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Investigation of the Effects of Solid-State Treatments on the Structure and Mobility of Copper in Zeolites

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ABSTRACT

Zeolites are microporous, aluminosilicate catalysts that play an important role in industrial applications as well as studies for the fundamental understanding of catalysts for emerging reactions of interest. The introduction of aluminum into the zeolite lattice introduces a negative charge on the framework that can be balanced with extra-framework cations. The control of the aluminum distribution and the choice of charge balancing cations allows for the ability to tailor the active sites to facilitate a desired reaction. This research focuses on studying copper active sites in zeolites. Copper oxide was used as a copper precursor to introduce copper ions in zeolites through solid-state ion-exchange (SSIE). Solid-state ion-exchange was studied using both dry air and wet air treatments at elevated temperatures. Three different zeolite topologies were studied: CHA (small pore), ZSM-5 (medium pore), and MOR (large pore). After SSIE, the copper-zeolites were characterized with atomic absorption spectroscopy (AAS) after sodium back exchange to quantify the number of ionic copper species, and temperature programmed desorption (TPD). These characterization techniques were used to understand how many copper ions were mobilized into the zeolites, which are potential active sites in zeolites. Based on current experimental data on Cu-MOR, SSIE using a wet air treatment has a greater impact for mobilizing copper in zeolites compared to a dry air treatment. The same trend is expected to follow on other zeolite topologies, ZSM-5 and CHA, that are still being studied.

KEYWORDS

Zeolites, Catalysis, Solid-State Ion-Exchange