Synthesis and Characterisation of Mesoporous Gadolinium-Doped-Ceria

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Fuel cells are now attracting much attention as environmentally friendly electric power generating systems. Solid oxide fuel cells (SOFCs) have a great potential to be the cleanest, most efficient, and versatile technologies for chemical-to-electrical energy conversion. However, the cost of materials and fabrication must be dramatically reduced to be economically competitive. For this purpose, the operating temperature must be reduced, so that interconnection, heat exchanges, and structural components may be fabricated from relatively inexpensive metal components.

With high ionic conductivity between 500 and 700 ºC, doped ceria have been extensively studied as electrolytes in reduced-temperature SOFCs [1-2]. Gadolinium-doped ceria (GDC) is considered to be one of the most promising electrolytes for SOFCs to be operated below 650ºC [2], but GDC have also been successfully used as part of anodes for SOFCs, especially those using hydrocarbon fuels. Studies on a Ni-YSZ cermet anode have demonstrated the importance of microstructure control in obtaining a good electrode. In this work, we report the synthesis and structural characterization of two different structures of GDC in view of its use as electrode for SOFCs applications.

Nanostructured mesoporous materials have been widely studied in the development of catalytic systems [3, 4] due to their large, controllable pore size and high surface area. The pore structure, such as pore size and channel conductivity can be designed for practical application, and a variety of synthetic pathways have been proposed for the development of these nanostructures [5].

In the present work, different structures of mesoporous GDC have been synthesized in a hard template route [4] with two silica templates: SBA-15 (two-dimensional hexagonal structure) and KIT-6 (three-dimensional cubic structure) (Fig 1). These materials show a small particle size, about 2-4 nm and high active surface area. Low angle XRD spectra show a high order mesoporous structure, without rests of silica template and TEM confirms that the silica host has been completely removed. HRTEM studies have been focused on the detailed structural characterization of these materials (Fig 2), showing an ordered mesostructure constructed by a packing of nanoparticles arrays.

References:

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Figures:

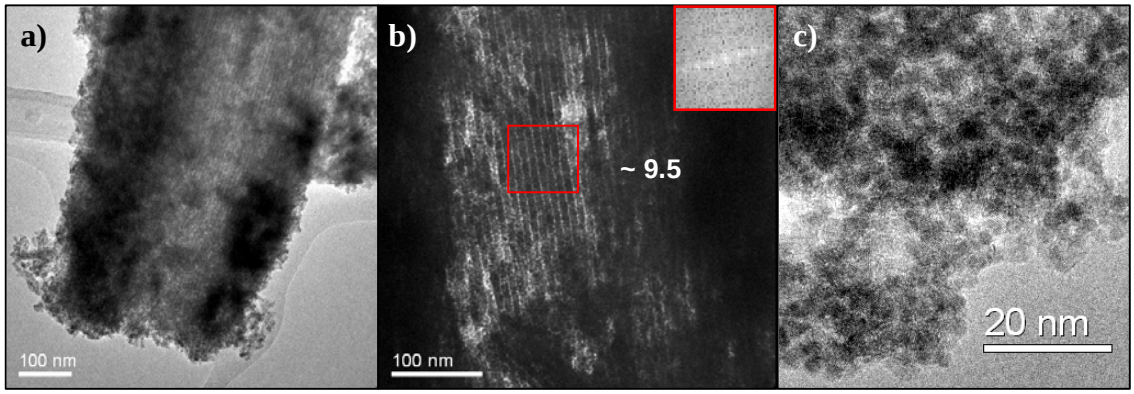

Figure 1. a) TEM image of GDC nanoparticle array, replica of SBA-15 silica template. b) TEM micrograph of the mesostructured framework of SBA-15 GDC replica and c) KIT-6 GDC replica.

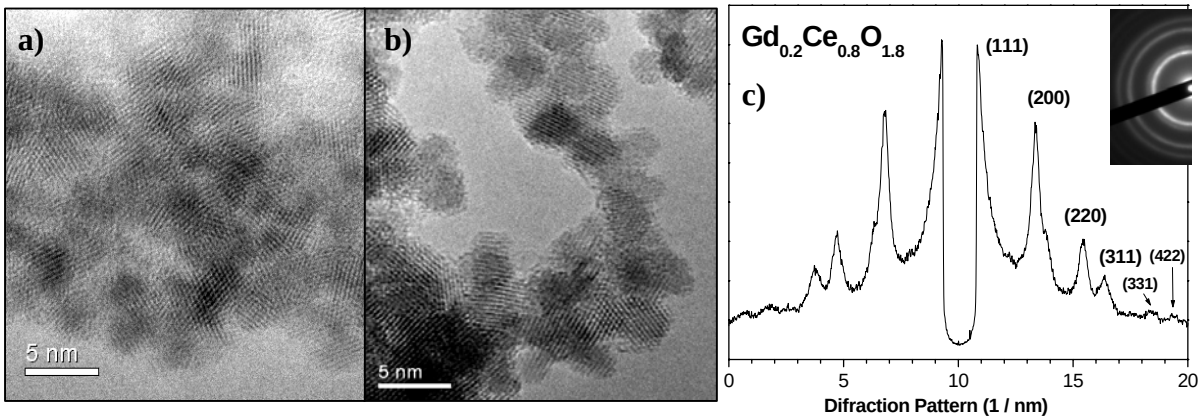

Figure 2. a) HRTEM image of KIT-6 GDC replica. b) HRTEM micrograph of the crystalline framework of SBA-15 GDC replica and c) SAED of the previous image, which shows the mesostructure constructed by nanoparticles array.