

Investigation of Ce(III) promoter effects on the tri-metallic Pt, Pd, Ni/MgO catalyst in dry-reforming of methane

ABSTRACT

A mixture of cerium oxide and magnesium oxide supports with certain mole ratios of Mg^{2+}/Ce^{3+} were prepared via the co-precipitation of Mg and Ce nitrates, and followed by impregnation with 1 wt% each of Ni, Pd, and Pt metals to form Pt, Pd, Ni/Mg $_{1-x}$ Ce $_x$ O catalysts. Evaluation of the prepared catalysts was carried out by a DRM reaction for 200 h and they were characterised by means of in situ XRD, XRF, XPS, BET, H₂-TPR, TEM and TGA. It was found that the interaction of a suitable amount of MgO with Ce₂O₃ stabilised a cubic phase in the catalysts, which has a high basicity to adsorb CO₂ forming a monoclinic Ce₂O₂CO₃ species in the DRM reaction. The introduction of MgO also created surface oxygen ions. The oxidation and the removal of the deposited carbon maybe achieved by both monoclinic Ce₂O₂CO₃ and surface oxygen, keeping the metal Ni, Pd, and Pt catalyst at high activity and stability. The Ce₂O₃ as a promoter in the catalyst had several effects such as: stabilisation of the magnesia cubic phase; increase in its thermal stability, increase in the basicity of the support, decrease in the carbon deposition, and decrease in the reducibility of the Ni²⁺, Pd²⁺, and Pt²⁺ ions.

Keyword: Cerium oxide; Magnesium oxide; Catalysts; Dry-reforming of methane