ADVANCED MATERIALS

Book Reviews

Sol-Gel, Drug Release, Superconductors and Liquid Crystals

Sol-Gel Technology for Thin Films, Fibers, Preforms, Electronics and Specialty Shapes. Edited by *L. C. Klein*. Noyes Publications, New Jersey, USA 1988. xxi, 407 pp., bound, US$ 72. – ISBN 0-8155-1154-X

Sol-gel technology has been a popular subject in materials science and engineering for some four decades. Its promise for the preparation of controlled and homogeneous compositions and for the fabrication of various forms such as powders, fibers, coatings and monoliths has made it the potential answer for many of the problems which have been identified by people working with the processing of ceramics and glass. The technology has proved difficult to apply to some of the more classical sectors of ceramics such as powder and monolith preparation but notable successes have been achieved particularly where precise performance is required in components of limited dimensions (films, coatings, fibers).

The present book performs the valuable function of summarizing the technical advances that have been made in the subject to the end of 1987. In 17 chapters contributed by 27 authors and co-authors drawn from the United States, from Europe and from Japan, sol-gel technology is reviewed with emphasis on examples where progress in applications has been achieved. The editor has been successful in building the book around a logical arrangement which allows the different sectors of the technology to be systematically treated; there is throughout an emphasis on processing methods and on applications and this together with the concentration on topics where commercial success has been reached or can be foreseen, makes the book a valuable and instructive guide for those wishing to find their way in what has become a complex subject.

The opening section of the book contains three introductory chapters which review the preparation of glass using sol-gel methods, the contribution which has been made by molecular dynamics theory to the understanding of the sol-gel process and the subject of phase transformations in gels; in the latter, emphasis is given to the differences that can be identified between the behavior of gel derived and conventional glasses.

The second part of the book relates to the preparation of coatings and thin films by the sol-gel process. As pointed out in the opening chapter on film preparation, such coatings directly exploit the advantages of the sol-gel process; they have reached commercial application in large quantities and they in fact predate much of the fashionable interest of recent years. Specialized treatments of anti-reflective films and of oxynitride films are given in separate chapters. The third part of the book describes the use of sol-gel methods for the preparation of fibers by drawing, blowing or by unidirectional freezing. Following a review of such developments, more detailed treatments are given of the aluminoborosilicate system and of the preparation of continuous fibers.

The fourth section of the book describes the use of sol-gel procedures for monolith formation. The treatment is in terms of glass products and this indeed reflects a general tendency in the book; where appropriate, discussions are included of the polycrystalline products which can stem from sol-gel methods but the major attention is given to glasses and amorphous systems. This section also includes descriptions of thermal insulation, of the manufacture of ultrapure glass and of particulate gels and glasses. The book concludes with a section devoted to specific applications of the technology. Following a short chapter on the fabrication of electronic ceramics, there are treatments of superionic conducting systems (both glass and crystalline, with emphasis on sodium and lithium conductors) of the fabrication of hollow glass microspheres and of filters and membranes.

The editor is to be congratulated on having assembled a timely and authoritative text around a subject which has caused a certain degree of confusion. The emphasis on practical aspects and on applications will be of particular value for those who are trying to clarify the precise contribution to be expected from this much debated technology.

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Controlled Release of Drugs: Polymers and Aggregate Systems. Edited by *M. Rosoff*, VCH Verlagsgesellschaft, Weinheim, 1989, xi, 315 pp., bound, DM 132. – ISBN 3-527-26797-2

This book is the first in a designated series intended to provide topical reviews in various areas of controlled release technology as well as from other pertinent disciplines where advances may contribute to the field of controlled release. The series itself is designed to consolidate, across a wide breadth of topics, a rapidly expanding primary literature database; each volume within the series supposedly allowing substantial review of specific current areas while emphasizing the more subjective exploration of ideas and speculation for future directions from the authors of each chapter. The overall goal of such a strategy is to provide a relevant overview of controlled release issues, problems and progress aiming at broad readership, practical utility and volume longevity. To achieve this the editors of each volume have collected an impressive set of advisory editors to assure and

endorse coherency of content as a whole as well as accuracy and quality within each chapter.

Chapters 1, 2 and 9 deal specifically with issues concerning the use of polymeric materials as matrices for the controlled release of drugs while the remaining six chapters are devoted to dispersed or aggregated system technology – emulsions, dispersions, liposomes, liquid crystals, micelles and microemulsions. I was pleasantly surprised to find so much information compiled on "organized systems" – those utilizing organizing principles which are involved in the field of lyotropic liquid crystals – directed towards controlled release technologies. In this sense, I find the term "aggregated" used in the title to be misleading as, in my opinion, lyotropic liquid crystals "organize" instead of "aggregate". It is, in fact, this organization which is critical to their use in controlled release technology. Aggregation is correctly applied in terms of microcapsules and microspheres. However, were it aggregation per se that compelled lyotropic phases to form and transform, I would believe that the anisotropy so critical to function would not exist. This may be a matter of semantics.

This is one of the few books on controlled release I have read where nine different approaches to the same problem are uniquely presented – each in the style, interests, and scope of each author with little discontinuity or repetition. Each author starts and ends his reviews and discussions within the bounds of his assigned topic which I find refreshing. In addition, each author makes an attempt to break the reader in gently to the topic at hand with short but generally adequate introductions to developments and concepts within each chapter. In this way and considering the effective, relatively straight-forward method with which theory, concept, and applications are developed and focused, the volume qualifies well as a text for newcomers to the field, persons in neighboring fields, and graduate students exposed to these ideas for the first time.

Specifically with regard to the text, chapter 1 addresses the development of models for drug release from various porous polymer matrices. Models for the classical cases of steady-state flow-through and diffusion-controlled release from macro-porous membranes are presented. Closer analyses of tortuosity, corrugation, percolation models, admittedly borrowed originally from other fields, along with various simulation procedures using Monte Carlo and other numerical methods are well formulated and digestible for the neophyte. Microporous systems, where drug and pore size are comparable, are also analyzed at length and in general concepts are well formulated and adequately presented within the constraint of the chapter length.

Chapter 2 discusses controlled drug release from biodegradable polymers. Starting from a review that contrasts polymeric controlled release with conventional drug therapies, the author continues to describe and develop ideas within the scope of biodegradeable polymer matrices. Matrix erosion and resulting release profiles for diffusion-controlled, reservoir and hydrogel devices as well as enterically-coated and covalently-bound drug matrices are addressed. A short overview of the various factors affecting polymeric biodegradation, both chemically and physically, is also given. In addition, factors considered in biodegradable device formulation, administration, and evaluation are briefly presented. Finally, mechanisms of the chemical degradation of polymers currently in use are outlined. Again, the information supplied is stimulating and heavily referenced.

Chapter 3 moves away from polymer matrices to discuss dispersed systems for injectable (parental) drug carrier systems. Materials and device formation techniques for microspheres and microcapsules are given, following an introduction to parental systems and their degradation. The author then moves on to non-polymeric dispersions – liposomes, nonionic surfactant vesicles (niosomes) and loaded erythrocytes as alternative parental vehicles. Two last sections deal with parental emulsions and nanoparticles (polymeric). I enjoyed the review and was satisfied with the content and referenced material.

Chapter 4 discusses liquid crystals and their role in dispersion stabilization and briefly, drug delivery applications. I was excited to see such a chapter because of the applicability of such molecular dynamics and organization to controlled release. However, I soon became bogged down in differentiating arrays of photomicrographs and phase diagrams that the chapter barely has room to detail. Although I did get a lot out of most sections qualitatively (liquid crystal nomenclature and properties, emulsifier associations and stabilization issues), I felt that the sections on l.c. phase behavior and applications to drug delivery lacked sufficient detail and significance and detracted from the quality of the majority. This is particularly clear after reading other chapters dealing with emulsion stabilization by other methods where applications are much more fully discussed. More importantly, I could not discriminate after all was said and done, if liquid crystals had any future in drug delivery or if they should better be left alone. Aside from these issues, I found the content of this chapter, for the most part, interesting.

Chapter 5 goes on to describe and support the weaknesses from Chapter 4 (which may indicate that Chapter 4 was an essential and fully adequate foundation to build upon). The concepts of multiple emulsions, their construction and stability, are fully detailed and referenced. Transport mechanisms for solutes, although not well understood, are developed for both micelles and facilitated transport. A final section on the in vivo administration of emulsions as parental drug delivery systems highlights current interests and levels of understanding for these systems.

Chapter 6 is structured much like Chapter 5 except that it deals with microemulsions. Two differences are notable in this interesting and well written account: namely, that unlike emulsions, microemulsions form spontaneously without external agitation, and that, unlike emulsions, the pharmaceutical value of microemulsions has not yet been adequately

assessed. The authors detail very effectively the requirements and stability of microemulsions and then explain that very little has been done in drug delivery with these systems. From the optimistic description of the basic research undertaken it seems like a ripe research opportunity.

Chapter 7 details liposomal formulations from a more commercial perspective with emphasis on macromolecular drug delivery. An array of materials and methods for the construction of liposomal vehicles having various properties are first described rather extensively. Issues concerning the various routes to delivery are reviewed, touching briefly on trouble-shooting clearance and RES uptake problems. Finally, a short section mentions the specific case of liposomes as macromolecular carriers. Issues in formulation stability and internalization by cells were not addressed to any significant extent. Nevertheless, the chapter gives a very current, well-informed review of a topic that has received much attention in the last decade.

Chapter 8 presents data on the inclusion of nucleic acids into reverse micelles. DNA and RNA of various sizes and types are shown to be solubilized into reverse micelles much smaller than the dimensions of the DNA and RNA themselves. This chapter could have been formatted more effectively in the same style as all others chapters but was instead kept in a classical journal format: Introduction, Experimental, Results, Discussion. It seems to be one of the few mistakes made by the editor. Not only is this format inappropriate for this type of literature review of applied techniques, but reader appeal becomes problematic for anyone unfamiliar with this type of work due to the less-generalized, non-conceptualized style of presentation. Not that this detracts from the quality of the data presented; it simply makes it less comprehensible. Data from spectrometric studies (UV and CD) of the inclusion of biopolymers of DNA and RNA into reverse micelles are given and explained. How this relates to controlled release drug delivery issues is mentioned in a small, speculative section at the end of the chapter.

Chapter 9 returns to polymeric matrices with a well presented review of transdermal delivery systems and models, problems in the development of these systems, and explanations about what can be done to deliver more drugs with this strategy. Less attention is paid to actual materials as is to the design of devices for specific functions, characteristics, and properties, e.g., skin or device rate control and skin permeability enhancement for desired kinetics of delivery. Strategies include diffusion and rate controlling membranes for desired release parameters, examples from current commercial products, and factors to consider in future designs. Modeling analysis include skin depot effects, permeability measurements and predictions, and rate control. This chapter is easy to read and understand and presents most essential and pertinent considerations for transdermal delivery.

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Superconductors: The Breakthrough. By *R. M. Hazen*, Unwin Hyman Ltd., London, 1988, xxviii, 271 pp., bound, £ 12.95. – ISBN 0-04-440288-0

A review of this book from 1988 is still worthwhile just in case someone has missed it. In writing this book in such a popular style the author is running the risk of having his leg pulled by colleagues, not least for employing such a modest title. However, he should be congratulated most warmly for doing so.

This is the story of the discovery of superconductivity at temperatures above the boiling point of nitrogen, the temperature above which commercial exploitation of the effect becomes a viable proposition.

The Preface, Foreword and the first Prologue all give a historical overview and set the scene, explaining the reason for, and the potential importance of the research in the area up until the first indications of success in January 1986 from *Bednorz* and *Müller* at IBM Zürich (who were eventually awarded the Nobel Prize in Physics for their work).

The book is structured in three main sections. The first details the work in the laboratory of Prof. "*Paul*" *Chu* in Houston where the complex-metal oxide synthesis work was done and where, by switching ingredient elements from the original *Bednorz/Müller* recipe ($T_c \sim 30$ K) possibly the first indications of superconductivity above 77 K were seen. One has to say possibly, because, after the initial announcement of the IBM team there were many groups from many nations suddenly devoting their full resources to the problem.

The second section follows the work in which the author was directly involved, that of solving the structures of the two crystalline phases, work carried out at the National Geophysical Lab. in Washington DC in collaboration with *Chu*. The interactions of the multidisciplinary teams are highlighted and even espionage, betrayal and unethical publishing are hinted at.

The third section describes the intense excitement which was generated by the race to be recognized as the pioneer of high-T_c superconductivity above the all important 77 K which culminated in the New York meeting of the American Physical Society which has become known as the "Woodstock of Physics" where representatives of the various competing groups came together resulting in the most memorable scientific meeting in years.

An erroneously spelt erroneous, along with a few other minor defects are counteracted by pictures of the important participants and by lines such as "A good X-ray peak has a silhouette that soars like a futuristic skyscraper; our peaks looked more like melting igloos" which emphasize humorously the sort of problems and disappointments which were overcome on the way to success while bringing a smile to the lips of the more knowing.

The book is written with a humor which can be appreciated both by the scientist and the more general public and a good effort is made to explain enough of basic physics and chemistry to capture the attention of the non specialist, to