

Polymer Processing

D. H. Morton-Jones
Chapman and Hall, UK, 1989,
xi + 260 pages, £16.00
ISBN 0-412-26700-4

This book is a student text concerned with the basic principles of polymer processing. The first two chapters deal with the basics of polymer science and the physical properties of polymer liquids. The remaining chapters are concerned with mixing and polymer processing techniques such as extrusion, blow moulding, thermoforming, injection moulding, rubber technology, composite fabrication and PVC technology.

The book is well presented with clear text, diagrams and tables. Some chapters have a large number of references and details of further reading whereas others are rather thin on references. However, this may be a reflection of the variation of the level of knowledge in the different areas covered. The approach adopted is somewhat empirical and it would be expected that rather more mathematical details would be given in a student text, as is found for example in 'Plastics Engineering' by Crawford. One important omission is the lack of worked examples (except in Chapter 2) and questions at the end of each chapter. They are really essential in a modern student text.

This book by Morton-Jones is a useful addition to the Chapman and Hall series of polymer science and technology text books. They are reasonably priced and have captured a significant part of the market in this important area.

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Analysis of Polymers

T. R. Crompton
Pergamon, Oxford, 1989, viii + 362
pages, £45.00
ISBN 0-08-033942-5

This book contains a large amount of information relating to the analysis of polymeric materials abstracted from an extensive literature base (1086 references). Most of this work relates to the 1960s and 1970s with very few references post 1980. This does not detract from the value of the book but it is unfortunate that it is not more up to date. Some of this work has already been covered in the author's previous book ('The Analysis of Plastics'). Here the subject matter was broken down according to a particular polymer or

group of polymers whilst this new book is organized according to the type of information required by the analyst.

The book is divided into nine chapters plus an extensive list of references. The first chapter is of an introductory nature, briefly describing the types of polymers used commercially. It contains two very useful tables listing the properties and uses of a large number of polymers. Chapter 2, although rather brief, discusses the elemental analysis of polymers by both chemical and instrumental methods. Chapter 3 goes on to discuss the determination of functional groups in polymers by both chemical (e.g. bromination, hydrogenation) and physical techniques (e.g. n.m.r., i.r.). Chapter 4 presents various quick, simple tests for 'fingerprinting' polymers and concludes with instrumental methods such as i.r. and pyrolysis/gas chromatography. This latter technique is presumably a 'pet' technique of the author. It is described and applied extensively throughout most of the chapters in the book. Although useful in some circumstances it is not all that common in laboratories involved in polymer analysis and is overemphasized in this book. Chapter 5 deals with the determination of the microstructure of polymers. It is the largest chapter in the book containing more than 100 pages. Details of methods for the determination of unsaturation, branching, copolymer composition, sequence distribution, tacticity, and end group analysis are presented with appropriate examples taken from the literature. I.r. and n.m.r. (both ^1H and ^{13}C) are extensively referred to in this chapter. Chapter 6 deals with the thermal methods of analysis including thermogravimetric, differential thermal, differential scanning calorimetry, thermal volatilization and thermomechanical analysis. Thermchemical analysis (pyrolysis/g.c. again) and oxidative stability are also included. The techniques are dealt with very briefly and the chapter is rather short (14 pages) for such important polymer characterization techniques. Methods for the determination of molecular weights are presented briefly in Chapter 7. Fractionation procedures and the measurement of gel content are described along with a very brief summary of osmometry, light scattering and viscometry. The section on g.p.c. describes an instrument equipped with a dielectric detector. This is a very uncommon type of detector and is not normally encountered in polymer analysis. A refractive index detector is the standard detector for this work.

The final two chapters deal with the analysis of additives which may be

present in polymers. Non-volatile additives are covered in Chapter 8. This is a large chapter (67 pages) covering both direct determination of additives in a polymer and the various extraction procedures for removal of additives from the polymeric matrix. A wide range of techniques, both chemical and physical, for the subsequent analysis of these additives are then described. The chapter is poorly organized and the material presented in a rather disjointed fashion. The concluding chapter describes methods for the analysis of volatile component in polymers. Head space/g.c. is the most important technique but u.v., polarography and h.p.l.c. are also included.

In conclusion, the book contains a large amount of information and an extensive list of references relating to the analysis of polymers. Some of the information is difficult to find and it is unfortunate that the reference list is not more up to date. However it will be a useful reference book for laboratories involved in analysing polymeric materials.

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Handbook of Fiber Science and Technology: Vol. III. High Technology Fibers Part B
M. Lewin and J. Preston (Eds)
Marcel Dekker, Inc., New York,
1989, xx + 332 pages, \$180.00

The present volume forms one of the five volumes comprising the Handbook of Fiber Science and Technology and is one of two volumes devoted to High Technology Fibers. It contains nine chapters, each of which provides an up-to-date review of the situation for a wide range of new materials. In the second chapter there is a comprehensive review of one of the major developments of the last 20 years, the invention and widespread application of Kevlar fibres. This is very well presented by a team from Du Pont and it is very exciting to learn of the many and varied successful applications of this material. This chapter is preceded by new contenders in the aramid fibre range, the aramid copolymer fibres and in particular Technora fibre from Teijin.

Chapter 3 describes another potential competitor to Kevlar, the thermotropic copolyester fibres invented by Hoechst-Celanese which are marketed as a thermoplastic under the trade name Vectra. This chapter gives an excellent

introduction to the basic science and technology of the copolyester fibres, which is reinforced by a later chapter giving details of the spinning behaviour of these types of polymer. These two chapters, the first by a group at Hoechst-Celanese closely involved in the invention and development of the copolyesters, and the second by W. R. Krigbaum of Duke University, provide a very good overall account for the reader.

The fourth chapter in this book is a very well presented account of polydiacetylene single crystal fibres. The structure and morphology of these materials has been illuminated by some remarkable electron micrographs, and the understanding of mechanical behaviour greatly advanced by studies of the Raman spectrum under stress. Both of these developments are due to R. J. Young, the author of this chapter.

Two further chapters deal with the specialized areas of polystyrene-based functional fibres (Toray Industries) and bioabsorbable fibres for medical use (Y. Ikada). The polystyrene-based fibres are of especial interest as ion exchange resins and solid acid-base catalysts. A wide range of practical applications for the bioabsorbable fibres are discussed.

Finally, this handbook contains two chapters on inorganic fibres. The preparation and applications of lead fibres are considered by Kikuchi and Shoji (Toray Industries). Aluminium oxide fibres are discussed by Romine (Du Pont) who presents a comprehensive account of their processing, structure, properties and applications.

In summary, this handbook offers authoritative discussion of a very wide range of new fibres. The presentations are of a uniformly high standard and in most cases provide the reader with valuable information on the applications of these new materials, as well as a comprehensive account of their preparation, structure and properties.

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Polymer Characterization

D. Campbell and J. R. White
Chapman and Hall, UK, 1989,
viii + 362 pages, £19.95
ISBN 0-412-27170-2

This book has 78 pages on electron microscopy and 30 pages on other optical

techniques that provide a good account of these methods and their applications to polymers. The 25 pages on molecular weight determination and 34 pages on electron spin resonance are of doubtful value. Other sections cover vibrational spectroscopy, ultraviolet, nuclear magnetic resonance, X-ray diffraction and thermal analysis. These sections give the impression of having been compiled by authors with little depth of research or teaching experience in these fields. In vibrational spectroscopy, for example, no indication is given of the tremendous advantages that the Fourier Transform infra-red spectrometers have brought to polymer studies. This reviewer must declare an interest having first obtained FTi.r. spectra of polymers in 1965 but the volume of recent publications on applications of FTi.r. to polymers should clearly indicate the importance of this technique.

Density measurements, neutron diffraction and e.s.c.a. are covered under 'Other Techniques'. No other technique of surface analysis is mentioned; chromatographic techniques are ignored apart from molecular weight applications.

It is difficult to envisage anyone who would benefit from the book as it stands. Much of the book contains descriptions of techniques that are readily available elsewhere (e.g. in textbooks of physical chemistry) and which are too detailed for the average polymer technologist, but insufficient for the specialist polymer chemist. The section on microscopy alone would have made an excellent monograph but the present volume is a disappointment.

T. R. Manley

An Introduction to Rheology

H. A. Barnes, J. F. Hutton and
K. Walters
Elsevier, Amsterdam, 1989, ix + 199
pages, US\$92.00
ISBN 0-444-87140-3

Although this is a relatively small book, it gives a good introduction to rheology. It introduces the reader to the many aspects of this difficult topic, with chapters on viscosity, linear viscoelasticity, normal stresses, extensional viscosity, rheology of polymeric solutions and of suspensions and theoretical rheology. It also gives a

comprehensive bibliography for more detailed rheological reading and an extensive glossary of rheological terms.

The book is well written and illustrated and the text is logically laid out and easy to follow. However, it does lean towards the pure scientist's point of view. There are a large number of illustrations, although some of these could have been made larger for easier interpretation. The four photographic illustrations concentrate on the more dramatic, but nevertheless important, effects of rheological behaviour of viscoelastic fluids.

The content of the book concentrates on viscoelastic behaviour of 'fluids'. This was initially confusing for an introductory text, until the authors' philosophy was clearly spelt out in Chapter 3, namely that all fluids are viscoelastic in theory, and that deviations from this behaviour are only due to the application of a narrow range of practical operating conditions. This leads to a focusing on rheology of polymer solutions and melts, and a virtual total lack of reference to food and fermentation 'fluids'. This concentration is in itself of no major concern, but when coupled with other minor points, gave the impression that this is an introductory text for rheologists rather than one for scientists and engineers in general.

The mathematical treatment of rheological behaviour is deliberately kept to a minimum. For both viscoelastic and the brief mention of non-viscoelastic fluids, a general approach is made to mathematically describe the rheological behaviour. From this the traditional rheological equations for fluids, like pseudoplastic, Bingham, Kelvin and Maxwell, are obtained as special situations. This unifying of mathematical models is thought useful to the non-specialist, even if a larger operating range of shear rate than normal in practical situations is needed to see the difference between the modern and general model and the traditional models for pseudoplastic and Bingham fluids. For the more mathematically oriented reader, theoretical rheology is introduced briefly in the last chapter of the book.

The overall impression is of a text which competently and concisely introduces the new reader to the general theoretical aspects, but which lacks the more practical aspects of rheology.

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