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NOx reduction via selective catalytic reduction with NH3 over Cu-ZnO loaded onto core-shell Al-MCM-41: The effect of metal loading

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A series of Cu-ZnO/core-shell Al-MCM-41 catalysts having different metal loadings of 3, 5, and 7 wt% (with Cu:ZnO ratio of 1:1) was studied for NOx reduction via selective catalytic reduction (SCR) with NH3 at 300 °C. Copper was loaded onto core-shell Al-MCM-41 by a combination of three methods like substitution, ion-exchange, and impregnation to obtain various forms of copper species, while zinc was loaded by impregnation method to obtain ZnO form only. The physicochemical properties of the prepared catalysts were investigated by N_2 physisorption, transmission electron microscopy (TEM), X-ray diffraction (XRD), temperature programmed desorption of NH_3 (NH_3-TPD), H_2 temperature programmed reduction (H_2-TPR), X-ray adsorption spectroscopy (XAS), and X-ray photoelectron spectroscopy (XPS). TEM images reveal that the core-shell structure of the catalysts was remain intact after metal loading. H2-TPR profiles indicated that the Cu reducibility decreased with increasing metal content, which agreed with XPS results, as the peak shifting to higher binding energy. The catalytic performance test demonstrated that Cu-ZnO/core-shell Al-MCM-41 with total metal content of 5 wt% exhibited the best catalytic activity, as it possessed a proper amount of Cu^+ ion, which is the active species for this reaction. The average NO conversions based on the reaction time of 3 h of 1.5Cu-1.5ZnO/Al-MCM-41, 2.5Cu-2.5ZnO/Al-MCM-41, and 3.5Cu-3.5ZnO/Al-MCM-41 were 80, 87, and 73 %, respectively. The effects of Cu:ZnO ratio was also studied based on Cu content of 2.5 wt%. However, it was found that the optimum ratio of Cu:ZnO ratio was 1:1.

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