

CO₂ hydrogenation to methanol: investigating the role of ZnO loaded on different polymorphs of ZrO₂

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Methanol synthesis via CO₂ hydrogenation is an important part of the strategy for generating clean energy as we attempt to reduce our dependency on fossil fuels. Herein, we have synthesized different polymorphs of ZrO₂ i.e. amorphous, monoclinic, and tetragonal by coprecipitation method, then impregnated 10 wt% of ZnO and evaluated their activity for methanol synthesis. The surface interaction of CO₂, H₂, and reduction behavior of the catalysts vary remarkably with the phases of ZrO₂ due to the presence of different strong Lewis acidic Zr⁴⁺ cation and strong Lewis basic O²⁻ anion. The structure-activity relationship was developed with in-depth characterization and catalytic experiments for CO₂ hydrogenation to methanol, which revealed a strong dependence of CO₂ conversion and methanol selectivity on the phase of the ZrO₂.