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Structure–activity relationships of ternary $Cu/ZrO_2/CeO_2$ catalysts for methanol steam reforming

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The combustion of hydrogen in a fuel cell is regarded as a clean process, providing energy and releasing only water as exhaust [1]. Methanol can be a storage and transport medium for hydrogen. The production of H_2 from CH_3OH can be performed by steam reforming of methanol which affords a substantial H_2 yield, and high CO_2 selectivity with Cu based catalysts [1]. Unfortunately, CO is formed as a byproduct of this reaction. In order to eliminate the need for gas purification, more selective catalysts need to be developed. Here structure–activity relationships for ternary $Cu/ZrO_2/CeO_2$ (CZC) catalysts with different Cu content (5% to 35%) were investigated under methanol steam reforming conditions.

The catalysts were prepared by coprecipitation followed by a templating technique on polystyrene beads [2]. Characteristic CuO peaks in the XRD patterns could be distinguished only for the samples with the highest Cu contents. The in situ XRD experiments of the sample CZC35 clearly showed the formation of Cu_2O and Cu after reduction either in H_2 or in a mixture of H_2O and CH_3OH. The reduction in H_2 was measured by in situ X-ray absorption spectroscopy (XAS) at the Cu K edge. The XAS investigations during the heating ramp from 298 K to 523 K revealed a higher reduction temperature with increasing Cu content. The variation in the Cu concentration altered the microstructure of the Cu particles and, thus, the active Cu surface, which considerably affected the catalytic behavior of these catalysts.

References:

[1] P.J. de Wild, M.J.F.M. Verhaak, Catal. Today 60 (2000) 3.
[2] A. Mastalir, et. al., Journal of Catalysis 230 (2005) 464.