

book reviews

Polyelectrolytes — Science and Technology

Masanori Hara (Ed.)

Marcel Dekker, Inc., New York,
1993, 416 pages, \$150.00
ISBN 0-8247-8759-5

Amongst the enormous literature on the science and technology of polymers, polyelectrolytes have been treated as an almost extinct species, despite their widespread industrial importance. This book goes some way to redressing the balance.

The book presents a number of aspects of polyelectrolyte behaviour in aqueous and non-aqueous solution, biopolymers and interactions between oppositely charged polyelectrolytes. These are presented by leading research workers in their fields and are primarily aimed at research workers rather than undergraduate students. Each of the six chapters starts from simple concepts and then gives a review of the state of the subject, including quite recent references. Each chapter is fully referenced, and thus the book fulfils the authors' aims of providing a review of polyelectrolytes for research workers in the field or for people wanting to start research on them. The book is well produced with a good number of diagrams to illustrate the points made in the text. Throughout, the English is easy to read and understand.

Polyelectrolytes can be prepared synthetically or may occur naturally as proteins or polysaccharides. With both classes, their behaviour in solution is largely, though not completely, dominated by the electrostatic interactions. There have long been simple theories for these, though multicharge interactions have been difficult to treat with simple theories. The recent development of scaling theory has proved most useful in handling some of the more difficult aspects of solution properties, especially as solutions become more concentrated. This applies particularly to synthetic random coil polyelectrolytes, though less so to proteins, where hydrophobic bonding and hydrogen bonding often play a greater role. The contrast between these two aspects is well dealt with in the two initial chapters on 'Scaling theory' and 'Biological polyelectrolytes'. Although proteins are far more subtle than synthetic polyelectrolytes, it is interesting to see how far one can get in looking at e.g.

transitions in DNA, starting from a simple electrostatic point of view. The enormous subject of polysaccharides is clearly beyond the scope of this book and their omission simply highlights the paucity of recent books on polyelectrolytes.

One major issue plaguing the study of the solution behaviour of polyelectrolytes is the relative contribution of inter- and intramolecular interactions. With highly charged polymers, these interactions tend to keep the molecules unassociated, but have a strong influence on properties such as viscosity and diffusion. In particular, as the third chapter points out, there can be a number of diffusion processes, both fast and slow, occurring in polyelectrolyte solutions simultaneously, and their interpretation is an active area of debate. The third chapter correctly outlines the areas of certainty and conjecture.

We normally think about polyelectrolytes in aqueous solutions, though it is quite possible to dissolve them in polar, often hydrogen bonding non-aqueous solvents. The changes this brings to the transport and thermodynamic properties are less surprising than one might think at first, as pointed out in Chapter 4. Nevertheless association between like charged groups on polyelectrolytes of low charge density (ionomers) can occur, in contrast to behaviour in water. In water association of charged groups can occur, but are usually of opposite charge. These complexes of oppositely charged polyelectrolytes can form interesting material for membranes, drug delivery vehicles and these applications are described.

The emphasis of the early chapters tends to be on fundamental properties of polyelectrolytes, with the later chapters giving more emphasis to applications — indeed the final chapter gives a good insight into the relation between polyelectrolyte properties and their application in practical systems, especially biological/pharmaceutical ones.

In general, the book is an invaluable summary of certain features of polyelectrolyte behaviour and properties, giving up to date, well-referenced views from leaders in the fields. The inevitable omissions of certain aspects only serves to highlight the need for more such books. The excellent referencing for each chapter makes the book very good value for money.

I. D. Robb

Unilever Research,
Port Sunlight Laboratory

Cyclopolymerisation and Cyclocopolymerisation

George B. Butler

Marcel Dekker, Inc., New York,
1992, 568 pages, \$175
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In 1949, quite a lot was known about the polymerisation of certain difunctional vinyl monomers but it was always assumed that, after the first double bond had been incorporated into a polymer chain, the second would either remain inert or would inevitably contribute to ramification and eventually crosslinking. It never occurred to anyone that the product of complete reaction could be a soluble saturated polymer, yet this is exactly the outcome that Butler found and explained, simply but ingeniously. It was a marvellous example of how a fact can be utterly baffling until explained, and subsequently be so simple as to be unremarkable; it takes insight of an unusual kind to bridge the gap, and that is precisely what George Butler brought to the study of what became known as 'cyclopolymerisation'.

Perhaps a brief explanation would be in order at this point. It is perfectly feasible that two double bonds in a monomer molecule should enter a polymer structure independently; if they did so, the ramification mentioned above would result. What Butler found and understood was that, with the double bonds in certain relative positions, there is a high probability that they will *not* behave independently but that the first to react will attack the second intramolecularly, forming a ring which becomes part of the polymer backbone or main chain. Whether the competition is essentially kinetic or thermodynamic in nature is a fascinating question which is discussed in detail in the book but, surprisingly, neither 'kinetics' nor 'thermodynamics' is cited in the index. (Neither is 'metathesis', a type of mechanism that often incorporates rings into polymer backbones.)

The substance of the last paragraph should not be taken to imply that only a few systems engage in cyclopolymerisation: the list of cyclopolymerising monomers is extensive, embracing symmetrical and unsymmetrical varieties, as well as monomers with two different types of multiple bonds, and moreover cyclopolymerisation extends to cyclocopolymerisation, where two or more

monomers are reacted together. All these topics are covered in the book, which indeed is an exhaustive repository of information of all kinds on its subject.

The author has taken great pains to be comprehensive, and for this he deserves respect because many people in a similar position would have concentrated on their own work to a large extent. Indeed, it is rare to find such a complete discussion of a topic by its inceptor, giving credit to all those who have followed his lead and contributed to current knowledge of the subject. No one else could claim to bring the same level of authority to this topic, and probably no one else would have been so even-handed in reporting. It has to be said that a by-product of the desire to be comprehensive has meant that some sections of this volume are little more than catalogues; in fact, it might have been possible to present substantial sections of it, notably Chapter 12, in tabular form, but undoubtedly the book is all the more valuable as a work of reference for its inclusion of all the relevant material. A further example of the trouble that the author has taken on behalf of his readers is the addition of the *Chemical Abstracts* citation to references. (Even so, care should be taken in using the information presented: the classic paper on cyclisation by Stoll and Rouvé is attributed, on page 121, to Stoll and Rowe.)

As a compendium of the literature on cyclopolymerisation, it is hard to believe that this book could be surpassed. It could have been written in a more personal dramatic style but that is not the author's way. The price is in line with that of scientific texts in general, and this means that it will appeal to libraries (where it will certainly be indispensable) rather than to individuals. In summary, this is a 'horse's mouth' text that completely satisfies the need for a state-of-the-art statement on its subject.

A. D. Jenkins
University of Sussex

Polymer Yearbook 9

R. A. Pethrick (Ed.)

Harwood Academic Publishers,
Philadelphia, 1992, 431 pages,
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'Polymer Yearbook' is an annual series. The ninth volume is divided into three sections. The first one collects review articles from Russian researchers, the second one consists of a list of reports on different topics under the title 'Progress of polymer science in Japan' and the third section, 'Current awareness', a tradition

of this series, contains reports on several international and Russian conferences, held in 1990, and covering different topics in the area of macromolecular science and technology. In addition, an impression is given of the state of polymer science research in Russia, Korea and Eastern Europe and a list of recent publications in polymer science is presented.

The first section contains eight review articles. The first, 'Doping of properties of carbon- and hetero-chain polymers by organic silicon and silicon compounds', by L. M. Khananashvili, emphasizes the concept that the introduction of the above substances, even in small amounts, considerably modifies the technological and processing properties of the polymeric materials. In the second review, 'Biodegradable polymer-based drug delivery systems: the physicochemical aspects', by V. S. Livshits and G. E. Zaikov, several physicochemical parameters, such as crystallinity, molecular weight and its distribution, degree of crosslinking and drug content of the biodegradable polymers, which may influence the release rate from polymeric systems, are considered. In the other six review articles: 'The interrelation between relaxation properties and factors influencing polymer fracture' by V. E. Gul' and Yu. G. Yanovsky, 'The role of intermolecular interaction in polymer degradation processes' by E. F. Vainstein, 'The influence of stress on the kinetics of thermal and thermal oxidative processes in elastomers' by E. F. Vainstein, A. A. Sokolovskii and A. S. Kuzminskii, 'Kinetics of the changing products molecular-mass distribution in thermodegradation of associated polymers' by E. A. Baranova, E. F. Vainstein and O. F. Shlensky, 'Molecular-dynamic concept of the reactivity of polymers and solids in the light of PVT-effects' by A. L. Kovarskii, and finally 'Quantitative criterion of polymer hydrophilicity' by L. P. Razumovskii, A. L. Iordanskii and G. E. Zaikov, the authors interpret the main aspects of the above topics in terms of kinetics, thermodynamics and microscopic properties in order to find a rationalization and a prediction of the macroscopic phenomena.

In the second section, an impression of recent research in polymer science in Japan is given by 12 reports dealing with a wide range of topics such as conductive polymers as solid solvents, ionic polymerization, block and graft copolymers, solution properties of the polymers, polyaddition and polycondensation, polymeric biomaterials, physical properties and superstructure of polymeric solids, biopolymers, polymeric membranes, polymer dynamics and rheology, photo-sensitive polymers, polymer engineering and technology and finally silicon- and fluorine-containing polymers.

The third section presents reports on conferences, held in 1990 in Russia

and in other countries, devoted to macromolecular chemistry and to polymeric materials, as well as to more specific topics such as: stabilization and controlled degradation of polymers, combustion of polymers, modification of polyolefins, their processing, properties and applications, free radical processes in biological systems, complexes of organometallic compounds with polymers as catalysts, polymer blends, relaxation effects on polymeric materials and low-combustibility polymers.

In addition, an overview on 'Polymer science in Eastern Europe' is given on the occasion of the 1989 conference commemorating the 30th anniversary of the establishment of the Division of Polymers and Composite Materials of the Institute of Chemical Physics of the USSR Academy of Sciences.

A wide list of publications in polymer science is given, including selected books on polymers published in Russian in 1990. Selected titles of dissertation abstracts on polymer science are also reported, mainly covering 1988–1990. Finally, a compilation of journals in the area of macromolecular science is given.

In conclusion, this book is readable and comprehensive. It is useful for managers and academic professors but it is also aimed at students with experience in polymer science. In my opinion the book is good value for money. The only criticism I have is the poor quality of the figures in the first section.

C. Carlini
University of Bologna,
Italy

Comprehensive Polymer Science: First Supplement

S. L. Aggarwal and S. Russo
(Vol. Eds)

Pergamon Press, Oxford,
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'Lexicographer: a writer of dictionaries,
a harmless drudge.'
Samuel Johnson, 1755

My first traumatic essay at public speaking came in my last year at school with a requirement to respond to the toast 'Dr Johnson's old school' to an audience of academics and middle class professionals who had both eaten and drunk well, advantages not afforded to me at that time. In preparation for and performance of this ordeal I learned several valuable lessons. First, that the works of the