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Stearate-Based Cu Colloids in Methanol Synthesis: Structural Changes Driven by Strong Metal–Support Interactions

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Metal stearate-stabilized Cu nanoparticles, synthesized by an efficient one-step process, were applied in the continuous liquid-phase synthesis of methanol. After optimizing the reduction procedure, twofold higher rates of methanol formation were found for Cu–Zn colloids, compared to the conventional ternary $Cu/ZnO/Al_2O_3$ catalyst applied as fine powder in the liquid phase. Structural changes were investigated as a function of time on stream; after reduction in H_2, spherical, well-separated 5–10 nm Cu particles stabilized by a Zn stearate shell were found. Under catalytic high-pressure conditions Zn stearate was hydrolyzed forming ZnO. High-resolution transmission electron microscopy revealed the presence of triangular ZnO prisms with truncated edges. Applying optimized synthesis conditions these triangularly shaped ZnO particles were found to be mostly attached to the spherical Cu particles. The catalytic results and the structural and spectroscopic characterization suggest that these ZnO particles act as a reservoir, releasing ZnO_x species, which diffuse onto the Cu particles and promote the catalytic activity.