book reviews

Cellulose Structure, Modification and Hydrolysis

R. A. Young and R. M. Rowell (Eds.)
John Wiley and Sons,
New York, 1986, xx+380 pages, £61.75
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This book, comprising twenty chapters contributed by experts in the cellulose field, is dedicated to Professor R. D. Preston, winner of the 1983 Anselme Payen Award presented by the Cellulose, Paper, and Textile Division of the American Chemical Society. Its content appropriately provides an excellent review of the background and recent advances with respect to the structure, hydrolysis, and thermal degradation of cellulose, with additional topics on selected cellulose derivatives and cellulosic liquid crystals. Chapters are written with a clarity of presentation that makes the book a readable and informative one for undergraduates as well as academic and industrial workers in this now expanding field of cellulose chemistry. Where chapter summaries are provided (regrettably for only half of the chapters) these usefully draw the main conclusions together, while the evident cognizance of the contents of other chapters shown by the contributors provides a refreshing coherence to the book with minimal repetition of literature citation.

The first part deals with cellulose structure and biosynthesis and contains chapters on natural cellulose (Preston), recent X-ray crystallographic studies (Sarko), cellulose–solvent complexes (Blackwell/Lee/Kurz/Mao-Yao Su), pea cellulose and xyloglucan (Hayashi/Maclachlan), the primary cell wall (Lamport), and the structure, swelling and bonding of cellulose fibres (Young). Chemical modification of cellulose is covered in the second part with chapters on cellulose carbamate (Ekman/Eklund/Fors/Huttunen/Selin/Turunen), cellulose ethers (Reuben), monomer photografting (Garnett), anionic graft polymerization (Narayan/Tsao), and recent innovations in the production of dissolving-grade cellulose and cellulose acetate (Klausmeier). The fascinating field of liquid crystals which now embraces cellulose derivatives, following earlier work of Gray and co-workers (1976), is adequately dealt with in Part 3. Three chapters dealing with chain configuration and mesophase detection in lyotropic liquid crystal solutions (Sixou/Ten Bosch), structural studies of cellulose derivatives in both the crystalline and liquid crystalline state (Zugenmaier), and the rheology of isotropic and lyotropic cellulose solutions with relevance to single filament spinning (Navard/Haudin) form a good introduction for workers new to this field and summarize our present state of knowledge of these systems.

It is to be expected from the importance of the topics that Part 1, dealing with cellulose structure (128 pages), and Part 4, covering hydrolysis and degradation (101 pages), form the largest portion of the book; Parts 2 and 3 provide a sensible balance with 73 and 59 pages, respectively. The first three chapters in Part 4, dealing with the production of fermentable sugars for subsequent ethanol formation are well written and, again, informative. The importance of alcohol as a fuel is emphasized early in the first chapter on comparative effectiveness of different acid catalysts for hydrolysis of cellulose (Wayman), where we learn that half a million Brazilian cars now run exclusively on undried alcohol. A chapter on kinetic modelling of the saccharification process (Conner/Wood/Hill/Harris) nicely complements the previous one, and includes a computer program (BASIC) to simulate the acid hydrolysis of cellulose, which forms an appendix to the book. The advantages of hydrogen fluoride as catalyst in sugar formation from biomass are convincingly presented in the third chapter on saccharification of lignocellulosic materials (Hawley/Downey/Selke). The importance of pretreatment before enzymatic saccharification (Moriyama/Saida) follows and introduces the reader to two further aspects of cellulose hydrolysis. This enzymatic theme is continued in the fifth chapter on enzymatic breakdown of cellulose crystals (Henrissat/Chanzy), where electron microscopy and diffraction experiments are explored as ways of providing new information on enzymatic breakdown of cellulose. A final chapter deals with thermal decomposition of wood pulps at different degrees of lignification (Kiran), an often overlooked aspect of cellulose degradation; here thermogravimetric results on the pyrolysis of red spruce and maple open the way to new characterization schemes for the pulp-and-paper industry.

The book is remarkably free from grammatical errors, but some criticism can be made of the presentation of results in Chapter 17. The terms 'rate' and 'rate constant' are confused in Table 17.8 (p. 313); k is the accepted symbol for rate-constant in kinetics (Tables 17.9–17.11); activation energies are given in Tables 17.10 and 17.11, and not in 17.8 and 17.9, as stated on p. 312. These are minor criticisms of an otherwise excellent book, which can be recommended as a worthwhile addition to the shelves of cellulose chemists.

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Elastic and Plastic Fracture

A. G. Atkins and Y.-W. Mai
Ellis Horwood, Chichester,
1985, 817 pages, £75
ISBN 0-85312-562-7

Professors Atkins and Mai are disciples of Charles Gurney, who published some important work on elastic fracture in the 1960s. He used a thermodynamic approach in that the analysis was couched in energy terms and followed, very much, the Griffith fracture papers of the 1920s. This book pursues the energy approach and is, a description of what might be called the 'English School' of fracture as opposed to the 'US School' based on characterizing parameters. This latter approach uses the K_c and J_c parameters and has been driven by commercial and safety requirements so that it has dominated the literature. As the authors point out, the rather abstract arguments are not easy to teach and, if for no other reason, it is worth asking if the energy approach is a better basis for the subject. Their thesis is that it is better because one has a clearer view of the physics and the text makes this case well.

For elastic fracture the two approaches give identical results and much of the standard literature in the area is covered. The use of the energy approach does, I feel, give a clear view of the subject and is particularly good when unusual problems are tackled. This is because the energy methods define clearly what is required and in many of these cases it is possible to do the necessary calculations. When elastic–plastic and plastic fracture are considered, things are much less clearly defined and the virtue of this approach is that in some cases it is again possible to calculate the necessary energy terms such as in adhesion and some

bending problems. As is pointed out, sometimes, and often in practical problems, such calculations are not possible, and then some scheme rather less specific such as J seems to be the only answer. Arriving at this point via the energy approach seems to me to be inherently better than the basic use of a characterizing parameter.

The text makes a very good case for the energy approach and does it via an extraordinarily wide range of examples and with data from a wide range of materials. It is thought-provoking and will be most useful for those from other disciplines who need a start in fracture with a lead into their particular problem. There are even worked examples and problems to solve, though some of the latter are rather open-ended and, unfortunately, do not have solutions. I tried some and was not sure if I had done them correctly.

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