Design Rules for Cu-Zeolites for Methane to Methanol Conversion

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The characterization and catalytic properties of Cu-zeolites with 12 different framework topologies (MOR, EON, MAZ, MEI, BPH, FAU, LTL, MFI, HEU, FER, SZR, and CHA) are compared in the stepwise partial oxidation of methane to methanol. Cu^{2+} ion-exchanged zeolite omega, a MAZ-type material, reveals the highest yield (86 μmol g-cat.-1) ever reported for this reaction using methanol extraction, ascribed to the relatively high density of copper-oxo active species formed inside its three-dimensional 8-membered (MB) ring channels. The dominating factors for achieving high methanol yields are; i) highly dispersed copper-oxo species; ii) large amount of exchanged copper in 8-MB rings of zeolites; iii) moderately high temperature of activation; and iv) use of proton form zeolite precursors. Cu-omega and Cu-mordenite, using the proton form of mordenite as a precursor, yield methanol already after 200 °C oxygen activation.