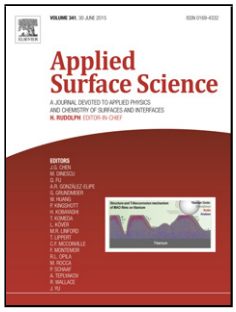

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<AT>Lanthanum and cerium co-modified Ni/SiO_2 catalyst for CO methanation from syngas

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<ABS-Head><ABS-HEAD>Graphical abstract
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<*ABS-HEAD*>Highlights► Two promoters modified catalyst is proposed to improve catalytic performance. ► La and Ce co-modified Ni/SiO_2 was prepared by using $La_{1-x}Ce_xNiO_3/SiO_2$ as precursor. ► $Ni\text{-}La_2O_3\text{-}CeO_2/SiO_2$ showed high activity, good selectivity and excellent stability. ► The excellent performance is attributed to the synergy of bi-promoters and nickel.

<ABS-HEAD>Abstract

<ABS-P>Sintering of active metal nanoparticles (NPs) and carbon deposition are critical problems for many metal catalysts, such as nickel based catalysts for generating methane from syngas. To improve the resistance to the sintering and carbon deposition, a new scheme was proposed in this work. Lanthanum and cerium co-modified Ni/SiO_2 catalysts were synthesized by using perovskite type oxide of $La_{1-x}Ce_xNiO_3$ loaded on SiO_2 as the precursor. In a nanocrystallite of $La_{1-x}Ce_xNiO_3$, ions of nickel, lanthanum and cerium are evenly mixed at atomic level and confined in the nanocrystallite, therefore, Ni NPs and the two promoters of La_2O_3 and CeO_2 should be in close contact and highly dispersed on SiO_2 after reduction. The catalysts were characterized by using XRD, TEM, BET, H_2-TPD, XPS, TG and Raman techniques. Compared with the mono-promoted catalysts, the bi-promoted $La_{0.75}Ce_{0.25}NiO_3/SiO_2$ showed much better resistance to carbon deposition, higher resistance to sintering and higher activity for CO methanation, which are attributed to co-eliminating effect of the two promoters for the deposited carbon, confinement of the interacted two promoters for Ni NPs and the higher dispersion of Ni NPs derived from the smaller size of $La_{0.75}Ce_{0.25}NiO_3$.

<KWD>Key words: Cerium; Lanthanum; Methanation; Metal sintering; Carbon deposition

<H1>1. Introduction

Additives are important for a catalyst, which can regulate the geometric and/or electronic state of the active metal [1, 2], modify the interaction between metal and carrier [3], etc, and thus to improve the catalytic performance including activity, selectivity and stability. Supported metal nanoparticles (NPs) are a kind of extensively used and studied catalyst, and additives are generally used in this kind of catalyst. To tailoring the catalytic performance, in many cases one additive is not enough, while most researches concentrated on the catalysts containing only one additive to make the system simple in order to address viewpoints clearly.