainly from mismatch between the different porosity volume fractions at the layers and their interface. In this paper, we analyze the model case of dense taped of 8 mol% Y₂O₃-stabilized ZrO₂ laminated on ca. 400 μ thick 3 mol% Y₂O₃-doped zirconia porous tapes, with homogenous spherical porosity of 13 vol%, 46 vol%, and 54 vol%. Sintering stress during densification is evaluated from the shrinkage rates and viscoelastic behavior during sintering by thermo-mechanical analysis, using cyclic loading dilatometry. The camber development of the bi-layers is measured by in-situ optical dilatometry. In accordance with the model prediction, cambering can be controlled tuning the porosity while achieving a synergetic effect between densification and formation of open porosity at the bilayers.
Enhanced densification of thin tape cast Ceria-Gadolinium Oxide (CGO) layers by rheological optimization of slurries
Optimized CGO-based slurries are formulated and shaped into thin dense layers via a tape-casting process. The formulation is adjusted with respect to the rheological behaviour. The internal structure and flow properties of slurries are explored with the aim of identifying the required conditions to obtain thin dense CGO layers at reduced sintering temperatures (1200 °C). We demonstrate a correlation between the rheological properties of the slurries, the sintering behaviour and the microstructure of the resulting tapes. Remarkably, a dense CGO layer less than 20 μm thick is obtained with a non-congested slurry, having optimized ceramic loading and liquid-like behaviour.
For solid oxide fuel and electrolysis cells, precise tracking of 3D microstructural change in the electrodes during operation is considered critical to understand the complex relationship between electrode microstructure and performance. Here, for the first time, we report a significant step towards this aim by visualizing a complete redox cycle in a solid oxide cell (SOC) electrode. The experiment demonstrates synchrotron-based ptychography as a method of imaging SOC electrodes, providing an unprecedented combination of 3D image quality and spatial resolution among non-destructive imaging techniques. Spatially registered 3D reconstructions of the same location in the electrode clearly show the evolution of the microstructure from the pristine state to the oxidized state and to the reduced state. A complete mechanical destruction of the zirconia backbone is observed via grain boundary fracture, the nickel and pore networks undergo major reorganization and the formation of internal voids is observed in the nickel-oxide particles after the oxidation. These observations are discussed in terms of reaction kinetics, electrode mechanical stress and the consequences of redox cycling on electrode performance.

Ex-situ tracking solid oxide cell electrode microstructural evolution in a redox cycle by high resolution ptychographic nanotomography

For solid oxide fuel and electrolysis cells, precise tracking of 3D microstructural change in the electrodes during operation is considered critical to understand the complex relationship between electrode microstructure and performance. Here, for the first time, we report a significant step towards this aim by visualizing a complete redox cycle in a solid oxide cell (SOC) electrode. The experiment demonstrates synchrotron-based ptychography as a method of imaging SOC electrodes, providing an unprecedented combination of 3D image quality and spatial resolution among non-destructive imaging techniques. Spatially registered 3D reconstructions of the same location in the electrode clearly show the evolution of the microstructure from the pristine state to the oxidized state and to the reduced state. A complete mechanical destruction of the zirconia backbone is observed via grain boundary fracture, the nickel and pore networks undergo major reorganization and the formation of internal voids is observed in the nickel-oxide particles after the oxidation. These observations are discussed in terms of reaction kinetics, electrode mechanical stress and the consequences of redox cycling on electrode performance.
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Power Sources
Volume: 360
ISSN (Print): 0378-7753
Ratings:
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 6.22 SJR 1.945 SNIP 1.483
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.945 SNIP 1.686 CiteScore 6.34
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.983 SNIP 2.071 CiteScore 6.3
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.985 SNIP 2.138 CiteScore 5.63
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 2.293 SNIP 2.016 CiteScore 5.04
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 2.247 SNIP 2.181 CiteScore 5.13
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 2.297 SNIP 1.981
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 2.117 SNIP 1.793
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 1.968 SNIP 1.726
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.597 SNIP 1.489
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 1.8 SNIP 2.224
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 1.65 SNIP 1.825
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 1.852 SNIP 1.818
Scopus rating (2003): SJR 1.66 SNIP 1.583
Scopus rating (2002): SJR 1.959 SNIP 1.4
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 1.115 SNIP 1.492
Scopus rating (2000): SJR 1.106 SNIP 0.914
Scopus rating (1999): SJR 0.854 SNIP 0.998
Original language: English
Ex-situ, Ptychography, Nano-tomography, Solid oxide cell, Oxidation, Reduction
DOIs:
NOx Selective Catalytic Reduction (SCR) on Self-Supported V-W-doped TiO2 Nanofibers

Electrospun V–W–TiO$_2$ catalysts, resulting in a solid solution of V and W in the anatase phase, are prepared as nonwoven nanofibers for NOx selective catalytic reduction (SCR). Preliminary catalytic characterization indicates their superior NOx conversion efficiency to the-state-of-the-art material. A novel concept of a self-supported, ultra-compact, and lightweight nanofibrous SCR-reactor is defined.

General information

State: Published
Organisations: Department of Energy Conversion and Storage, Ceramic Engineering & Science, Fundamental Electrochemistry, Mixed Conductors
Pages: 3466-3472
Publication date: 2017
Main Research Area: Technical/natural sciences

Publication information

Journal: New Journal of Chemistry
Volume: 41
Issue number: 9
ISSN (Print): 1144-0546
Ratings:
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 3.08 SJR 0.869 SNIP 0.766
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.954 SNIP 0.836 CiteScore 3.27
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.01 SNIP 0.872 CiteScore 3.14
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.047 SNIP 0.838 CiteScore 3.03
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.209 SNIP 0.825 CiteScore 2.8
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.148 SNIP 0.81 CiteScore 2.66
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.282 SNIP 0.852
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.366 SNIP 0.899
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 1.549 SNIP 0.936
Scopus rating (2007): SJR 1.394 SNIP 1.084
Scopus rating (2006): SJR 1.25 SNIP 1.024
Nucleophilic stabilization of water-based reactive ink for titania-based thin film inkjet printing

Drop on demand deposition (DoD) of titanium oxide thin films (<500 nm) is performed via a novel titanium-alkoxide-based solution that is tailored as a reactive ink for inkjet printing. The ink is developed as water-based solution by a combined use of titanium isopropoxide and n-methyldiethanolamine (MDEA) used as nucleophilic ligand. The function of the ligand is to control the fast hydrolysis/condensation reactions in water for the metal alkoxide before deposition, leading to formation of the TiO₂ only after the jet process. The evolution of the titanium-ligand interactions at increasing amount of MDEA is here elucidated in terms of long term stability. The ink printability parameter (Z) is optimized, resulting in a reactive solution with printability, Z, >1, and chemical stability up to 600 h. Thin titanium oxide films (<500 nm) are proved on different substrates. Pure anatase phase is obtained after annealing at low temperature (ca. 400 °C).
Oxygen Permeation and Stability Study of (La0.6Ca0.4)0.98(Co0.8Fe0.2)O3-δ Membranes

The perovskite-type oxide (La0.6Ca0.4)0.98(Co0.8Fe0.2)O3-δ (LCCF) was investigated for use as oxygen separation membrane. A 25 µm thick dense membrane on a porous LCCF support with a thickness of around 175 µm was prepared by a tape casting and lamination process. The optimum sintering temperature of the component was established to be 1050 °C by analysis of microstructures of membranes sintered at different temperatures. Scanning electron microscopy (SEM) examination of cross-sections of the sintered membrane showed that it consisted of two phases, the main phase being enriched in calcium (Ca) and depleted in lanthanum (La), relative to the nominal composition. A surface activation layer of LCCF was deposited onto the dense layer to increase the exchange rate of oxygen at the surface. For the coated membrane, the oxygen permeation flux increased with temperature and reached a maximum value of 3.32 Nml cm⁻² min⁻¹ at 900 °C when, for characterization purpose pure oxygen was used as feed and a maximum value of 2.06 Nml cm⁻² min⁻¹ at 900 °C was obtained when air was used at the feed side, both with N₂ sweep on the permeate side. The stability of the membrane against sulfur dioxide (SO₂) and pure carbon dioxide (CO₂) was tested. A small decrease in the flux was observed over 48 h in CO₂ at 850 °C. SEM examinations of the cross-section of the tested membrane showed that the Ca rich phase in the membrane showed a tendency to migrate to the feed side. Whereas the material shows a CO₂ stability superior to that of Sr or Ba containing analogues, the material stability is not sufficient for applications requiring direct exposure to sulfur-rich flue gases.
Releasing cation diffusion in self-limited nanocrystalline defective ceria thin films

Acceptor-doped nanocrystalline cerium oxide thin films are mechanically constrained nano-domains, with film/substrate interfacial strain and chemical doping deadlock mass diffusion. In contrast, in this paper we show that chemical elements result in highly unstable thin films under chemical reduction, with unexpected diffusion-driven effects such as fast migration of grain boundaries, porosity nucleation, and interdiffusion at low temperatures.
When two become one: an insight into 2D conductive oxide interfaces

Recent progress has led to conductance confinement at the interface of complex oxide heterostructures, thereby providing new opportunities to explore nano-electronic as well as nano-ionic devices. In this paper we describe how interfacial contiguity between materials can trigger redox reactions inducing metallic conductivity along the interface of SrTiO3-based heterostructures and create new types of 2 Dimension Electron Gases (2DEG) at the hetero-interface with electron mobility enhancements of more than one order of magnitude higher than those of hitherto investigated perovskite-type interfaces. Furthermore, our recent results, examining strain effects at interfaces, demonstrate the potential of achieving hetero-epitaxial thin films with superior ionic or electronic properties. We also present a novel concept that uncovers a wide variety of possible technological opportunities for materials design utilizing ionic conducting multi-layered heterostructures. These findings hold the potential to pave the way for novel and/or superior all-oxide electronic and ionic devices.
Accelerated ceria–zirconia solubilization by cationic diffusion inversion at low oxygen activity

Fast elemental diffusion at the Gd-doped ceria/Y-stabilized zirconia interface occurs under reducing conditions at low oxygen activity (\(pO_2 < 10^{-12}\) atm) and high temperature (1400 °C). This effect leads to formation of thick ceria–zirconia solid solution reaction layers in the micro-range vs. thin layers of few tens of nanometers under oxidative conditions (i.e. in synthetic air at \(pO_2 = 0.21\) atm). The fast dissolution occurs by an inversion of the dominating limiting mechanism from the expected Zr\(^{4+}\) diffusion into the CGO lattice at high \(pO_2\) to an unexpected Ce\(^{3+}\) diffusion into the YSZ component under reducing conditions. The diffusion coefficient of 8-fold coordinated Ce\(^{3+}\) in YSZ at 1400 °C and \(pO_2 = 10^{-13}\) atm is estimated to be around \(10^{-11}\) cm\(^2\) s\(^{-1}\). This value is around 3 orders of magnitude higher than Zr\(^{4+}\) interdiffusion in CGO under oxidative conditions and about 8 orders of magnitude higher than Ce\(^{4+}\) self-diffusion in CGO in air at the same temperature.

Design and optimization of porous ceramic supports for asymmetric ceria-based oxygen transport membranes

The microstructure, mechanical properties and gas permeability of porous supports of Ce\(_{0.9}\)Gd\(_{0.1}\)O\(_{1.95-\delta}\) (CGO) were investigated as a function of sintering temperature and volume fraction of pore former for use in planar asymmetric oxygen transport membranes (OTMs). With increasing the pore former content from 11 vol% to 16 vol%, the gas permeabilities increased by a factor of 5 when support tapes were sintered to comparable densities. The improved permeabilities were
due to a more favourable microstructure with larger interconnected pores at a porosity of 45% and a fracture strength of 47±2 MPa (m=7). The achieved gas permeability of 2.25×10−15 m2 for a 0.4 mm thick support will not limit the gas transport for oxygen production but in partial oxidation of methane to syngas at higher oxygen fluxes. For integration of the CGO support layer into a flat, asymmetric CGO membrane, the sintering activity of the CGO membrane was reduced by Fe2O3 addition (replacing Co3O4 as sintering additive).

General information
State: Published
Organisations: Department of Energy Conversion and Storage, Ceramic Engineering & Science, Fundamental
Electrochemistry, Mixed Conductors
Pages: 85-94
Publication date: 2016
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Membrane Science
Volume: 513
ISSN (Print): 0376-7388
Ratings:
BFI (2017): BFI-level 2
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 6.13 SJR 2.062 SNIP 1.72
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2 SNIP 1.771 CiteScore 5.89
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.433 SNIP 1.935 CiteScore 5.42
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 2.452 SNIP 2.001 CiteScore 5.38
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 2.201 SNIP 1.968 CiteScore 4.37
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 1.82 SNIP 1.726 CiteScore 4.29
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.802 SNIP 1.821
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 1.638 SNIP 1.693
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 1.461 SNIP 1.805
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.474 SNIP 1.578
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 1.812 SNIP 2.444
Fabrication of doped Titania (TiO2) nanofibers to serve as catalysts in NH3-Selective Catalytic Reduction (SCR)

In a context of significant interest for energy and environment, nanostructured ceramic materials are considered ideal candidates for the development of cost and energy efficient innovative systems. Such attention is essentially due...
to the unique properties originating from the confinement of either one or more dimensions into the nanoscale level. Among others, the large surface-to-volume ratio is a feature that greatly increases the reactivity of the nanomaterials towards gaseous species when compared with the non-nanodimensional materials. With this regards, catalysis is one of those applications that unquestionably benefit from this novel feature. In addition, when nanofibers (1D nanostructure) are used as catalysts, the further advantage of a self-supported wide open and well-interconnected porous structure is achieved. Herein we demonstrate nanofibers as catalysts for the removal of the NOx in exhausts via the NH3 Selective Catalytic Reduction (SCR) method. By combining electrospinning and sol-gel chemistry, materials are processed as nanofibers with the catalytic components (e.g., V2O5-WO3) incorporated as dopants into the supporting anatase phase (e.g., TiO2). Remarkable high NOx conversion efficiencies are obtained and associated with the unique features deriving from the synergism among the doping approach, the nanoscale confinement, and the nano-fibrous texture. A novel concept of self-supported, lightweight and ultra-compact design SCR reactor is defined.

General information
State: Published
Organisations: Department of Energy Conversion and Storage, Ceramic Engineering & Science, Mixed Conductors, Imaging and Structural Analysis, Fundamental Electrochemistry, Technical University of Denmark
Authors: Marani, D. (Intern), Silva, R. H. (Ekstern), Dankeaw, A. (Ekstern), Gudik-Sørensen, M. (Intern), Norman, K. (Intern), Kammer Hansen, K. (Intern), Esposito, V. (Intern)
Number of pages: 1
Publication date: 2016
Event: Main Research Area: Technical/natural sciences
Electronic versions:
OralAbstract_dmar_TNFs_final.pdf
Source: PublicationPreSubmission
Source-ID: 126278638
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2016

High ionic conductivity in confined bismuth oxide-based heterostructures
Bismuth trioxide in the cubic fluorite phase (δ-Bi2O3) exhibits the highest oxygen ionic conductivity. In this study, we were able to stabilize the pure δ-Bi2O3 at low temperature with no addition of stabilizer but only by engineering the interface, using highly coherent heterostructures made of alternative layers of δ-Bi2O3 and Yttria Stabilized Zirconia (YSZ), deposited by pulsed laser deposition. The resulting [δ-Bi2O3=YSZ] heterostructures are found to be stable over a wide temperature range (500-750 °C) and exhibits stable high ionic conductivity over a long time comparable to the value of the pure δ-Bi2O3, which is approximately two orders of magnitude higher than the conductivity of YSZ bulk.

General information
State: Published
Organisations: Department of Energy Conversion and Storage, Electrofunctional materials, Ceramic Engineering & Science
Authors: Sanna, S. (Intern), Esposito, V. (Intern), Christensen, M. (Ekstern), Pryds, N. (Intern)
Number of pages: 5
Publication date: 2016
Main Research Area: Technical/natural sciences
Publication information
Journal: A P L Materials
Volume: 4
Article number: 121101
ISSN (Print): 2166-532X
Ratings:
Web of Science (2017): Indexed Yes
Scopus rating (2016): SJR 1.889 SNIP 0.898 CiteScore 3.67
Web of Science (2016): Indexed yes
Scopus rating (2015): SJR 1.802 SNIP 1.055 CiteScore 3.76
Scopus rating (2014): SJR 1.525 SNIP 1.25 CiteScore 2.9
Original language: English
Electronic versions:
High_ionic_conductivity.pdf
DOIs:
10.1063/1.4971801

Bibliographical note
Synthesis and characterization of 2D layered gadolinium-doped cerium oxide (CGO) nanomaterials

By the virtue of versatility in composition, morphology, and structure, two-dimensional (2D) layered nanomaterials have attracted in the last decade huge interest. Such materials, consisting in stacked charged nanosheets intercalated with opposite charged exchangeable anions, are of great potential for the design and fabrication of nanomaterials in many applications. Indeed, the interlayer gallery provides a flexible space to accommodate various sized molecules (e.g. pollutants) and tune specific active sites at the atomic space (e.g. catalyst materials). The interest for 2D layered nanomaterials is also associated with the possibility of obtaining via exfoliation ultra-thin nanosheets with lateral dimensions of hundreds of nanometres and thickness of few nanometres. This unique class of nanomaterials has shown many unprecedented properties mainly originating from the dimensional anisotropy and nano-confinement effects. Herein we propose novel 2D layered ceria based oxides (e.g. CGO) synthesized via the heterogeneous precipitation. CGO materials were selected because of their strategic relevance in many technological applications (e.g. catalysis and electrochemical devices). The synthesized CGO layered materials were characterized for their composition, morphology and crystallographic features. The combined experimental results indicated that the layered CGO, with tunable dopant concentration, can be obtained in different morphologies by controlling the synthesis parameters.

Method for producing and controlling the morphology of metal-oxide nanofiber and/or nanotube catalysts.

Disclosed herein is a process for the controlled production of metal-containing nanofibers and/or nanotubes, where the morphology of the nanofibers and/or nanotubes is followed in real time by TEM measurements.
**Effect of chemical redox on Gd-doped ceria mass diffusion**

The valence and size of cations influence mass diffusion and oxygen defects in ceria. Here we show that reduction of Ce\(^{4+}\) to Ce\(^{3+}\), at high temperatures and low oxygen activity, activates fast diffusion mechanisms which depend on the aliovalent cation concentration. As a result, polycrystalline solid solutions with enhanced electrochemical properties are formed.

**General information**

State: Published
Organisations: Department of Energy Conversion and Storage, Ceramic Engineering & Science, Universidade Federal do ABC
Number of pages: 4
Pages: 18835-18838
Publication date: 2015
Main Research Area: Technical/natural sciences

**Publication Information**

Journal: Journal of Materials Chemistry A
Volume: 3
Issue number: 37
ISSN (Print): 2050-7488
Ratings:
- BFI (2017): BFI-level 1
- Web of Science (2017): Indexed Yes
- BFI (2016): BFI-level 1
- Scopus rating (2016): CiteScore 8.46 SJR 3.037 SNIP 1.468
- Web of Science (2016): Indexed yes
- BFI (2015): BFI-level 1
- Scopus rating (2015): SJR 2.672 SNIP 1.663 CiteScore 8.36
- Web of Science (2015): Indexed yes
- BFI (2014): BFI-level 1
- Scopus rating (2014): SJR 2.343 SNIP 1.526 CiteScore 7.27
- Web of Science (2014): Indexed yes
- BFI (2013): BFI-level 1
- ISI indexed (2013): ISI indexed no
- Web of Science (2013): Indexed yes
- Original language: English
- DOIs: 10.1039/c5ta05537g

**Enhancement of the chemical stability in confined δ-Bi\(_2\)O\(_3\)**

Bismuth-oxide-based materials are the building blocks for modern ferroelectrics\(^1\), multiferroics\(^2\), gas sensors\(^3\), light photocatalysts\(^4\) and fuel cells\(^5\,6\). Although the cubic fluorite δ-phase of bismuth oxide (δ-Bi2O3) exhibits the highest conductivity of known solid-state oxygen ion conductors\(^5\), its instability prevents use at low temperature\(^7\-10\). Here we demonstrate the possibility of stabilizing δ-Bi2O3 using highly coherent interfaces of alternating layers of Er\(_2\)O\(_3\)-stabilized δ-Bi\(_2\)O\(_3\) and Gd\(_2\)O\(_3\)-doped CeO\(_2\). Remarkably, an exceptionally high chemical stability in reducing conditions and redox cycles at high temperature, usually unattainable for Bi\(_2\)O\(_3\)-based materials, is achieved. Even more interestingly, at low oxygen partial pressure the layered material shows anomalous high conductivity, equal or superior to pure δ-Bi\(_2\)O\(_3\) in air. This suggests a strategy to design and stabilize new materials that are comprised of intrinsically unstable but high-performing component materials.

**General information**

State: Published
Number of pages: 5
**Fabrication of doped Titania (TiO2) nano-catalysts in the shape of nanofibers**

Nanostructured materials have attracted incredible interest during the recent years for a large variety of applications. In heterogeneous catalysis, the use of nano-sized catalytic materials is expected to significantly impact the performances of materials as consequence of their large surface-to-volume ratios [1]. The "nanomaterial" approach enables to achieve structures with incredible large exposed surface area. When nanofibers are used as nano-catalysts, the further advantage of a quite open porous structure is further achieved. In this work, nanomaterial approach was adopted to fabricate nano-catalysts for the removal of the NOx in exhausts via the NH3 Selective Catalytic Reduction method (SCR). The state-of-art system WO3-V2O5 was incorporated into TiO2 ceramic nanofibers through combination of electrospinning and sol-gel process. Catalytic functionalized nanofibers were characterized using SEM, TEM, EDX, BET, XRD, to analyze fiber diameter, morphology, composition, specific surface area, crystallization phases of TiO2 functionalized, atomic percentage of elements in fiber respectively. Catalytic activity was also measured.

**General information**
State: Published
Organisations: Department of Energy Conversion and Storage, Ceramic Engineering & Science, Fundamental Electrochemistry, Technical University of Denmark
Authors: Marani, D. (Intern), Silva, R. H. (Ekstern), Zhang, W. (Intern), Werchmeister, R. M. L. (Intern), Kammer Hansen, K. (Intern), Esposito, V. (Intern)
Publication date: 2015
Event: Abstract from 1st Annual World Congress of Smart Materials 2015, Busan, Korea, Republic of.
Main Research Area: Technical/natural sciences
Source: PublicationPreSubmission
Source-ID: 106753942
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2015

**Fabrication of thin yttria-stabilized-zirconia dense electrolyte layers by inkjet printing for high performing solid oxide fuel cells**

In this work, we present how a low-cost HP Deskjet 1000 inkjet printer was used to fabricate a 1.2 mm thin, dense and gas tight 16 cm² solid oxide fuel cells (SOFC) electrolyte. The electrolyte was printed using an ink made of highly diluted (<4 vol.%) nanometric yttria stabilized zirconia (YSZ) powders (50 nm in size) in an aqueous medium. The ink was designed to be a highly dispersed, long term stable colloidal suspension, with optimal printability characteristics. The electrolyte was made by a multiple printing procedure, which ensures coverage of the several flaws occurring in a single printing pass. Together with an optimized sintering procedure this resulted in good adhesion and densification of the electrolyte. The SOFC exhibited a close-to-theoretical open circuit voltage and a remarkable peak power density above 1.5 W cm⁻² at 800 °C.

**General information**
State: Published
Organisations: Department of Energy Conversion and Storage, Ceramic Engineering & Science, Applied Electrochemistry, Fundamental Electrochemistry, Mixed Conductors
Pages: 89-95
Publication date: 2015
Main Research Area: Technical/natural sciences
Publication Information
Journal: Journal of Power Sources
Volume: 273
ISSN (Print): 0378-7753
Ratings:
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 6.22 SJR 1.945 SNIP 1.483
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.945 SNIP 1.686 CiteScore 6.34
Web of Science (2015): Indexed yes
Fast mass interdiffusion in ceria/alumina composite

Gadolinium-doped ceria (CGO) presents unique processes at low oxygen partial pressure (pO2 < 10^-12 atm) and low temperatures (T > 800 °C) such as faster mass diffusion, which are not observed in conventional sintering under ambient air conditions. In CGO/Al2O3 composites the resulting effects driven by such mass diffusion are low viscosity flows and high reactivity between phases, indicated by the formation of CeAlO3. This reaction is promoted by the high content of oxygen defects and the chemical reduction of Ce4+ cations to Ce3+ in CGO/Al2O3 composites under low temperature and low pO2. In this work, a comparison is made between sintering CGO/Al2O3 under ambient air conditions and under low pO2, focusing on densification, viscosity and the evolution of the microstructure.

General information

State: Published
Instability of supercritical porosity in highly doped ceria under reduced oxygen partial pressure

The thermomechanical behavior and microstructural evolution of low relative density (∼0.40) gadolinium-doped ceria are characterized under oxidative and reducing conditions at high temperatures. The electronic defects generated in the structure by Ce⁴⁺ to Ce³⁺ reduction play an important role on all mass diffusion phenomena, including densification and grain growth. Thermodynamically stable porosity (supercritical porosity) is dominant for isothermal sintering treatments in air. Conversely, the facilitated diffusion of ions through the lattice in reducing conditions results in a nearly full densification.

© 2014 Acta Materialia Inc. Published by Elsevier Ltd. All rights reserved.
Gadolinium-doped ceria, Sintering, Densification, Reducing atmosphere

DOIs:
10.1016/j.scriptamat.2014.08.030

Source: PublicationPreSubmission
Source-ID: 100592739
Modeling constrained sintering of bi-layered tubular structures

Constrained sintering of tubular bi-layered structures is being used in the development of various technologies. Densification mismatch between the layers making the tubular bi-layer can generate stresses, which may create processing defects. An analytical model is presented to describe the densification and stress developments during sintering of tubular bi-layered samples. The correspondence between linear elastic and linear viscous theories is used as a basis for derivation of the model. The developed model is first verified by finite element simulation for sintering of tubular bi-layer system. Furthermore, the model is validated using densification results from sintering of bi-layered tubular ceramic oxygen membrane based on porous MgO and Ce0.9Gd0.1O1.95-d layers. Model input parameters, such as the shrinkage kinetics and viscous parameters are obtained experimentally using optical dilatometry and thermo-mechanical analysis. Results from the analytical model are found to agree well with finite element simulations as well as measurements from sintering experiment.

General information
State: Published
Organisations: Department of Energy Conversion and Storage, Mixed Conductors, Ceramic Engineering & Science, Electrofunctional materials, San Diego State University
Pages: 941–950
Publication date: 2015
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of the European Ceramic Society
Volume: 35
Issue number: 3
ISSN (Print): 0955-2219
Ratings:
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 3.25 SJR 1.135 SNIP 1.776
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.15 SNIP 1.841 CiteScore 3.03
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.187 SNIP 2.099 CiteScore 3.16
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.122 SNIP 1.794 CiteScore 2.57
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.305 SNIP 2.244 CiteScore 2.81
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.343 SNIP 2.217 CiteScore 2.83
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.392 SNIP 1.945
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Planar half-cell shaped precursor body

The invention relates to a half-cell shaped precursor body of either anode type or cathode type, the half-cell shaped precursor body being prepared to be free sintered to form a sintered or pre-sintered half-cell being adapted to be stacked in a solid oxide fuel cell stack. The obtained half-cell has an improved planar shape, which remains planar also after a sintering process and during temperature fluctuations.

General information

State: Published
Organisations: Department of Energy Conversion and Storage, Ceramic Engineering & Science
Authors: Esposito, V. (Intern), Linderoth, S. (Intern)
Publication date: 2015

Publication information

IPC: H01M4/86; H01M4/88; H01M8/12; H01M4/90
Patent number: WO2015059166
Date: 30/04/2015
Priority date: 22/01/2013
Priority number: EP20130189677
Original language: English
Electronic versions:
Planar.pdf
Main Research Area: Technical/natural sciences
Source: PublicationPreSubmission
Source-ID: 110738794
Publication: Research › Patent – Annual report year: 2015

Solid-oxide fuel cells

General information

State: Published
Organisations: Department of Energy Conversion and Storage, Ceramic Engineering & Science, Electrofunctional materials, Technical University of Denmark
Authors: Esposito, V. (Intern), Garbayo, I. (Ekstern), Linderoth, S. (Intern), Pryds, N. (Intern)
Stabilized thin film heterostructure for electrochemical applications.

The invention provides a method for the formation of a thin film multi-layered heterostructure upon a substrate, said method comprising the steps of: a. providing a substrate; b. depositing a buffer layer upon said substrate, said buffer layer being a layer of stable ionic conductor (B); c. depositing a layer A upon said buffer layer, said layer A being a layer of fast ionic conductor (A), said layer A having a thickness (tA) of 20 nm or less; d. depositing a layer B upon said layer A, said layer B being a layer of stable ionic conductor (B), said layer B having a thickness (tB) of 150 nm or less; and e. repeating steps b. and c. a total of N times, such that N repeating pairs of layers (A/B) are built up, wherein N is 1 or more. The invention also provides a thin film multi-layered heterostructure as such, and the combination of a thin film multi-layered heterostructure and a substrate. The heterostructure finds use as an electroceramic, in particular in SOFCs.

Densification and grain growth kinetics of Ce0.9Gd0.1O1.95 in tape cast layers: The influence of porosity

The sintering behavior of Ce0.9Gd0.1O1.95 (CGO) tape cast layers with different porosity was investigated by an extensive characterization of densification, microstructural evolution, and applying the constitutive laws of sintering. The densification of CGO tapes associates with grain coarsening process at the initial sintering stage at T < 1150 °C, which is mainly influenced by small pores and intrinsic characteristics of the starting powders. At the intermediate sintering stage, densification is remarkably influenced by large porosity. Moreover, the sintering constitutive laws indicate that increasing the initial porosity from 0.38 to 0.60, the densification at the late stage is thermally activated with typical activation energy values increasing from 367 to 578 kJ mol−1. Similar effect of the porosity is observed for the thermally activated phenomena leading to grain growth in the CGO tapes. The analysis of sintering mechanisms reveals that the grain growth behavior at different porosity can be described using an identical master curve.© 2014 Elsevier Ltd. All rights reserved.
A novel methodology, called in-situ solid state reaction (SSR), is developed and achieved for the densification of gadolinia doped ceria (CGO) barrier layer (BL) within the solid oxide fuel cell (SOFC) technology. The method is based on the combined use of impregnation technique and a designed two-step sintering process to promote the densification of the CGO-BL on dense yttria stabilized zirconia (YSZ) electrolyte. A pre-sintering step is carried out at temperature $T_1$ ($1150-1250 \, ^{\circ}C$) to obtain porous and interconnected CGO-BL on dense electrolyte substrate. Impregnation of the porous BL is then carried out with small amount of either cobalt or copper nitrate solutions as sintering aids. Final sintering of the CGO-BL at temperature $T_2$ ($1250-1275 \, ^{\circ}C$, $T_2 > T_1$) is used to promote an SSR between the sintering aid and CGO-BL to obtain densification and grain growth. The approach proposed in this work was proved on both screen printed and tape cast CGO-BL, showing feasibility for the densification of generic ceramic multilayer systems undergoing different constrained sintering conditions and for a large variety of materials.

© 2014 Elsevier B.V. All rights reserved.
Densification of Highly Defective Ceria by High Temperature Controlled Re-Oxidation

Highly enhanced densification and grain growth of Ce0.9Gd0.1O1.95-δ (CGO, gadolinium-doped ceria, with 10 mol% Gd) is achieved in low oxygen activity atmospheres. However, the material can suffer mechanical failures during cooling when the re-oxidation process is not controlled due to the large volume changes. In this work, the redox process of CGO is investigated using dilatometry, microscopy, electrochemical impedance spectroscopy and thermodynamic analysis. In addition, the conditions allowing controlled re-oxidation and cooling in order to preserve the mechanical integrity of the CGO component are defined: this can be achieved over a wide temperature range (800−1200°C) by gradually increasing the oxygen content of the atmosphere. It is found that the electrical conductivity of the CGO, particularly at low temperature (<450°C) is influenced by the sintering and controlled re-oxidation conditions. An increase in activation energy for conduction at low temperature is observed as the re-oxidation temperature decreases. Moreover it was observed that the ionic conductivity blocking effect, usually associated with grain boundary contributions, is not influenced by the grain size but rather by the chemical history of the material. © 2014 The Electrochemical Society.

General information
State: Published
Organisations: Department of Energy Conversion and Storage, Mixed Conductors, Electrofunctional materials, Ceramic Engineering & Science
Pages: F3072-F3078
Publication date: 2014
Main Research Area: Technical/natural sciences

Publication information
Journal: Electrochemical Society. Journal
Volume: 161
Issue number: 11
ISSN (Print): 0013-4651
Ratings:
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.97 SJR 1.134 SNIP 0.867
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.037 SNIP 1 CiteScore 3.17
Effects of co-sintering in self-standing CGO/YSZ and CGO/ScYSZ dense bi-layers

Viscoelastic properties and sintering mechanisms of tape-casted gadolinium-doped ceria (CGO), yttrium-stabilized zirconia (YSZ), and scandium–yttrium-stabilized zirconia (ScYSZ) are characterized in order to investigate the reciprocal thermo-mechanical compatibility when arranged as a self-standing bi-layered electrolyte system. The combined use of thermo-mechanical analysis, optical dilatometry, and scanning electron microscopy ensures a systematic characterization of both the individual layers and CGO/YSZ and CGO/ScYSZ bi-layered laminates. The results of the co-firing process of the bi-layers are critical due to the mismatch of thermo-mechanical and sintering properties among the materials. Despite
the better sinteractivity of ScYSZ, the self-standing CGO/ScYSZ bilayer presents more challenges in terms of densification compared with the CGO/YSZ bi-layer. In particular, above 1200 C, ScYSZ and CGO show residual porosity, and at higher sintering temperatures, above 1300 C, full densification is completely inhibited by constrained sintering phenomena.
In situ characterization of delamination and crack growth of a CGO–LSM multi-layer ceramic sample investigated by X-ray tomographic microscopy

The densification, delamination and crack growth behavior in a Ce0.9Gd0.1O1.95 (CGO) and (La0.85Sr0.15)0.9MnO3 (LSM) multi-layer ceramic sample was studied using in situ X-ray tomographic microscopy (microtomography) to investigate the critical dynamics of crack propagation and delamination in a multilayered sample. Naturally occurring defects, caused by the sample preparation process, are shown not to be critical in sample degradation. Instead defects are nucleated during the debinding step. Crack growth is significantly faster along the material layers than perpendicular to them, and crack growth and delamination only accelerates when sintering occurs.

General information
State: Published
Organisations: Department of Energy Conversion and Storage, Electrofunctional materials, Ceramic Engineering & Science, Imaging and Structural Analysis, Paul Scherrer Institut
Pages: 3019-3025
Publication date: 2014
Main Research Area: Technical/natural sciences
Porous La$_{0.6}$Sr$_{0.4}$CoO$_3$ thin film cathodes for large area micro solid oxide fuel cell power generators

Porous La$_{0.6}$Sr$_{0.4}$CoO$_3$ thin films were fabricated by pulsed laser deposition for being used as a cathode for micro solid oxide fuel cell applications as MEMS power generators. Symmetrical La$_{0.6}$Sr$_{0.4}$CoO$_3$/yttria-stabilized zirconia/La$_{0.6}$Sr$_{0.4}$CoO$_3$ free-standing membranes were fabricated using silicon as a substrate. A novel large-area membrane design based on grids of doped-silicon slabs was used. Thermomechanical stability of the tri-layer membranes was ensured in the intermediate range of temperatures up to 700 °C. In-plane conductivity of ca. 300 S cm$^{-1}$ was measured for the cathode within the whole range of application temperatures. Finally, area specific resistance values below 0.3 Ω cm$^2$ were measured for the cathode/electrolyte bi-layer at 700 °C in the exact final micro solid oxide fuel cell device configuration, thus presenting La$_{0.6}$Sr$_{0.4}$CoO$_3$ as a good alternative for fabricating reliable micro solid oxide fuel cells for intermediate temperature applications.

© 2013 Elsevier B.V. All rights reserved.

General information

State: Published
Organisations: Department of Energy Conversion and Storage, Electrofunctional materials, Ceramic Engineering & Science, Universidad Autonoma de Barcelona, Catalonia Institute for Energy Research
Authors: Garbayo, A. (Ekstern), Esposito, V. (Intern), Sanna, S. (Intern), Morata, A. (Ekstern), Pla, D. (Ekstern), Fonseca, L. (Ekstern), Sabaté, N. (Ekstern)
Pages: 1042-1049
Publication date: 2014
Micro solid oxide fuel cell, Thin film cathode, Self-supported electrolyte, Lanthanum strontium cobaltite, Microelectromechanical systems
Sintering and grain growth kinetics in $La_{0.85}Sr_{0.15}MnO_3$–$Ce_0.9Gd_{0.1}O_{1.95}$ porous composite

The sintering kinetics in $La_{0.85}Sr_{0.15}MnO_3$–$Ce_0.9Gd_{0.1}O_{1.95}$ porous composite was studied by applying a two-stage master sintering curve (MSC) approach and comparing with LSM and CGO single-phase materials. In the two-stage MSC, sintering mechanisms occurring at different stages were separated with respect of density, giving a typical apparent activation energy values for each sintering stage of the LSM–CGO system. Compared with the single-phase materials, retardant effect of the different phases on mass diffusion leads to much higher apparent activation energy for densification of the composite. Similarly, constrain effect was also observed in grain growth in the composite. Particularly, in the investigated temperature range (1100–1250°C), the determined grain boundary mobility of CGO in the LSM–CGO composite ($10^{-17}$–$10^{-16}$ m$^2$N$^{-1}$s$^{-1}$) is comparable with the single-phase CGO, while the grain boundary mobility of LSM in the composite ($10^{-17}$–$10^{-16}$ m$^2$N$^{-1}$s$^{-1}$) is around 1 order of magnitude smaller than the single-phase LSM.
Structural instability and electrical properties in epitaxial Er2O3-stabilized Bi2O3 thin films

Bismuth oxide based materials exhibit the highest oxygen ion conductivities, making them of great interest for use in energy conversion devices such as solid oxide fuel cells. However, these materials exhibit chemical and thermal instabilities and understanding and their stabilization is an actively pursued research goal. In this study, we investigate the structural and electrical properties of erbium oxide stabilized bismuth oxide (Er0.4Bi1.6O3 − δ) as thin films. These are deposited by pulsed laser deposition onto several single crystal substrates (MgO, Al2O3 and SrTiO3). The films show new forms of instabilities, both upon aging treatments in air and even under conductivity measurements, with remarkable changes in the film composition and microstructure. © 2014 Published by Elsevier B.V.
Thermo-mechanical properties of SOFC components investigated by a combined method

Co-firing process of different ceramic materials can lead to significant stress and deformation at the multilayer. This is the net effect of a complex set of phenomena such as the removal of organic additives from the green tapes (de-binding), solid state diffusive phenomena during the sintering, and differential thermo-mechanical behavior at each layer. The combination of such factors can have a critical effect on the final shape and microstructure, and on the mechanical integrity. Thermo-mechanical properties and sintering mechanisms of important SOFC materials (CGO, YSZ, ScYSZ)
were systematically characterized by mean of the combined use of optical dilatometry, cyclic loading thermo-mechanical analysis and scanning electron microscopy. The results from the different techniques were found complementary and the thorough understanding of viscoelastic properties of individual layers led to optimization of firing strategy and SOFC design, fundamental to avoid shape instability. Work sponsored by EUDP (Danish energy agency) project 64012-0225 “SOFC accelerated”.

General information
State: Published
Organisations: Department of Energy Conversion and Storage, Ceramic Engineering & Science, Mixed Conductors
Authors: Teocoli, F. (Intern), Esposito, V. (Intern), Ramousse, S. (Intern), Kiebach, W. (Intern)
Number of pages: 1
Publication date: 2014
Event: Abstract from 38th International Conference and Exposition on Advanced Ceramics and Composites, Daytona Beach, FL, United States.
Main Research Area: Technical/natural sciences
Source: dtu
Source-ID: u::10732
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2014

Three-Dimensional Nanofiber Cathode for Low Temperature and High Temperature Fuel Cells

General information
State: Published
Organisations: Department of Energy Conversion and Storage, Ceramic Engineering & Science, Vanderbilt University
Authors: Zhang, W. (. (Intern), Esposito, V. (Intern), Zhang, W. (Intern), Ramousse, S. (Intern), Pintauro, P. N. (Ekstern)
Number of pages: 1
Pages: MA2014-03 367
Publication date: 2014
Main Research Area: Technical/natural sciences

Publication information
Journal: Electrochemical Society. Meeting Abstracts (Online)
Volume: MA2014-03
ISSN (Print): 2151-2043
Original language: English
Source: FindIt
Source-ID: 262091665
Publication: Research - peer-review › Conference abstract in journal – Annual report year: 2014

Viscoelastic properties of doped-ceria under reduced oxygen partial pressure
The viscoelastic properties of gadolinium-doped ceria (CGO) powder compacts are characterized during sintering and cooling under reduced oxygen partial pressure and compared with conventional sintering in air. Highly defective doped ceria in reducing conditions shows peculiar viscoelastic properties due to fast mass diffusion phenomena activated at low temperatures by Ce4+ to Ce3+ reduction. Particularly, the viscous behavior is affected by dramatic microstructural changes, fast grain growth and densification, which are rapidly completed in the last stage of sintering.

General information
State: Published
Organisations: Department of Energy Conversion and Storage, Ceramic Engineering & Science
Authors: Teocoli, F. (Intern), Esposito, V. (Intern)
Pages: 82-85
Publication date: 2014
Main Research Area: Technical/natural sciences

Publication information
Journal: Scripta Materialia
Volume: 75
ISSN (Print): 1359-6462
Ratings:
BFI (2017): BFI-level 2
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Viscoelastic properties of doped-ceria under reduced oxygen partial pressure

General information
State: Published
Organisations: Department of Energy Conversion and Storage, Ceramic Engineering & Science, Mixed Conductors
Authors: Teocoli, F. (Intern), Ni, D. W. (Intern), Esposito, V. (Intern)
Number of pages: 1
Publication date: 2014
Event: Abstract from International Conference on SINTERING 2014, Dresden, Germany.
Main Research Area: Technical/natural sciences
Electronic versions:
Abstract_Sintering2014.pdf

A method for the densification of ceramic layers, especially ceramic layers within solid oxide cell (SOC) technology, and products obtained by the method
A ceramic layer, especially for use in solid oxide cell (SOC) technology, is densified in a method comprising (a) providing a multilayer system by depositing the porous ceramic layer, which is to be densified, onto the selected system of ceramic layers on a support, (b) pre-sintering the resulting multilayer system at a temperature T1 to consolidate a sintered, but porous layer, (c) impregnating a solution or suspension of one or more sintering aids directly into the layer to be densified, (d) evaporating the solution or suspension of step (c) to obtain a homogeneous dispersion of the sintering aid(s) in the porous layer surface and (e) performing a thermal treatment at a temperature T2, where T2 > T1, to obtain densification of and grain growth in the porous layer formed in step (b). The method makes it possible to obtain dense ceramic layers at temperatures, which are compatible with the other materials present in a ceramic multilayer system.

Camber Evolution and Stress Development of Porous Ceramic Bilayers During Co-Firing
Camber evolution and stress development during co-firing of asymmetric bilayer laminates, consisting of porous Ce0.9Gd0.1O1.95 gadolinium-doped cerium oxide (CGO) and La0.85Sr0.15MnO3 lanthanum strontium manganate (LSM)-CGO were investigated. Individual layer shrinkage was measured by optical dilatometer, and the uniaxial viscosities were determined as a function of layer density using a vertical sintering approach. The camber evolution in the bilayer laminates was recorded in situ during co-firing and it was found to correspond well with the one predicted by the theoretical model. The estimated sintering mismatch stress in co-fired CGO-LSM/CGO bilayer laminates was significantly lower than general sintering stresses expected for free sintering conditions. As a result, no co-firing defects were observed in the bilayer laminates, illustrating an acceptable sintering compatibility of the ceramic
Densification and grain growth during sintering of porous Ce$_{0.9}$Gd$_{0.1}$O$_{1.95}$ tape cast layers: A comprehensive study on heuristic methods

The sintering behavior of porous Ce$_{0.9}$Gd$_{0.1}$O$_{1.95}$ (CGO10) tape cast layers was systematically investigated to establish fundamental kinetic parameters associated to densification and grain growth. Densification and grain growth were characterized by a set of different methods to determine the dominant sintering mechanisms and kinetics, both in isothermal and at constant heating rate (iso-rate) conditions. Densification of porous CGO10 tape is thermally activated with typical activation energy which was estimated around 440–470 kJ mol$^{-1}$. Grain growth showed similar thermal activation energy of $\sim 427 \pm 22$ kJ mol$^{-1}$ in the temperature range of 1100–1250ºC. Grain-boundary diffusion was identified to be the dominant mechanism in porous CGO10 tapes. Grain growth and densification mechanism were found strictly related in the investigated temperature range. Porosity acts as a grain growth inhibitor and grain boundary mobility in the porous body was estimated around $10^{-18}$–$10^{-16}$ m$^3$ N$^{-1}$ s$^{-1}$ at the investigated temperature range. © 2013 Elsevier Ltd. All rights reserved.

General information
State: Published
Organisations: Department of Energy Conversion and Storage, Ceramic Engineering & Science, Mixed Conductors
Pages: 2529-2537
Publication date: 2013
Main Research Area: Technical/natural sciences

Publication information
Journal: European Ceramic Society. Journal
Volume: 33
Issue number: 13-14
ISSN (Print): 0955-2219
Ratings:
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 3.25 SJR 1.135 SNIP 1.776
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.15 SNIP 1.841 CiteScore 3.03
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.187 SNIP 2.099 CiteScore 3.16
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.122 SNIP 1.794 CiteScore 2.57
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Enhanced mass diffusion phenomena in highly defective doped ceria

The densification and grain growth of the solid state ionic conductor material Ce0.9Gd0.1O1.95−δ (i.e. GDC10, gadolinium-doped ceria, with Gd 10mol.%) are analysed for nanometric and fine powders of various particle sizes, both in air and in a 9vol.% H2–N2 mixture. Due to a dominant solute drag effect in aliovalent highly doped ceria, the starting morphology of the powders controls the diffusion mechanisms of the material in air. Conversely, highly enhanced densification and grain growth are achieved by firing the materials at reduced temperatures (800°C).

General information
State: Published
Organisations: Department of Energy Conversion and Storage, Ceramic Engineering & Science, Mixed Conductors, Imaging and Structural Analysis, Fundamental Electrochemistry
Pages: 6290-6300
Publication date: 2013
Main Research Area: Technical/natural sciences

Publication information
Journal: Acta Materialia
Volume: 61
Gadolinium-doped ceria, Solute drag, Defects, Sintering, Grain growth
Influence of porosity on densification and grain growth kinetics of Ce$_{0.9}$Gd$_{0.1}$O$_{1.95}$ tape

Gadolinium doped-ceria (CGO) is an important material that offers high stability, tolerance against harsh environments and high ionic and electronic conductivity at high temperatures. For most of its applications, CGO is applied as a thin dense layer on a porous support structure. However, highly porous layer allowing gas flow is necessary in catalytic and in gas purification devices. During the sintering with shrinkage, the total solid volume is maintained to be a constant value but the shape and size of each particle change with the formation of grain boundaries. This change in solid particles is accompanied by the change of shape, size and fraction of pores in a given volume. Therefore, porosity can be treated as an extra phase during sintering study. In this work, we presented the densification and grain growth behaviour of Ce$_{0.9}$Gd$_{0.1}$O$_{1.95}$ tape cast layers with different percentage of porosity. The emphasis was put on the effect of porosity on densification and grain growth kinetics. Derived from the sintering constitutive laws, the densification and grain growth kinetics were experimentally characterized and analyzed. Furthermore, the activation energies for viscous flow were determined from master viscosity curves, which are comparable to the kinetic values obtained from densification and grain growth. It is indicated that porosity has negligible effect on densification kinetics, but high porosity decreases the chance of particle contact, and grain boundary mobility is therefore slowed, which leads to slower grain growth.

Modeling sintering of multilayers under influence of gravity

There is a tendency for multiple functional ceramic layers used in various applications to have increasing surface areas and decreasing thicknesses. Sintering samples with such geometry is challenging, as differential shrinkage of the layers causes undesired distortions. In this work, a model, which describes the combined effect of sintering and gravity of thin multilayers, is derived and later compared with experimental results. It allows for consideration of both uniaxial and biaxial stress states. The model is based on the Skorohod-Olevsky viscous sintering framework, the classical laminate theory and the elastic-viscoelastic correspondence principle. The modeling approach is then applied to illustrate the effect of gravity during sintering of thin layers of cerium gadolinium oxide (CGO), and it is found to be significant. © 2012 The American Ceramic Society.
Shape distortion and thermo-mechanical properties of dense SOFC components from green tape to sintered body

Sintering of ceramic materials is a critical process, especially when the components are shaped as multilayer. Microstructural changes and stresses take place in ceramics as single layer from the green stage to the densification stage, leading to shape distortion, delamination and cracks. The characterization of thermo-mechanical properties, such as viscoelasticity, enables a prediction of microstructural stability of SOFCs. Tape-cast bi-layer structures for CGO/YSZ and CGO/ScYSZ was studied during the thermal processing. Different sintering kinetics of bi-layer tape give rise to
localized tensile stresses, which develop a camber in the final sintered body. To analyze the phenomena, shrinkage of SOFC components single layers and camber development of bi-layers were measured in-situ by optical dilatometry. In addition, a thoughtful investigation of the viscoelastic properties of individual layers was carried out by thermo-mechanical analysis (TMA). The results from the different techniques were found complementary and viscous behavior of the layered ceramics was verified.

General information
State: Published
Organisations: Department of Energy Conversion and Storage, Ceramic Engineering & Science, Mixed Conductors
Authors: Teocoli, F. (Intern), Esposito, V. (Intern), Ni, D. W. (Intern), Brodersen, K. (Intern), Ramousse, S. (Intern)
Number of pages: 1
Publication date: 2013
Event: Abstract from 10th Pacific Rim Conference on Ceramic and Glass Technology, San Diego, CA, United States.
Main Research Area: Technical/natural sciences

Relations
Activities:
10th Pacific Rim Conference on Ceramic and Glass Technology
Source: dtu
Source-ID: u::10731
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2014

Sintering of bi-layered porous structures: Stress development and shape evolution
Ce0.9Gd0.1O1.95 (CGO) and (La, Sr)MnO3 (LSM) are electro-ceramics materials with high potential for several electrochemical applications such as solid Oxide Fuel Cell (SOFC), gas separation membranes, and flue gas purification application. In the latter case, these materials are shaped as thick porous layers and sintered by co-firing process. In this work, porous CGO and LSM/CGO single layers were prepared by tape casting, and CGO-LSM/CGO bi-layer structures were obtained by lamination. The shrinkage characteristics of individual layers were measured by optical dilatometry and the uniaxial viscosity of layers was determined as a function of temperature and density using a vertical sintering approach. The distortion in the bi-layer configurations was experimentally recorded and compared with the analytical calculations. The sintering mismatch stress was calculated from both the camber development and linear strain rate mismatch, which showed a good agreement.

General information
State: Published
Organisations: Department of Energy Conversion and Storage, Mixed Conductors, Ceramic Engineering & Science, Electrofunctional materials
Authors: Ni, D. W. (Intern), Esposito, V. (Intern), Ramousse, S. (Intern), Pryds, N. (Intern)
Publication date: 2013
Event: Abstract from 8th International Conference on High-Performance Ceramics, Chongqing, China.
Main Research Area: Technical/natural sciences
Source: dtu
Source-ID: u::9467
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2013

Sintering of Multilayered Porous Structures: Part I- Constitutive Models
Theoretical analyses of shrinkage and distortion kinetics during sintering of bilayered porous structures are carried out. The developed modeling framework is based on the continuum theory of sintering; it enables the direct assessment of the cofiring process outcomes and of the impact of process controlling parameters. The derived "master sintering curve"-type solutions are capable of describing and optimizing the generic sintering shrinkage and distortion kinetics for various material systems. The approach utilizes the material-specific parameters, which define the relative kinetics of layer shrinkages such as the relative intensity of sintering, and employs the conversion between real and specific times of sintering. A novel methodology is also developed for the determination of the ratio of the shear viscosities of the layer's fully dense materials. This new technique enables the determination of all input parameters necessary for modeling sintering of bilayers using experimental techniques similar to optical dilatometry applied to each individual layer and to a symmetric trilayered porous structure based on the two-layer materials utilized in the bilayered system. Examples of sintering different porous bilayered systems are presented to justify the capability of the model in predicting and optimizing sintering kinetics.

General information
State: Published
Organisations: Department of Energy Conversion and Storage, Mixed Conductors, Electrofunctional materials, Ceramic Engineering & Science, San Diego State University, Moscow Engineering Physics Institute
Authors: Olevsky, E. (Ekstern), Tadesse Molla, T. (Intern), Frandsen, H. L. (Intern), Bjørk, R. (Intern), Esposito, V. (Intern), Ni, D. W. (Intern), Ilyina, A. (Ekstern), Pryds, N. (Intern)
Experimental analyses of shrinkage and distortion kinetics during sintering of bilayered porous and dense gadolinium-doped ceria Ce0.9Gd0.101.95d structures are carried out, and compared with the theoretical models developed in Part I of this work. A novel approach is developed for the determination of the shear viscosities ratio of the layer fully dense materials. This original technique enables the derivation of all the input parameters for the bilayer sintering modeling from one set of optical dilatometry measurements, including the conversion between real and specific times of sintering, the layers’ relative sintering intensity, and the shear viscosities ratio of the layer fully dense materials. These optical dilatometry measurements are conducted simultaneously for each individual layer and for a symmetric trilayered porous structure based on the two layers utilized in the bilayered system. The obtained modeling predictions indicate satisfactory agreement with the results of sintering of a bilayered cerium–gadolinium oxide system in terms of distortion and shrinkage kinetics.
Sintering process optimization for multi-layer CGO membranes by in situ techniques

The sintering of asymmetric CGO bi-layers (thin dense membrane on a porous support; Ce0.9Gd0.1O1.95-delta = CGO) with Co3O4 as sintering additive has been optimized by combination of two in situ techniques. Optical dilatometry revealed that bi-layer shape and microstructure are dramatically changing in a narrow temperature range of less than 100 degrees C. Below 1030 degrees C, a higher densification rate in the dense membrane layer than in the porous support leads to concave shape, whereas the densification rate of the support is dominant above 1030 degrees C, leading to convex shape. A flat bi-layer could be prepared at 1030 degrees C, when shrinkage rates were similar. In situ van der Pauw measurements on tape cast layers during sintering allowed following the conductivity during sintering. A strong increase in conductivity and in activation energy E-a for conduction was observed between 900 and 1030 degrees C indicating an activation of the reactive sintering process and phase transformation of cobalt oxide. (C) 2012 Elsevier Ltd. All rights reserved.
The effect of forming stresses on the sintering of ultra-fine Ce0.9Gd0.1O2-δ powders

The effect of particle and pore arrangement on sintering and densification of ultra-fine (~130nm) Ce0.9Gd0.1O2-δ powder was evaluated. The common understanding that higher initial density of a ceramic network leads to a higher sintered density is not valid for fine powders, which have extremely good sinterability when there is a favourable particle packing. The effect of the applied stresses during forming (which produce different particle packing arrangements) was investigated.
by forging green bodies by different shaping techniques, including casting, and cold isostatic pressing. Samples formed with techniques that apply low levels of stress had a particle arrangement which significantly enhanced sintering at low temperature, compared to those prepared by high stress techniques. The sample geometry, heat treatment for organic removal and the initial density of the green body had a negligible effect on the final density when the ratio of the pore size to particle size was around 1. © 2013 Elsevier Ltd.

General information
State: Published
Organisations: Department of Energy Conversion and Storage, Ceramic Engineering & Science, Technical University of Denmark
Authors: Glasscock, J. (Intern), Esposito, V. (Intern), Foghmoes, S. P. V. (Intern), Stegk, T. (Intern), Matuschek, D. (Ekstern), Ley, M. W. H. (Intern), Ramousse, S. (Intern)
Pages: 1289-1296
Publication date: 2013
Main Research Area: Technical/natural sciences

Publication information
Journal: European Ceramic Society. Journal
Volume: 33
Issue number: 7
ISSN (Print): 0955-2219
Ratings:
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 3.25 SJR 1.135 SNIP 1.776
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.15 SNIP 1.841 CiteScore 3.03
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.187 SNIP 2.099 CiteScore 3.16
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.122 SNIP 1.794 CiteScore 2.57
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.305 SNIP 2.244 CiteScore 2.81
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.343 SNIP 2.217 CiteScore 2.83
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.392 SNIP 1.945
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.381 SNIP 1.724
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 1.146 SNIP 1.645
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.22 SNIP 1.76
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 1.191 SNIP 1.67
Three-dimensional Nanofiber Cathode for Low Temperature and High Temperature Fuel Cells

General information
State: Published
Organisations: Department of Energy Conversion and Storage, Ceramic Engineering & Science, Imaging and Structural Analysis, Applied Electrochemistry, Proton conductors, Fundamental Electrochemistry, Technical University of Denmark
Number of pages: 1
Publication date: 2013
Event: Abstract from Annual meeting of the Danish Electrochemical Society, Ringsted, Denmark.
Main Research Area: Technical/natural sciences
Electronic versions:
Three_dimensional_Nanofiber_Cathode.pdf
Source: dtu
Source-ID: u::10495
Publication: Research › Conference abstract for conference – Annual report year: 2014

Analysis of the sintering stresses and shape distortion produced in co-firing of CGO-LSM/CGO bi-layer porous structures
Gadolinium-doped cerium oxide (CGO) and lanthanum strontium manganate (LSM) are electro-ceramics materials with high potential for several electrochemical applications such as solid Oxide Fuel Cell (SOFC), gas separation membranes, and flue gas purification devices. Especially for novel electrochemical flue gas purification devices, multilayer structures with alternating porous layers of CGO and a LSM/CGO mixture are used to achieve specific functional requirements. In a manufacturing process of such ceramic multilayer devices, co-firing is one of the critical steps as many defects such as cracks, de-lamination and shape distortion can result as a consequence of sintering mismatch stresses caused by the strain rate difference between layers. This work seeks to understand the underlying mechanisms that occur during the co-firing of porous CGO-LSM/CGO bi-layer laminates, by evaluating the sintering mismatch stress and distortion development through modeling and experiments.

General information
State: Published
Organisations: Department of Energy Conversion and Storage, Ceramic Engineering & Science, Mixed Conductors, Electrofunctional materials
Number of pages: 1
Publication date: 2012
Event: Poster session presented at 4th International Congress on Ceramics (ICC4), Chicago, IL, United States.
Main Research Area: Technical/natural sciences
Electronic versions:
Poster_ICC4.pdf
Source: dtu
Source-ID: u::5452
Publication: Research › Poster – Annual report year: 2012
Chemical stability of La$_{0.6}$Sr$_{0.4}$CoO$_{3-\delta}$ in oxygen permeation applications under exposure to N$_2$ and CO$_2$.

Phase stability and chemical reactivity of (La$_{0.6}$Sr$_{0.4}$)$_{0.99}$CoO$_{3-\delta}$ (LSC64) was tested in oxidative (pO$_2$=0.21 atm) and slightly reducing conditions (pO$_2$~10$^{-5}$ atm), as well as in carbon dioxide (pO$_2$~10$^{-4}$ atm) to evaluate the material performance for oxygen separation technologies. Thin film LSC64 oxygen separation membranes (20–30 μm) were manufactured and electrochemical performance was evaluated at a range of temperatures with either nitrogen or CO$_2$ purged on the permeate side of the membrane. Material stability was also investigated by high temperature X-ray diffraction, TGA and conductivity measurements in air, N$_2$ and CO$_2$. Under mild reduction LSC64 partly decomposes to a K2NiF4-type phase (i.e. (La,Sr)$_2$CoO$_4$), and Co-oxide, and under high pCO$_2$ forms SrCO$_3$. The latter is found to impair membrane performance. Electrical properties and oxygen permeation (j$_{O2}$) in thin membranes depend on the thermal and chemical history of the samples. A flux of 4–6 Nml min$^{-1}$ cm$^{-2}$ in the temperature range of 800–900 °C was demonstrated for optimized membranes and conditions. © 2012 Elsevier B.V. All rights reserved.

General information
State: Published
Organisations: Department of Energy Conversion and Storage, Ceramic Engineering & Science, Mixed Conductors
Authors: Esposito, V. (Intern), Søgaard, M. (Intern), Hendriksen, P. V. (Intern)
Pages: 46–56
Publication date: 2012
Main Research Area: Technical/natural sciences

Publication information
Journal: Solid State Ionics
Volume: 227
ISSN (Print): 0167-2738
Ratings:
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.41 SJR 0.751 SNIP 0.88
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.819 SNIP 1.033 CiteScore 2.5
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.843 SNIP 1.304 CiteScore 2.62
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.902 SNIP 1.274 CiteScore 2.35
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.055 SNIP 1.258 CiteScore 2.31
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.383 SNIP 1.621 CiteScore 2.96
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.459 SNIP 1.503
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.507 SNIP 1.483
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 1.516 SNIP 1.621
Densification and grain growth during sintering of porous Ce$_{0.9}$Gd$_{0.1}$O$_{1.95}$ tape cast layer

General information
State: Published
Organisations: Department of Energy Conversion and Storage, Ceramic Engineering & Science
Authors: Ni, D. W. (Intern), Esposito, V. (Intern), Schmidt, C. G. (Intern), Teocoli, F. (Intern), Ramousse, S. (Intern)
Number of pages: 1
Publication date: 2012
Event: Poster session presented at Nordic Conference on Ceramic and Glass Technology, Roskilde, Denmark.
Main Research Area: Technical/natural sciences
Electronic versions:
Densification_and_grain_growth.pdf
Source: dtu
Source-ID: u::6401
Publication: Research › Poster – Annual report year: 2012

Durable and Robust Solid Oxide Fuel Cells
The solid oxide fuel cell (SOFC) is an attractive technology for the generation of electricity with high efficiency and low emissions. Risø DTU (now DTU Energy Conversion) works closely together with Topsoe Fuel Cell A/S in their effort to bring competitive SOFC systems to the market. This 2-year project had as one of its’ overarching goals to improve durability and robustness of the Danish solid oxide fuel cells. The project focus was on cells and cell components suitable for SOFC operation in the temperature range 600 – 750 °C. The cells developed and/or studied in this project are intended for use within the CHP (Combined Heat and Power) market segment with stationary power plants in the range 1 – 250 kW in mind. Lowered operation temperature is considered a good way to improve the stack durability since corrosion of the interconnect plates in a stack is lifetime limiting at T > 750 °C. The fact that degradation and robustness is not very well explored or understood at operating temperatures below 750 °C, provides motivation for focussing on materials and cells suitable for, and operated in this temperature range.
A significant part of this project was concerned with improved understanding of degradation and failure mechanisms. Improved understanding of performance and lifetime limiting factors will make it possible to develop strategies for countering degradation and improving the power density of SOFC based systems, both necessary to advance towards the goals set out in the national plan for SOFC implementation.

General information
State: Published
Electrochemical properties of dense (La, Sr)MnO$_{3-\delta}$ films produced by pulsed laser deposition

The electrical conductivity and the electrochemical properties of dense La$_{0.85}$Sr$_{0.15}$MnO$_{3-\delta}$ (LSM) films, prepared using Pulsed Laser Deposition (PLD) have been investigated. The nano-structure of the LSM films has been characterized using scanning electron microscopy (SEM). The oxygen transport properties of the films were studied using electrochemical impedance spectroscopy (EIS) on symmetrical cells. Electrical conductivity measurement were carried out in an oxygen partial pressure range from 1 to 0.0032 atm, and a temperature range from 950 to 700°C. The electrical conductivity at 800°C was 116 S cm$^{-1}$ and did not vary with the pO$_2$. Impedance spectra were recorded in the temperature range from 600 to 950°C in the oxygen partial pressure range from 0.06 to 1.00 atm. At 900°C and 1.00 atm the area specific resistance was 30.6 Ω cm$^2$ and an activation energy of 2.7 eV was found. Based on the impedance spectra an oxide ion conductivity of 5.0 × 10$^{-1}$ S cm$^{-1}$ was found at 900°C and pO$_2$ = 1.00 atm. The characteristic length, at which the oxide transport reaction switch from being limited by bulk diffusion to that of surface exchange, was estimated to be approximately 220 and 130 nm at 700 and 900°C, respectively.
Improved Modeling Approaches for Constrained Sintering of Bi-Layered Porous Structures

Shape instabilities during constrained sintering experiment of bi-layer porous and dense cerium gadolinium oxide (CGO) structures have been analyzed. An analytical and a numerical model based on the continuum theory of sintering has been implemented to describe the evolution of bow and densification kinetics in the sintering processes that consists of iso-rate and isothermal phases. The significant influence of weight of the sample (gravity) on the evolution of bow, especially in the isothermal sintering phase, is taken in to account. The modeling predictions indicate good agreement with the results of sintering of a bi-layered cerium-gadolinium oxide system in terms of evolution of bow, porosity and thickness.

General information
State: Published
Organisations: Department of Energy Conversion and Storage, Mixed Conductors, Ceramic Engineering & Science, Electrofunctional materials, San Diego State University
Authors: Tadesse Molla, T. (Intern), Frandsen, H. L. (Intern), Esposito, V. (Intern), Bjørk, R. (Intern), Ni, D. W. (Intern), Olevsky, E. (Ekstern), Pryds, N. (Intern)
Number of pages: 8
Shape distortion and thermo-mechanical properties of SOFC components from green tape to sintering body

Sintering in ceramic materials is a critical process, especially when these are shaped as multilayer. From the green stage to the densification, the effects of organic additives removal, solid state diffusive phenomena, and either differential expansion or contraction of the layers can have critical effect on the final shape leading also failure, delamination etc. In this work, a tape-cast bi-layer structure for CGO and YSZ-(Sc) was studied during the thermal processing from debinding to the sintering. The bilayered samples undergo to several phenomena of shape instabilities and deformation due to binder burn out, differential shrinkage behavior and to a potential interfacial reaction between the two materials. To analyze the phenomena, shrinkage of SOFC components single layers and bilayered samples were measured insitu by optical dilatometer. The densification mismatch stress, due to the strain rate difference between materials, was calculated using Cai’s model. Camber (curvature) development for in situ co-firing of a bi-layer ceramic green tape has been investigated. Analysis of shape evolution from green to sintered body can be carried out by the thermo-mechanical analysis techniques.

Strain induced ionic conductivity enhancement in epitaxial Ce0.9Gd0.1O2d

Strained epitaxial Ce0.9Gd0.1O2d (CGO) thin films are deposited on MgO(001) substrates with SrTiO3 (STO) buffer layers. The strain in CGO epitaxial thin films is induced and controlled by varying the thickness of STO buffer layers. The induced strain is found to significantly enhance the in-plane ionic conductivity in CGO epitaxial thin films. The ionic conductivity is found to increase with decrease in buffer layer thickness. The tailored ionic conductivity enhancement is explained in terms of close relationships among epitaxy, strain, and ionic conductivity.
Analysis of Key Factors Controlling Sintering of Dense and Porous CGO Bi-layers

General information
State: Published
Organisations: Thermo Ceramics, Fuel Cells and Solid State Chemistry Division, Risø National Laboratory for Sustainable Energy, Electroceramics, Ceramic processing, San Diego State University
Authors: Tadesse Molla, T. (Intern), Frandsen, H. L. (Intern), Esposito, V. (Intern), Bjørk, R. (Intern), Foghmoes, S. P. V. (Intern), Olevsky, E. (Ekstern), Pryds, N. (Intern)
Publication date: 2011
Event: Poster session presented at Material science and technology 2011, Columbus, Ohio (US), .
Main Research Area: Technical/natural sciences
Electronic versions:
Poster_sintering[1].pdf
Source: orbit
Source-ID: 313722
Publication: Research › Poster – Annual report year: 2011

Nanostructured PLD-grown gadolinia doped ceria: Chemical and structural characterization by transmission electron microscopy techniques

The morphology as well as the spatially resolved elemental and chemical characterization of 10 mol% gadolinia doped ceria (CGO10) structures prepared by pulsed laser deposition (PLD) technique are investigated by scanning transmission electron microscopy accompanied with electron energy loss spectroscopy and energy dispersive X-ray spectroscopy. A dense, columnar and structurally inhomogeneous CGO10 film, i.e. exhibiting grain size refinement across the film thickness, is obtained in the deposition process. The cerium M4,5 edges, used to monitor the local electronic structure of the grains, indicate apparent variation of the ceria valence state across and along the film. No element segregation to the grain boundaries is detected. These results are discussed in the context of solid oxide fuel cell applications.

General information
State: Published
Organisations: Electroceramics, Fuel Cells and Solid State Chemistry Division, Risø National Laboratory for Sustainable Energy, Microstructures and Interfaces, Thermo Ceramics, Ceramic processing, Fuel Cells and Solid State Chemistry Division. Management, Optical Microsensors and Micromaterials, Department of Photonics Engineering, Paul Scherrer Institut
Pages: 5341-5346
Publication date: 2011
Main Research Area: Technical/natural sciences
The effects of thermal annealing on the structure and the electrical transport properties of ultrathin gadolinia-doped ceria films grown by pulsed laser deposition

Ultrathin crystalline films of 10 mol% gadolinia-doped ceria (CGO10) are grown on MgO (100) substrates by pulsed laser deposition at a moderate temperature of 400°C. As-deposited CGO10 layers of approximately 4 nm, 14 nm, and 22 nm thickness consist of fine grains with dimensions ≤∼11 nm. The films show high density within the thickness probed in the X-ray reflectivity experiments. Thermally activated grain growth, density decrease, and film surface roughening, which may result in the formation of incoherent CGO10 islands by dewetting below a critical film thickness, are observed upon heat treatment at 400°C and 800°C. The effect of the grain coarsening on the electrical characteristics of the layers is
investigated and discussed in the context of a variation of the number density of grain boundaries. The results are evaluated with regard to the use of ultrathin CGO10 films as seeding templates for the moderate temperature growth of thick solid electrolyte films with improved oxygen transport properties.
Electrical characterization of gadolinia doped ceria films grown by pulsed laser deposition

Electrical characterization of 10 mol% gadolinia doped ceria (CGO10) films of different thicknesses prepared on MgO(100) substrates by pulsed laser deposition is presented. Dense, polycrystalline and textured films characterized by fine grains (grain sizes <18 nm and <64 nm for a 20-nm and a 435-nm film, respectively) are obtained in the deposition process. Grain growth is observed under thermal cycling between 300 and 800°C, as indicated by X-ray-based grain-size analysis. However, the conductivity is insensitive to this microstructural evolution but is found to be dependent on the sample thickness. The conductivity of the nanocrystalline films is lower (7.0×10^{-4} S/cm for the 20-nm film and 3.6×10^{-3} S/cm for the 435-nm film, both at 500°C) than that of microcrystalline, bulk samples ( S/cm at 500°C). The activation energy for the conduction is found to be 0.83 eV for the bulk material, while values of 1.06 and 0.80 eV are obtained for the 20-nm film and the 435-nm film, respectively. The study shows that the ionic conductivity prevails in a broad range of oxygen partial pressures, for example down to about 10^{-26} atm at 500°C.
Enhanced conductivity in pulsed laser deposited Ce0.9Gd0.1O2−δ/SrTiO3 heterostructures

Significant enhancement in the electrical conductivity of Ce0.9Gd0.1O2−δ (CGO) thin films (250 and 500 nm) deposited on MgO(001) substrate is observed by introducing ~ 50 nm thin SrTiO3 buffer layer film. Introduction of the buffer layer is found to form epitaxial films, leading to minimal grain boundary network that results in a free conduction path with near-zero blocking effects perpendicular to current flow. The in-plane conductivity measurements confirm increase in conductivity with increase in compressive strain on CGO films. © 2010 American Institute of Physics
Enhancement of ionic conductivity in Sm-doped Ceria (SDC)/Yttria-stabilized Zirconia (YSZ) hetero-epitaxial structures

General information
State: Published
Organisations: University of Roma ‘Tor Vergata’
Authors: Sanna, S. (Intern), Esposito, V. (Intern), Tebano, A. (Ekstern), Licoccia, S. (Ekstern), Traversa, E. (Ekstern), Balestrino, G. (Ekstern)
Pages: 1863-1867
Publication date: 2010
Main Research Area: Technical/natural sciences

Publication information
Journal: Small
Volume: 6
Issue number: 17
ISSN (Print): 1613-6810
Ratings:
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 8.11 SJR 3.324 SNIP 1.505
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 3.249 SNIP 1.624 CiteScore 8.11
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 3.118 SNIP 1.668 CiteScore 7.74
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 3.576 SNIP 1.672 CiteScore 8.13
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 4.471 SNIP 1.9 CiteScore 8.17
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 4.122 SNIP 1.83 CiteScore 8.15
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 3.764 SNIP 1.73
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 3.457 SNIP 1.677
Novel Y2-xPrxRu2O7 (x = 0–2) Pyrochlore Oxides Prepared Using a Soft Chemistry Route and their Electrical Properties

Y2xPrxRu2O7 (0rxr2) pyrochlore powders were prepared using a precipitation method, which allowed control of their composition and morphology. Materials structure and morphology were characterized by X-ray diffraction analysis and field emission scanning electron microscopy, respectively. All the synthesized powders exhibited a single pyrochlore phase with particle size depending on the Pr content. Powders with Pr content smaller than 25 mol% were nanometric. X-ray photoelectron spectroscopy analysis revealed a mixed oxidation state of both Pr and Ru, and a variation of the oxidation state of the elements in response to oxygen partial pressure changes. Electrical conductivity measurements were performed by dc 4-probe method at several temperatures, showing that increasing the Pr content in the A site of the pyrochlore structure increased the oxide electrical conductivity.

General information
State: Published
Organisations: Università degli Studi di Roma Tor Vergata, University of Florida, Agenzia nazionale per le nuove tecnologie, l’energia e lo sviluppo economico sostenibile
Authors: Abate, C. (Ekstern), Esposito, V. (Intern), Duncan, K. (Ekstern), Nino, J. C. (Ekstern), Gattia, D. M. (Ekstern), Wachsman, E. D. (Ekstern), Traversa, E. (Ekstern)
Pages: 1970-1977
Publication date: 2010
Main Research Area: Technical/natural sciences

Publication information
Journal: American Ceramic Society. Journal
Volume: 93
Issue number: 7
ISSN (Print): 0002-7820
Ratings:
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 1 SNIP 1.369 CiteScore 2.77
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.017 SNIP 1.42 CiteScore 2.71
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.192 SNIP 1.628 CiteScore 2.78
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.168 SNIP 1.481 CiteScore 2.52
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.277 SNIP 1.523 CiteScore 2.39
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Ceria-based thin films are often applied as key functional components in miniaturized electroceramic devices such as solid oxide fuel cells or gas sensors. Processing routes that prevent thermal degradation and yield access to the optimum microstructures are sought. Multi-step growth, involving the preparation of ultrathin seed layers in the first stage of the deposition process is often envisaged to control the growth and physical properties of the subsequent coating. This work suggests that the limitations of conventional pulsed laser deposition (PLD), performed at moderate temperature (400°C), to the growth of dense, gas impermeable 10 mol% gadolinia-doped ceria (CGO10) solid electrolyte can be overcome by the seeding process. In order to evaluate the seed layer preparation, the effects of different thermal annealing treatments on the morphology, microstructure and surface roughness of ultrathin CGO10 layers with a thickness of 4 nm, 13 nm and 22 nm, respectively, grown on Mg(100), were studied by atomic force microscopy and X-ray reflectometry.

Pulsed laser deposition of gadolinia doped ceria layers at moderate temperature – a seeding approach

Ceria-based thin films are often applied as key functional components in miniaturized electroceramic devices such as solid oxide fuel cells or gas sensors. Processing routes that prevent thermal degradation and yield access to the optimum microstructures are sought. Multi-step growth, involving the preparation of ultrathin seed layers in the first stage of the deposition process is often envisaged to control the growth and physical properties of the subsequent coating. This work suggests that the limitations of conventional pulsed laser deposition (PLD), performed at moderate temperature (400°C), to the growth of dense, gas impermeable 10 mol% gadolinia-doped ceria (CGO10) solid electrolyte can be overcome by the seeding process. In order to evaluate the seed layer preparation, the effects of different thermal annealing treatments on the morphology, microstructure and surface roughness of ultrathin CGO10 layers with a thickness of 4 nm, 13 nm and 22 nm, respectively, grown on Mg(100), were studied by atomic force microscopy and X-ray reflectometry.

General information
State: Published
Authors: Rodrigo, K. A. (Intern), Heiroth, S. (Ekstern), Pryds, N. (Intern), Kuhn, L. T. (Intern), Esposito, V. (Intern), Linderoth, S. (Intern), Schou, J. (Intern), Lippert, T. (Ekstern)
Publication date: 2010
Event: Poster session presented at 7th International Conference on Photo-Excited Processes and Applications, Copenhagen, Denmark.
Main Research Area: Technical/natural sciences
Solid Oxide Fuel Cells, Fuel Cells and Hydrogen
A wet-chemical route for the preparation of Ni–BaCe0.9Y0.1O3−δ cermet anodes for IT-SOFCs

Nano-sized BaCe0.9Y0.1O3−δ (BCY10) protonic conductor powders were used to prepare Ni-BCY10 cermets for anode-supported intermediate temperature solid oxide fuel cells. A new wet-chemical route was developed starting from Ni nitrates as precursors for NiO. BCY10 powders were suspended in a Ni nitrate aqueous solution that was evaporated to allow NiO precipitation on the BCY grains, obtaining NiO-BCY10 cermets. To obtain the final Ni-BCY10 anodes, pellets were reduced in dry H2 at 700 °C. The structural and microstructural properties of the pellets were investigated using X-ray diffraction analysis and field emission scanning electron microscopy. A homogeneous dispersion of perovskite and nickel phases was observed. The chemical stability of the anodes was evaluated under wet H2 and CO2 atmosphere at 700 °C. The electrical properties of the Ni-BCY10 pellets were evaluated using electrochemical impedance spectroscopy measurements. The Ni-BCY10 cermet electrodes showed large electronic conductivity, demonstrating percolation through the Ni particles, and low area specific resistance at the BCY10 interface. These characteristics make the cermet suitable for application in BCY-based protonic fuel cells. The developed chemical route offers a simple and low-cost procedure to obtain promising high performance anodes.
Fabrication and Electrochemical Properties of Epitaxial Samarium-Doped Ceria Films on SrTiO3-Buffered MgO Substrates

Thin films of samarium-oxide-doped (20 mol%) ceria (SDC) are grown by pulsed-laser deposition (PLD) on (001) MgO single-crystal substrates. SrTiO3 (STO) prepared by PLD is used as a buffer layer on the MgO substrates to enable epitaxial growth of the fluorite-structured SDC film; the STO layer provides a proper crystalline match between SDC and MgO, resulting in highly crystalline, epitaxial SDC films grown in the (001) orientation. Film conductivity is evaluated by electrochemical impedance spectroscopy measurements, which are performed at various temperatures (400–775 °C) in a wide range of oxygen partial pressure (pO2) values (10−25−1 atm) in order to separate ionic and electronic conductivity contributions. At 700 °C, SDC/STO films on (100) MgO exhibit a dominant ionic conductivity of about 7 × 10−2 S cm−1, down to pO2 values of about 10−15 atm. The absence of grain boundaries make the SDC/STO/MgO heterostructures stable to oxidation-reduction cycles at high temperatures, in contrast to that observed for the more disordered SDC/STO films, which degraded after hydrogen exposure.
Improved total conductivity of nanometric samaria-doped ceria powders sintered with molten LiNO\textsubscript{3} additive

Nanometric 20\% molar Sm-doped ceria (SDC20) powders were synthesized by co-precipitation in the presence of N, N, N', N' tetramethylethylenediamine (TMEDA). SDC20 powders were sintered using lithium nitrate salt in various concentrations (0.1, 1, 3, and 10 mol\% with respect to the SDC20 total moles) as an additive to promote the liquid phase sintering and without additive for comparison. The addition of the Li salt allowed reducing significantly the sintering temperature of SDC. Electrochemical impedance spectroscopy (EIS) measurements were performed to estimate the contribution of grain boundary and bulk to the electrical conductivity in different sintering conditions. Liquid phase sintering allowed to produce dense samples with enhanced ionic conductivity especially at the grain boundary when compared to the samples sintered without additive. The additive liquid phase was evaporated in large part at the high temperatures throughout the sintering process. Residual extra-phases were segregated at the grain boundary, generated probably by reaction of the Li salt with impurities, which were removed by a chemical etching.

General information
State: Published
Organisations: Institute for Multidisciplinary Research, Università degli Studi di Roma Tor Vergata
Authors: Esposito, V. (Intern), Zunic, M. (Ekstern), Traversa, E. (Ekstern)
Pages: 1069-1075
Publication date: 2009
Main Research Area: Technical/natural sciences

Publication information
Journal: Solid State Ionics
Volume: 180
Issue number: 17-19
ISSN (Print): 0167-2738
Ratings:
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.41 SJR 0.751 SNIP 0.88
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Master sintering curve for Gd-doped CeO2 solid electrolytes

The sintering behavior of gadolinia-doped ceria powders was studied by the master sintering curve (MSC). Dilatometric analyses of powders produced by a soft chemical method were performed to provide the experimental data set for the construction of the MSC. The assumed model provided good fittings of the MSC and the activation energy for the sintering of Ce1−x Gd x O3−δ, with x = 0, 0.05, 0.1, and 0.2 were found to be in the 218–325 KJ/mol range, depending on the dopant content. The results supported that both the nanometric size of the particles and the difference in ionic radii...
between Gd3+ and Ce4+ affects the sintering of Gd-doped CeO2.
Nafion-Mesoporous Silica as Electrolyte for Ethanol Fuel Cells

In this work, mesoporous silica with medium surface area was prepared. The synthesized mesoporous silica was characterized by BET, SEM and TEM demonstrating the formation of an organized pore structure of the silica. Nafion-SiO2 composite membrane with 5% of the filler was characterized by thermogravimetry and ac impedance spectroscopy. The composite membranes exhibited higher proton conductivity than the reference Nafion membrane, due to the increasing of the water retention of the system. Direct ethanol fuel cell polarization curves of the composite were also conducted at 80°C and 130 °C, confirming the enhancement in ethanol fuel cells performance, due to a reduced ethanol cross over, as well as to enhanced proton conductivity of the composite membrane.

General information
State: Published
Organisations: Università degli Studi di Roma Tor Vergata, Federal University Mato Grosso, Universidade Federal do ABC
Authors: Ahmed, Z. (Ekstern), de Matos, B. R. (Ekstern), de Florio, D. (Ekstern), Licoccia, S. (Ekstern), Traversa, E. (Ekstern), Esposito, V. (Intern), Santiago, E. I. (Ekstern), Fonseca, F. C. (Ekstern)
Pages: 853-860
Publication date: 2009
Conference: 216th ECS Meeting, Vienna, Austria, 04/10/2009 - 04/10/2009
Main Research Area: Technical/natural sciences

Publication information
Journal: E C S Transactions
Volume: 25
Issue number: 1
ISSN (Print): 1938-5862
Ratings:
BFI (2017): BFI-level 1
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 0.4 SJR 0.231 SNIP 0.246
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.214 SNIP 0.257 CiteScore 0.36
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.214 SNIP 0.246 CiteScore 0.36
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.192 SNIP 0.237 CiteScore 0.27
ISI indexed (2013): ISI indexed no
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.24 SNIP 0.263 CiteScore 0.29
ISI indexed (2012): ISI indexed no
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.262 SNIP 0.284 CiteScore 0.36
ISI indexed (2011): ISI indexed no
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.247 SNIP 0.245
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.241 SNIP 0.266
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.253 SNIP 0.25
Scopus rating (2007): SJR 0.213 SNIP 0.206
Scopus rating (2006): SJR 0.135 SNIP 0.062
Original language: English
DOIs:
10.1149/1.3210639
Source: PublicationPreSubmission
Design of electroceramics for solid oxides fuel cell applications: Playing with ceria

Nanostructured samaria- and gadolinia-doped ceria (SDC and GDC) powders were synthesized at low temperature (400°C) using diamine-assisted direct coprecipitation method. Fast-firing (f.f.) processes, where sintering temperatures are reached in a short time to promote lattice diffusion, were compared with conventional sintering, for the formation of dense microstructures from the nanostructured powders. Highly dense SDC and GDC samples (96%) with reduced grain size (150 nm) were obtained by f.f. even at 1300°-1400°C and, unexpectedly, high electrical conductivity and low blocking effect at grain boundary was obtained. Conventionally sintered samples showed that the grain boundary resistivity decreased with increasing the grain size, in agreement with the increase in geometrical bulk volume/grain boundary area ratio. Conversely, f.f. samples showed grain boundary resistivity smaller for small grain size. The above effect was observed only for high dopant (>10% molar) contents. The combined effect of powder grain size, dopant content, and sintering temperature-time profile, can be exploited to tune ceria microstructures for specific ionic device applications. © 2008 The American Ceramic Society.

Keyword: Diamine-assisted direct coprecipitation method, Sintering temperatures, Nanostructured materials, Electroceramics, Solid oxide fuel cells (SOFC)
Nanostructured La$_{1-a}$Sr$_a$Co$_{1-b}$Fe$_b$O$_{3-x}$, $a = 0.3-0.5; b = 0-0.2$ and Ce$_{0.8}$Sm$_{0.2}$O$_2$ powders were successfully prepared by citrate-nitrate auto-combustion synthesis and were characterized by scanning electron microscopy and X-ray diffraction analysis. Electrochemical impedance spectroscopy measurements on symmetric cells were performed to evaluate the applicability of La$_{1-a}$Sr$_a$Co$_{1-b}$Fe$_b$O$_{3-x}$ as a cathode material for intermediate temperature solid oxide fuel cells based on Sm doped-ceria electrolytes. Our results demonstrated that strontium has a positive effect while iron shows a slightly negative effect on the interfacial resistance. The effect of the electrode sintering temperature was investigated by varying the temperature from 850 to 1250°C, and the best sintering temperature was found to be 900°C. The best characteristics as cathode at intermediate operating temperatures were found for the composition with $a = 0.4$ and the minimum iron doping, $b = 0.05$; at 700°C, an area specific resistance of 0.13 cm$^2$ was measured. © 2006 The Electrochemical Society
Ceria-Based Thin Film Hetero-structure Growth and Characterization for SOFC Applications

Electrolyte thin films of Ce0.8Gd0.2O1.9-δ (GDC20) were deposited by pulsed laser deposition (PLD) for the fabrication of micro solid oxide fuel cells (SOFCs). The crystal structure and morphology of the films deposited on different substrates were investigated as a function of the growth parameters, using X-ray diffraction (XRD) and field emission scanning electron microscopy (FE-SEM) analysis. The film conductivity was measured in parallel and perpendicular directions of the film substrate using electrochemical impedance spectroscopy (EIS). Pt or La0.8Sr0.2Co0.8Fe0.2O3-δ (LSCF) films were...
used as electrodes in symmetrical cells. For parallel conductivity measurements, two electrodes were deposited by PLD on the surface of the film, while for perpendicular conductivity, thin film hetero-structure were grown sandwiching the electrolyte film between the two electrodes.

**Fabrication of Ce$_{1-x}$Gd$_x$O$_2$-0.5x Electrolytes with Tunable Dense Microstructures for IT-SOFC Applications**

Nano-sized Ce$_{1-x}$Gd$_x$O$_2$-0.5x (0 < x < 0.3) powders, with a narrow particle size distribution in the 5-10 nm range, were synthesized via a soft chemical route. The obtained materials were highly sinteractive and their grain growth was strongly controlled by gadolinium dopant content. Selected fast firing and conventional sintering processes were used to tailor the dense microstructures of the electrolytes. The combined effects of grain size and dopant content on the electrical properties was evaluated taking into consideration the bulk and the grain boundary of the final microstructures. A careful control of the sintering parameters is crucial for the fabrication of tunable microstructures of nanoelectroceramics for IT-SOFC components.
Synthesis and Densification of Nanometric Ce₀.₈Sm₀.₂O₁.₉₋δ

Nanometric 20% molar Sm-doped ceria (SDC20) powders were synthesized by tetramethylethyl ammine (TMDA) co-precipitation method. SDC20 was sintered in several conditions to control the final microstructure. Fast firing and conventional sintering were performed. LiNO₃ was used as an additive to promote liquid phase sintering of ceria at low temperatures (900-1200°C). Powders and dense pellets were analysed using X-ray diffraction (XRD), field emission scanning electron microscopy (FE-SEM), and transmission electron microscopy (TEM). Electrochemical impedance spectroscopy (EIS) measurements were performed on dense pellets in air to estimate the contribution of grain boundary and bulk to the electrical conductivity. Liquid phase sintering produced the densest samples with the highest conductivity.
Applicability of Bi2Ru2O7pyrochlore electrodes for ESB and BIMEVOX electrolytes

Bismuth ruthenate pyrochlore (Bi2Ru2O7, BRO) was tested as a cathode in several bismuth oxide-based electrolyte cells. Erbium oxide stabilized bismuth oxide (ESB) (Bi2O3)‌0.8 (Er2O3) 0.2, Bi2V0.9 Me0.1 O5.35 (BIMEVOX10, Me=Co, Cu, Zn), and Bi2Ru2O7 (BRO) were synthesized via solid-state reaction. ESB and BIMEVOX powders were pressed and sintered into dense pellets while BRO was deposited and sintered as porous electrodes onto ESB and BIMEVOX dense pellet surfaces. Morphologies and phases of the materials were characterized by field emission scanning electron microscope and X-ray diffraction, respectively. Electrochemical performances of BRO/ESB and BRO/BIMEVOX symmetric cells were tested using electrochemical impedance spectroscopy at 200-700°C in air. High polarization for BRO/BIMEVOX cells was observed. In contrast, BRO/ESB cells showed promising low polarization behavior. Different electrochemical performances of BRO electrodes, with ESB or BIMEVOX, indicated that the phases formed at the electrode/electrolyte interface dominated the cell polarization process for BRO/BIMEVOX cells. The Electrochemical Society © 2006 The Electrochemical Society.

General information
State: Published
Organisations: Hanoi University of Science and Technology, Università degli Studi di Roma Tor Vergata, University of Florida
Authors: Esposito, V. (Intern), Luong, B. H. (Ekstern), Di Bartolomeo, E. (Ekstern), Wachsman, E. D. (Ekstern), Traversa, E. (Ekstern)
Pages: A2232-A2238
Publication date: 2006
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of the Electrochemical Society
Volume: 153
Issue number: 12
ISSN (Print): 0013-4651
Ratings:
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.97 SJR 1.134 SNIP 0.867
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.037 SNIP 1 CiteScore 3.17
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.147 SNIP 1.206 CiteScore 3.36
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.151 SNIP 1.299 CiteScore 2.92
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Bi$_2$Ru$_2$O$_7$ Pyrochlore Electrodes for Bi$_2$O$_3$ based Electrolyte for IT-SOFC Applications

Bismuth ruthenate pyrochlore (Bi$_2$Ru$_2$O$_7$: BRO) was tested as a cathode in several bismuth oxide-based electrolyte cells. Erbium oxide stabilized bismuth oxide (ESB) (Bi$_2$O$_3$)$_{0.8}$ (Er$_2$O$_3$)$_{0.2}$, Bi$_2$V$_{0.9}$Me$_{0.1}$O$_{5.35}$ (BIMEVOX$_{10}$, Me = Co, Cu, Zn), and Bi$_2$Ru$_2$O$_7$ (BRO) were synthesized via solid state reaction. ESB and BIMEVOX powders were pressed and sintered into dense pellets while BRO was deposited and sintered as porous electrodes onto ESB and BIMEVOX dense pellet surfaces. Morphologies and phases of the materials were characterized by Field Emission Scanning Electron Microscope and x-ray diffraction, respectively. Electrochemical performances of BRO/ESB and BRO/BIMEVOX symmetric cells were tested using Electrochemical Impedance Spectroscopy (EIS) at 200-700 °C in air. High polarization for BIMEVOX cells was observed, while ESB cells showed a promising behaviour. Different electrochemical performances of BRO electrodes, with ESB or BIMEVOX, indicated that the phases formed at electrodes/electrolyte interface controlled the cell polarization process.
Chemical vapour deposition of multi-walled carbon nanotubes from Nickel/yttria stabilize zirconia catalysts

ABSTRACT
Multi-walled carbon nanotubes (MWNT) were produced by chemical vapor deposition using yttria-stabilized zirconia/nickel (YSZ/Ni) catalysts. The catalysts were obtained by a liquid mixture technique that resulted in fine dispersed nanoparticles of NiO supported in the YSZ matrix. High quality MWNT having smooth walls, few defects, and low amounts of by-products such as amorphous carbon were obtained, even from catalysts with large Ni concentrations (> 50 wt.%). By adjusting the experimental parameters, such as flux of the carbon precursor (ethylene) and Ni concentration, both the MWNT morphology and the process yield could be controlled. The resulting YSZ/Ni/MWNT composites can be interesting due to their mixed ionic-electronic transport properties, which could be useful in electrochemical applications.

General information
State: Published
Organisations: Universidade Federal de Minas Gerais, Instituto de Química, Instituto de Pesquisas Energeticas e Nuclearaes, Università degli Studi di Roma Tor Vergata
Authors: Ferlauto, A. (Ekstern), de Florio, D. (Ekstern), Fonseca, F. (Ekstern), Esposito, V. (Intern), Muccillo, R. (Ekstern), Traversa, E. (Ekstern), Ladeira, L. (Ekstern)
Pages: 271-276
Publication date: 2006
Electrode performance of nanostructured La\(_{1-a}\)Sr\(_a\)Co\(_{1-b}\)Fe\(_b\)O\(_3-x\) on a Ce\(_{0.8}\)Sm\(_{0.2}\)O\(_2\) electrolyte prepared by citrate nitrate auto-combustion

Nanostructured La\(_{1-a}\)Sr\(_a\)Co\(_{1-b}\)Fe\(_b\)O\(_3-x\) (a=0.3-0.5; b=0-0.2) and Ce\(_{0.8}\)Sm\(_{0.2}\)O\(_2\) powders were successfully prepared by citrate-nitrate auto-combustion synthesis and were characterized by scanning electron microscopy and X-ray diffraction analysis. Electrochemical Impedance Spectroscopy measurements on symmetric cells were performed to evaluate the applicability of La\(_{1-a}\)Sr\(_a\)Co\(_{1-b}\)Fe\(_b\)O\(_3-x\) as a cathode material for Single Chamber Solid Oxide Fuel Cells. Our results demonstrated that strontium has a positive effect while iron shows a slightly negative effect on the interfacial resistance. The effect of the electrode sintering temperature was investigated by varying the temperature from 850 °C to 1250 °C and the best sintering temperature was found to be 900 °C. The best characteristics as cathode around the operating temperature of Single Chamber Fuel Cells were found for the composition with a=0.4 and the minimum iron doping; at 700°C, an Area Specific Resistance of 0.13 Ω·cm\(^2\) was measured.
Mixed ionic-electronic YSZ/Ni composite for SOFC anodes with high electrical conductivity

The preparation of the Zr O$_2$: 8 mol % Y$_2$ O$_3$ NiO (YSZ/NiO) composites by a modified liquid mixture technique is reported. Nanometric NiO particles dispersed over the yttria-stabilized zirconia (YSZ) were prepared, resulting in dense sintered specimens with no solid solution formation between the oxides. Such a feature allowed for the electrical characterization of the composites in a wide range of relative volume fraction, temperature, and oxygen partial pressure. The main results indicate that the composites have high electrical conductivity, and the transport properties in these mixed ionic-electronic (MIEC) composites are strongly dependent on the relative volume fraction of the phases, microstructure, and temperature. These parameters should hence be taken into consideration for the optimized design of MIEC composites for electrochemical applications. In this context, the composite was reduced under H$_2$ for the preparation of high-conductivity YSZ/Ni cermet for use as solid oxide fuel cell anode material with relatively low metal content. © 2005 The Electrochemical Society. All rights reserved.
Synthesis and characterization of Y$_2$Ru$_2$O$_7$ and Y$_{2-x}$Pr$_x$Ru$_2$O$_7$ for cathode application in intermediate temperature solid oxide fuel cells

Nanocrystalline powders of Y$_2$Ru$_2$O$_7$ and Y$_{2-x}$Pr$_x$Ru$_2$O$_7$ were prepared by a co-precipitation method. Pr was chosen as the A-site dopant in order to increase the electrical conductivity of Y$_2$Ru$_2$O$_7$. Phase and morphology were studied by XRD and FE-SEM, which showed both systems exhibit a particle size of about 100 nm, and the doped powders were single pyrochlore phase. The electrical conductivity of a dense bar of Y$_{2-x}$Pr$_x$Ru$_2$O$_7$ was measured at several temperatures by d.c. 4-probe method, while the electrochemical properties of Y$_{2-x}$Pr$_x$Ru$_2$O$_7$ pyrochlores were tested in contact to ESB electrolytes, using Electrochemical Impedance Spectroscopy (EIS) in air. The Y$_{2-x}$Pr$_x$Ru$_2$O$_7$ on ESB electrolyte solid-state cells presents a significant decrease of electrodes impedance.

General information
State: Published
Organisations: University of Roma ‘Tor Vergata’
Authors: Abate, C. (Ekstern), Duncan, K. (Ekstern), Esposito, V. (Intern), Traversa, E. (Ekstern), Wachsman, E. D. (Ekstern)
Pages: 255-261
Publication date: 2006
Conference: 208th ECS Meeting, Los Angeles, California, United States, 16/10/2005 - 16/10/2005
Main Research Area: Technical/natural sciences

Publication information
Journal: ECS Transactions
Volume: 1
Issue number: 7
ISSN (Print): 1938-5862
Ratings:
BFI (2017): BFI-level 1
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 0.4 SJR 0.231 SNIP 0.246
BFI (2015): BFI-level 1
Synthesis, Characterization and Densification of Samaria Doped Ceria (SDC) ultra-fine Powders
Nanometric Samaria 20% mol Doped Ceria (SDC20) powders were synthesized by a co-precipitation method. Nano-sized SDC20 powders (crystal size ∼ 15 nm) were obtained by calcination at 600 °C. The powders were formed by uniaxial pressure and then sintered. Sintering procedures were led both conventionally, at 1500 °C for different sintering times (1, 5, and 10 h), and by fast firing process at different temperatures (1200, 1300, 1400, 1500, and 1600 °C for ∼ 0.1 h). Different microstructures were obtained from the different thermal treatments. Electrochemical impedance spectroscopy (EIS) was used to determine total conductivity and to separate bulk and grain boundary impedance contributions. As expected, densification and electrical properties of the conventionally sintered samples showed to be mainly dependent on the average grain size. On the other hand, for the fast fired samples, lattice diffusion mechanism mainly controlled the densification, boundary arrangement and the resulting microstructures at various temperatures.
Alternative chemical route to mesoporous titania from a titanatrancomplex

High-purity, mesoporous titania was prepared by reaction of dimethylaminotitanatran, [NMe2–Ti(OCH2CH2)3N] in the presence of micellar aggregates as templating agents followed by thermal treatments in the temperature range 350–450 °C. The powders were characterized by nitrogen adsorption–desorption isotherms, thermogravimetry–differential thermal analysis, Fourier transform infrared, field-emission scanning electron microscopy, and x-ray diffraction. Analysis of the morphological characteristics of titanium oxide powders calcined at 350 °C for 120 h and at 450 °C for 6 h showed the presence of a mesoporous structure, with an average pore size of about 3.5 nm. Firing temperatures above 450 °C caused the collapse of the mesoporous structure. Composite Nafion-based membranes, containing 5 wt% mesoporous titania fired at 450 °C as a filler were successfully prepared. Preliminary tests in a prototype direct methanol fuel cell demonstrated that the composite membrane allowed cell operation up to 145 °C, thus showing a significant performance improvement over pure Nafion.

General information
State: Published
Organisations: University of Roma ’Tor Vergata’
Authors: Trakanprapai, C. (Ekstern), Esposito, V. (Intern), Licoccia, S. (Ekstern), Traversa, E. (Ekstern)
Pages: 128-134
Publication date: 2005
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Materials Research
Volume: 20
Issue number: 1
ISSN (Print): 0884-2914
Ratings:
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 0.648 SNIP 0.661 CiteScore 1.51
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.649 SNIP 0.73 CiteScore 1.48
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.825 SNIP 0.979 CiteScore 1.8
Composite Mesoporous Titania Nafion-Based Membranes for Direct Methanol Fuel Cell Operation at High Temperature

General information
State: Published
Organisations: Consiglio Nazionale delle Ricerche, Mediterranea University of Reggio Calabria, University of Roma ‘Tor Vergata’
Authors: Baglio, V. (Ekstern), Di Blasi, A. (Ekstern), S. Aricò, A. (Ekstern), Antonucci, V. (Ekstern), Antonucci, P. L. (Ekstern), Trakanprapai, C. (Ekstern), Esposito, V. (Intern), Licoccia, S. (Ekstern), Traversa, E. (Ekstern)
Pages: A1373-A1377
Publication date: 2005
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of the Electrochemical Society
Volume: 152
Issue number: 7
ISSN (Print): 0013-4651
Ratings:
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.97 SJR 1.134 SNIP 0.867
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.037 SNIP 1 CiteScore 3.17
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.147 SNIP 1.206 CiteScore 3.36
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.151 SNIP 1.299 CiteScore 2.92
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.329 SNIP 1.296 CiteScore 2.61
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.33 SNIP 1.345 CiteScore 2.74
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.417 SNIP 1.312
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.45 SNIP 1.267
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 1.608 SNIP 1.416
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.58 SNIP 1.325
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 1.611 SNIP 1.54
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 1.519 SNIP 1.484
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 1.719 SNIP 1.706
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 1.962 SNIP 1.679
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 2.147 SNIP 1.646
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 1.651 SNIP 1.738
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 1.788 SNIP 1.708
Web of Science (2000): Indexed yes
Scopus rating (1999): SJR 1.657 SNIP 1.85
Original language: English
DOIs:
10.1149/1.1931427
Source: orbit
Source-ID: 314623
Publication: Research - peer-review › Journal article – Annual report year: 2005
Electrical properties of YSZ/NiO composites prepared by a liquid mixture technique

We report the preparation and characterization of yttria-stabilized zirconia/nickel oxide composites (YSZ/NiO). This composite is the precursor material of the cermet YSZ/Ni, which is used as solid oxide fuel cell anode material. The performance of the anode is strongly dependent on the microstructural properties of the cermet. Therefore, the control of the microstructure of the YSZ/NiO composite is a key step for the fabrication of high-performance anodes. In this study, the composites were prepared by a modified liquid mixture technique. Scanning electron microscopy analysis evidenced the good dispersion of the phases and that NiO nanoparticles are spread over the YSZ surface. Sintered pellets were studied by X-ray diffraction and impedance spectroscopy. The main results show that the composite is comprised of a well-dispersed mixture of the two phases. The electrical conductivity data show that there is a strong dependence of the transport mechanism on the relative composition of phases. © 2005 Elsevier Ltd. All rights reserved.

General information
State: Published
Organisations: Instituto de Química, Instituto de Pesquisas Energeticas e Nucleares, Università degli Studi di Roma Tor Vergata
Authors: Esposito, V. (Intern), de Florio, D. (Ekstern), Fonseca, F. (Ekstern), Muccillo, E. (Ekstern), Muccillo, R. (Ekstern), Traversa, E. (Ekstern)
Pages: 2637-2641
Publication date: 2005
Main Research Area: Technical/natural sciences

Publication information
Journal: European Ceramic Society. Journal
Volume: 25
ISSN (Print): 0955-2219
Ratings:
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 3.25 SJR 1.135 SNIP 1.776
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.15 SNIP 1.841 CiteScore 3.03
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.187 SNIP 2.099 CiteScore 3.16
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.122 SNIP 1.794 CiteScore 2.57
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.305 SNIP 2.244 CiteScore 2.81
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.343 SNIP 2.217 CiteScore 2.83
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.392 SNIP 1.945
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.381 SNIP 1.724
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 1.146 SNIP 1.645
Pb2Ru2O6.5 as a low temperature cathode for bismuth oxide electrolytes

A chemical route, called direct condensation method DCM, was developed to synthesize nanometric Pb2Ru2O6.5 as a cathode material for intermediate temperature solid oxide fuel cells. The electrolyte used was Er2O3-0.2Bi2O3-0.8 ESB. Porous lead ruthenate and ESB-lead ruthenate composite electrodes were deposited onto dense ESB pellets. X-ray diffraction, field-emission scanning electron microscopy, and energy dispersive spectroscopy analysis were used to investigate the reactivity and the morphology of the materials prepared. Electrochemical impedance spectroscopy in air at different operating temperatures was used to evaluate polarization and electrical performance of cells in symmetric configuration. Lead ruthenate-based electrodes were sintered at different temperatures to understand the role of the triple-phase boundary on the electrode polarization. An increase in the sintering temperature induced the formation of intermediate phases at the interface between ESB and the pyrochlore, thereby resulting in an increase in the polarization resistance at the electrode/electrolyte interface of the symmetric cells. © 2005 The Electrochemical Society.
Preparation and Electrochemical Characterization of Perovskite/YSZ Ceramic Films

Perovskite-type La_{0.8}Sr_{0.2}Co_{0.8}Fe_{0.2}O_{3-2\delta} powders were prepared using a complex polymeric precursor method. Thermal analysis was carried out on the perovskite precursor to investigate the oxide-phase formation. The structural phase of the powders was determined by X-ray diffraction. These results showed that the decomposition of the precursors occurs in a two-step reaction and temperatures higher that 1000°C are required for these decomposition reactions. For the electrochemical characterization, La_{0.8}Sr_{0.2}Co_{0.8}Fe_{0.2}O_{3-2\delta} electrodes were deposited by a wet spray technique on dense yttria-stabilized zirconia (YSZ) layers. The morphology of the deposited perovskite thick films (;50 mm) was investigated by field emission scanning electron microscopy and showed a porous microstructure. Electrochemical impedance spectroscopy (EIS) measurements were carried out under synthetic air flux at temperatures ranging from 200-600°C in the 10 mHz-10 MHz frequency range showing an interfacial electrical resistance related to the La_{0.8}Sr_{0.2}Co_{0.8}Fe_{0.2}O_{3-2\delta} electrodes. EIS measurements were also performed in the same frequency range at different oxygen partial pressures (1025-1 atm) at 600°C. At this temperature and frequencies below 0.1 MHz, the electrical response to the applied signal of the electrode material is best fitted by two semicircles, which can be related to charge-transfer processes. The activation energy for the limiting step ~adsorption/desorption! was found to be 1.6 eV. © 2004 The
Process for the production of nanocrystalline oxides and mixed oxides of the lanthanides group, obtained products and their use

The present invention relates to a process for the production of nanocrystalline oxides and mixed oxides of the lanthanides group, obtained products and their use.

General information
State: Published
Organisations: University of Roma ’Tor Vergata’
Authors: Licoccia, S. (Ekstern), Traversa, E. (Ekstern), Rainer, A. (Ekstern), Esposito, V. (Intern), Trakanprapai, C. (Ekstern)
Publication date: 2005

Bibliographical note
Also published as: WO2005080271 (A3); ITRM200400089 (A1)
Main Research Area: Technical/natural sciences
Source: PublicationPreSubmission
Source-ID: 110738737
Publication: Research › Patent – Annual report year: 2005

EIS study of humidity sensor based on mesostructured porous silica thin film material

General information
State: Published
Organisations: University of Roma ’Tor Vergata’, University of Padua, University of Sassari
Authors: Esposito, V. (Intern), de Florio, D. Z. (Ekstern), Bertolo, J. M. (Ekstern), Bearzotti, A. (Ekstern), Falcaro, P. (Ekstern), Innocenzi, P. (Ekstern), Traversa, E. (Ekstern)
Publication date: 2003

Host publication information
Title of host publication: Proceedings of the 204th Meeting of The Electrochemical Society
Publisher: Electrochemical Society, Incorporated
Article number: 1481
Main Research Area: Technical/natural sciences
Conference: 204th Meeting of the Electrochemical Society, Orlando, FL, United States, 12/10/2003 - 12/10/2003
Projects:

GIANT-E: Microstructural forging of electromechanically active bulk ceria
Department of Energy Conversion and Storage
Period: 15/04/2017 → 14/04/2020
Number of participants: 3
Phd Student:
Kabir, Ahsanul (Intern)
Supervisor:
Van Nong, Ngo (Intern)
Main Supervisor:
Esposito, Vincenzo (Intern)

Financing sources
Source: Internal funding (public)
Name of research programme: Forskningsrådsfinansiering
Project: PhD

Fabrication and electrical properties of advanced thin film materials for resistive switching memories
Department of Energy Conversion and Storage
Period: 01/04/2017 → 31/03/2020
Number of participants: 4
Phd Student:
li, Yang (Intern)
Supervisor:
Esposito, Vincenzo (Intern)
Traulsen, Marie Lund (Intern)
Main Supervisor:
Pryds, Nini (Intern)

Financing sources
Source: Internal funding (public)
Name of research programme: Forskningsrådsfinansiering
Project: PhD

GIANT-E - Ceria Thin Films Giant Electrostrictors
Department of Energy Conversion and Storage
Period: 15/02/2017 → 14/02/2020
Number of participants: 4
Phd Student:
Santucci, Simone (Intern)
Supervisor:
Lubomirsky, Igor (Ekstern)
Pryds, Nini (Intern)
Main Supervisor:
Esposito, Vincenzo (Intern)

Financing sources
Source: Internal funding (public)
Name of research programme: Forskningsrådsfinansiering
Project: PhD
The fabrication and testing of two terminal memristor device - Nano Ionic Conducting Engineered materials for information application

Department of Energy Conversion and Storage
Ceramic Engineering & Science
Electrofunctional materials
Fundamental Electrochemistry

ETH Zurich
Period: 01/01/2017 → 31/01/2020
Number of participants: 3
Acronym: NICE
Number of related Ph.D. students: 1
Project participant:
Esposito, Vincenzo (Intern)
Traulsen, Marie Lund (Intern)
Project Manager, organisational:
Pryds, Nini (Intern)

Highly defective oxides – the next generation of electromechanical materials
Materials capable of changing shape in response to an electrical field work as muscles and have important applications as actuators in many different contexts. At present, the most widely used materials contain lead (Pb) which is highly toxic. Recently, an entirely new class of electromechanically active materials has been discovered: highly defective cerium oxides, i.e. ceria with a large concentration of oxygen vacancies in the crystal lattice. Such materials contain no toxic elements and have a giant electromechanical response even under moderate electric fields. Governed by a still unexplored atomistic mechanism, the main underlying phenomenon seems to be the organization of the oxygen vacancies. This effect is observed so far only in thin films (below 1micron) in textured microstructures, but in order to replace the current lead-based actuator materials the properties have to be brought to the level of thick films and bulk components. To this scope, the GIANT-E project has 2 success criteria, namely: (1) Understanding the fundamental effect of the film thickness on the electrostrictive properties of highly defective oxides; (2) Identifying a methodology for stabilizing the electromechanical properties in bulk by tailoring microstructure and oxygen defects. Such results will lay the foundations for a new paradigm of bulk lead-free electromechanically active materials for multi-scale applications. The concept will be tested by a Danish industrial player, NOLIAC, for biomedical applications.

Department of Energy Conversion and Storage
Ceramic Engineering & Science

Weizmann Institute of Science
Period: 01/09/2016 → 31/08/2019
Number of participants: 1
Acronym: GIANT-E
Project participant:
Esposito, Vincenzo (Intern)

Nano-Editor: Development of nano-materials based printing media for all-ceramic solid oxide fuel cells manufacturing
Department of Energy Conversion and Storage
Period: 01/09/2016 → 31/08/2019
Number of participants: 3
Phd Student:
Rosa, Massimo (Intern)
Supervisor:
Zielke, Philipp (Intern)
Main Supervisor:
Esposito, Vincenzo (Intern)
Cost-effective and flexible 3D printed SOFC stacks for commercial applications

A Solid Oxide Fuel Cell (SOFC) is a ceramic-based multilayer device that involves expensive and time-consuming multipstep manufacturing processes including tape casting, screen printing, firing, shaping and several high-temperature thermal treatments. In addition, these cells are manually assembled into stacks resulting in extra steps for joining and sealing that difficult the standardization and quality control of the final product while introducing weak parts likely to fail. Since current ceramics processing presents strong limitations in shape and extremely complex design for manufacturing (more than 100 steps), industrially fabricated SOFC cells and stacks are expensive and present low flexibility and long time to market. This is particularly relevant for the commercial segment of the stationary fuel cells market (5-400kW) that is highly heterogeneous in terms of the overall power and heat requirements and requires customization of the final product. The main goal of the Cell3Ditor project is to develop a 3D printing technology for the industrial production of SOFC stacks by covering research and innovation in all the stages of the industrial value chain (inks formulation, 3D printer development, ceramics consolidation and system integration). All-ceramic joint-free SOFC stacks with embedded fluidics and current collection will be fabricated in a two-step process (single-step printing and sintering) to reduce in energy, materials and assembly costs while simplifying the design for manufacturing and time to market. Compared to traditional ceramic processing, the Cell3Ditor manufacturing process presents a significantly shorter time to market (from years to months) and a cost reduction estimated in 63% with an initial investment below one third of an equivalent conventional manufacturing plant (production of 1000 units per year). The project is product-driven and involves SMEs (with proved technologies) in the entire value chain to ensure reaching TRL>6.

Department of Energy Conversion and Storage
Ceramic Engineering & Science
Period: 01/07/2016 → 31/12/2019
Number of participants: 2
Acronym: Cell3Ditor
Project participant: Esposito, Vincenzo (Intern)
Rosa, Massimo (Intern)

Breaking the temperature limits of Solid Oxide Fuel Cells: Towards a new family of ultra-thin portable power sources

Solid Oxide Fuel Cells (SOFCs) are one of the most efficient and fuel flexible power generators. However, a great limitation on their applicability arises from temperature restrictions. Operation approaching room temperature (RT) is forbidden by the limited performance of known electrolytes and cathodes while typical high temperatures (HT) avoid their implementation in portable applications where quick start ups with low energy consumption are required.

The ULTRASOFC project aims breaking these historical limits by taking advantage of the tremendous opportunities arising from novel fields in the domain of the nanoscale (nancionics or nano photochemistry) and recent advances in the marriage between micro and nanotechnologies. From the required interdisciplinary approach, the ULTRASOFC project addresses materials challenges to (i) reduce the operation to RT and (ii) technological gaps to develop ultra-low-thermal mass structures able to reach high T with extremely low consumption and immediate start up.

A unique μSOFC technology fully integrated in ultrathin silicon will be developed to allow operation with hydrogen at room temperature and based on hydrocarbons at high temperature. Stacking these μSOFCs will bring a new family of ultrathin power sources able to provide 100 mW at RT and 5W at high T in a size of a one-cent coin. A stand-alone device fuelled with methane at HT will be fabricated in the size of a dice.

Apart from breaking the state-of-the-art of power portable generation, the ULTRASOFC project will cover the gap of knowledge existing for the migration of high T electrochemical devices to room temperature and MEMS to high T. Therefore, one should expect that ULTRASOFC will open up new horizons and opportunities for research in adjacent fields like electrochemical transducers or chemical sensors. Furthermore, new technological perspectives of integration of unconventional materials will allow exploring unknown devices and practical applications.

Department of Energy Conversion and Storage
Ceramic Engineering & Science
Period: 01/04/2016 → 31/03/2021
Number of participants: 2
Acronym: ULTRA-SOFC
Project participant: Esposito, Vincenzo (Intern)
New composite materials for high temperature water splitting and synthetic fuel production by solar thermochemical conversion

In this project we propose a novel concept material for high temperature H2O/CO2 splitting based on a porous ceramic composite comprised of high-temperature ceramics and cerium oxide in its highly doped form. In the composite, the low diffusivity at the refractory component inhibits the mass diffusion mechanisms in the catalytic component (doped-ceria), thus preserving the microstructure from the detrimental densification effects.

Department of Energy Conversion and Storage
Ceramic Engineering & Science
Period: 01/05/2015 → 31/03/2018
Number of participants: 1
Acronym: HT-COMPO
Project Coordinator:
Esposito, Vincenzo (Intern)

Advanced nano-inks for ink-jet printing of functional metal oxides for energy and environment devices - Smart Inks

Department of Energy Conversion and Storage
Period: 15/12/2014 → 14/12/2017
Number of participants: 3
Phd Student:
Gadea, Christophe (Intern)
Supervisor:
Ramousse, Severine (Intern)
Main Supervisor:
Esposito, Vincenzo (Intern)

Financing sources
Source: Internal funding (public)
Name of research programme: Institut stipendie (DTU)
Project: PhD

Electrospun functionalized nano-materials for ultra-compact de-NOX SCR system in naval shipping

Department of Energy Conversion and Storage
Ceramic Engineering & Science
Period: 01/05/2014 → 01/07/2016
Number of participants: 1
Acronym: BLUESHIP
Project ID: 605102
Project participant:
Esposito, Vincenzo (Intern)

Developing New Electrolytes Materials and Methods for the Manufacture of Nanostructured Electrolytes for Low Temperature SOFC Operating Around 400°C

Rise National Laboratory for Sustainable Energy
Period: 01/08/2007 → 28/09/2011
Number of participants: 8
Phd Student:
Janik, Katarzyna Agnieszka (Intern)
Supervisor:
Esposito, Vincenzo (Intern)
Kuhn, Luise Theil (Intern)
Linderoth, Søren (Intern)
Main Supervisor: Pryds, Nini (Intern)
Examiner: Holtaappels, Peter (Intern)
Amoruso, Salvatore (Ekstern)
Feidenhans'l, Robert Krarup (Intern)

Financing sources
Source: Internal funding (public)
Name of research programme: Institut/centerfinansieret
Project: PhD

Activities:

*Cerâmica (Journal)*
Period: 2018
Vincenzo Esposito (Editor)
Department of Energy Conversion and Storage

Related journal
*Cerâmica*
0366-6913
Scopus rating (2016): CiteScore 0.24 SJR 0.165 SNIP 0.226
Indexed in DOAJ
Local database
Activity: Research › Journal editor

21st International Conference on Solid State Ionics
Period: 18 Jun 2017 → 23 Jun 2017
Vincenzo Esposito (Organizer)
Department of Energy Conversion and Storage
Ceramic Engineering & Science

Description
Low-dimensional ionic and mixed ionic/electronic conductor nanostructures
Links:
http://www.chimica.unipd.it/ssi21/Symposium_II_1.html

Related event
21st International Conference on Solid State Ionics
18/06/2017 → 23/06/2017
Padova, Italy
Activity: Attending an event › Participating in or organising a conference

Topics in Mining, Metallurgy and Materials Engineering (Journal)
Period: 18 May 2017
Vincenzo Esposito (Editor)
Ceramic Engineering & Science
Department of Energy Conversion and Storage

Description
Topics in Mining, Metallurgy and Materials Engineering

Related journal
Topics in Mining, Metallurgy and Materials Engineering
41st International Conference and Expo on Advanced Ceramics and Composites
Period: 22 Jan 2017 → 27 Jan 2017
Vincenzo Esposito (Organizer)
Department of Energy Conversion and Storage
Ceramic Engineering & Science

Description
14th International Symposium on Solid Oxide Fuel Cells (SOFC): Materials, Science and Technology
Links:
http://ceramics.org/icacc17-s3

Related event
41st International Conference and Expo on Advanced Ceramics and Composites
22/01/2017 → 27/01/2017
Florida, United States
Activity: Attending an event › Participating in or organising a conference

ELSEVIER (Publisher)
Period: 2016
Vincenzo Esposito (Editor)
Ceramic Engineering & Science
Department of Energy Conversion and Storage

Description
Metal Oxide-Based Thin Film Structures
Degree of recognition: International
Links:
https://www_elsevier_com/books/metal-oxide-based-thin-film-structures/pryds/978-0-12-810418-7

Related Publisher
ELSEVIER
Local database
Activity: Research › Series editor

Effect of fast mass diffusion regime on defective ceria mechano-chemo-electrical properties: By Vincenzo Esposito
Period: 2 Jun 2016
Vincenzo Esposito (Invited speaker)
Department of Energy Conversion and Storage
Ceramic Engineering & Science

Description
Invited Talk - Mechano-Electro-Chemical Coupling in Energy Related Materials and Devices 2 symposium at the 229th ECS mtg.
Links:
http://ma.ecsdl.org/content/MA2016-01/30/1496.abstract

Related event
The 229th ECS Meeting
29/05/2016 → 02/06/2016
San Diego, CA, United States
Activity: Talks and presentations › Conference presentations
40th International Conference and Exposition on Advanced Ceramics and Composites
Period: 24 Jan 2016 → 29 Jan 2016
Vincenzo Esposito (Organizer)
Department of Energy Conversion and Storage
Ceramic Engineering & Science

Description
13th International Symposium on Solid Oxide Fuel Cells (SOFC): Materials, Science, and Technology

Links:

Related event
40th International Conference and Exposition on Advanced Ceramics and Composites: ICACC´16
24/01/2016 → 29/01/2016
Daytona Beach, FL, United States
Activity: Attending an event › Participating in or organising a conference

39th International Conference and Expo on Advanced Ceramics and Composites
Period: 25 Jan 2015 → 30 Jan 2015
Vincenzo Esposito (Organizer)
Department of Energy Conversion and Storage
Ceramic Engineering & Science

Description
11th International Symposium on Solid Oxide Fuel Cells (SOFC): Materials, Science and Technology

Links:

Related event
39th International Conference and Expo on Advanced Ceramics and Composites
25/01/2015 → 30/01/2015
Daytona Beach, FL, United States
Activity: Attending an event › Participating in or organising a conference

Period: 14 Oct 2014
Vincenzo Esposito (Invited speaker)
Department of Energy Conversion and Storage
Ceramic Engineering & Science

Description
Materials Science & Technology 2014

Links:

Related external organisation
Unknown external organisation
Activity: Talks and presentations › Conference presentations

38th International Conference and Expo on Advanced Ceramics and Composites
Period: 26 Jan 2014 → 31 Jan 2014
Vincenzo Esposito (Organizer)
Department of Energy Conversion and Storage
Ceramic Engineering & Science

Description
11th International Symposium on Solid Oxide Fuel Cells (SOFC): Materials, Science and Technology

38th International Conference and Expo on Advanced Ceramics and Composites
Links:

Related event
38th International Conference and Expo on Advanced Ceramics and Composites
26/01/2014 → 31/01/2014
Daytona Beach, FL, United States
Activity: Attending an event › Participating in or organising a conference

ENHANCED MASS DIFFUSION PHENOMENA IN HIGHLY DEFECTIVE DOPED CERIA: LIMITS AND APPLICATIONS:
Ionic and Electronic Conductors and Applications to Solid Oxide Fuel Cells and Membrane Technology
Period: 13 Nov 2013
Vincenzo Esposito (Invited speaker)
Department of Energy Conversion and Storage
Ceramic Engineering & Science
Documents:
ICE2013-VIES_GDC enhanched
Links:
http://www.ice2013.net/conference-invited-speakers.php

Related event
6th International Conference on Electroceramics
09/11/2013 → 13/11/2013
João Pessoa, Brazil
Activity: Talks and presentations › Conference presentations

Oxygen permeation and chemical reactivity of alkaline earth-doped cobaltite perovskites for membrane applications: VII Brazilian Electroceramics Symposium
Period: 26 Oct 2010
Vincenzo Esposito (Invited speaker)
Department of Energy Conversion and Storage
Ceramic Engineering & Science
Documents:
K578
Links:
http://sbpmat.org.br/9encontro/apresentacao/?lang=eng

Related event
IX Brazilian MRS meeting: The Brazilian Materials Research Society
24/10/2010 → 28/10/2010
Minais Gerais, Brazil
Activity: Talks and presentations › Conference presentations

DESIGN OF THE ELECTROCERAMICS FOR SOLID OXIDE FUEL CELL APPLICATIONS: PLAYING WITH CERIA:
Nanotechnology: Controlled Processing of Nanoparticle Structures and Composites
Period: 7 Oct 2008
Vincenzo Esposito (Invited speaker)
Department of Energy Conversion and Storage
Ceramic Engineering & Science

Description
Session: Nanoparticle Sintering II

Related event

Materials Science & Technology Conference and Exhibition: MS&T08
05/10/2008 → 09/10/2008
Pittsburgh, Pennsylvania, United States
Activity: Talks and presentations › Conference presentations

Influence of Sintering on Electrochemical Properties of Nanocrystalline Doped-Ceria: F5 - Nanostructured Metal Oxides: Processing and Applications
Period: 2 Nov 2006
Vincenzo Esposito (Invited speaker)
Department of Energy Conversion and Storage
Ceramic Engineering & Science
Documents:
Meet. Abstr.-2006-Esposito-1765

Related event

210th ECS meeting, Cancun, Mexico, Oct 29-Nov 3, 2006.
01/01/2006 → …
Cancun, Mexico
Activity: Talks and presentations › Conference presentations