Synthesis and Characterization of Mesoporous Zeolites and Molecular Sieves Based on Carbon Particles

Feng Wang, Douglas L Moushey, Pavani M. Sreekanth and Panagiotis G. Smirniotis*

Department of Chemical and Materials Engineering, University of Cincinnati

Cincinnati, OH 45221-0012, USA

*panagiotis.smirniotis@uc.edu

Introduction

Zeolite and zeolite-like materials have wide spared applications in various domains like adsorption, separation and catalysis. To overcome the mass transfer limitations of these materials much research efforts has been devoted to increase the pore size of these materials [1]. Using carbon material as template during crystallization is a potential method to create mesoporosity in zeolites [2]. Here we report the preparation of various mesoporous zeolites, SBA-15 and MCM-41 using carbon particles.

Materials and Methods

The mesoporous zeolite ZSM-12 and molecular sieves MCM-41, and SBA-15 were prepared by hydrothermal synthesis by using carbon particles as secondary “template” for mesoporosity. The intracrystalline mesopores were formed after the included carbon black was burned off at 550 ºC in air atmosphere.

Results and Discussion

The experimental results showed that the degree of mesoporosity increases with the increase of C/Si ratio. The XRD results showed that the samples remained highly crystalline at C/Si ratio as high as 1.5 , and the frameworks of the mesoporous zeolites were not destroyed by the addition of carbon particles. However, higher C/Si ratios result in the generation of amorphous material or mixtures of zeolites. The mesopore diameters distributed from 10nm to 50nm were determined by nitrogen physisorption. The BET results showed that the mesoporous ZSM-12 had the mesopore volumes in the range of 0.15-0.19cm^3/g. The STPD and FT-IR results revealed that all these mesoporous samples possessed nearly the same number of Bronsted acid sites and Lewis acid sites as regularly zeolite samples for comparable Si/Al ratios. Compared to conventional zeolites, the mesoporous ones exhibited higher activity and selectivity for the hydroisomerization of n-heptan. This method was successfully employed for the generation of mesoporosity in MCM-41 and SBA-15. Small angle X-ray diffraction patterns for various SBA-15s with different C/Si ratios are shown in Figure 1. These patterns were obtained after removing the templates. It can be seen from Fig.1a that the samples having the C/Si ratios lower than 10 are highly crystallized. However, SBA-15 with C/Si ratio equal to 10 is amorphous

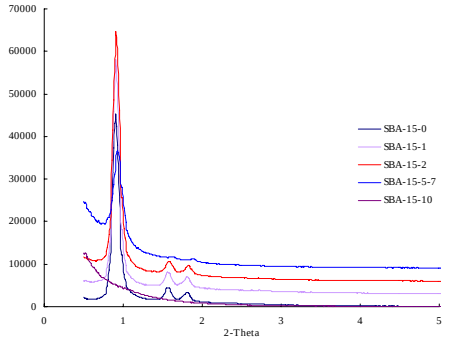

Fig.1 Small angle XRD patterns of various SBA-15 samples

Significance

This method of generating mesoporosity can be generalized for many other zeolites. We believe that the formation of controlled mesoporous zeolites offers unique advantages for a large variety of applications utilizing zeolites.

References

1. Wei, X; Smirniotis,P.G.; *Microporos Mesoporos Mater.* **2006** *97*, 97

2. Wei, X; Smirniotis,P.G.; *Microporos Mesoporos Mater*. **2006**, *89*, 170