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Lanthanum Doped Ceria Shaped Nanostructures for Oxidative Coupling of Methane

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The abundance of natural gas due to the advancements in exploration and extraction technologies has increased the interest in the direct conversion of methane to C_2 molecules via oxidative coupling of methane (OCM) reactions [1]. The design of catalysts by tailoring shape and oxygen vacancies has a significant impact on their performance [2]. Within this context, in this work, the fine-tuning of structural defects of ceria rod-like and cube-like shaped nanoparticles were performed via La^{3+} doping ($La_xCe_{1-x}O_{2-x/2}$) in molar ratios of x=5-90 mol %. The morphology control was achieved by varying the hydrothermal synthesis temperature from 110 °C to 180 °C. The characterization of $La_xCe_{1-x}O_{2-1/2}$ catalysts was performed by SEM, HRTEM, XRD, and Raman spectroscopy. The catalytic performance of the new nanomaterials for the OCM reaction was studied at 750 °C with an in-line gas chromatograph. In the $La_xCe_{1-x}O_{2-x/2}$ nanorods, the fluorite crystalline structure is essentially maintained even for x = 0.6. The Raman spectra analysis indicates that the addition of La^{3+} leads and increases the formation of different amounts of extrinsic and intrinsic oxygen vacancies. In addition, the catalytic tests for OCM reaction show that the $La_xCe_{1-x}O_{2-1/2}$ (x=50%) nanorods catalyst have 25% of CH_4 conversion and 48% of selectivity for C_2 products. The concentration of reactive oxygen species in the $La_xCe_{1-x}O_{2-1/2}$ (x=50%) nanorods was crucial to improving the conversion rates and selectivity.

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