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The interaction of hydrogen with alumina-supported copper catalysts: A temperature-programmed adsorption/temperature-programmed desorption/isotopic exchange reaction study

H. Wilmer, T. Genger,[1] and O. Hinrichsen *

Laboratory of Industrial Chemistry, Ruhr-University Bochum, D-44780 Bochum, Germany

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Abstract

The interaction of hydrogen with a series of copper catalysts (Cu/Al_2O_3, Cu/ZnO, and $Cu/ZnO/Al_2O_3$) was studied by combining temperature-programmed (TP) techniques and the isotopic exchange reaction of H_2 and D_2 with microkinetic modeling. Various TP experiments (TP desorption, TP adsorption) were carried out, resulting in a set of kinetic parameters for a quantitative description. Only small differences in the kinetics of the ZnO-containing Cu catalysts and Cu/Al_2O_3 were observed, suggesting that the interaction of H_2 with the Cu surface is therefore only slightly influenced by the presence of zinc oxide, and alumina seems to act only as a structural promoter. Significant changes in the results were found when the treatment prior to the actual experiments was altered. From these observations and further supporting experiments it was deduced that a change in the morphology of the metallic Cu particles and surface alloying occur under more severe reducing conditions. These dynamical changes seem to be highly relevant for methanol synthesis.

Keywords: Hydrogen; Cu catalysts; Microkinetics; Adsorption; Desorption; H_2 TPD; H_2 TPA; IER; Methanol synthesis