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Improved Performance of Mn Substituted Ceria Nanospheres for Water Gas Shift Reaction: Influence of Preparation Conditions

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Abstract : The present study reports the development of noble metal free nano catalysts for low-temperature CO oxidation and water gas shift reaction. Mn-substituted CeO2 solid solution catalysts were synthesized by co-precipitation, combustion and hydrothermal methods. The formation of solid solution was confirmed by XRD with Rietveld refinement and the percentage of carbon and nitrogen doping was ensured by CHNS analyzer. Raman spectroscopic confirmed the oxygen vacancies. The surface area, pore volume and pore size distribution confirmed by N2 physisorption analysis, whereas, UV-visible diffuse reflectance spectroscopy and XPS data confirmed the oxidation state of the Mn ion. The particle size and morphology (spherical shape) of the material was confirmed using FESEM and HRTEM analysis. Ce0.8Mn0.2O2-δ was calcined at 400 °C, 600 °C and 800 °C. Raman spectroscopy confirmed that the catalyst calcined at 400 °C has the best redox properties. The activity of the designed catalysts for CO oxidation (0.2 vol%), carried out with GHSV of 21,000 h-1 and it has been observed that co-precipitation favored the best active catalyst towards CO oxidation and water gas shift reaction, due to the high surface area, improved reducibility, oxygen mobility and highest quantity of surface oxygen species. The activation energy of low temperature CO oxidation on Ce0.8Mn0.2O2- δ (combustion) was 5.5 kcal.K-1.mole-1. The designed catalysts were tested for water gas shift reaction. The present study demonstrates that Mn ion substituted ceria at 400 °C calcination temperature prepared by co-precipitation method promise to revive a green sustainable energy production approach.

Keywords : Ce0.8Mn0.2O2-ð, CO oxidation, physicochemical characterization, water gas shift reaction (WGS)
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