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Synthesis and properties of Pd/CeO_2-based nanotubes for catalysis

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Abstract – In the present work, $Zr_{0.1}Ce_{0.9}O_2$ (ZCE) and $Gd_{0.1}Ce_{0.9}O_{1.95}$ (GDC) nanotubes (NTs) were synthesized, using a commercial polycarbonate membrane (with pore size of 800 nm) as a template. These nanotubes were impregnated with PdO (1 %wt) and the resulting Pd/ceria-based nanotube materials were characterized by X-ray diffraction (XRD), X-ray absorption spectroscopy (XANES and EXAFS) and scanning and high resolution transmission electron microscopy (SEM and HRTEM).

Recently, novel nanostructured CeO_2-based mixed oxide tubes were synthesised at high yield by the pore wetting method. [1,2] The resulting nanotubes had lengths of a few microns, diameters of around 400 nm and wall thicknesses of about 20 nm. The $Zr_{0.1}Ce_{0.9}O_2$ (ZCE) and $Gd_{0.1}Ce_{0.9}O_{1.95}$ (GDC) nanotube compositions were found to have the highest BET specific surface area (~100 $m^2.g^{-1}$), making them of particular interest for applications in catalysis, especially in the application of these tubular structures as catalyst supports for metal nanoparticles (Figure 1). To achieve this aim, ZCE and GDC nanotubes were synthesized, using a commercial polycarbonate membrane (with pore size of 800 nm) as a template, and impregnated with PdO. The resulting Pd/ZCE and Pd/GDC nanotube materials were characterized by employing X-ray diffraction (XRD), X-ray absorption spectroscopy (XANES and EXAFS) and scanning and high resolution transmission electron microscopy (SEM and HRTEM), both with elemental analysis (EDS). A qualitative analysis of the XRD data indicated that all samples exhibited a cubic phase (fluorite type crystal structure with space group *Fm3m*). SEM observations confirmed the tubular shape and high nanotube yield. The nanotube walls were composed of nanoparticles and the distribution of Pd nanoparticles in the nanotubes appeared to be homogeneous (Figure 2).

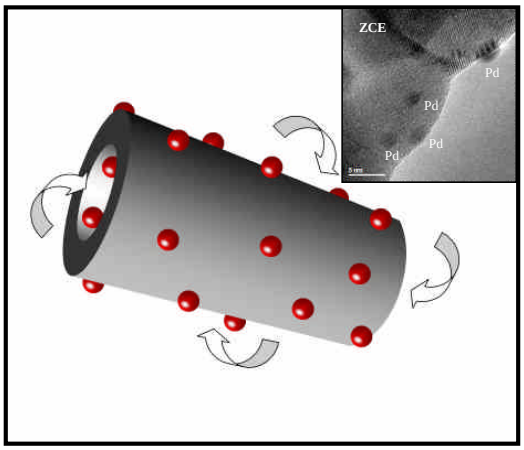

Figure 1: Schematic of catalyst consisting of metal nanoparticles supported on a ceria-based nanotube with HRTEM micrograph of Pd/ZCE nanotube (inset)

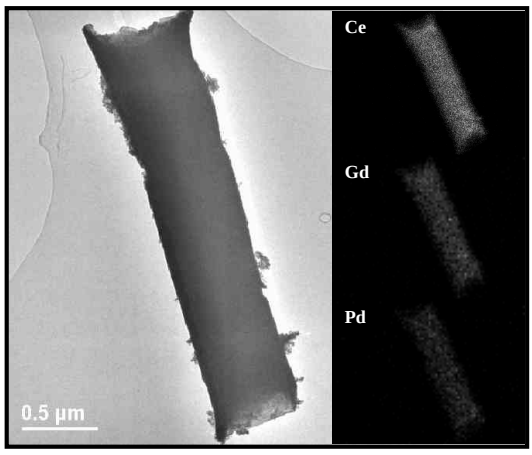

Figure 2: TEM micrograph and EDS elemental map of a single Pd/GDC nanotube

References

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[2] R.O. Fuentes, L.M. Acuña, M.G. Zimicz, D.G. Lamas, J.G. Sacanell, A.G. Leyva, R.T. Baker. Chem Mater **20** 23 (2008) 7356-7363.