

## High Active Co/Mg<sub>1-x</sub>Ce<sup>3+</sup>O Catalyst: Effects of Metal-Support Promoter Interactions on CO<sub>2</sub> Reforming of CH<sub>4</sub> Reaction

### ABSTRACT

Co/Mg<sub>1-x</sub>Ce<sup>3+</sup>O ( $x = 0, 0.03, 0.07, 0.15$ ; 1 wt% cobalt each) catalysts for the dry reforming of methane (DRM) reaction were prepared using the co-precipitation method with K<sub>2</sub>CO<sub>3</sub> as precipitant. Characterization of the catalysts was achieved by X-ray diffraction (XRD), X-ray fluorescence spectroscopy (XRF), X-ray photoelectron spectroscopy (XPS), temperature programmed reduction (H<sub>2</sub>-TPR), Brunauer–Emmett–Teller (BET), transmission electron microscopy (TEM), and thermal gravimetric analysis (TGA). The role of several reactant and catalyst concentrations, and reaction temperatures (700–900 °C) on the catalytic performance of the DRM reaction was measured in a tubular fixed-bed reactor under atmospheric pressure at various CH<sub>4</sub>/CO<sub>2</sub> concentration ratios (1:1 to 2:1). Using X-ray diffraction, a surface area of 19.2 m<sup>2</sup>.g<sup>-1</sup> was exhibited by the Co/Mg<sub>0.85</sub>Ce<sup>3+</sup><sub>0.15</sub>O catalyst and MgO phase (average crystallite size of 61.4 nm) was detected on the surface of the catalyst. H<sub>2</sub> temperature programmed reaction revealed a reduction of CoO particles to metallic Co<sup>0</sup> phase. The catalytic stability of the Co/Mg<sub>0.85</sub>Ce<sup>3+</sup><sub>0.15</sub>O catalyst was achieved for 200 h on-stream at 900 °C for the 1:1 CH<sub>4</sub>:CO<sub>2</sub> ratio with an H<sub>2</sub>/CO ratio of 1.0 and a CH<sub>4</sub>, CO<sub>2</sub> conversions of 75% and 86%, respectively. In the present study, the conversion of CH<sub>4</sub> was improved (75%–84%) when conducting the experiment at a lower flow of oxygen (1.25%). Finally, the deposition of carbon on the spent catalysts was analyzed using TEM and Temperature programmed oxidation-mass spectroscopy (TPO-MS) following 200 h under an oxygen stream. Better anti-coking activity of the reduced catalyst was observed by both, TEM, and TPO-MS analysis.