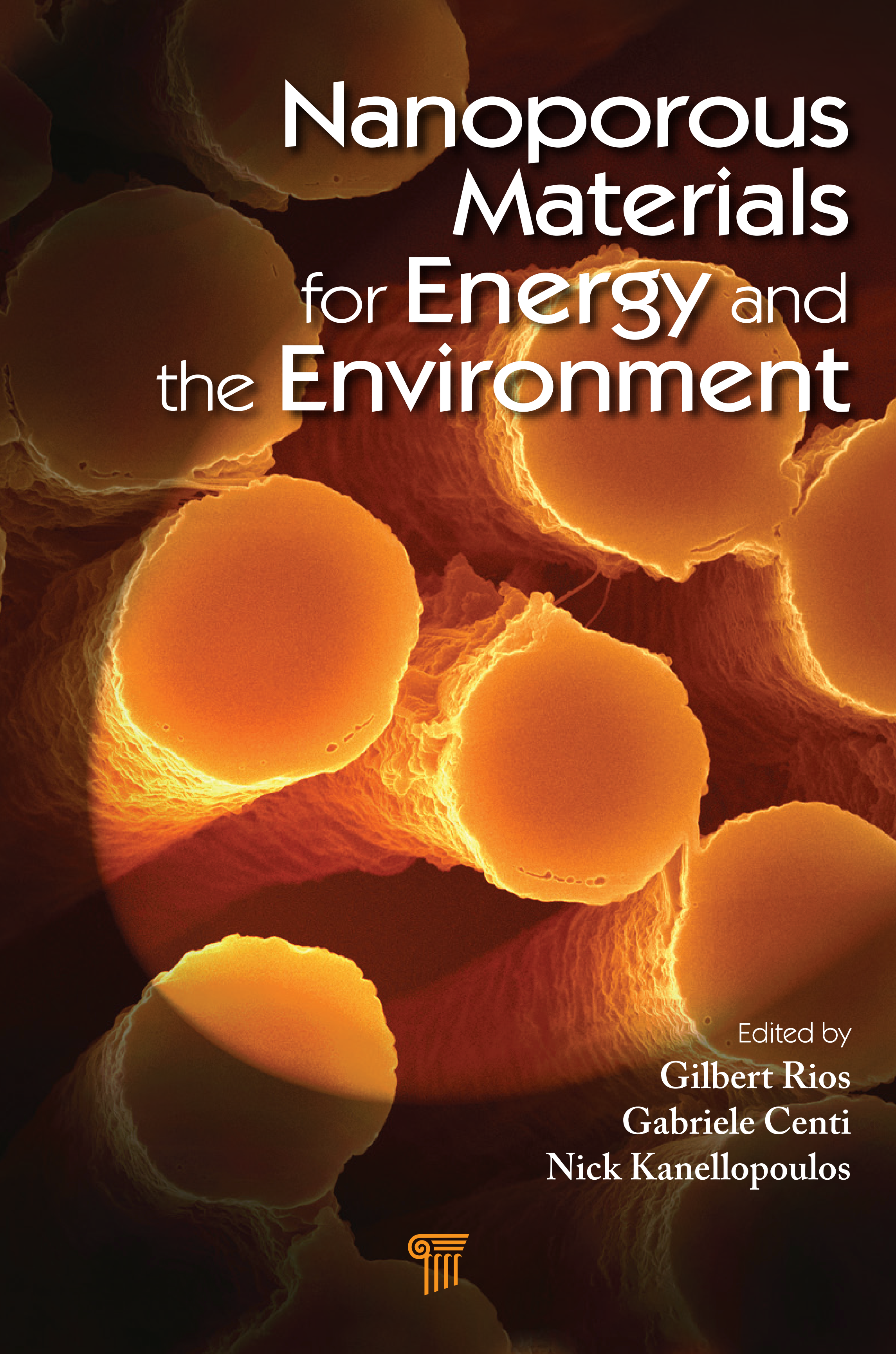

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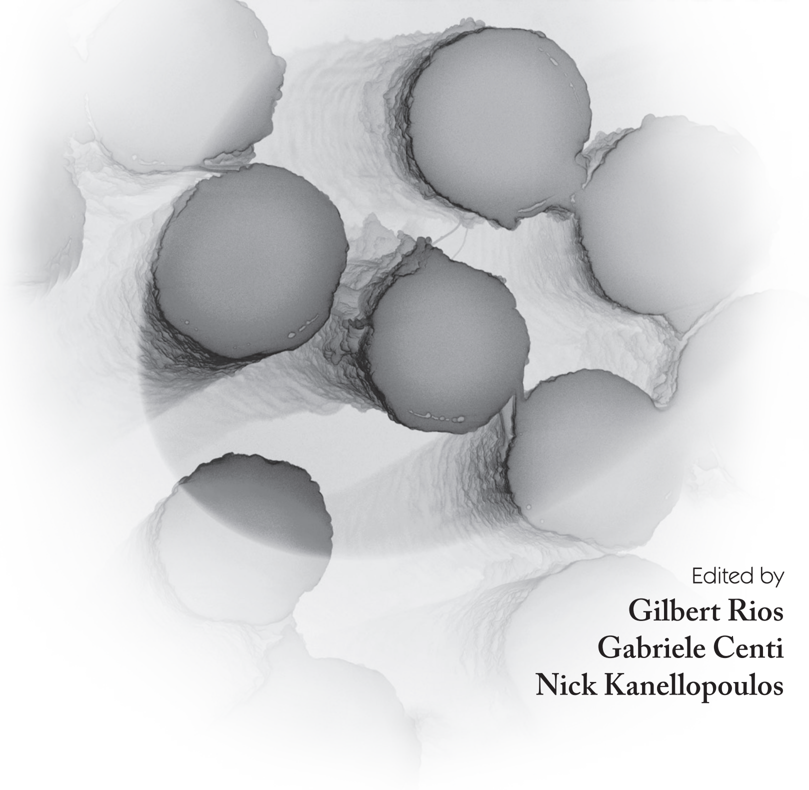

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Pan Stanford Publishing

Published by

Pan Stanford Publishing Pte. Ltd.
Penthouse Level, Suntec Tower 3
8 Temasek Boulevard
Singapore 038988

Email: editorial@panstanford.com
Web: www.panstanford.com

British Library Cataloguing-in-Publication Data
A catalogue record for this book is available from the British Library.

Nanoporous Materials for Energy and the Environment

ISBN 978-981-4267-17-5 (Hardcover)
ISBN 978-981-4303-12-5 (eBook)

Printed in the USA

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Preface

Energy and environment are two closely related challenges for a sustainable future. We need an increasing availability of energy that is estimated to grow worldwide from the current 16TW to approximately 25TW by 2050, while at the same time it is necessary to address the issue of decreasing the impact on the environment associated with the increase of the energy production. To this end, a step enhancement in the introduction of breakthrough technologies is needed in the field of energy production, transport, and saving; of clean production; and of environment protection. At the core of these technologies and processes is the development of novel materials, such as catalysts, membranes, adsorbents, and advanced coatings. Most of the aforementioned materials are nanoporous because the presence of pores and interfaces induces unique properties in these materials, which are not present in the corresponding bulk materials.

The applications of these materials are very important and they already represent a very huge market of several tenths billion euros, covering aspects such as the following:

- Environmental separations, e.g., CH_4 and H_2 storage, N_2/CH_4 separation from natural gas, and NO_x removal
- Clean energy production and storage, e.g., H_2 production with CO_2 sequestration and porous electrodes for fuel cells
- Catalysis and photocatalysis, e.g., catalysis in refinery and chemical processes, catalytic purification of auto exhaust emissions, TiO_2 for new water treatment systems or in indoor/outdoor air purification
- Sensors and actuators, e.g., for fast and reliable gas detection

- Biological applications, e.g., new ways of controlling proteins, cells, and tissue interaction by tailoring the material topography and the spatial distribution of functional groups, more efficient bioseparations, enzymatic transformation of raw substances into high value products, and drug delivery systems with considerably improved properties

Nanoporous materials are a subset of porous materials, with pore diameters ranging from 1 to 100 nm. Among the more relevant properties of these materials are the the high surface to volume ratio and the large porosity with a very ordered uniform nanoporous structure. A large part of inorganic nanoporous materials are made from oxides. They are often nontoxic, inert, and chemically and thermally stable even in extreme conditions. What makes these materials so fascinating and so attractive is the possibility to get various functionalities and properties by tailoring their nanostructure and their internal surface properties.

Developing these materials properly and making possible their production at an industrial level need new engineering concepts and novel characterization methods. It is also worth keeping in mind that a strong commitment to fully develop the desired functionalities is to develop effective control of system/process working conditions by applying novel concepts in the fields of nanofluidics, transport and reaction phenomena, characterization, modeling, and simulation.

It is thus evident that in addition to the design, the behavior of the nanoporous materials and the nanostructure changes during their application as a sequel of their interaction with the reaction medium are also crucial. To this end, there is a need to combine expertise ranging from the chemistry and science of materials to the material and system engineering, passing through the experimentation of their performances.

The achievement of the performance criteria — high adsorption capacity, high selectivity, favorable adsorption kinetics, excellent mechanical properties, good stability and durability in use, etc. — requires effective monitoring and controlling of the evolution of their properties during their synthesis. In addition, accounting for the high performance of the material as soon as the manufacturing process seems essential, this requires the application of novel methodologies that cap all of the length scales and even time scales.

From the aforementioned discussion it is clear that there is a need for strongly integrated and holistic approaches, involving many disciplines, skills, and know-how. Favoring the integration rather than the simple addition of competencies, as well as the loop schemes to the detriment of linear production processes, must also be a strong commitment in order to be able to realize a control system/process intensification by optimizing the whole chain from the molecular to the plant level. It is actually a strong paradigm of the think-tank on which our new economy of knowledge will be based.

Addressing the societal challenges for sustainable energy and environment protection by developing novel nanoporous materials is thus a very complex and multidisciplinary problem, which requires integration of a very broad range of knowledge and expertise in a novel vision and novel way of cooperation.

This is exactly the ambition and the aim of the three "complementary" Networks of Excellence (EC-FP6 – NMP's priority) and their Durable Integrated Structure (DIS):

- NanoMemPro/European Membrane House (EMH/Membranes)
- IDECAT/European Research Institute on Catalysis (ERIC/Catalysis)
- Inside Pores/European Nanoporous Materials' Institute of Excellence (ENMIX/Nanoporous materials)

The major objective of combining their complementary capabilities and competencies is the establishment of a world-class pole of excellence in the broad field of developing novel nanoporous materials and related processes for energy, environment, and other novel applications.

This book is a first result of this collaboration and it is based on a selection of contributions presented during 1st International Workshop on NanoPorous Material for Energy and Environment organized in Chania, Crete, 12–15 October 2008, which was organized by the three NoEs. The different chapters cover some of the key aspects of the broad topic of nanoporous materials for novel technologies, systems, and processes for clean and more efficient use of energy and environment protection. They also provide an example of the necessary, different interdisciplinary competencies, ranging from modeling to materials development and testing. The chapters are written by well-known experts in these fields, with the objective to first introduce the topic for a broader audience and then provide the new trends and developments in the area. The book may be thus used both for teaching specialized courses and for providing a concise overview of the perspectives and opportunities in the field to scientists and managers involved in the fields relevant to nanoporous materials.

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Acknowledgments

Thanks are due to Nick Kanellopoulos and his colleagues who took in charge the organization of the 1st NAPEN workshop in Chania, Crete.

We would also like to thank the European Commission/DG Research/NMP priority, which granted the financial support necessary for setting-up the three NoEs and which supported the idea of further cross-fertilization actions and thematic clustering between them. More particularly, thanks are due to Soren Bowadt, who acted as Project Officer for the three instruments.

Finally, Mr. Stanford Chong deserves praise to have offered the opportunity to publish this book, as well as all the authors for their invaluable contributions.