

BOOK REVIEW

Molecular Sieves: Principles of Synthesis and Identification. By R. SZOSTAK. Van Nostrand-Reinhold, New York, 1988. \$69.95.

The field of molecular sieves is burgeoning with much of the literature in the form of patents. Therefore, periodic, comprehensive reviews are especially helpful for those working in the area. Szostak attempts to review the molecular sieve literature through 1987 with particular emphasis on synthesis and identification techniques. While the monograph offers few insights or thoughtful interpretations of the data summarized, it is a very useful exposé of the patent and open literature.

Chapter 1 summarizes key features regarding molecular sieve structures and catalysis. Also discussed is the definition of a molecular sieve (variable elemental framework composition) and a zeolite (aluminosilicate framework). This distinction is important since a major emphasis in further chapters is on molecular sieves. Chapter 1 provides a brief opening to the subject matter, but those requiring more complete information should refer to the now classic text by D. W. Breck ("Zeolite Molecular Sieves." Wiley, New York, 1974).

Chapter 2 deals with hydrothermal synthesis of zeolites. Examples of the effects of the influencing factors, e.g., $\text{SiO}_2/\text{Al}_2\text{O}_3$, time, temperature, order of mixing, on the crystallization process are comprehensively illustrated. Szostak raises the classic question of whether or not organic additives function as templates. The answer remains elusive. The chapter closes with a note regarding the status of synthesizing new materials. She correctly states that "the ability to 'engineer' a desired zeolite pore structure has not yet been realized."

Chapter 3 deals with literature which attempts to define the processes of zeolite formation on a molecular level. Examples include the *in situ* Raman work of Dutta and colleagues and the use of NMR techniques to identify solution silicate and aluminate species. The two theories on the crystallization mechanism, namely, solid-solid transformation and solution phase transport, are discussed. Finally, a section on the mechanistic theories of ZSM-5 formation is provided. A word of caution here. Upon further work, the original authors of this theory are now somewhat skeptical of this mechanism. In conclusion, the mechanisms of zeolite crystallization remains unknown.

Chapter 4 is an overview of nonaluminosilicate molecular sieves. This is the newest and fastest growing area in the field of molecular sieve science primarily because of the work at Union Carbide. The chapter opens with comments on the extra-large pore materials (caxoxenite and VPI-5), which are molecular sieves that contain greater than 12 T atom rings and have not been realized as aluminosilicates. Although caxoxenite is not a true molecular sieve it is an interesting natural material whose structure was solved by Moore and Shen in 1983. In fact, within the first several pages of the monograph, a photograph and also a TEM of caxoxenite are provided. Since the TEM is not complemented by a size bar, an electron diffraction pattern, or a simulated pattern, it is impossible to tell whether the TEM is in fact of caxoxenite. The chapter begins with element substituted aluminosilicates and silicates and closes with discussions on aluminophosphate materials. The coverage of element substituted silicates has too much emphasis on Szostak's own work with total neglect of more definitive references. The exposé on aluminophosphate materials is more appropriate but again lacks key references.

Chapter 5 outlines techniques for the identification of molecular sieves. Particular emphasis is placed on X-ray powder diffraction and adsorption measurements. Other techniques such as infrared, solid-state NMR, TEM, and catalytic testing are briefly mentioned also.

Finally, the monograph closes with a X-ray powder diffraction data base. This appendix alone is sufficient to merit the purchase of the book. I believe that the following files within the database contain errors: ZSM-5, ZSM-38, ZKU-2, HS, Boralite E, and magnesium silicate (Aristech).

In conclusion, this monograph is a useful compilation of the molecular sieve literature through about 1987. It is very much needed because of the fact that Breck's text was written such a long time ago. I suspect that this book will find its way onto the shelves of most people working in the field. Szostak has performed the molecular sieve community a great service by writing this monograph.

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