book reviews

Material Science of Synthetic Membranes

D. R. Lloyd (Ed.)
ACS Symposium Series No. 269, American Chemical Society, Washington, D.C., ix+492 pages, US$79.95, Export US$95.75
ISBN 0-8412-0887-5

Although ceramic and liquid membranes are of growing interest, the synthetic membranes dealt with in this book are made of organic polymers. The twenty-one chapters assembled here are based on lectures given at a symposium held at St Louis, 9–11 April 1984, but it is evident that the authors have separately, and with great care, prepared their material for publication so that this volume makes a more significant and permanent contribution to the scientific literature than do many published symposia.

There is a dearth of systematic or review literature on the physics and chemistry of membranes themselves. Most books and articles concentration on the transport properties and the practical separation processes associated with membranes. Many people who use such processes are only dimly aware of the nature and the complex origins of membranes and so this book is especially timely and welcome.

At least two-thirds of the chapters should be of real interest to polymer scientists and not only to membrane scientists. Although there is relatively little preparative polymer chemistry here, gradually an era is opening in which the understanding of the connection between chemical structure and transport properties is becoming sufficiently precise to justify attempts to devise membrane polymers especially to meet the criteria of particular separations and environments. Thus membrane technology offers new, and potentially profitable, challenges to polymer chemists.

One of the main areas, covered here in seven chapters by acknowledged experts, is the formation by several techniques of asymmetric, microporous membranes of the types widely used in ultrafiltration; and the characterization of their pore structures. The physical chemistry involved in the making of such membranes is a complex mixture of phase-separation thermodynamics and molecular kinetics. The reviewer knows of no other account remotely approaching that given here in terms of clarity and completeness.

As always in a multi-authored work, there is some inhomogeneity in styles. Chapters here range from accounts of new research to reviews covering wide fields in a rather superficial way, but the great majority of the chapters are up-to-date in-depth reviews of topics that emphasize the need for a sound understanding of polymer physics and chemistry in order to make advances in membrane science. Indeed the title could as well have been Polymer Science of Synthetic Membranes. The reviewer hopes that polymer scientists may dip into this book to learn from its many eminently readable chapters about the important role of polymer science in membrane technology and that some of them may be encouraged to make positive contributions to the field.

The book contains an author and a subject index, although they do not greatly contribute to a volume of this kind. It is in camera-ready format but is very well produced and is a credit to its editor and the publishers.

P. Meares
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Vols. 66 and 67 of Advances in Polymer Science: Characterization of Polymers in the Solid State, Vols. I and II

H. H. Kausch and H. G. Zachmann (Eds.)
Springer-Verlag, 425 pages (together), DM128 (each),
ISBN 3-540-13779-3 and 3-540-13780-7

The early methods of characterizing polymers, by measurements on their solutions of osmotic pressure, viscosity and light scattering, required the identification of effects from the isolated chain in solution, the ideal-gas-equivalent of polymer science. Many other techniques were found to study this problem. However, the majority of macromolecules are prepared, processed, priced and sold for the physical properties of the solid state. If we are to understand polymeric materials better than as a type of viscoelastic porridge with macroscopic properties of use to the engineer, we shall have to discover how the polymer chain is organized within the bulk, and link that knowledge to the properties of value.

In pursuing this theme, Baltá-Calleja has made experiments to explore the dependence of the microhardness of polyethylene upon the organization of lamellae crystals and tie molecules. In other, more readily recognized, composite materials, such as fibre-reinforced plastic matrices, Theocaris describes how their mechanical behaviour is influenced by a mesophase present around and ordered by the inclusions. Colleagues of Professor Janeshitz-Kriegel have written on the development of fatigue in epoxy thermosets through the absorption of water. Other contributions to Volume I cover the application of cross-polarization magic-angle sample spinning n.m.r. to fibrous carbohydrates and to aromatic polymers including phenol formaldehyde thermosets and lignins (Lindberg and Hortling), and to saturated chain molecules such as cyclododecane, whose shifts and line shapes are determined mainly by intramolecular conformational effects, the molecules being held in a fixed conformation within the solid state (Möller). These studies are also of fundamental relevance in understanding the fine structure of the ^{13}C spectra of polymers in solution, where bond rotation populations are a statistical mechanical average. Finally there are two chapters on the measurement of chain orientation in the solid, which is important for maximizing the advantages of strength of the backbone and the development of high crystallinity to give useful mechanical properties. Ward defines orientation, and describes how information is to be obtained from infra-red, Raman and broad-line ^{1}H n.m.r., while Spiess explains how pulsed-deuteron n.m.r. may be used not only to study order, but also main and side-chain mobility within, for example, polymeric liquid crystals and membranes.

Volume II begins with the first general review of the scientific investigations of polymers by means of synchrotron radiation. As with neutron scattering, synchrotrons are expensive and difficult to access, yet new and worthwhile results are emerging. Elsner, Riekel and Zachmann have described the systems and ancilliary equipment required for small-angle and wide-angle X-ray scattering. The high intensity of the source permits the recording of several spectra over a period of five minutes, so that processes such as isothermal crystallization, high-temperature annealing, phase separations and crazing may be followed. Viovy and Monnerie describe fluorescence anisotropy decay studies that have followed the motion of anthracene residues at the centre of 1% of molecules of polystyrene in solution and of polybutadiene in the bulk. By this means the diffusion of orientation motion along the chain in polymer melts has been

observed. Hendrix describes position-sensitive X-ray detectors, whose development promises well for future investigations of solid state processes. Resonance or anomalous X-ray scattering of high-intensity synchrotron radiation in the near-edge region of X-ray absorption edges, as described by Struhmann, is still in its early days. Preliminary experiments, such as those on haemoglobin, where iron is the coherent scattering element, and experiments on membranes containing Erbium and on Caesium-DNA have been made, and it is expected that the strategy successfully used for single-crystal structure analysis may be adapted to the study of partly ordered and disordered structures. The volume concludes with articles on the characterization of the distribution of size and microstrain within crystallites from an analysis of the wide-angle X-ray line shapes, written by Bodor, and on the recovery from transmission electron micrographs of information on lamellae in polyethylene, by Voight-Martin.

Covering many of the new developments in the characterization of polymers in the solid state, both volumes sustain the standard of this series of reviews. Only individuals working within the fields described need feel obliged to purchase their own copies.

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Heat-Resistant Polymers: Technologically Useful Materials

J. P. Critchley, G. J. Knight and W. W. Wright
Plenum Press (New York and London), xiv+462 pages, £61.75, ISBN 0-306-41058-3

The subject matter of the title encompasses a vast area and many of the polymer structures involved are of great complexity. It is therefore greatly to the credit of the authors that they have produced a book that successfully reviews the area and yet remains readable.

The preface indicates that the approach has been to restrict coverage to polymers that have achieved some degree of commercial exploitation and to deal in greater depth with more recently developed polymers such as those with aromatic and/or heterocyclic rings in the chain. Any limitations in depth of treatment in a particular area are very well compensated, however, by abundant references and extensive bibliography lists, so that this can be regarded as a key reference work in its field.

The chapters cover thermosetting polymers, fluorine-containing polymers, polymers with aromatic rings in the chain and those with heterocyclic rings, silicones, carborane silixanes and phosphazenes. Each chapter concludes with a helpful summary. There is a final chapter discussing potential developments in the field. Aspects of each polymer class considered are preparation, processing, thermal and thermo-oxidative stability and modes of degradation and high-temperature properties. Since much of the available data on stability and degradation behaviour are based on thermogravimetry, the inclusion of an introductory chapter that includes a discussion of the experimental parameters that influence or could influence results is especially welcome, since this is an aspect that is often overlooked, which leads to conflicting results.

Much of the success of this book can be traced to its well-organized plan, clarity of style and presentation, and meticulous attention to helping the reader. For example, as well as the bibliography lists at the end of each chapter, there is an appendix listing general review articles from 1970 and a glossary indicating the chemical structure for commercial products with various trade names and code numbers.

This book is essential to the specialist, extremely useful to other workers in polymer or materials science and a valuable and readable guide for students seeking some information on this important group of materials. It can be highly commended.

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International Union of Pure and Applied Chemistry Macromolecular Division

Commission on Macromolecular Nomenclature

Comments sought on basic definitions relating to polymers

No nomenclature document is more fundamental to a given area of science than the definitions of the basic terms used in that area. The Commission on Macromolecular Nomenclature published a document entitled 'Basic Definitions Relating to Polymers' which appeared in *Pure Appl. Chem.* **40**, 479–491 (1974). That document defines fifty-two terms, including polymer, constitutional unit, monomer, polymerization, regular polymer, tactic polymer, block polymer, graft polymer, monomeric unit, degree of polymerization, addition polymerization, condensation polymerization, homopolymer, copolymer, bipolymer, terpolymer, copolymerization, and many others.

These definitions have now been in use for over ten years. The Commission believes that a revision of the original document may be advisable, and it seeks the opinions of interested scientists before undertaking this important task. It would especially like to hear of problems that may have arisen with these definitions in new areas of polymer science, but comments are also sought about any other shortcomings that may be perceived (inconsistencies, lack of conformity with terms used in other sciences, etc.).

Copies of the present definitions are available from the Secretary of the Commission, Dr N. M. Bikales, National Science Foundation, Washington, DC 20550, USA. Comments should be sent to him preferably before the next meeting of the Commission, scheduled for August 1986, but are welcome at any time.