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**MS-1-P-5995 SEM, HRTEM and HAADF analysis of nickel-doped ceria nanorods obtained by hydrothermal method**

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A series of Ni\(_x\)Ce(1-x)O\(_2\) nanorods with different nickel contents were synthesized via a simple hydrothermal method. The aim of this work is to simultaneously control the composition and morphology of cubic ceria (CeO\(_2\)) structure. These concepts are important defining catalytic properties of CeO\(_2\) or any other material [1]. Even though it is already known that composition and morphology are critical to improve catalytic properties a simultaneous control over such factors has been barely approached. Tuning the morphology into one-dimensional shapes leads a preferential exposure of reactive facets which improve catalytic performance [2]. SEM and TEM images of a Ni\(_x\)Ce(1-x)O\(_2\) nanorods sample are shown in figure 1a and 1b respectively. A one dimensional rod-like morphology, which is expected to exhibit \{110\} and \{110\} reactive ceria planes, is directly observed. In figure 1c HRTEM analysis of the same sample shows a [110] direction growth that corroborates the preferential exposure of \{110\} and \{110\} surface planes. Figure 2 show the STEM analysis of Ni\(_x\)Ce(1-x)O\(_2\) nanorods. HAADF image, figure 2a, also confirms the rod-like morphology. Cerium and nickel EDS elemental mapping, figure 2a and 2b, show a dispersed and homogeneous distribution of Ni species in the ceria host structure. Ni species distribution is a critical factor for catalytic properties as selectivity, activity and stability [3]. Catalytic performance for CO oxidization is superior in the doped Ni\(_x\)Ce(1-x)O\(_2\) nanorods samples than in undoped ceria nanorods. This is in agreement with the extrinsic formation of defects, which is inherent of the formation of the solid solution, and with the high dispersion of Ni that was corroborated by EDS mapping analysis. Nickel-doping and one-dimensional morphology are tuned together for the first time on ceria structure showing good catalytic properties. A full understanding of catalytic performance could only achieved with the careful structure analysis provided by microscopic techniques. EELS analysis is currently in progress and will be also presented to complement the present work.


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Fig. 1: Electron microscopy characterization of NixCe(1-x)O2-NR. 1D rod-like morphology of samples is confirmed by (a) SEM and (b) TEM images. (c) HRTEM image view along [110] in which interplanar distances and angles corroborate the [110] growth direction.

Fig. 2: STEM analysis of NixCe(1-x)O2 nanorods (a) HAADF image, EDS spectroscopic mapping of (b) Cerium and (c) Nickel.