Comparative Study on Dry Reforming of Methane Over Co-M (M=Ce, Fe, Zr) Catalysts Supported on N-Doped Activated Carbon

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Abstract: A series of Co-M (M = Ce, Fe, Zr) binary oxides supported on N-doped catalysts were prepared by impregnation methods and tested for DRM reaction. Moreover, the influence of Co and Ce atomic contents in the catalysts on DRM performance was investigated. Significant enhancement of activity performance over Ce promoted 3Co-1Ce/AC-N catalyst was observed. Compared with Fe and Zr, the catalyst with 1/4 mol% of Ce showed the highest activity and was higher than the supported Co catalyst. The calcined and spent catalysts were characterized by XPS, H_2-TPR, TEM and EDX mapping studies. The characterization results demonstrated that the improved DRM reaction activity of the 3Co-1Ce/AC-N was attributed to the presence of Ce in Co-based catalyst, which modified the chemical states of Co-Ce composite oxide and redox properties, increased the presence of Co^{2+} species, the content of chemisorbed oxygen, and the oxygen mobility. Among the different Co/Ce ratio catalysts, the one with a Co/Ce molar ratio at 1 displayed much better catalytic performance. The adding of higher Ce loading decreased the content of chemisorbed oxygen on the catalyst surface, declining the oxidation rate of CH_4. In addition, the introduction of N on support could also influence the catalyst reduction property and interaction of Co-Ce bimetal, which would improve catalytic performance.

Keywords: Carbon dioxide reforming of methane; Co-M/AC-N catalysts; Cobalt; Ceria; Different molar ratio