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"Solid-State NMR in Zeolite Catalysis"

By Jun Xu, Qiang Wang, Shenhui Li and Feng Deng (Wuhan Institute of Physics and Mathematics, China), Lecture Notes in Chemistry, Vol. 103, Springer Singapore, 2019, 260 pages, ISBN: 978-981-13-6965-0, £109.99, €139.09, US$159.99

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Introduction

"Solid-State NMR in Zeolite Catalysis" was written by four professors from the Wuhan Institute of Physics and Mathematics, Chinese Academy of Sciences, who have tremendous expertise in the fields of solid-state nuclear magnetic resonance (solid-state NMR) and heterogeneous catalysis. This book is Volume 103 in the series 'Lecture Notes in Chemistry' published by Springer. It can be organised into three sections: (a) principles of NMR theory (Chapter 1); (b) solid-state NMR studies of zeolites and related materials (Chapters 2 and 3); and (c) surface chemistry and reaction chemistry over zeolites (Chapters 4–6). Each chapter offers a sufficient introduction to move smoothly into the main content. The book guides readers to familiarise themselves with solid-state NMR and gives sufficient practical examples, detail and illustration. However, visually supported explanations by the authors were included only after Chapter 1. Adding to this could help deepen the understanding of pre-graduate readers. A few abbreviations were not explained, which could confuse readers. Advantages and disadvantages of solid-state NMR for each purpose are addressed in comparison with other techniques in each chapter. The discussion in this book further applies to materials for heterogeneous catalysts, glasses, ceramics, superconductors, lithium-ion batteries and biological systems.

Principles of Nuclear Magnetic Resonance

In Chapter 1, the authors provide a snapshot of NMR theory with the current state of methodology development, including strategies to enhance NMR sensitivity. This chapter gives sufficient background to understand the subsequent chapters without overwhelming.

Solid-State Nuclear Magnetic Resonance Studies of Zeolites and Related Materials

Highlights and lowlights of solid-state NMR for material characterisation are addressed at the beginning of Chapter 2. The chapter goes on to explain the local framework structure characterised by different chemical environments in zeolites. NMR spectroscopy provides detailed information on synthesis mechanisms in the solid and liquid phases, which may be complementary to X-ray diffraction and electron microscopy methods that are often used to gain structural information.

The application of NMR spectroscopy in zeolite crystallisation, *in situ* and *ex situ* methods is also introduced to investigate the kinetics of crystallisation for the convenience of a general audience. As an example, the structural changes in the aluminosilicate gels of zeolite faujasite (FAU) were confirmed in addition to the changes in silicon:aluminium ratios during the ageing and crystallising processes. In addition to zeolite analysis, xenon-129 chemical shifts were used to examine the pore geometry and chemical surroundings. This also fits the discussion of the guest-host interaction study. Additional visual aids could improve understanding in this chapter. The basics of characterisation of Brønsted acid sites may also be complemented by a review by Hunger (1).

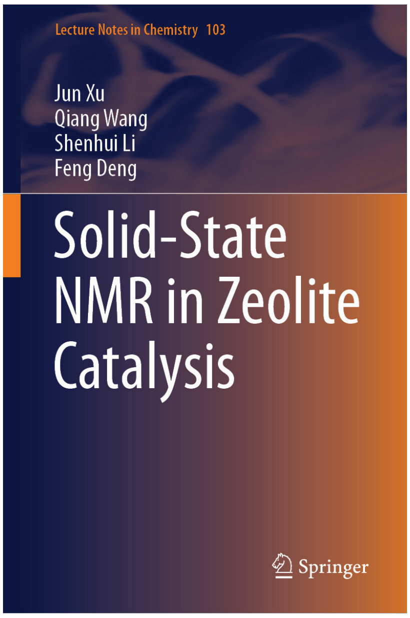
Surface Chemistry and Reaction Chemistry Over Zeolites

NMR spectroscopy has the advantage of providing detailed information on local bonding and solid-state interactions. Investigations on host-guest interactions between organic molecules, such as aromatics to surfactants and inorganic moieties of zeolites, are well summarised in Chapter 4 with sufficient examples and explanation of local structures and dynamic behaviours between adsorbed molecules and active sites. Although several informative figures were cited from references, additional visual supports to explain the host-guest interaction would further elucidate this interaction. The content of Chapter 4 reintroduced and extended this reviewer's understanding of Li-ion battery and Li-ion ultracapacitor materials (2).

Chapters 5 and 6 elucidate interfacial chemistry by solid-state NMR approaches. Several representative reactions are given including *in situ* studies with a focus on how surface and interfacial phenomena significantly influence the catalytic performances (activity and selectivity) of heterogeneous catalysts. Many essential aspects of interfacial chemistry can be emphasised on the chemical and electrochemical reactions at interfaces. The following readings may bring additional value (3, 4), and this is also applicable for an understanding of Li-ion battery and Li-ion ultracapacitor materials (5).

Conclusions

The reviewer would like to recommend this book for anyone who would like to quickly grasp the capability of solid-state NMR as well as researchers working on nanoporous materials, nanocrystals, nanomaterials, Li-ion batteries and capacitors with surface and interfacial phenomena in addition to zeolites and zeolite related materials. This is exciting reading and reminded the reviewer of the ability of solid-state NMR to assess the mechanisms of intermolecular interactions, chemical reactions and transport phenomena. Additional visual supporting materials should be added to deepen the readers' understanding of the authors' explanations, particularly in Chapter 4.



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The Reviewer

Shingo Watanabe received his PhD from the Pennsylvania State University, USA, in the field of fuel, surface and materials chemistry. He worked for Johnson Matthey, USA, for eight years in heterogeneous catalysis and purification in petrochemicals, oleochemicals, biorenewable chemicals and gas and liquid purification. Currently, he is working for a start-up company, Nanoramic Laboratories, USA, as a business development director for the Japan market in the areas of Li-ion batteries, ultra- and supercapacitors and thermal interface materials.

