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Effects of TiO2 and CS supports on hydrogen spillover in Co and Ru supported catalysts

Dlamini, Sthembile

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ABSTRACT

Hydrogen spillover is the surface migration of activated hydrogen atoms from a metal catalyst particle, on which they are generated, onto the catalyst support. A lot of research work has been done on hydrogen spillover since its discovery in 1964, and its incidence on reducible supports such as titanium oxide is established, yet questions remain about the role of the support in hydrogen spillover in heterogeneous catalysis.

The aim of this research was to investigate the role of a support in hydrogen spillover, using cobalt and ruthenium supported on TiO2 and CS catalysts. These two catalysts were prepared by deposition precipitation-urea, incipient wetness impregnation and polyol methods and characterized using TGA, TEM, BET, XRD and Raman spectroscopic analysis. The Fischer-Tropsch evaluation of the catalysts was done in a fixed bed reactor and the products were analyzed on offline gas chromatographs.

The results show a significant shift to lower reduction temperatures for the CoO to Co peak for the physical mixture of Co/TiO2 and Ru/TiO2. However, when Co/TiO2 and Ru/TiO2 catalysts were packed in a bed system separated by different amounts of TiO2, no significant change was observed compared to the “hybrid” catalyst. The separation distance between the two catalysts had no effect in the reduction temperature. The improved reducibility of CoO to Co was attributed to the dissociation of H2 on the Ru, which made the Ru/TiO2 catalyst the donor phase causing the hydrogen to spillover to the acceptor phase which is the Co/TiO2. The same finding was observed for the Ru and Co catalysts supported on the carbon spheres where the CoO to Co peak was shifted to lower reduction temperature compared to the monometallic Co/CS catalyst. The reducibility was attributed to the presence of Ru. For the Co and Ru catalysts supported on carbon spheres the physically mixed Co/CS and Ru/CS catalysts resulted in the increase of C5+ selectivities compared to the monometallic catalysts of Co catalysts. Microwave irradiation had a positive effect on the dispersion and surface area on the catalyst prepared using the polyol and incipient wetness methods.