Synthesis and Characterization of a Novel Tin-SPP Zeolite

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Introduction

Zeolites are a class of porous, crystalline solid typically comprised of an ordered framework of silicon, oxygen, and usually a metal such as aluminum. Zeolites are most commonly used in industry for catalyzing reactions, such as hydrocarbon cracking, and for gas separations.

Interest in zeolites for their application in biomass conversion has become a major area of research. Converting this renewable resource into commercial chemicals holds many challenges, but tin-containing zeolites, such as Sn-Beta zeolite, have shown promise as active and efficient catalysts.

The purpose of this work is to synthesize and characterize a new tin zeolite with a self-pillared pentasil (SPP) framework containing both mesopores and micropores.

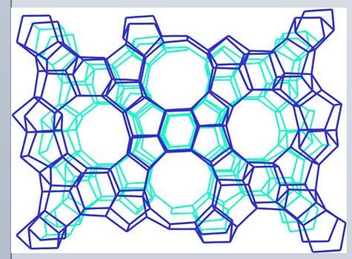

Figure 1: The MFI lattice of SPP zeolite.
Source: kofo.mpg.de

Materials & Methods

- Tetraethyl orthosilicate, tetrabutyl phosphonium hydroxide (TBPOH), and tin (IV) chloride are mixed overnight, forming a clear sol.
- The sol is placed in a Teflon-lined steel autoclave and heated at 121 C for 7 days. The product is then washed with DI water and centrifuged repeatedly.
- After two more cycles of calcination at 550 K and washing in a centrifuge, the final white product is obtained.

Characterization

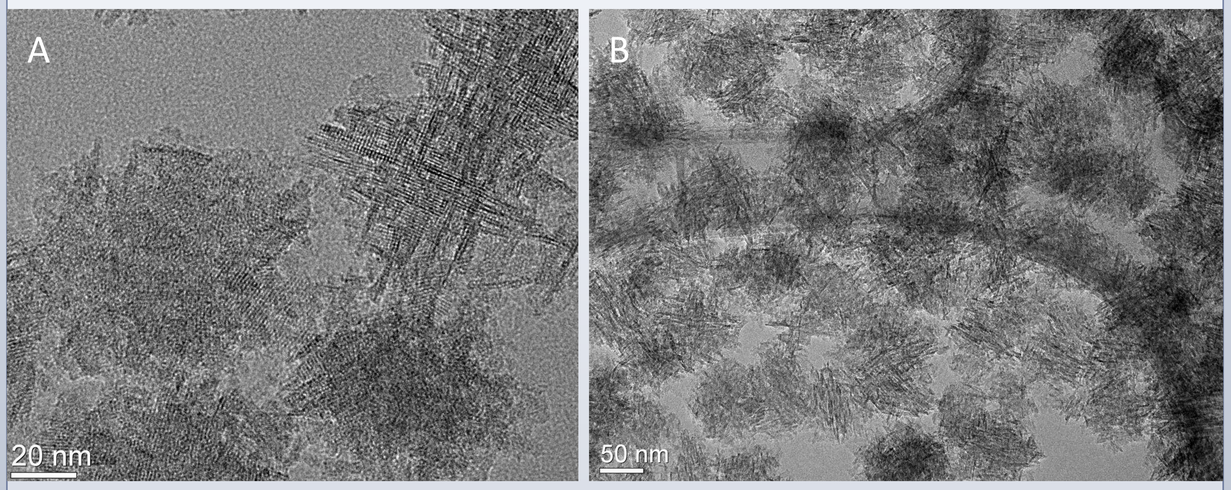

Figure 2: (A) High-magnification TEM image showing mesopores between zeolite layers, as well as the "house-of-cards" arrangement of lamellae. (B) Low-magnification TEM image of the zeolite particles.

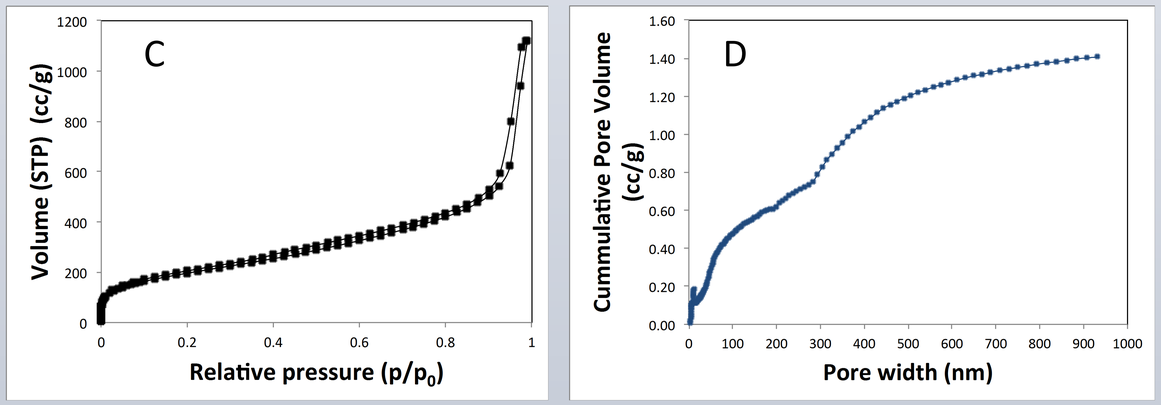

Figure 3: (C) Argon (87 K) adsorption-desorption isotherms of Sn-SPP zeolite. (D) NLDFT cumulative pore volume plot over the whole range of pore widths.

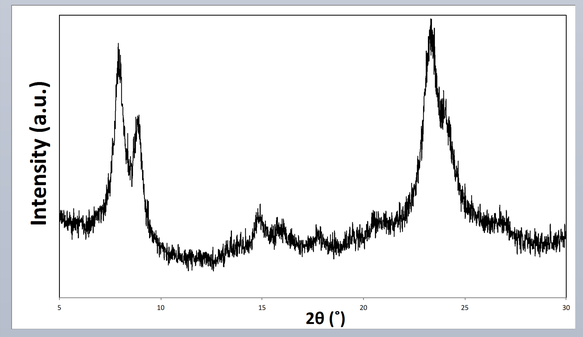

Figure 4: The XRD pattern of Sn-SPP zeolite, showing characteristic peaks at 8, 9 and 23 degrees.

This data was collected at the Characterization Facility, University of Minnesota, which receives partial support from NSF through the MRSEC program.

Results

- A tin-containing zeolite with a self-pillared pentasil framework containing both micro and mesopores was successfully synthesized using hydrothermal synthesis.
- Characterization of the Sn-SPP zeolite was done through TEM, XRD, and argon adsorption

Future Work

- Further optimize variables to reduce synthesis time
- Preliminary experiments show that Sn-SPP acts as a catalyst in the conversion of dihydroxyacetone to ethyl lactate in ethanol
  - Potential to replace existing inefficient bio-reactors that run such conversions

References

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