



Pore Size Engineering In Zeolites

**P.J. Grobet, W.J. Mortier, E.F.
Vansant, G. Schulz-Ekloff**



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Innovation in Zeolite Materials Science P.J. Grobet, W.J. Mortier, E.F. Vansant, G. Schulz-Ekloff, 2011-09-22 The proceedings of this zeolite scientific meeting reflect the growing drive to discover new materials. It is evident that zeolite materials science is in a post ZSM 5 period pushed by a massive expansion of new compositions and topologies and the application of new scientific tools. Four new zeolite topologies were detailed at this meeting. Important new trends were the resurgence of interest in computational and theoretical approaches to explain synthesis, sorption and catalytic data and the increasing use of NMR and high resolution imaging.

Methods for Pore Size Engineering in ZSM-5 Zeolite David Ohayon, 2002 The desilicated form of the ZSM 5 was prepared by a process which involved the selective removal of silicon atoms from the parent sodium form zeolite in an aqueous basic solution of sodium carbonate. If the resulting material was activated at 700 °C its pore size was larger than that of the parent zeolite. The sample is called DS for Desilication and Stabilization. The desilication treatment has the effect of lowering the Si/Al ratio while keeping the zeolite structure essentially unmodified. The silicate material which had been removed was determined to be in large proportion sodium orthosilicate. Ion exchange of the Na/DZSM 5 with ammonium chloride gives us the more acidic form H/DZSM 5. An amount of 5 wt % sodium orthosilicate is reinserted on the H/DZSM 5 zeolite and with a stepwise heating treatment to 700 °C for 16-18 hours the pore size decreases to 4-6 nm. This process is termed DRS which stands for Desilication Reinsertion and Stabilization. To get this pore narrowing there is a reaction that occurs between the zeolite's and the orthosilicate's silanols during the thermal treatment. This reaction results from dehydroxylation and formation of siloxane bonds. Selective adsorptive tests with the BTX aromatics and catalytic runs performed with methanol at various reaction temperatures confirm the enlargement due to the DS treatment and the pore narrowing as the result of the DRS treatment. With the goal of better understanding the mechanism involved in the DRS process and to improve the success rate we passed the sodium orthosilicate through an acid resin and then an amount of 8 wt % of the resulting orthosilicic acid was reinserted into the H/DZSM 5. The sample was then activated to 700 °C for a period of 16-18 hours and a measure of the median pore size gave us 4-4 nm with an improved reproducibility. The reaction temperature between the zeolite's and the orthosilicic silanols was determined with the Differential Scanning Calorimetry Thermal Gravimetric Analysis (DSC/TGA) instrument to be ca 600 °C. The product of this reaction gives us the formation of new siloxane bonds which are responsible for pore narrowing. Selective adsorption tests with n-heptane and isooctane catalytic runs performed with methanol at various reaction temperatures, the determination of the constraint index and the internal space confirmed the pore narrowing as the result of the DRS treatment.

Catalysis and Zeolites Jens Weitkamp, Lothar Puppe, 2013-04-17 Zeolites occur in nature and have been known for almost 250 years as aluminosilicate minerals. Examples are clinoptilolite, mordenite, offretite, ferrierite, erionite and chabazite. Today most of these

and many other zeolites are of great interest in heterogeneous catalysis yet their naturally occurring forms are of limited value as catalysts because nature has not optimized their properties for catalytic applications and the naturally occurring zeolites almost always contain undesired impurity phases. It was only with the advent of synthetic zeolites in the period from about 1948 to 1959 thanks to the pioneering work of R M Barrer and R M Milton that this class of porous materials began to play a role in catalysis. A landmark event was the introduction of synthetic faujasites zeolite X at first zeolite Y slightly later as catalysts in fluid catalytic cracking FCC of heavy petroleum distillates in 1962 one of the most important chemical processes with a worldwide capacity of the order of 500 million t a. Compared to the previously used amorphous silica alumina catalysts the zeolites were not only orders of magnitude more active which enabled drastic process engineering improvements to be made but they also brought about a significant increase in the yield of the target product viz motor gasoline. With the huge FCC capacity worldwide the added value of this yield enhancement is of the order of 10 billion US per year. Progress in Zeolite and Microporous Materials H. Chon, S.-K. Ihm, Y.S. Uh, 1996-12-04 The proceedings of the 11th Zeolite Conference has been published in three volumes containing 5 plenary lectures and 274 full papers. Part A comprises Synthesis and Characterization 99 papers. Part B Catalysis and Environment 102 papers and Part C Adsorption and Diffusion Modifications Novel Materials and Theory 78 papers. Zeolite science and technology has been and continues to be an area receiving great attention. Increasing interest in the synthesis and the characterization of zeolite and microporous materials is reflected in the large number of contributions. Other areas gaining recognition include novel materials adsorption theory and modeling.

Chemistry of Zeolites and Related Porous Materials Ruren Xu, Wenqin Pang, Jihong Yu, Qisheng Huo, Jiesheng Chen, 2009-05-29 Widely used in adsorption catalysis and ion exchange the family of molecular sieves such as zeolites has been greatly extended and many advances have recently been achieved in the field of molecular sieves synthesis and related porous materials. Chemistry of Zeolites and Related Porous Materials focuses on the synthetic and structural chemistry of the major types of molecular sieves. It offers a systematic introduction to and an in depth discussion of microporous mesoporous and macroporous materials and also includes metal organic frameworks. Provides focused coverage of the key aspects of molecular sieves. Features two frontier subjects molecular engineering and host guest advanced materials. Comprehensively covers both theory and application with particular emphasis on industrial uses. This book is essential reading for researchers in the chemical and materials industries and research institutions. The book is also indispensable for researchers and engineers in R D for catalysis divisions of companies in petroleum refining and the petrochemical and fine chemical industries. **Engineering Catalysis** Dmitry Yu. Murzin, 2020-02-10 The book illuminates various aspects of heterogeneous catalysis engineering from catalysis design catalyst preparation and characterization reaction kinetics mass transfer and catalytic reactors to the implementation of catalysts in chemical technology. Aimed at graduate students it is also a useful resource for professionals working in research and development. Gas Engineering James G. Speight, 2022-11-07 Volume 2

covers the constituents of gas streams and their properties The author presents the chemistry and engineering aspects of the methods and principles by which the gas streams might be cleaned from their noxious constituents The concept of gas condensate is also discussed as well as the methods which can be applied to the analysis of streams and condensate Vol 1 Origin and Reservoir Engineering Vol 3 Uses of Gas and Effects *Nanoporous Materials: Science And Engineering* G Q Max Lu,Xiu Song Zhao,2004-11-22 Porous materials are of scientific and technological importance because of the presence of voids of controllable dimensions at the atomic molecular and nanometer scales enabling them to discriminate and interact with molecules and clusters Interestingly the big deal about this class of materials is about the nothingness within the pore space International Union of Pure and Applied Chemistry IUPAC classifies porous materials into three categories micropores of less than 2 nm in diameter mesopores between 2 and 50 nm and macropores of greater than 50 nm In this book nanoporous materials are defined as those porous materials with pore diameters less than 100 nm Over the last decade there has been an ever increasing interest and research effort in the synthesis characterization functionalization molecular modeling and design of nanoporous materials The main challenges in research include the fundamental understanding of structure property relations and tailor design of nanostructures for specific properties and applications Research efforts in this field have been driven by the rapid growing emerging applications such as biosensor drug delivery gas separation energy storage and fuel cell technology nanocatalysis and photonics These applications offer exciting new opportunities for scientists to develop new strategies and techniques for the synthesis and applications of these materials This book provides a series of systematic reviews of the recent developments in nanoporous materials It covers the following topics 1 synthesis processing characterization and property evaluation 2 functionalization by physical and or chemical treatments 3 experimental and computational studies on fundamental properties such as catalytic effects transport and adsorption molecular sieving and biosorption 4 applications including photonic devices catalysis environmental pollution control biological molecules separation and isolation sensors membranes hydrogen and energy storage etc a , *Membrane Reactor Engineering* Angelo Basile,Marcello De Falco,Gabriele Centi,Gaetano Iaquaniello,2016-08-22 Uniquely focussed on the engineering aspects of membrane reactors Provides tools for analysis with specific regard to sustainability Applications include water treatment wastewater recycling desalination biorefineries agro food production Membrane reactors can bring energy saving reduced environmental impact and lower operating costs *Comprehensive Membrane Science and Engineering* Enrico Drioli,Lidietta Giorno,Enrica Fontananova,2017-07-20 Comprehensive Membrane Science and Engineering Second Edition Four Volume Set is an interdisciplinary and innovative reference work on membrane science and technology Written by leading researchers and industry professionals from a range of backgrounds chapters elaborate on recent and future developments in the field of membrane science and explore how the field has advanced since the previous edition published in 2010 Chapters are written by academics and practitioners across a variety of fields including chemistry

chemical engineering material science physics biology and food science Each volume covers a wide spectrum of applications and advanced technologies such as new membrane materials e g thermally rearranged polymers polymers of intrinsic microporosity and new hydrophobic fluoropolymer and processes e g reverse electrodialysis membrane contractors membrane crystallization membrane condenser membrane dryers and membrane emulsifiers that have only recently proved their full potential for industrial application This work covers the latest advances in membrane science linking fundamental research with real life practical applications using specially selected case studies of medium and large scale membrane operations to demonstrate successes and failures with a look to future developments in the field Contains comprehensive cutting edge coverage helping readers understand the latest theory Offers readers a variety of perspectives on how membrane science and engineering research can be best applied in practice across a range of industries Provides the theory behind the limits advantages future developments and failure expectations of local membrane operations in emerging countries

New Frontiers in Nanochemistry: Concepts, Theories, and Trends, 3-Volume Set Mihai V. Putz, 2022-05-29 New Frontiers in Nanochemistry Concepts Theories and Trends 3 Volume Set explains and explores the important fundamental and advanced modern concepts from various areas of nanochemistry and more broadly the nanosciences This innovative and one of a kind set consists of three volumes that focus on structural nanochemistry topological nanochemistry and sustainable nanochemistry respectively collectively forming an explicative handbook in nanochemistry The compilation provides a rich resource that is both thorough and accessible encompassing the core concepts of multiple areas of nanochemistry It also explores the content through a trans disciplinary lens integrating the basic and advanced modern concepts in nanochemistry with various examples applications issues tools algorithms and even historical notes on the important people from physical quantum theoretical mathematical and even biological chemistry

Fundamentals of Interfacial Engineering Robert J. Stokes, D. Fennell Evans, 1996-12-27 Fundamentals of Interfacial Engineering provides chemical electronic mechanical and biomedical engineers with a coherent integrated introduction to the fundamental concepts that relate to interfacial phenomena with applications to different processes and product situations This book emphasizes the importance of intermolecular forces in holding materials together within a bulk phase or across an interface It outlines the fundamental intermolecular interactions that occur in all interfacial systems The work also describes the properties processing and behavior of fluid interfacial systems and treats solid surfaces and interfaces In addition to being of direct industrial relevance this book will provide engineering instructors with an excellent starting point for planning curriculum development in this important area

Membrane Engineering for the Treatment of Gases Volume 2 Enrico Drioli, Giuseppe Barbieri, Adele Brunetti, 2017-10-06 Volume 1 Gas separation issues with membranes volume 2 Gas separation issues combined with membrane reactors

An Introduction to Air Pollution Control Engineering J. Paul Guyer, P.E., R.A., 2021-04-13 Introductory technical guidance for mechanical engineers environmental engineers civil engineers and construction

managers interested in air pollution control engineering Here is what is discussed 1 CYCLONE COLLECTORS 2 FABRIC FILTERS 3 SCRUBBERS AND PRECIPITATORS 4 SULFUR AND NITROGEN OXIDES CONTROL 5 AIR STRIPPING

Introduction to Zeolite Science and Practice P.A. Jacobs,E.M. Flanigen,J.C. Jansen,Herman van Bekkum,2001-06-26 In view of the substantial progress made in the last decade in the fields of zeolites and related materials it was decided to go for an extended 2nd Edition of Introduction to Zeolite Science and Practice Unfortunately as often is the case this process took more time than expected by the Editors In the mean time some new texts on zeolites were issued Nevertheless the combination of data discussion and dedication provided by the present book is a unique coverage of the field in the opinion of the Editors In the present Edition the number of chapters rose from 16 22 The contributions can be divided into three categories updated chapters by the original authors updated chapters by an expanded or new team of authors and completely new chapters This 2nd Edition also contains new chapters on Zeolite based supramolecular assemblies by Dirk De Vos and Pierre Jacobs experts in this area and on The use of bulky probe molecules by Paul Kunkeler Roger Downing and one of the Editors Finally the super large pore zeolites and the fast growing area of ordered mesoporous materials are dealt with by Eelco Vogt Charlie Kresge and and Jim Vartuli The latter two authors belong to the discoverers of the M41S family of mesoporous materials

Multiphase Reactor Engineering for Clean and Low-Carbon Energy Applications Yi Cheng,Fei Wei,Yong Jin,2017-02-21 Provides a comprehensive review on the brand new development of several multiphase reactor techniques applied in energy related processes Explains the fundamentals of multiphase reactors as well as the sophisticated applications Helps the reader to understand the key problems and solutions of clean coal conversion techniques Details the emerging processes for novel refining technology clean coal conversion techniques low cost hydrogen productions and CO2 capture and storage Introduces current energy related processes and links the basic principles of emerging processes to the features of multiphase reactors providing an overview of energy conversion in combination with multiphase reactor engineering Includes case studies of novel reactors to illustrate the special features of these reactors

Membrane Engineering for the Treatment of Gases Enrico Drioli,Giuseppe Barbieri,Adele Brunetti,2017-10-06 Elaborating on recent and future developments in the field of membrane engineering Volume 2 is devoted to the main advances in gaseous phase membrane reactors and separators The book covers innovative membranes and new processes and includes new chapters on cost analysis and life cycle assessment Together with Volume 1 these books form an innovative reference work on membrane engineering and technology in the field of gas separation and gaseous phase membrane reactors

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