Effect of Reduction Time on the Exsolution of the Active Metals in CoNi/$MgAl_2O_4$ Catalyst and Its Application for the Dry Reforming of Methane

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From the thermodynamics of dry reforming of methane (DRM), a high temperature is necessary to attain a high conversion of CH_4 and CO_2. However, the high temperature causes sintering of the metal nanoparticles (NPs) the active sites. As a result, the surface area to volume ratio of the NPs decreases, leading to the rapid deactivation of the catalyst. Thus, the design of a highly stable catalyst for the DRM still a challenge. Herein, we successfully synthesized a highly stable CoNi/$MgAl_2O_4$ catalyst using one-pot evaporation induced self-assembly combined with exsolution method. We found that the reduction time highly influences on the exsolution of the active metals from the support ($MgAl_2O_4$), and hence on its catalytic activity towards the DRM. At reduction temperature of 800 °C and reduction time of 2.0 h, the in-situ XRD analysis showed that the active metals were fully exsoluted from the support. Consequently, the catalyst showed the best performance for DRM reaction with stable CO_2 and CH_4 conversions of 94% and 85%, respectively after operating the reaction for 100 h, at gas hourly space velocity of 36,000 h^{-1}.