

monomers which have so far been subjected to study, including styrene, methyl methacrylate, vinyl acetate, methyl acrylate, acrylonitrile, vinyl chloride, ethylene, acrylamide and others. These compounds are discussed under different headings according to whether they are irradiated in fluid, gas, solid or dissolved state and whether the polymer remains soluble or precipitates under irradiation. Included is an account of the recent and practically promising application of radiation in producing grafted copolymers. The article finishes with a discussion of the design and calculation of radioactive sources suitable for industrial applications of radiation polymerization.

Principal effects in irradiation of polymers are (1) cross-linking of polymer chains, leading to increased molecular weight and eventually, with sufficiently high dosage, to an insoluble three dimensional network (gel) and (2) ruptures in the main chain, leading to decreased molecular weight. Some of the essential physical properties of polymers (solubility, fusibility, swelling, elasticity) depend largely on molecular size, with relatively little dependence on chemical constitution. Important aspects of the radiation effect can be discussed, therefore, on basis of the change in molecular weight of the irradiated polymer. The principles were developed by Kuhn, Flory, etc. The greater part (5 chapters) of the article by Charlesby is devoted to an outline of this theory and its application to experimental data in the field of radiation. In addition, the article contains two chapters which deal with pertinent aspects of the underlying chemical effects and one chapter in which is discussed the effect of radiation on the crystallinity of polymers and the resultant changes in physical properties. The article deals mainly with commercial polymers; proteins and nucleic acids are not discussed. For rewarding reading of this review, the student should have some previous acquaintance with the experimental aspects of the subject, as might be obtained by making use of the literature references (84) given in the article or by reading Dr. Charlesby's more popular review in *Nucleonics*, 12, 18 (1954).

The volume reviewed is an excellent addition to Haissinsky's series of monographs. Typography, illustrations and paper are of the usual high standard for the series. The book is particularly welcome since no comparable reviews of any of the subjects covered are at present available.

CHEMISTRY DIVISION  
ARGONNE NATIONAL LABORATORY  
LEMONT, ILLINOIS

HUGO FRICKE

**Organic Syntheses with Isotopes. Part I. Compounds of Isotopic Carbon.** By ARTHUR MURRAY, III, and D. LLOYD WILLIAMS, University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico. Interscience Publishers, Inc., 250 Fifth Avenue, New York 1, N. Y. 1958. x + 1146 pp. 15.5 × 23.5 cm. Price, \$25.00.

A considerable contribution to tracer chemistry has been made by the publication of this book. In this first part of their two-part volume the authors have assembled from the literature descriptions of the chemical syntheses of nearly 500 compounds labeled with  $C^{13}$  or  $C^{14}$ . Part II of this volume will give preparations of organic compounds labeled with isotopic halogens, hydrogen, nitrogen, oxygen, phosphorus and sulfur.

The authors have covered the literature through 1955. They present the descriptions of syntheses in sufficient detail so that a preparation may be carried out without further recourse to the original literature. The format used

is somewhat like that in *Organic Syntheses*. There is first a description of the procedure, followed by elaborations in the form of notes, and, finally, "Other Preparations." Where more than one method has been published for the labeling of a given compound, the method the authors regard as the "most feasible" has been presented, along with references to other preparations. From their long experience with syntheses of radiocarbon compounds, Murray and Williams are well qualified to select the best procedure. In cases where two or more preparations appear equally good, the authors present descriptions of each method.

At the present time several hundred isotopically-labeled organic compounds are available commercially. Consequently, it is now less frequently necessary for a research organization to have to synthesize its own desired tracer compounds. It is, nonetheless, very much in order that the wealth of existing and scattered information regarding isotopic syntheses be collected in one place. This book will be most valuable to anyone contemplating any synthesis of a compound containing isotopic carbon, including compounds whose syntheses are not described here. Beyond that, the book will be useful to anyone interested in the general subject of organic syntheses. Radiochemists have had to meet and solve many problems concerned with small-scale reactions, limiting reagents and high yields. This book details many of the solutions to such problems and it includes sketches of much of the apparatus devised to meet the radiochemists' special needs.

It is very disappointing to find no index accompanying Part I. The publishers have decided, very mistakenly in my opinion, to publish the indices to both parts in Part II only. The price of Part I alone is \$25, surely enough to have enabled the publishers to have included a separate index. Many chemists will be more interested in the compilation of the syntheses of carbon-isotope compounds than in compounds labeled with the other isotopes. However, they will find Part I sharply reduced in usefulness because it has no index. To make full use of Part I they will have to purchase Part II whether they want it or not.

This book is especially difficult to use without an index. For example, no acetylene- $C^{13}$  preparation is given under "Hydrocarbons." It is given as an intermediate in a sodium acetate- $C^{14}$  preparation in a chapter on "Acids" (p. 45) and again (different procedure) in an ethanol- $C^{14}$  preparation in the chapter on "Hydroxy Compounds" (p. 912). It will not be found without that missing index. As a second illustration, preparations of elemental  $C^{14}$ ,  $C^{14}H_4N_2$  and 3-(*p*-chlorophenyl-1- $C^{14}$ )-1,1-dimethylurea all appear in a chapter entitled "Carbonic Acid Derivatives." I never wished so much for an index as I did when reading this book.

Isotopic organic nomenclature is a thorny subject and various systems of naming labeled organic compounds have been devised by several workers. The authors of this book have considered the subject in the "Introduction" and they have proposed a new set of rules for isotopic nomenclature. Their rules, which they apply in the book, are necessarily complex (one of them alone is a half-page long) but they must be read in order to use the book effectively. The trouble is, however, that many non-chemists will want to use this volume and they may be mystified when they see "3-oxa-2-pentanone-2- $O^{18}$ " instead of a more familiar "ethyl acetate carbonyl- $O^{18}$ ." At worst, however, this will be no more than a minor annoyance.

This is an excellent and useful book, marred only by its high price and lack of an index. The authors are to be congratulated on their fine contribution to radiochemistry.

RADIATION LABORATORY  
UNIVERSITY OF CALIFORNIA  
BERKELEY, CALIFORNIA

RICHARD M. LEMMON