

Research Article

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Efficient and stable to coking catalysts of ethanol steam reforming comprised of Ni + Ru loaded on $\text{MgAl}_2\text{O}_4 + \text{LnFe}_{0.7}\text{Ni}_{0.3}\text{O}_3$ (Ln = La, Pr) nanocomposites prepared via cost-effective procedure with Pluronic P123 copolymer

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Abstract: Mesoporous $\text{MgAl}_2\text{O}_4 + \text{LnFe}_{0.7}\text{Ni}_{0.3}\text{O}_3$ (Ln = La, Pr) nanocomposites were prepared by a cost-effective one-pot procedure with the Pluronic P123 copolymer and Ni + Ru active components were supported on them by wet impregnation. The real structure of samples was studied by X-ray diffraction and transmission electron microscopy with energy-dispersive X-ray spectroscopy, surface properties were determined by Fourier transform infrared spectroscopy of adsorbed CO, reactivity was evaluated by temperature programmed reduction by H_2 , and catalytic activity was tested in ethanol steam reforming (ESR). Disorder of the real structure of nanocomposite supports due to incorporation of transition metal cations into MgAl_2O_4 results in the development of a metal-support interface and domination of single surface metal centers. This provides a high catalytic

activity in the ESR reaction in the intermediate temperature range $\sim 550^\circ\text{C}$, close to that of the best known catalysts, and stability to coking. A higher activity for the Pr-containing catalyst is provided by the high reactivity of surface oxygen species bound with Pr cations.

Keywords: ethanol steam reforming, nanocomposite spinel + perovskite supports + Ni + Ru, one-pot synthesis with the Pluronic P123 copolymer, surface sites, FTIRS of adsorbed CO

1 Introduction

The transformation of bio-renewable fuels into syngas and hydrogen is now considered one of the most important problems of green energy production [1]. Ethanol is among the easily produced, cheap, and broadly available fuels; hence, its steam reforming is among the most popular methods of catalysis in this area [2]. In this reaction, traditional cost-effective steam reforming catalysts comprising Ni and/or Co supported on alumina, silica, or zeolites suffer from coking, leading to rapid deactivation of the catalyst [2]. Although Pt group metals possess higher activity and coking stability [2], their high price makes it impossible for practical application. This problem is solved by the design of nanocomposite catalysts composed of mixed oxide supports (with perovskite, fluorite, spinel structures, etc.) possessing high oxygen mobility and reactivity and ability to strongly interact with loaded nanoparticles of Ni or Ni-based alloys [3]. Coking stability is provided by the so-called bifunctional mechanism of reforming, where fuel molecules are activated on metal sites and oxidants on reduced support sites produce reactive oxygen surface species, which rapidly migrate to the metal-support interface and interact with activated fuel fragments producing syngas

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