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Mesoporous ZrO_2-CeO_2 with SiO_2 for Catalytic Applications

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Abstract – ZrO_2-CeO_2 mesoporous samples were synthesized with triblock polymer template P123 and anhydrous $CeCl_3$ and $ZrCl_4$ precursors with Ce/Zr=0.9mol, in order to achieve high surface area aiming application in solid oxide fuel cells (SOFC). The ordered mesoporous structure is destroyed on the crystallization of the walls, during the calcinations process. A new synthesis was performed with 10%mol Si, using TEOS as a Si source. Better surface area was achieved and other strategies to remove the polymer to avoid the collapse of the mesoporous walls are under development.

Ordered mesoporous materials with bi-dimensional hexagonal and cubic structures are extensively studied, but only few works dealt with ZrO_2-CeO_2 ordered mesoporous structures for catalytic applications and no research in this system has been reported for their use as anode in solid oxide fuel cells (SOFC). These materials may exhibit better performance, due to an enhancement on surface area, aiming to achieve a lower operation temperature. In this work, a synthesis of high specific surface area zirconia-ceria powder was performed with anhydrous $CeCl_3$ and $ZrCl_4$ precursors, using the triblock copolymer Pluronic P-123 as template[1-5]. The Ce/Zr atomic composition was 0.9, which lead to a 100% cubic structure of the nanocrystalline walls.

Previous in-situ synchrotron experiments with ZrO_2-CeO_2 revealed that the ordered mesoporous network is destroyed at temperatures around 300ºC, which is not enough to remove the polymer[6]. The tested template removal procedures showed that these systems have a very low mechanical stability, which is related to the preservation of the ordered mesoporous structure during the crystallization of the walls. Nowadays that is the most challenging task in this research area.

In order to preserve the ordered mesoporous structure after the template removal, a palisade of silica was grown to support the zirconia-ceria walls. Samples containing 10mol% of Si were prepared using TEOS (tetraethylorthosilicate) as Si precursor (Fig. 1). Two different processes of Si incorporation were tested and, the as-synthesized samples yielded better ordered porous structures than the former samples. The usual calcination process destroyed the mesoporous structure, but the N_2 adsorption/desorption measurements showed a significant increase of the specific surface area (Fig. 2). Other strategies to remove the template that avoid the collapse of the zirconia-ceria walls are under test.

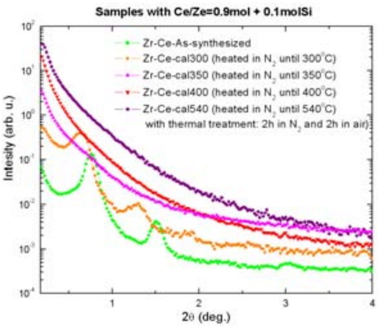

Figure 1: SAXS experiments for samples with 10%mol of Si.

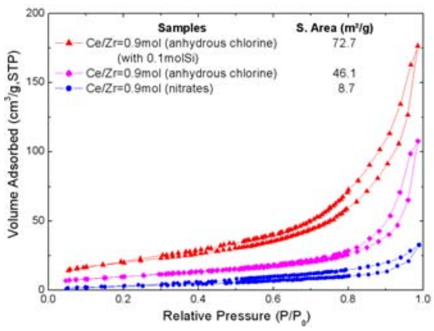

Figure 2: N_2 adsorption/desorption measurements for samples with and without 10%mol of Si.

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