Selective CO Methanation on Ru/TiO$_2$ Catalysts:

Role and Influence of Metal-Support Interactions

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Aiming at a detailed understanding of the role of metal-support interactions in the selective methanation of CO in CO$_2$-rich reformate gases we have investigated the catalytic performance of a set of Ru/TiO$_2$ catalysts with comparable Ru loading, Ru particle size and TiO$_2$ phase composition, but very different surface areas (ranging from 20 to 235 m$^2$g$^{-1}$) in this reaction. The activity for CO methanation, under steady-state conditions, was found to strongly depend on the TiO$_2$ support surface area, increasing first with increasing surface area up to a maximum activity for the Ru/TiO$_2$ catalyst with a surface area of 121 m$^2$ g$^{-1}$ and then decreasing for an even higher surface area, while the selectivity is mainly determined by the Ru particle size, which slightly decreases with increasing support surface area. This goes along with an increase in selectivity for CO methanation, in agreement with a model proposed previously for non-reducible supports. 

In situ infrared measurements further revealed that also the adsorption properties for these catalysts, as evidenced by the CO adsorption strength, change significantly with increasing catalyst surface area and that strong metal-support interactions cause a partial overgrowth of the Ru nanoparticles for the highest surface area catalyst. The interplay between catalyst surface area and reaction characteristics and the important role of metal-support interactions in the reaction, in addition to particle size effects, will be elucidated and discussed.

Keywords: Selective CO methanation, surface area, selectivity, particle size effects, metal-support interactions, Ru/TiO$_2$.

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