Zeolites and Catalysis

This two-volume set consists of 26 chapters that cover almost all aspects of modern zeolite catalysis comprehensively. Volume 1 is mainly devoted to the diverse methods for synthesizing zeolites, structural aspects, selected techniques for the modification and characterization of zeolites, and major aspects of zeolite modeling and mass transfer in zeolite pores. In the first chapter (by P. Cubillas and M. W. Anderson), emphasis is placed on the basic principles of zeolite synthesis. In particular, questions of nucleation and crystal growth of zeolites are discussed, as also are specific methods for tailoring crystallite size and shape for specific applications. The authors also discuss modern methods for investigating nucleation and crystallite formation in zeolite synthesis, such as NMR spectroscopy and atomic force microscopy.

Some more sophisticated methods for zeolite synthesis are described in Chapter 2 by K. G. Strohmaier; examples include the dry gel conversion method of synthesis, isomorphous substitution (i.e., replacing aluminum or silicon in zeolite synthesis by other tri- or tetravalent elements), and the simultaneous use of multiple-template species (co-templating). Sophisticated synthetic methods are also the theme of the following three chapters, where ionothermal synthesis, the use of co-templates, and the possibilities for tailoring the morphology of zeolite crystallites are discussed in more detail. Post-synthetic methods, in particular for tailoring the lattice composition in zeolites, are treated in the chapter by Chen and Zones, with a special focus on methods for "re-insertion" of aluminum into positions that were previously occupied by other trivalent metals and/or into vacancies within a given zeolite topology.

After a discussion of the main structural aspects of zeolites (P. A. Wright and G. M. Pearce) and descriptions of some particular zeolite structures that have important applications, the following chapters deal with modern methods for the characterization of zeolites (in particular of their catalytic properties) by in-situ studies ("operando" methods), for the investigation of texture in "mesoporous" zeolites (i.e., "hierarchical" zeolites), and for studying the nature and roles of the different aluminum species in zeolite structures. Volume 1 is completed by overviews of methods for the theoretical understanding of zeolites and their catalytic properties/activity, of the modeling of mass transport in zeolites, and of the interplay of diffusion and reaction processes during catalytic reactions in nanoporous solids.

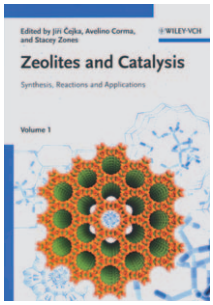
Volume 2 begins with an overview of some less familiar non-catalytic applications of zeolites, e.g., in membranes, sensors, medical applications, and as materials for hydrogen storage. One prerequisite for some of these potential applications is the possibility of tailoring the two- or three-dimensional arrangement of zeolite microcrystals. Currently available techniques for this purpose are reviewed by K. B. Yoon in the following chapter.

For many years, zeolites have played an important role as catalysts (and adsorbents) in petroleum refining and petrochemistry. Additional potential in these areas is described in the contribution by Bellussi and co-authors. One example of a field in which the authors expect advances in the near future is zeolite catalysis in the liquid phase (slurry phase), e.g., for selective catalytic oxidations using hydrogen peroxide as oxidant. It is also emphasized that there is considerable need for innovation to adapt the range of refinery products to changing markets, in particular by the production of more of the lighter products from heavier crude oils.

The nature, strength, and density of acid sites are important factors in almost all catalytic applications of zeolites. This is reflected in the chapter by M. Hunger, which concentrates on the generation of catalytically active acid sites in zeolites and their characterization. Related topics concerned with the formation of basic sites or of metal centers in zeolites are also discussed.

The largest and most important applications of zeolite catalysts are in the fields of crude oil refining and petrochemistry, and therefore the relevant processes are dealt with in a comprehensive manner. In view of the current changes in the feedstock basis, the topics of gas-to-liquids (GTL) processes, and conversion of methanol (derived from natural gas, coal, or biomass) to short-chain olefins (MTO, methanol-to-olefins) or to high-octane gasoline/aromatics (MTG, methanol-to-gasoline) are also addressed. The final three chapters are devoted to the applications of zeolites in environmental protection (in particular for the reduction of NO_x or for the catalytic combustion of volatile organic compounds), to the use of zeolite catalysts for the synthesis of fine chemicals, and to their potential in novel types of fuel cells.

The two-volume set *Zeolites and Catalysis—Synthesis, Reactions and Applications* offers a broad overview of the manifold applications of zeolites in industrial catalysis and of the scientific fundamentals for their applications. It is recommended not only for newcomers just entering the field but also for experienced zeolite scientists who want an update on the state of the art in applications. However, the sequence of chapters in one or the other case seems to be somewhat arbitrary. For example, the chapter on potential future applications of zeolites ("Special Applications of Zeo-



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lites") is placed before the chapters on already existing industrial applications. Also, one would have expected more detailed treatments of ion exchange in zeolites and of ultrastabilization/dealumination, which are both very important for the industrial use of zeolites, e.g., in catalytic cracking.

Nevertheless, these relatively minor points of criticism do not impair the high overall quality of the two volumes, and they are strongly recommended to scientists in both academia and industry. To all those whose interests extend beyond the topics covered in this two-volume set to include industrial processes using zeolites in adsorptive separation and purification, I also strongly recommend the recently published book *Zeolites in Industrial Separation and Catalysis*, edited by S. Kulprathipanja (Wiley-VCH, 2010).

Stefan Ernst
Lehrstuhl für Technische Chemie
Technische Universität Kaiserslautern (Germany)

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