series, the first three chapters are devoted to an introduction to the subject, the partial differential equations of physics and a succinct account of orthogonal sets of functions. Chapters 4 and 5 treat of the Fourier series proper, their various forms, fundamental properties and Fourier integrals, all of which are well discussed. Applications to boundary value problems then follow as the main subject-matter of the remaining four chapters. In these, the essential theoretical aspect, such as uniform convergence, uniqueness theorems, etc., are considered in their relation to the solution of the important problems connected with vibration, temperature, electric potential, and so on. Finally, Bessel functions and Legendre polynomials, with their respective applications to radiation, vibration and gravitational potential due to a circular plate, bring a very interesting and instructive course to a conclusion.

The book is excellently printed and abounds in illustrative examples and problems in wide variety for the student. Answers to most of the latter are provided, and references for further reading are given at the ends of most of the chapters.

The author's aim to render the course "both elementary and mathematically sound" has been skilfully carried out and the book is a valuable contribution to the subject.

[1] Boyer, "The Concepts of the Calculus", p. 277 (New York : Columbia Press, 1939).

[2] Sokolinkoff, "Higher Mathematics for Engineers and Physicists" p. 135.

POLYMERIC REACTIONS

High Polymeric Reactions

Their Theory and Practice. By Prof. H. Mark and R. Raff. Translated from the Manuscript by Luise Harris Weissberger and I. P. Irany. (High Polymers, Vol. 3.) Pp. xiii+476. (New York : Interscience Publishers, Inc. ; London : Imperia Book Co., Ltd., 1941.) 39*s*. net.

THIS is the first book exclusively devoted to an examination of the mechanism of polymerization reactions. Such reactions can now be well enough controlled to make practicable quantitative measurements on the rate processes involved. Consequently it becomes possible to inquire how chemical kinetics can throw light on the nature of the elementary types of reaction in the polymerization mechanism. In this respect it is a virgin field, and in spite of considerable effort there is still much to be done before a clear and reliable picture of polymerization may be constructed.

Admittedly the problem is much simplified by the development of the detailed theory of chain reactions started some fifteen years ago, but the theory of polymerization reactions has to do a good deal more than the straightforward chain theory. Here in essence it was necessary to deal with only two active molecules or chain propagators, and establish their identity and reaction velocity coefficients. With polymer reactions, on the other hand, the nature and reactivity of *each* polymer must be determined not only as a matter of kinetic interest but also as a prerequisite in calculating concentrations of the several polymers formed after the reaction has ceased. In addition, there are further complications. Linear chain polymers are not necessarily built up by a chain type of mechanism in the sense that one molecule of catalyst may induce the polymerization of many molecules of monomer. For example, in polycondensations it is certain that the polymer is built up step by step by a series of essentially similar reactions. Again, it is found in some reactions that, once started, they seem to proceed indefinitely provided monomer is continuously supplied to the growing polymer. The result is that the convenient and powerful stationary state method of analysis cannot be applied. Complexity reaches its peak when, to any one of these processes, are added the phenomena of the branching and subsequent cross-linking of the linear chains to form three-dimensional networks. Explosive or indefinitely rapid polymerization has not so far been observed, and hence the theory of branching chains provides no help at present.

It is therefore no mean task to devise methods which will yield quantitative information about the molecular statistics of so diverse a series of processes. The volume under review gives a description of the efforts that have been made in recent years to tackle some of these problems. The first part gives an account of the structure of high polymers and their physical and chemical characteristics. There follows next a comprehensive description of the experimental methods employed to trace the course of polymer reactions—a section which will be of particular interest, as the methods are manifold and widely scattered in the literature.

A considerable portion of Part 1 is devoted to the consideration of general reaction kinetics. This subject has received so much publicity that the newer material is at last finding its way into text-books and thus its reproduction here is not so necessary. On the other hand, it makes the volume complete in itself. Thereafter follows the theory of polymer reactions. Its particular form follows closely the presentation which has been adopted by Prof. Mark and his collaborators in previously published work. Here there are many controversial points, but since the assumptions made are often extremely difficult to check experimentally, there is no point in discussing the more detailed parts of the theory provided it is realized that modification in the near future is almost inevitable.

Reference is made in Part 1 to some of the experimental work on the kinetics of polymerization, but the main account of the behaviour of various types of monomer is reserved for Part 2, in which each individual reaction is considered separately and all the relevant facts brought to notice. While this is invaluable as a compilation, it is disappointing to anyone primarily interested in discovering just how far kinetic analysis may be pushed in the examination of these reactions. Many of the reactions have, of course, not been studied in such a way that the data are suitable for analysis, and therefore strictly should be excluded. On the other hand, this lack of knowledge serves to emphasize where further work is needed and what reactions are most likely to be amenable to kinetic discipline.

This volume is, in short, a survey of the beginnings of a new subject and is in no sense a description of a rigorously developed theory supported adequately by exact measurements. It must therefore be read in this spirit. Prof. Mark and Dr. Raff may be congratulated on having the courage to attempt to bring coherence into a fresh region of reaction kinetics.

H. W. MELVILLE.