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

Alharbi, Abdulaziz (School: Taibah High School)

Amid the pressing need to combat global warming, attention is increasingly turning towards innovative technologies that harness greenhouse gases like (CO2) carbon dioxide and (CH4) methane to value added products. Given this realization, dry reforming of methane (DRM) emerges as a promising solution, capable of transforming CO2 and CH4 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, H2-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 H2 production (60.54%) and selectivity (51.10%) over 420 minutes on stream, while maintaining a uniform H2/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.

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