Book Reviews

A Showplace for Blending Science and Technology

Copolymerization. George E. Ham, Ed. Interscience (Wiley), New York, 1964. xvi + 939 pp. Illus. $27.50.

Copolymers, that is to say polymeric molecules made up of two or more kinds of repeating units, are of enormous technical importance and, in the form of proteins and nucleic acids, make up the stuff of life itself. The reaction of copolymerization, by which such molecules are formed, has received intensive study and has generated a copious literature. Ignoring its biochemical aspects, not treated in this volume which is in fact concerned solely with addition copolymers derived from unsaturated molecules, copolymerization has attracted the attention of three somewhat separate groups of investigators—chemical technologists concerned with the development of economically useful copolymers; polymer chemists interested in understanding the nature of the reactions involved; and physical organic chemists who have recognized that copolymerization provides a useful tool for studying the relation between structure and reactivity in chain (chiefly radical chain) reactions. Central to all of these efforts has been the "copolymerization equation" developed independently some 20 years ago by Alfrey and Goldfinger and by Mayo and Lewis. The present book is a collective volume made up of 15 sections each written by a different group of specialists, and covering topics of current interest. The topics selected are the theory of copolymerization; the Q-e, scheme; copolymers of α-olefins (four sections); cationic, anionic, and block and graft copolymerizations; and copolymerizations involving the technically important monomers, styrene, acrylonitrile, vinyl and vinylidene chlorides, ethylene, and the acrylates and methacrylates. The volume closes with a comprehensive appendix (135 pages) of monomer reactivity ratios, and an extensive tabulation of Q-e values. In almost every section the close relation between theory and practical application is amply demonstrated, and, in fact, copolymerization has proved to be rather a showplace for the happy blending of science and technology. Although there is some duplication of the sort that seems inevitable in a collected work (the references to some authors in the index considerably exceed the number of their published papers), the result is a compendium which will be of great interest to polymer chemists and technologists and which brings together much recent material until now available only as scattered references in the original literature.

Since space does not permit detailed discussion of the many individual chapters, I will comment specifically only on my own particular interest—the treatment of the general theory of copolymerization and the factors that determine copolymer compositions. Although "Theory of copolymerization" is the title of the opening chapter by George E. Ham, the treatment is actually spread throughout the book. Factors determining structure and reactivity in radical copolymerization are well treated by Alfrey and Young in their discussion of the Q-e scheme, while structure and reactivity in reactions that proceed by other mechanisms appear in subsequent chapters.

Ham's chapter is actually a rather specialized treatment of extensions of the copolymerization equation to systems showing penultimate group (and more remote) effects or containing more than two types of monomer unit, both subjects to which he has made contributions. While the mathematics are general, discussion is restricted to free radical systems. In developing his expressions, the author uses a statistical rather than a kinetic approach, which sometimes simplifies the mathematics. However, I seriously doubt that this avoids "steady state assumptions of dubious significance" (p. 8). Actually, the steady state assumption merely requires (i) long chains and (ii) independence of relative reactivities of chain length, precisely the same conditions required for validity of the statistical method.

Ham uses his expressions for penultimate and more remote effects to interpret data on systems such as styrene-fumaronitrile where the simple copolymerization equation fails. Unfortunately, little direct comparison with experiment is given, and, in view of the uncertainties of polymer analysis, the reader may doubt that any effect of monomer groups lying more than one unit back down the chain has actually been demonstrated.

The treatment of multicomponent systems also suffers somewhat from shortage of data. On pages 35 and 36 Ham claims that the application of the Q-e scheme to terpolymerization is confirmed by the data of Tables III and IV. However, since the tables refer to the *same* experiments, and Q's and e's were calculated from the same data as were the terpolymer compositions, the scheme could hardly have gone wrong. The last part of the chapter is devoted to a rather puzzling examination of the relation $r_{13}r_{21}r_{32} = r_{12}r_{31}r_{23}$ which is stated to be an identity for many terpolymer systems with a constant value. Ham seems not to have realized that the identity is predicted by the Q-e scheme, and its value is determined solely by the e's of the three monomers. Accordingly it can have any value, and any constancy noted must be a matter of chance. Further, the use of the identity to estimate r's for unknown monomer pairs really amounts to using the Q-e scheme and is subject to the same uncertainties.

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Psychology

A History of Psychology. Erwin E. Esper. Saunders, Philadelphia, 1964. xii + 368 pp. $6.50.

Years ago the German psychologist Hermann Ebbinghaus made a statement that has been often quoted: "Psychology has a long past but only a short history." The present volume is built on the thesis that psychology's long past is also its history and, further, that this