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Fabrication of Active Cu-Zn Nanoalloys on H-ZSM5 Zeolite for Enhanced Dimethyl Ether Synthesis via Syngas

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1. Details of experimental section

In situ diffuse reflectance infrared Fourier transform spectra (DRIFTS) were conducted on Nicolet Nexus 470 FTIR spectrometer with a diffuse reflectance attachment and MCT detector. ZnSe window was used for the in situ infrared cell. The absorbance spectra were collected for 32 scans with a resolution of 2 cm^{-1}. Prior to CO adsorption, catalyst of about 0.015 g was heated to the corresponding reduction temperature with a He flow (99.99%) of 30 $mL\cdot min^{-1}$. After sweeping for 1h, a pure H_2 flow (99.99%) of 30 $mL\cdot min^{-1}$ was introduced instead of He to reduce the catalyst for 1h. Subsequently, a pure He was flowed into the cell for 4 h to remove H_2 residual in cell and adsorbed on the catalyst, followed by cooling down the temperature to 50°C. After keeping for 0.5 h, the background spectra under this condition were recorded. Then, pure CO flow (99.99%) of 30 $mL\cdot min^{-1}$ was introduced into the IR cell for 0.5 h at 50°C. After adsorption, He flow of 50 $mL\cdot min^{-1}$ was employed to sweep for 2 h, followed by obtaining desorption spectra of CO desorption.

H_2 temperature-programmed reduction (H_2-TPR) for the reduced catalysts and N_2O-pulse experiment were performed with an in situ reduction procedure at corresponding temperature prior to the common tests. Samples used in this experiment were CZ-S and CZ-I. H_2-TPR was performed by using Catalyst Analyzer BELCAT-B-TT (Nippon Bel Co.) The catalyst was heated to 150°C for 1 h in an Ar flow prior to the following test. Samples needing in situ reduction continued to be heated to corresponding temperature, followed by cooling down to 50°C in a Ar flow. Then, TCD signals were recorded at 5% H_2 (Ar balance) flow with a heating rate of 10°C·min^{-1}.

NH_3-TPD was performed using the same equipment as in H_2-TPR. Samples were pretreated at 150°C in a He flow followed by cooling down to 80°C. A flow of 5% NH_3 (He balance) was introduced at a rate of 30 mL·min^{-1} for 0.5 h. Then, sweeping by He until a constant TCD signal was conducted. Desorption curves of NH_3 were recorded with a heating rate of 10°C·min^{-1}.

2. Acidic sites distribution of prepared catalysts and H-ZSM5

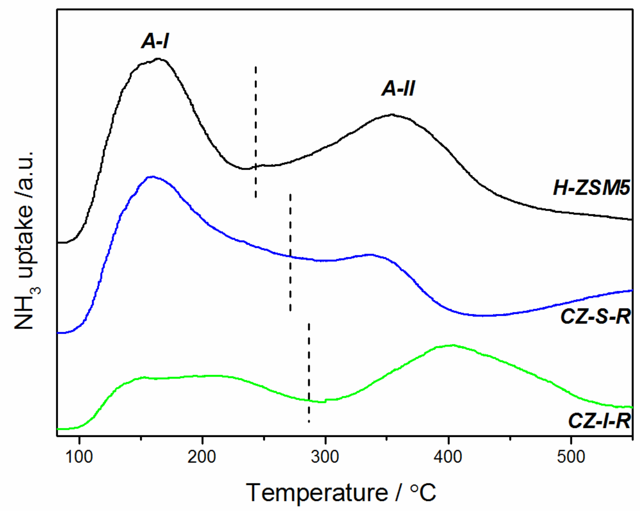

Figure S1 NH_3-TPD curves of prepared catalysts and H-ZSM5 zeolite.