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
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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.

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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.)
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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