

PHYSICAL CHEMISTRY OF HIGH POLYMERS

Principles of Polymer Chemistry

By Prof. Paul J. Flory. (The George Fisher Baker Non-Resident Lectureship in Chemistry at Cornell University.) Pp. xvi+672. (Ithaca: Cornell University Press; London: Oxford University Press, 1953.) 68s. net.

IN 1935, the Faraday Society held a General Discussion on the subject of polymerization and condensation. At that time it was still possible to debate seriously whether natural and synthetic polymers could properly be regarded as strictly comparable materials, the properties of which were to be understood in terms of ordinary physicochemical principles, applied to long-chain molecules. This Discussion may be considered to mark the beginning of the surprising growth of polymer science which has taken place in the past twenty years. This same period coincides with the research activity of Prof. P. J. Flory, who now, in the book under review, presents a systematic account of these developments. Flory's own contributions to polymer science have been both profound and extensive. In 1937 he set out clearly the now generally accepted principles of vinyl polymerization processes. In 1942, he evaluated the entropy of mixing of high polymers with liquids. He has made notable contributions to our understanding of the equilibrium and flow properties of polymer solutions, of polymer crystallization, and of rubber elasticity. A book by Flory will therefore command wide attention, and it is safe to say that its readers will not be disappointed.

The plan and scope of the book reflect the author's interests, and, as its title indicates, it is concerned with physico-chemical principles rather than with the presentation of detailed factual information. As a text-book for a postgraduate course on polymer science it could scarcely be bettered, while as a reference book it provides a theoretical background to current research activity and applications of high polymers.

Following two introductory chapters, the author deals first, in Chapters 3-5, with the mechanisms and kinetics of polymerization reactions, discussing in turn polycondensation, free-radical polymerization, copolymerization, and (briefly) ionic polymerization. These chapters, in conformity with the plan of the book, discuss the principles involved, and quote ample illustrative data, but do not compete with or replace the more specialized texts on polymer reactions.

The next main section of the book (Chapters 6-9) is broadly concerned with the structure of polymers, both linear and cross-linked, with especial reference to the determination and distribution of molecular weights. The various experimental techniques are adequately outlined; but the main thread of argument is provided by thorough discussion of the principles of the methods, the origins of molecular-weight distribution, and the correlation of theory with experiment. The application of these methods to specific polymers and the compilation of detailed results have very reasonably been held to lie outside the scope of the book.

In Chapter 10, the author turns to the problem of chain configuration, outlines the random flight approximation and discusses briefly some of the restrictions imposed by bond angles and rotation

barriers. Discussion of rubber elasticity follows naturally in Chapter 11, and here, as elsewhere in the book, the author has chosen to develop the subject simply and systematically without interrupting his argument to discuss disagreements in points of detail which have been expressed by different workers in the field.

Chapter 12 contains a statistical derivation of the thermodynamic properties of polymer solutions. The limitations of the elementary lattice treatment are dealt with and the excluded-volume problem discussed by Flory's own method based on the analogy between polymer solutions and imperfect gases. The usefulness and power of these methods are illustrated by reference to a few well-chosen examples.

Chapter 13 is entitled "Phase Equilibria", and is concerned in the main with the applications of the results of Chapter 12 to problems of polymer solubility, fractionation and swelling. Polymer crystallization is discussed in a surprisingly short section of a dozen pages.

The final chapter contains a concise but very satisfying account of the important though difficult problem of the viscosities of polymer solutions. Here, as throughout the book, the treatment is essentially original, the contributions of various workers being interwoven and often illuminated by the author's systematic presentation. No attempt has been made to review the vast literature which has grown around the empirical use of viscosity as a measure of molecular weight.

This book can be unreservedly recommended to beginners and experts alike. Although it would be easy, as the author himself points out, to mention subjects which have been omitted, the field covered is very broad. Readers unfamiliar with the methods of statistical thermodynamics will find some sections difficult without supplementary study, but physical principles are never submerged in mathematics. Clarity of expression and depth of physical insight are outstanding characteristics of the book, as they have been of Flory's research papers. All workers in polymer science owe him a debt of gratitude for this monograph.

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MAXWELL'S THEORY AND SOME OF ITS APPLICATIONS

Electromagnetics

By Prof. John D. Kraus. (McGraw-Hill Electrical and Electronic Engineering Series.) Pp. xiii+604. (London: McGraw-Hill Publishing Co., Ltd., 1953.) 76s. 6d.

MANY years ago, the reviewer overheard a conversation between two colleagues about a recently published book, when one of them remarked: "If one masters Maxwell's theory the book can be read like a novel". At that time there were not many people who could boast of mastering this theory. Some years earlier, as Michael Pupin tells in his autobiography, he came to England and tried to get information about Maxwell's theory but could not find any university here to help him and had to go to the Continent and to study with Helmholtz. But times have changed since then, and there exist at present, besides Maxwell's original work, which perhaps is not easily understood, quite a few comprehensive treatises on electromagnetic theory.