Preface

Aerogels are rather old materials that were invented back in 1931 by Steven Kistler at the College of the Pacific in Stockton, California. The first aerogels were synthesized from silica gels by replacing the liquid component with a gas. They appeared as quite revolutionary solid-state materials because of their extremely low density and their outstanding physical properties, especially for thermal and acoustical insulation, and were marketed by Monsanto in the form of granular material a few years later. However, their development was slowed almost to a standstill for about three decades, mainly because of the time-consuming and labor-intensive solvent-exchange steps. That changed with a major technological breakthrough by Teichner at the University of Claude Bernard in Lyon, who replaced Kistler's sodium silicate by alkoxysilanes and thus eliminated simultaneously the inorganic salt byproducts from the gels and the need for a water-to-alcohol exchange step. New developments followed rapidly as many scientists joined the field. However, the field remained mostly of scientific interest till the mid-eighties when the alcohol in the gels was replaced by liquid carbon dioxide before supercritical drying, a major advance in safety eliminating the explosion hazards due to the alcohol during the preparation process. For mostly historical reasons, the recent development of aerogels followed a somewhat distinct route from the fast growing sol–gel field, as specific International Symposia were organized regularly from 1985 to 2003. More recently, a few 1–2 day, international meetings were held in which companies could divulge a limited amount of technical information. Therefore, when in November, 2008, Dr. David Packer, Executive Editor at Springer, asked the Editor-in-Chief of the Journal of Sol–Gel Science and Technology, Prof. Dr. M. A. Aegerter, about his interest to edit a Handbook on Aerogels, his answer was of course quite positive since no such book summarizing the development and the state-of-the-art of these outstanding materials had been published before.

Realizing that such task would be impossible to realize alone, he asked for the collaboration of two renowned scientists in the field, Prof. Nicholas Leventis from the Missouri University of Science and Technology (MST), Rolla (USA) and Dr. Matthias M. Koebel, head of the Building Material Group at the Swiss Federal Laboratories for Materials Testing and Research (EMPA), Duebendorf (Switzerland), who readily accepted the offer. Working together, the editorial structure of the Handbook was rapidly built up keeping in mind that it should present for *the first time in a single book* the state-of-the-art in the development, processing, and properties of inorganic, organic and composite aerogels, the most important techniques of characterization as well as a multidisciplinary description of the use, recent applications and the main products commercialized today by companies. Out of 52 prospective leading authors in the field contacted by the editors in early 2009, 41 accepted to write specific overviews with exhaustive lists of references presenting not only their own research and development but also those realized by other international colleagues in each selected area. This Handbook serves consequently as an authoritative source for a broad audience of

individuals involved in research, products development and use of aerogels as well as for advanced undergraduate and graduate students in many fields. It presents a rather exhaustive coverage of the processing and properties of most types of aerogels developed till now from the original silica-based systems, to nonsilicate inorganics, natural, and synthetic organic compounds such as carbon aerogels, the most recent composite systems involving cross-linked, aerogel-polymer, interpenetrating hybrid networks which exhibit remarkable mechanical properties of strength and flexibility as well as more exotic aerogels based on clays, chalcogenides, phosphides, doped quantum dots, and chitin. Many scientific and industrial applications are also reported in the field of electronics, chemistry, mechanics, engineering, energy production and storage, sensors, medicine, biology, pharmaceutics, nanotechnology, military and aerospace, nuclear waste, C-sequestration, oil and gas recovery, thermal insulation, as well as household uses for which a conservative estimated market annual growth rate of around 70% is expected over the next 5 years.

The **Aerogels Handbook** presents 42 contributions arranged in 16 parts. Part I is dedicated to the **History of aerogels** with one contribution numbered Chap. 1. Parts II–VI, entitled **Materials and processing** summarize the development of the different types of aerogels: *Inorganic-silica based aerogels* with 4 contributions (Chaps. 2–5), *Inorganic-non silicate aerogels* with 3 contributions (Chaps. 6–8), *Organic-natural and synthetic aerogels* with 4 contributions (Chaps. 9–12), *Composite aerogels* with 4 contributions (Chaps. 13–16) and finally *Exotic aerogels* containing 4 contributions (Chaps. 17–20). The basic properties of aerogels (structural, mechanical, thermal and modeling) are then described in Part VII entitled **Properties** which comprises 4 contributions (Chaps. 21–24). Parts VIII to XIV describe rather exhaustively many recent **Applications** in fields such as *Energy* (2 contributions; Chaps. 25 and 26), *Chemistry and Physics* (3 contributions; Chaps. 27–29), *Biomedical and pharmaceutical* (2 contributions; Chaps. 30 and 31), *Space and airborne* (2 contributions; Chaps. 32 and 33), *Metal industry* (1 contribution; Chap. 34), *Art* (1 contribution; Chap. 35) and *Other* (1 contribution; Chap. 36). Finally many **Commercial products** are described in Part XV where 5 contributions written by US, Chinese, and German companies are presented (Chaps. 37–41). All the contributions were evaluated by two reviewers.

The Handbook also contains:

A *List of contributors* arranged alphabetically with, for each author, their affiliation and Email addresses.

A brief section entitled *Concluding remarks and outlook* written by the editors (Part XVI, Chap. 42).

The *Subject index* has been worked out by the editors and is partly based on the author's suggestions; it should assist the readers in finding references to a particular topic. Effort has been made to realize an index as comprehensive and useful as possible. Cross-references are also given to terms of related interest, and are found after the entry for the first-level term to which they apply. The numbers in parenthesis correspond to a chapter; when there is a substantial discussion in a chapter, the number appears in bold.

Finally a section entitled *Glossary, acronyms, and abbreviations* has also been included. The words with their definition also have been in great part suggested by the authors. All these words and acronyms are written in italic in the text of the different contributions.

The editors express their sincere thanks to all authors of the contributions included in this Handbook for their precious time in writing excellent overviews. We also extend our gratitude to Dr. David Packer, Executive Editor at Springer, who suggested the edition of this Handbook and accepted the publication of more than half of the illustrations in color.

Michel A. Aegerter
Nicholas Leventis
Matthias M. Koebel

http://www.springer.com/978-1-4419-7477-8

Aerogels Handbook
Aegerter, M.A.; Leventis, N.; Koebel, M.M. (Eds.)
2011, XXXI, 932 p., Hardcover
ISBN: 978-1-4419-7477-8