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Title: Synthesis of Nanometric Oxide Powders for SOFC Applications

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Abstract

Fuel Cell are electrochemical devices that convert the chemical energy of a fuel (generally hydrogen) and oxygen in electrical energy producing at the same time water and heat. These systems are interesting not only for the possibility of producing "clean" energy but also for the benefit linked to the high conversion efficiency. The Solid Oxide Fuel Cells (SOFC) in particular, are considered the most promising among the new systems of energy production especially for their intrinsic fuel flexibility (hydrocarbon, hydrogen, biogas, etc.). For these reasons, basic as well as technological studies focused on the improvement of the materials and production paths are of paramount importance to obtain SOFC competitive with the traditional energy production systems. Part of ISTEC research is devoted to the development of chemical synthesis able to produce tailored nano-oxides with characteristics suitable for SOFC applications. In particular soft-chemical synthesis routs were optimized to synthesize ceria and gadolinium-doped ceria nano-powders. Nano-structured powders exhibit in fact several size-dependant properties; among those, their high reactivity allows milder sintering conditions and as a consequence, better performances and lower production costs.

Cerium oxide has been extensively used in a wide range of applications ranging from three way catalysts to gas sensors. When doped with gadolinum oxide, ceria becomes an alternative electrolyte for Intermediate Temperature Solid Oxide Fuel Cells (IT-SOFC). Nano-structured ceria has recently attracted extensive attention because of its properties which were found to be size, shape and orientation-dependent. Although several methods were proposed for the synthesis of ultrafine powders, most of them generally require a subsequent calcination step. This thermal treatment is known to promote the crystallisation of the amorphous phase; however it also induces aggregation, reducing the specific surface area of the powder. The aim of this work was to produce ultrafine, pure and Gd-doped CeO_2 powders using standard chemical routes coupled with non-conventional heating processes. Nano-crystalline ceria and $Ce_{1-x}Gd_xO_{2-\delta}$ (GDC) particles were successfully produced under mild conditions with two different methods: i) applying infrared heating to a common sol-gel process (IR-SG); ii) assisting with microwaves a polyol precipitation method (MW-PP). The correlation of the synthesis parameters with the thermodynamic and kinetic factors involved, allowed the control of fundamental properties such as size distribution, purity and morphology. Nano-structured ceria of particle size in the micron range with complex morphology and high specific surface area was prepared by adjusting the MW-PP synthesis conditions (temperature, time and templating agents). These mesoporous aggregates were found to be active in the catalytic oxidation of toluene. Moreover the GDC obtained through the optimization of the IR-SG parameters exhibited values of ionic conductivity higher than the ones showed by commercial and conventional sol-gel produced powders of similar composition.

Biography

Elisa Mercadelli was born in Faenza in 1982. After receiving her Master Degree in Products, Materials and Processes for Industrial Chemistry in 2006, she completed her PhD in Industrial Chemistry at the University of Bologna, Italy, in 2010. She is now post-doctoral researcher at the Institute of Science and Technology for Ceramics, National Council of Research (CNR-ISTEC). Her main research activities concern the synthesis and characterization of advanced ceramics micro- and nano- powders and their shaping processes. Her expertise is especially focused on the synthesis of ceria and titanate based nano-ceramics, as well as on multilayer systems with functionally graded properties produced by tape casting and screen-printing. She is co-author of around 10 papers published on international journals.