Promoting Novel Ni-based Catalysts for Efficient Hydrogen-Rich Syngas Production in Dry Reforming of Methane

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Amid the pressing need to combat global warming, attention is increasingly turning towards innovative technologies that harness greenhouse gases like (CO_2) carbon dioxide and (CH_4) methane to value added products. Given this realization, dry reforming of methane (DRM) emerges as a promising solution, capable of transforming CO_2 and CH_4 into synthesis gas. However, the challenge lies in the synthesis of cost-effective, efficient, and durable catalysts with high resistance to coke and sintering. This study presents a novel modification to Ni/10ZrAl by doping (1wt.%) cerium, strontium, and gallium precursors in the catalytic system. All samples were synthesized via wet impregnation. The performed characterizations were XRD, TGA, SEM, BET, H_2-TPR, and Raman spectroscopy. All of the catalysts were tested at reaction temperatures ranging from 500℃ to 800℃ under atmospheric pressure and a space velocity of 42,000 mL/(min·gcat). Upon testing, 5Ni-1Ga-1Ce/10ZrAl presented enhanced oxygen mobility within the active sites by fostering active oxygen vacancies which resulted in higher resistance to carbon-deposits formation. The optimal performance was achieved at 700℃, demonstrating stable H_2 production (60.54%) and selectivity (51.10%) over 420 minutes on stream, while maintaining a uniform H_2/CO ratio. The enhanced catalytic stability and activity is attributed to the optimized active-metal dispersion, high porosity, and the nanocomposite’s crystallinity. Thus, the present modification offers an efficient, stable, and cost-effective catalyst in hydrogen-rich syngas production from dry reforming of methane. By harnessing abundant and robust gases, it can potentially unlock a wide variety of valuable petrochemical products and industrial applications.