Abstract

In the present work, the preparation of metal or metal oxide nanoparticles for catalytic applications was studied. Various routes and reaction conditions were explored, including the preparation through coordination polymers, sol-gel synthesis, and heat-treatment of metal salt solutions etc. TG-IR or TG-MS was employed to investigate the thermolysis of precursors. SEM, TEM, IR, XRD and EXAFS were used to elucidate the morphology and structure of the samples. Nitrogen physisorption and N_2O chemisorption were applied to investigate the specific surface area, the pore structure, and copper surface area.

Ru_3Sn_7 or (Sn, Ru)O_2 were obtained in nanocrystalline forms by the thermolysis of $[(CH_3)_3Sn]_4Ru(CN)_6$. A batch-wise method and a continuous synthesis method were applied for the precipitation of $Zn[Cu(CN)_3]$. The thermolysis of the cyanide led to Cu-Zn bimetallic oxides, which were reduced to Cu/ZnO and used as catalysts for methanol synthesis. ZnO nanoparticles were prepared by the thermolysis of the binuclear complex $[Zn(en)_3][Zn(CN)_4]$ and the mononuclear compound $Zn(CN)_2$. A sol-gel route was employed to prepare Cu/Zn/Al xerogels and aerogels with propylene oxide as the gelation initiator. ZnO can be atomically dispersed in Al_2O_3 in xerogels in a wide range of Zn concentrations. A higher Cu dispersion was observed in the aerogels than in the xerogels, leading to a higher specific surface area, a higher Cu surface area and subsequently a higher catalytic activity in methanol synthesis. In addition, Cu-Zn oxides were prepared by heat-treatment of the corresponding metal hydrate solutions. The preparation conditions, such as the additives (NaAOT etc.) and the solvents (aqueous or organic), have significant effects on the morphology of the products.