Rational synthesis of colloidal Cu and core-shell Cu@ZnO nanoparticles for the CO_2 hydrogenation to methanol

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ABSTRACT

In recent decades, copper and copper-based nanoparticles have become increasingly important in catalysis due to their abundance and cost-effectiveness compared to metals like silver, gold, or platinum. One prominent example is the $Cu/ZnO/Al_2O_3$ system, used since the early 20th century to convert CO_2 into methanol in industrial processes. [1]

Numerous studies have aimed to better understand the activity of this catalyst, both theoretically [2] and experimentally [3], focusing on simplified model Cu/ZnO catalysts. However, these studies often overlook the effects of particle shape, size, crystallinity, and interface nature on the catalyst's activity. This is mainly due to the smaller number of available studies on Cu NPs synthesis compared to other noble metals (Au, Ag NPs) because of the Cu NPs intrinsic susceptibility to oxidation. Additionally, the higher oxidation potentials of Cu (I) and Cu (II) precursors necessitate the use of stronger reducing agents and/or higher synthesis temperatures, posing challenges for shape and crystallinity control.[4,5] However, few works reported the synthesis of Cu NPs with shape control through the dismutation of copper (I) halides precursors.[6] In this work, we report the synthesis of Cu NPs with different shapes and crystallinity as well as Cu-ZnO core-shell (Cu@ZnO) NPs through seed mediated growth method. This method enables ZnO satellite growth on Cu NPs seeds and facilitates exploring how various experimental parameters affect copper seed shape and crystallinity control. Additionally, we provide initial insights into the catalytic activity of these systems for CO_2 hydrogenation to methanol.

Références :

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