Ceramic Membranes New Opportunities And Practical

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Ceramic Membranes New Opportunities And Practical ***2020-05-20***

GRIFFIN LEBLANC

Advanced Ceramic Membranes and Applications Elsevier
Nano and Micro Engineered Membrane Technology is about Nano and micro engineered membrane technology, an emerging new technological area in membrane technology. Potential applications cover a broad spectrum of science, such as micro and nano filtration, gas separation, optics and nanophotonics, catalysis, microbiology, controlled drug delivery, nanopatterning, micro contact printing, atomisation, cross flow emulsification, etc. A brief overview of filtration membranes and pore structures is presented in chapter 1 and in the subsequent chapter 2 an overview is presented of conventional micro perforation methods, like laser drilling, electroforming, precision etching etc. With micro engineering techniques (chapter 3), originating from the semiconductor industry, it is relatively easy to downscale and form submicron pores (down to 100 nm) using photolithographic methods, with e.g. contact masks and wafer steppers. In chapter 4 some elementary fluid mechanics related to fluid flow in conducts and single and multiple orifices is presented covering analytical methods as well as computational fluid dynamics. Much effort has been put in strength and maximum pressure load analysis (chapter 5) of perforated and unperforated membranes. New analytical expressions were obtained that were verified by a number of computer simulations and many experiments. A separate chapter (chapter 6) has been devoted to the pioneering work of manufacturing polymeric perforated membranes because of its potential future economical impact. Large scale microfiltration applications on e.g. skim milk and lager beer are presented in chapter 7, whereas in chapter 8 a micro scale Lab-on-a-Chip microfiltration/fractionation demonstrator is discussed. Nanotechnology and nano engineered membranes is the fascinating topic of chapter 9, with typical examples as nanopatterning, nanophotonics and nanomembrane technology. This book closes with novel pioneering applications on atomization (chapter 10) for deep pulmonary inhale and cross flow emulsification (chapter 11) for the manufacturing of e.g. functional foods and nano/micro emulsions. Overview on the implementation of nano and micro engineering techniques in membrane science; which is an upcoming new cross-road technology Demonstration of feasibility with respect to micro and nano filtration, gas separation, photonic structures, catalysis, microbiology, controlled drug delivery, nanopatterning, micro contact printing, atomisation and emulsification techniques Informative introductions with rules of thumb for fluid flow in micro channels, pressure strength of thin supported perforated and unperforated membranes, silicon micro machining techniques, membrane filtration technology, Rayleigh breakup and cross-flow emulsification
Mixed Conducting Ceramic Membranes Royal Society of Chemistry
Current Trends and Future Developments on (Bio-) Membranes: Ceramic Membrane Bioreactors presents the latest information on the application of ceramic MBR technology, including its maximum robustness and reliability when compared with other membrane-based systems. The book includes a comprehensive analysis of scenarios that are ideal for the potential use of ceramic MBRs. Sections cover applications, advantages/disadvantages, the modeling of ceramic membrane bioreactors, a comparison with other membrane systems, and a section on fouling mechanisms. Presents comprehensive coverage of ceramic membranes and ceramic membranes-based bioreactors Describes the various types of ceramic membranes, i.e., silica, titanium, and more Explains the mechanisms of action and the reasons behind the superiority of these membranes over other types Lists various applications of ceramic membrane bioreactors
Special Issue on Ceramic Membranes John Wiley & Sons
Ceramic Membranes for Reaction and Separation is the first single-authored guide to the developing area of ceramic membranes. Starting by documenting established procedures of ceramic membrane preparation and characterization, this title then focuses on gas separation. The final chapter covers ceramic membrane reactors;- as distributors and separators, and general engineering considerations. Chapters include key examples to illustrate membrane synthesis, characterisation and applications in industry. Theoretical principles, advantages and disadvantages of using ceramic membranes under the various conditions are discussed where applicable.
Preparation and Properties of Ceramic and Surface Modified Ceramic Membranes Elsevier
This edited volume is based on the best papers accepted for presentation during the 1st Springer Conference of the Arabian Journal of Geosciences (CAJG-1), Tunisia 2018. The book is of interest to all researchers in the fields of Mineralogy, Geochemistry, Petrology and Volcanology. The Earth's interior is a source of heat, which makes our planet unique. This source regulates the formation and evolution of rocks at larger scales, and of minerals and sediments toward smaller scales. In such context, the exploration of georesources (products) has to be related to petrogenesis (processes). This volume offers an overview of the state-of-the-art petrogenesis and exploration in, but not limited to, the Middle East and Mediterranean regions. It gives new insights into processes and products related to the Earth's interior, and associated georesources by international researchers. Main topics include: 1. Petrogenetic processes: geochemistry, geochronology and geophysical approaches 2. Surficial processes: sedimentation and facies analysis 3. Applied mineralogy and tectonics 4. Geological research applied to mineral deposits
Advanced Ceramics for Versatile Interdisciplinary Applications Springer
Synthetic membranes have a high separation efficiency, small footprint, low energy consumption and ease of operation, making them an attractive alternative to traditional separation operations. For this reason, membranes have been extensively studied for the treatment and recycling of bitumen-containing wastewaters. Such wastewaters include petroleum produced water, residual pipeline cleaning solutions and contaminated water from oil spills. Ceramic membranes are preferred in these applications over polymeric membranes because they are highly resistant to solvents and can be operated at high temperatures over a wide range of pH. Fine clays and silicates, coated with bitumen, are significant foulants for membrane filtration systems. These foulants possess acidic, basic and amphoteric groups, leading to the presence of both positive and negative surface charges. Ceramic membranes in aqueous media have a pH dependent surface charge. It was hypothesized that these surface charges are responsible for the high fouling of ceramic membranes that is observed when treating wastewaters containing bituminous fines. The overall objective of this research was to reduce fouling and increase the lifetime of ceramic membranes in treating oil sands produced water; an example of a wastewater containing bituminous fines. This goal was achieved through the surface modification of the ceramic membrane's selective layer, as well as by the implementation of a novel in-place steam regeneration technique. All membrane filtration tests were performed with field samples of oil sands produced water that were supplied to CanmetMINING (NRCan) by three Canadian oil sands companies. Organosilanes are silicon-based monomers that can possess a wide array of chemical functionality due to their organic moieties. They are capable of reacting with oxide surfaces, and have seen extensive use as surface modification agents for ceramic membranes in various applications. To maintain desirable hydrophilic properties without surface charges, highly hydrophilic and non-ionic polyethylene oxide (PEO) based organosilanes were identified. These PEO-silanes were then used to modify ceramic membranes of several different selective layer materials, and the thermal stability of the silane layer was studied using FTIR, SEM, zeta potential and contact angle measurements. The modification procedure with PEO-silanes was first applied to lab-scale membrane disks, and subsequently to commercial scale multilumen membrane tubes that were tested in a pilot-scale system at CanmetMINING. Results obtained from both sets of experiments were promising and demonstrate that ceramic membranes can be surface modified in a way that successfully renders them fouling resistant to the bituminous fines present in these wastewaters. Upon surface modification, foulants were more readily released from the membrane surface, resulting in an enhanced flux and separation performance. A novel steam regeneration technique was also applied as a means of bituminous fouling alleviation. This technique was tested in the CanmetMINING pilot-scale system and consisted of periodically injecting steam into the membrane lumen feed channels during operation. Direct steam injection rapidly heated foulant cake layers, and water droplets in the saturated steam caused surface abrasions that ultimately resulted in the scouring of bitumen away from the membrane surface. Membrane fluxes when steam regeneration was active were up to 4 times higher when compared to tests where only traditional permeate backflushing was used. The fouling remediation techniques developed in this work have broad potential applicability in ceramic membrane filtration systems aimed at treating all wastewaters containing bituminous compounds, such as process waters in general and contaminated water from oil spills.
Membrane Technology Elsevier
A membrane reactor is a device for simultaneously performing a reaction and a membrane-based separation in the same physical device. Therefore, the membrane not only plays the role of a separator, but also takes place in the reaction itself. This text covers, in detail, the preparation and characterisation of all types of membranes used in membranes reactors. Each membrane synthesis process used by membranologists is explained by well known scientists in their specific research field. The book opens with an exhaustive review and introduction to membrane reactors, introducing the recent advances in this field. The following chapters concern the preparation of both organic and inorganic, and in both cases, a deep analysis of all the techniques used to prepare membrane are presented and discussed. A brief historical introduction for each technique is also included, followed by a complete description of the technique as well as the main results presented in the international specialized literature. In order to give to the reader a summary look to the overall work, a conclusive chapter is included for collecting all the information presented in the previous chapters. Key features: Fills a gap in the market for a scientific book describing the preparation and characterization of all the kind of membranes used in membrane reactors Discusses an important topic - there is increasing emphasis on membranes in general, due to their use as energy efficient separation tools and the ‘green’ chemistry opportunities they offer Includes a review about membrane reactors, several chapters concerning the preparation organic, inorganic, dense, porous, and composite membranes and a conclusion with a comparison among the different membrane preparation techniques
Direct Biofiltration as a Pretreatment to Control Fouling in Ceramic Membranes in Drinking Water Treatment CRC Press
This book presents a collection of recent contributions in the field of transport phenomena in multiphase systems, namely, heat and mass transfer. It discusses various topics related to the transport phenomenon in engineering (including state-of-the-art, theory and applications) and introduces some of the most important theoretical advances, computational developments and technological applications in multiphase systems domain, providing a self-contained key reference that is appealing to scientists, researchers and engineers alike. At the same time, these topics are relevant to a variety of scientific and engineering disciplines, such as chemical, civil, agricultural, and mechanical engineering.
Transport Phenomena in Multiphase Systems BoD – Books on Demand
Ceramic membrane processes are a rapidly emerging technology for water treatment, yet virtually no information on the performance and fouling mechanisms is available to the industry. Ceramic microfiltration of model feed solutions and a synthetic river water was examined, and a systematic comparison with polymeric counterpart was performed. The results suggested that the models which have been applied to polymeric membranes agreed well with the ceramic membrane filtration data. The fouling was characterized by the initial pore blocking mechanism and transition to the

cake filtration mechanism at a later phase. Cake resistance was dominant and readily removable by physical cleaning. The effects of solution chemistry including ionic strength, divalent ion concentration and pH on the flux behavior were comparatively evaluated for ceramic and polymeric ultrafiltration of synthetic water containing model natural organic matter. Experimental evaluations further included resistance-in-series model analysis, organic matter fouling visualization using quantum dots, batch adsorption test, and contact angle measurement, and provided a quantitative a quantitative comparison of fouling characteristics between ceramic and polymeric membranes. The results collectively suggested that the effects of solution chemistry on the fouling behavior with ceramic membranes were mostly similar with polymeric membranes in terms of trends, while the extents varied depending on water quality parameters. Less fouling tendency and better cleaning efficiency were observed with the ceramic membranes, which was a promising finding for ceramic membrane application to surface water treatment. The study further examined a coagulation-ceramic membrane process as a robust option for surface water treatment. The performance of the hybrid system was evaluated using selected surface waters by varying coagulation conditions and types of coagulants. Results suggested that ceramic membranes experienced relatively less fouling and had better cleaning efficiency than polymeric counterpart. The results of this study provide critical information to guide the industry practitioners, consultants, and regulatory agents considering early adoption of this new technology as well as fundamental knowledge upon which further in-depth studies can be built.

Inorganic Membranes for Separation and Reaction Elsevier

Membrane technology is a rapidly developing area, with key growth accross the process sector, including biotech separation and biomedical applications (e.g. haemodialysis, artificial lungs), through to large scale industrial applications in the water and waste-water processing and the food and drink industries. As processes mature, and the cost of membranes continues to dramatically reduce, so their applications and use are set to expand. Process engineers need access to the latest information in this area to assist with their daily work and to help to develop and apply new and ever more efficient liquid processing solutions. This book covers the latest technologies and applications, with contributions from leading figures in the field. Throughout, the emphasis is on delivering solutions to practitioners. Real world case studies and data from leading organizations -- including Cargill, Lilly, Microbach, ITT -- mean this book delivers the latest solutions as well as a critical working reference to filtration and separation professionals. Covers the latest technologies and applications in this fast moving bioprocessing sector Presents a wide range of case studies that ensure readers benefit from the hard-won experience of others, saving time, money and effort World class author team headed up by the Chair of Chemical Engineering at Oxford University, UK and the VP of Plant Operations and Process Technology at Cargill Corp, the food services company and largest privately owned company in the US

Ceramic Membranes for Separation and Reaction John Wiley & Sons

In order to enable an affordable, sustainable, fossil-free future energy supply, research activities on relevant materials and related technologies have been intensified in recent years, Advanced Ceramics for Energy Conversion and Storage describes the current state-of-the-art concerning materials, properties, processes, and specific applications. Academic and industrial researchers, materials scientists, and engineers will be able to get a broad overview of the use of ceramics in energy applications, while at the same time become acquainted with the most recent developments in the field. With chapters written by recognized experts working in their respective fields the book is a valuable reference source covering the following application areas: ceramic materials and coatings for gas turbines; heat storage and exchange materials for solar thermal energy; ceramics for nuclear energy; ceramics for energy harvesting (thermoelectrics, piezoelectrics, and sunlight conversion); ceramic gas separation membranes; solid oxide fuel cells and electrolysers; and electrochemical storage in battery cells. Advanced Ceramics for Energy Conversion and Storage offers a sound base for understanding the complex requirements related to the technological fields and the ceramic materials that make them possible. The book is also suitable for people with a solid base in materials science and engineering that want to specialize in ceramics. Presents an extensive overview of ceramic materials involved in energy conversion and storage Updates on the tremendous progress that has been achieved in recent years Showcases authors at the forefront of their fields, including results from the huge amount of published data Provides a list of requirements for the materials used for each energy technology Includes an evaluation and comparison of materials available, including their structure, properties and performance

Membrane-Based Separations in Metallurgy Springer Science & Business Media

Advanced Ceramics for Versatile Interdisciplinary Applications describes recent progress in ceramic synthesis and their applications in areas of catalysis, lithium-ion batteries, microbial fuel cells, and biomedical applications. Advancements in ceramic syntheses, such as laser additive manufacturing technologies are also discussed, as are developments in magnetic-based, doped and piezoelectric ceramics and their applications. Other sections cover mixed ionic-electronic conducting ceramic membranes for electrochemical applications, ceramic separators for microbial fuel cells, ceramic polymer composites for lithium-ion batteries, and hybrid ceramic nanocomposites for catalysis applications. The use of metal and metal oxide nanostructures as antimicrobial agents offer a wide range of advantages, ranging from straightforward synthesis to less prone towards resistance development by microbes. Finally, the development of biocompatible ceramic materials, mechanical and chemical properties, and applications are discussed in detail. The book will be useful for new researchers, academics and postgraduate students all working in the area of ceramics and their potential applications. Focuses on the optical and electrochemical properties of advanced ceramic materials and MXenes Covers synthesis, characterization techniques and a diverse range of applications, including energy and biomaterials Contains contributions from a diverse range of backgrounds across chemistry, physics, materials science, engineering, medical science, environmental and industrial technology, biotechnology and biomedical engineering

Petrogenesis and Exploration of the Earth's Interior The Electrochemical Society

The Handbook of Membrane Separations: Chemical, Pharmaceutical, Food, and Biotechnological Applications, Second Edition provides detailed information on membrane separation technologies from an international team of experts. The handbook fills an important gap in the current literature by providing a comprehensive discussion of membrane application

Advanced Membrane Science and Technology for Sustainable Energy and Environmental Applications CRC Press

This project addresses the need for reliable fabrication methods of supported thin/thick dense ceramic membranes for oxygen separation. Some ceramic materials that possess mixed conductivity (electronic and ionic) at high temperature have the potential to permeate oxygen with perfect selectivity, making them very attractive for oxygen separation and membrane reactor applications. In order to maximize permeation rates at the lowest possible temperatures, it is desirable to minimize diffusional limitations within the ceramic by reducing the thickness of the ceramic membrane, preferably to thicknesses of 10 {micro}m or thinner. It has proven to be very challenging to reliably fabricate dense, defect-free ceramic membrane layers of such thickness. In this project we are investigating the use of ultrafine SrCo{sub 0.5}FeO{sub x} (SCFO) powders produced by aerosol pyrolysis to fabricate such supported membranes. SrCo{sub 0.5}FeO{sub x} is a ceramic composition that has been shown to have desirable oxygen permeability, as well as good chemical stability in the reducing environments that are encountered in some important applications. Our approach is to use a doctor blade procedure to deposit pastes prepared from the aerosol-derived SCFO powders onto porous SCFO supports. We have previously shown that membrane layers deposited from the aerosol powders can be sintered to high density without densification of the underlying support. However, these membrane layers contained large-scale cracks and open areas, making them unacceptable for membrane purposes. In the past year, we have refined the paste formulations based on guidance from the ceramic tape casting literature. We have identified a multicomponent organic formulation utilizing castor oil as dispersant in a solvent of mineral spirits and isopropanol. Other additives were polyvinylbutyral as binder and dibutylphthalate as plasticizer. The nonaqueous formulation has superior wetting properties with the powder, and presumably evolves less tensile stress during drying. Membrane layers have been first made from the commercial SCFO powder to accelerate evaluation of the new formulations, since the aerosol power synthesis process is time consuming. We found that, with appropriate levels of the dispersant, we could increase the powder loading in pastes made from the commercial SCFO powder up to 43 wt%. This, combined with the attributes of the other additives, has allowed us to prepare sintered supported membranes with no evidence of cracking. However, the membranes prepared from the relatively coarse commercial powder did not sinter to the high density level (at 1100 C in N{sub 2}) that we had observed with the aerosol-derived powder. This is the current status of the project. The future efforts will be focused toward evaluation of the new paste formulation with aerosol-derived SCFO powder. We anticipate that some adjustments, particularly to the dispersant levels, will be needed for the high specific area aerosol powders.

High Temperature Ceramic Membrane Reactors for Coal Liquid Upgrading Technical Insights

This textbook gives a clear and coherent overview of ceramic membranes, from preparation methods all the way to applications and economics. The authors, who are known for their clear writing style, combine their expertise in environmental engineering and porous materials to cover a wide range of examples, with over 1000 references. Chapters 1, 2 and 3 give a detailed introduction to membrane synthesis, transport mechanisms, and characterisation. Building on this, Chapter 4 outlines the state-of-the-art in ceramic membrane applications, including fuel cells, water purification, gas separation, and the making of cheeses, fruit juice, wine and beer. The final chapter deals with the economics of ceramic membrane processes, using industrial case studies to examine market barriers and opportunities. Ceramics are known throughout history, but now, after thousands of years, they´re making a comeback. Indeed, they may hold the key for addressing three of today´s biggest challenges: clean energy, drinking water and air pollution. This book is a must-have for anyone who wants to enter the ceramic membranes field, or keep up-to-date with the latest developments and applications.

Proceedings of the First International Symposium on Ceramic Membranes Elsevier

The book covers the subject of membrane bioreactors (MBR) for wastewater treatment, dealing with municipal as well as industrial wastewaters. The book details the 3 types of MBR available and discusses the science behind the technology, their design features, operation, applications, advantages, limitations, performance, current research activities and cost. As the demand for wastewater treatment, recycling and re-use technologies increases, it is envisaged that the membrane separation bioreactor will corner the market. Contents Membrane Fundamentals Biological Fundamentals Biomass Separation Membrane Bioreactors Membrane Aeration and Extractive Bioreactors Commercial Membrane Bioreactor Systems Membrane Bioreactor Applications Case Studies

Synthesis and Modification of Ceramic Membranes for Gas Separation John Wiley & Sons

Introducing the advances of functional membranes along with their design and environmental applications. This book is a useful reference for environmental chemists and membrane engineers.

Supported Ceramic Membranes for High Temperature Elsevier

Table of Contents Preface Acknowledgments for the first edition Acknowledgments for the second edition 1 Overview of Membrane Science and Technology 1 2 Membrane Transport Theory 15 3 Membranes and Modules 89 4 Concentration Polarization 161 5 Reverse Osmosis 191 6 Ultrafiltration 237 7 Microfiltration 275 8 Gas Separation 301 9 Pervaporation 355 10 Ion Exchange Membrane Processes - Electrodialysis 393 11 Carrier Facilitated Transport 425 12 Medical Applications of Membranes 465 13 Other Membrane Processes 491 Appendix 523 Index 535.

Membrane Processes in Separation and Purification Elsevier

The withstanding properties of inorganic membranes provide a set of tools for solving many of the problems that the society is facing, from environmental to energy problems and from water quality to more competitive industries. Such a wide variety of issues requires a fundamental approach, together with the precise description of applications provided by those researchers that have been close to the industrial applications. The contents of this book expand the lectures given in a Summer School of the European Membrane Society. They combine an easily accessible

description of the technology, suitable for the graduate level, with the most advanced developments and the prospective of future applications. The large variety of membrane types makes almost compulsory to select a specialist for each of them, and this has been the approach selected in this book. In the case of porous membranes, the advances are related to the synthesis of microporous materials such as silica, carbon and zeolite membranes and hollow fibre membranes. A chapter covers the increasingly relevant hybrid membranes. Attention is also devoted to dense inorganic membranes, experiencing constantly improved properties. The applications of all these membranes are considered throughout the book. Covers all the inorganic membranes field, by different experts It comes from a European Summer School It includes future directions in the field

Membrane Contactors: Fundamentals, Applications and Potentialities IWA Publishing

Inorganic membrane science and technology is a new field of membrane separation technology which until recently was dominated by the earlier field of polymer membranes. Currently the subject is undergoing rapid development and innovation. The present book describes the fundamental principles of both synthesis of inorganic membranes and membrane supports and also the associated phenomena of transport and separation in a semi-quantitative form. Features of this book: - Examples are given which illustrate the state-of-the-art in the synthesis of membranes with controlled properties - Future possibilities and limitations are discussed - The reader is provided with references to more extended treatments in the literature - Potential areas for future innovation are indicated. By combining aspects of both the science and technology of inorganic membranes this book serves as a useful source of information for scientists and engineers working in this field. It also provides some observations of important investigators who have contributed to the development of this subject.

SUPPORTED DENSE CERAMIC MEMBRANES FOR OXYGEN SEPARATION. John Wiley & Sons

This book provides a balanced blend of fundamental concepts of fabrication, characterization of conventional ceramics, extending to present the recent advances in ceramic membranes. It covers the basic concepts of ceramic membranes as well as practical and theoretical knowledge in conventional and advanced ceramic membranes combined with unorthodox ideas for novel approaches in ceramic membranes. Book includes lot of real time examples derived largely from research work by authors. Aimed at researchers, students and academics in the field of membrane engineering around the globe, it has following key features: Guides readers through manufacturing, characterizing and using low-cost ceramic technology. Provides an overview of the different types of ceramic membranes, catalytic reactors and their uses. Covers industrial application, separation and purification. Includes recent developments and advances in membrane fabrication. Discusses new raw materials for ceramic membranes.