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BOOK REVIEW

Mario Pagliaro: Silica-Based Materials for Advanced Chemical Applications

RSC Publishing, 2009, Hardcover, *i-xv* + 192 pages, ISBN: 978-1-84755-898-5, EUR 82.90, £ 70.00, USD 149.00

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It is estimated that the worldwide market for sol-gel materials is currently ~0.5 billion US Dollars ($). Silicon-based sol-gel systems play a dominant role in this sector of the chemical industry. Key precursor molecules in silicon-based sol-gel formulations are the tetrafunctional and the trifunctional silicon alkoxides which have the following chemical formulas:

$$\mathbf{Si(OR)_4 \text{ or } R'_xSi(OR)_{4-x}}$$

and where R and R′ represent various organic groups. Furthermore, the chemistry of the hydrolysis and condensation reactions of these precursor molecules that are built into the overall reaction scheme:

monomer → oligomer → sol → gel → xerogel

are of particular relevance for the systems described in this book by Mario Pagliaro.

In the preface to the book the author states "... the aim is to provide a unified picture of the chemistry of functional silica gels. Hence, in place of a complete coverage of what has been done with these immensely versatile materials, an attempt is made to provide readers with an understanding of the principles behind the applications". He then goes on to say "This book should be useful to researchers and undergraduate students who carry out research in the field, and to managers and management consultants in the chemical industry ...".

The emphasis throughout the book is on the science and technology of "using dopant molecules and silicon precursors derivatized with organic moieties (see Fig. 1) giving place to a vast class of hybrid organic-inorganic organosilica nanocomposites capable to meet numerous, advanced requirements in fields as diverse as catalysis, chromatography, surface coating, sensing, drug release and biotechnology".

Pagliaro states " … almost all of the 18 million existing organic or bioorganic molecules that could not be doped in glass, because glass is prepared at elevated temperatures (about 1,000 °C), can now be entrapped in sol-gel glasses. Organic chemistry and biochemistry have merged with the chemistry of ceramics."

Pagliaro explains how void space and deliberate disorder are used as design concepts across a wide range of length scales in sol-gel systems (see Fig. 2). Furthermore, the relatively mild conditions that are used to encapsulate molecules, biomolecules, macromolecules and biomacromolecules [1] is a particular advantage of the organic-inorganic hybrid materials synthesized by sol-gel routes.

The author also describes a variety of ordered organic-inorganic hybrids. These are typically seen where the organic phase or matrix can act as a template or structure directing agent during the sol-gel reactions—such as the hexagonal arrays seen for surfactant templating [2], for the helical silica formed in chiral organic media [3] and for the clay-like hexagonal silica sheets that are seen in bioinspired templating [4].

Two positive examples of the interactions of organic molecules with their inorganic host include firstly the red shifts in the absorption and emission spectra of dyes and secondly the enhancement of the activity of immobilized enzymes. Furthermore, it should be noted that the silica entrapped molecules are both physically and chemically protected—an important consideration in the recovery and the reuse of immobilized enzymes [5].

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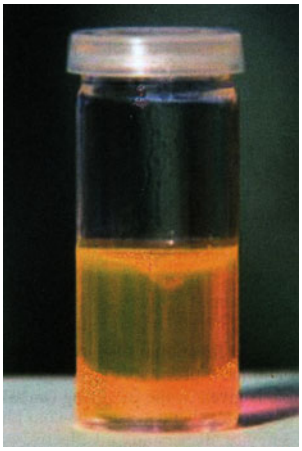

Fig. 1 A silica sol-gel system doped with a coloured organic molecule following Pagliaro

In the area of optically switchable materials, Pagliaro describes how the encapsulation of liquid crystal micro-droplets in ORMOSIL matrices results in better transparency and better thermal stability when compared to related polymer-dispersed liquid crystal systems (PDLCs).

In terms of structure and form, the book is divided into eight chapters: Functionalized Silicas—the Principles; Controlled Release; Purification and Synthesis; Coatings (see Fig. 3); Catalysis; Sensing; Hybrid Silica-Based Composites; Strategic Aspects of Functional Silicas. Of particular interest to the readers of ***SILICON*** is the inclusion of various applied sol-gel silica-based materials by new companies in countries as far from each other as Finland, Germany, Italy, Israel, Australia and the USA. An adequate, but by no means comprehensive, list of references is given at the end of each chapter for further reading. The first chapter is a fine review in its own right and it is inspiring to read [6]. The quality of some of the figures in this book leaves something to be desired. I suspect from their low resolution that these were "cut-and-pasted" directly from articles and other sources on the web. No doubt the author will address this issue in future print runs or editions of this fine book.

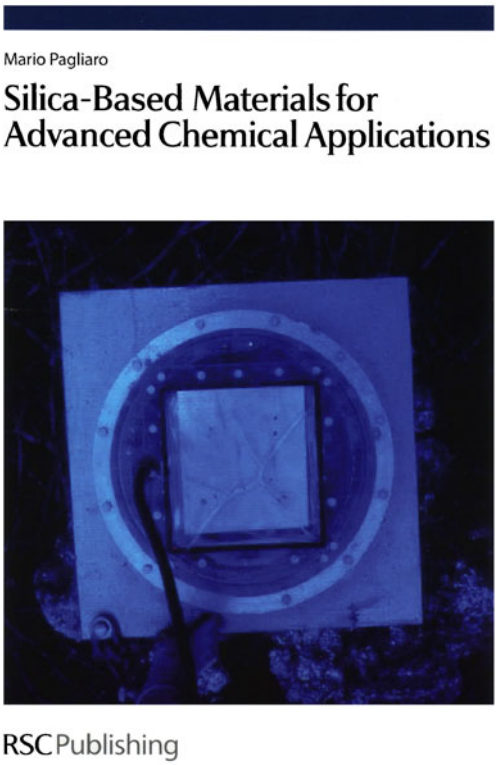

Fig. 3 The cover of the book depicts the application of an ORMOSIL antifouling coating for protecting underwater camera devices in a marine environment

As a University educator, I can see this book being useful as reading material alongside Iler [7] and Brinker [8] for a final year undergraduate course or for a post graduate course in Materials Science, in Chemistry or in Chemical Engineering. Do I recommend this book to the readers of a journal such as ***SILICON***? Most certainly, as there are many nuggets of information that are useful both to the silicon scientist and also to the materials chemist and even to the entrepreneur.

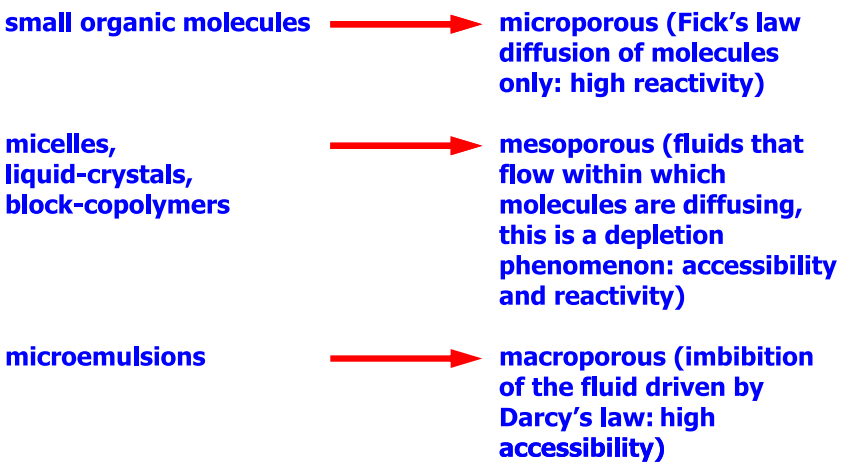

Fig. 2 Templating and structure directing effects of various organic molecules adapted from Pagliaro

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