Comparative study of Ni-Ce loading method: Beneficial effect of ultrasonic-assisted impregnation method in CO2 reforming of CH4 over Ni-Ce/SBA-15

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ABSTRACT

A series of Ni-Ce/SBA-15 catalysts with 6 wt% Ce and 5 wt% Ni were synthesized using conventional impregnation (Ni-Ce/SBA-15(C-IM)), ultrasonic-assisted impregnation (Ni-Ce/SBA-15(US-IM)) and reflux-assisted impregnation (Ni-Ce/SBA-15(R-IM)) methods The samples were characterized using XRD, TEM, SEM, BET, FTIR, H_2-TPR, XPS and TGA. The characterization results showed that Ni-Ce loading methods greatly influence the properties of Ni-Ce/SBA-15 whereby the homogeneity of metal dispersion and strength of metal-support interaction followed the order of Ni-Ce/SBA-15(C-IM) < Ni-Ce/SBA-15(R-IM) < Ni-Ce/SBA-15(US-IM). The smaller metal particle size and higher metal dispersion in Ni-Ce/SBA-15(US-IM) have led to the stronger metal-support interaction and further decreased the surface area and porosity of the catalyst. The activity and stability of catalysts followed the order of Ni-Ce/SBA-15(C-IM) < Ni-Ce/SBA-15(R-IM) < Ni-Ce/SBA-15(US-IM), with the conversion of CH_4 and CO_2 over Ni-Ce/SBA-15(US-IM) was about 96.3% and 93.5%, respectively, and H_2/CO ratio of 1.02 at reaction temperature of 800 °C and almost remained constant during 48 h of reaction. The superior catalytic performance of Ni-Ce/SBA-15(US-IM) probably was related with the smaller metal particles, stronger metal-support interaction and more homogenous metal dispersion, which altered the properties of catalyst towards an excellent catalytic performance. The characterization of spent catalysts showed the lowest carbon formation in Ni-Ce/SBA-15(US-IM) catalyst, demonstrating the positive role of ultrasonic effect on al-teration of catalyst properties towards carbon resistance. This study provides new perspective on the preparation of Ni-Ce/SBA-15 towards an excellent performance of CO_2 reforming of CH_4.

Keywords: Ni-Ce/SBA-15; CO_2 dry reforming; Ni-Ce loading methods; Ultrasonic-assisted impregnation; Metal-support interaction