Nuclear Chemistry, Vol. II. Edited by L. Yaffe, Academic Press, New York, 1968. $22.00.

Volume II of *Nuclear Chemistry* completes the two-volume set that has as its ambitious aim the exposition of most, if not all, of the research that is of interest to nuclear chemists. Because Vol. I was also reviewed by us [*Nucl. Sci. Eng.*, **34**, 349 (1968)], we shall make a few general remarks before discussing Vol. II.

The review articles are scholarly, broad in scope, and well written. Their main shortcoming lies in the fact that many of them were completed in 1965, with few additions having been made in proof. The absence of very recent developments is apparent in many of the articles and is most glaring in those that deal primarily with techniques and instrumentation. A time interval of less than three years between writing and publication would have been desirable.

Volume II begins with Chapter 7, "Nuclear Fission," by J. E. Gindler and J. R. Huizenga. It presents an excellent, exhaustive review of the subject; i.e., eleven pages alone are devoted to references. Each step of the complex fission process is discussed in a well-organized, detailed manner (an amusing error on p. 28 presents data for the exotic reaction, $^{238}He + {}^{4}U$). Unfortunately, two topics of current great interest receive little or no attention: fissioning isomers and the second minimum in the fission barrier.

Chapter 8, by A. G. Maddock and R. Wolfgang, deals with "The Chemical Effects of Nuclear Transformations." A good but brief discussion of the dynamics of various nuclear processes is presented as an introduction to the subject of hot-atom chemistry. Various hot-atom reaction mechanisms, as well as a kinetic theory of hot reactions, are discussed. Much attention is paid to the problem of annealing.

The ninth chapter, "Modern Rapid Radiochemical Separations" by S. Amiel, is a brief introduction to the techniques and methods used to effect rapid chemical separations of various elements. The chapter is ordered according to method, such as volatility techniques, liquid separation techniques, and physical separation methods. Interested readers will necessarily have to consult other treatises on this vast subject.

"Electromagnetic Separator and Associated Techniques," Chapter 10, by F. Brown is an extremely brief review of an experimental technique of especial importance to nuclear spectroscopists. The discussion covers the basic principles of separator technique, descriptions of various types of separators, and the preparation of monoisotopic targets and sources. No mention is made of current "on-line" separator projects in which many nuclear chemists are involved.

Chapter 11, "Computers Applied to Nuclear Chemistry" by D. L. Morrison, is mainly devoted to a detailed discussion of the computer analysis of decay curves and of γ, β, and α particle spectra. But, unfortunately, recent important developments such as the relatively simple analysis of γ ray spectra taken with Ge(Li) detectors, automated emulsion scanning, and on-line and multiparameter experiments are barely mentioned.

The last chapter, "Nuclear Chemistry of the Earth and Meteorites" by O. A. Schaeffer covers only a few of the topics implied by the title. Of interest are discussions of the heat from radioactivity in the earth's crust, of age determinations with terrestrial and meteoritic samples, and of the use of meteorites as probes of cosmic ray intensities in the solar system.

In conclusion, although some of the chapters would clearly benefit by including discussions of recent developments, we believe that *Nuclear Chemistry* does contain a wealth of information and recommend it as a very useful reference book.

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Radiation Chemistry. Vol. I, Advances in Chemistry Series 81, 616 pp, $16.00; Vol. II, Advances in Chemistry Series 82, 558 pp, $16.00, American Chemical Society, Washington, D.C. (1968).

The development of high-current pulsed electron accelerators provided a powerful tool for studying radiation-induced chemical reactions. The first decade of progress in pulse radiolysis was marked by an international conference on radiation chemistry sponsored by the Argonne National Laboratory in August 1968. The conference brought together about 200 prominent radiation chemists from 21 countries, representing 81 universities and research establishments. One hundred and eleven papers were presented, 77 of which are published in these two volumes along with abstracts of the other 34 papers. Unfortunately, the discussion, which often provides the best insight on current developments, interests, and thoughts of the participants, is not included.

The papers were submitted well in advance of the meeting (around the first of the year) and the books were available at the meeting. The papers were supposedly refereed according to ACS editorial standards and most are of high quality, although some seem to be more of the nature of a preliminary report. Most of the abstracts of oral presentations are informative, but some present little more than the title. While the conference was held to celebrate Argonne National Laboratory's participation in a decade of pulse radiolysis, it covered all phases of radiation chemistry ranging from theoretical to the experimental study of macromolecules and polymers. The multitude of papers is divided in such a way that Vol. I includes those on aqueous media and molecules of biological significance, plus a few papers on dosimetry. Volume II contains papers on gases, organic liquids, and solids.

About a third of the papers deal with pulse radiolysis studies. Many laboratories are now equipped to study transients that survive more than a microsecond. The intermediate is usually detected by its absorption spectrum, although conductivity, esr, and luminescence measurements have also been used. A microsecond is a long time after the initial act of energy absorption, which requires only 10^{-15} sec or less. However, many of the important intermediates such as triplet states of aromatic molecules, ions in polar systems, and free radicals can be observed on this time scale. The hydrated electron, for example, has a lifetime in pure water at pH 7 of > 200 μsec

(determined by reaction with H_3O^+). Some machines and techniques have now been developed that allow observation on a nanosecond time scale, and the time resolution is likely to be improved in the near future. This will allow observation of intermediates such as ions in nonpolar liquids and excited singlet states, and the study of details of geminate recombination and reactions in "spurs" and particle tracks. A paper by Cooper and Thomas of the Argonne National Laboratory (where much of the pioneering work on pulse radiolysis has been done) describes the observation of CCl_4^+ with $t_{1/2}$ = 15 nsec in the pulse radiolysis of pure CCl_4. Pulse radiolysis has been applied to the study of a wide variety of systems including ice and frozen solutions, aqueous solutions of inorganic solutes, organic solutes, and macromolecules of biological significance, liquid ammonia, gases, and monomers and polymers.

One of the important discoveries in radiation chemistry in recent years was the hydrated electron. Following the measurement of its absorption spectrum by Hart and Boag in 1962, hundreds of rate constants for reactions with many types of substrates have been measured. Several studies, both theoretical and experimental, of its structure and thermodynamic properties have been made (the details of its formation and binding are still not completely understood, however). Studies of the hydrated electron have also stimulated further interest in solvated electrons and trapped electrons in other media. An ACS symposium on the Solvated Electron was held in 1965 and published as Vol. 50 of this series. Some advances since then are included in a number of papers in the present two volumes. These include a summary of the properties of the hydrated electron and a discussion of its importance in chemistry, particularly its identification with the species formerly referred to as "nascent" hydrogen, determination of its thermodynamic properties, its formation and trapping in pure ice and frozen aqueous and alcoholic solutions, and its reactivity with numerous inorganic and organic molecules. The measurement of many rate constants for reaction of e^-_{aq} have allowed attempts to correlate reactivity with structure of the substrate.

The papers on condensed organic systems display a variety of approaches used to identify the intermediates and follow their reactions. Much progress has been made recently in the study of ionic intermediates. Papers in this section deal with theory of ion formation and neutralization, with experimental study by ultrafast luminescence techniques, pulse radiolysis, scavenging techniques, the use of optical, esr, conductance and luminescence measurements to study irradiated organic glasses and polymers, and the injection of organic ions into liquids and solids. N_2O has been a useful scavenger for solvated electrons, N_2 being an ultimate product. In concentrations greater than that required for scavenging ($\sim 10^{-3}$ *M*), higher N_2 yields are observed (in cyclohexane, e.g.), and comparison with photochemistry suggests that excitation energy can also be transferred to N_2O. Other papers deal with the detection of triplet excited states (benzene, e.g.) by chemical means, the use of D substitution (hexane) to establish mechanisms of H_2 formation, the study of radical-radical reactions by irradiation at extremely high dose rate [10^{28} eV/(g sec)] now possible with field emission pulsed electron accelerators.

There are a number of papers on the use of conventional scavenging techniques to study liquid water, organic liquids, and some important gases such as H_2O, NH_3, and CO_2. Two interesting papers describe the esr study of radicals condensed from organic vapors irradiated with high energy electrons, and NH_3 irradiated with electrons at known energies in the range from 5 to a few hundred eV. Use of the microwave technique to follow electron decay in pulse irradiated gases is discussed in another paper. There are a few papers on reactions in the mass spectrometer.

The development of theory in this field has been slow. Theoretical papers in these two volumes are concerned with the structure of heavy particle tracks in water, the physical stage of radiolysis, ion neutralization in dielectric liquids, and collisional excitation transfer.

The radiobiologist should be interested in many of the papers, especially those in Vol. I dealing with molecules such as amino acids, peptides, proteins, nucleic acids, other macromolecules and polymers, and, of course, water.

A number of papers present mostly review material on selected topics such as electron stabilization in polar systems at low temperature, the reactivity of hydrated electrons toward inorganic compounds, the importance of hydrated electrons in various aspects of chemistry, electron scavenging in hydrocarbons, pulse radiolysis studies of aromatic molecules in solution, pulse radiolysis of monomers and polymers, radiation damage in inorganic solids studied by esr, radiation-chemical synthetic reactions with alkyl halides, and a critical review of measurements of radical yields in water.

While this collection of conference papers does not provide a concise overall review of the field, it does reflect the current status of the field and samples the research activity throughout the world.

These two volumes will be valuable not only to the radiation chemist but also to the reactor chemist and reactor engineer, the radiobiologist, and to the chemist generally who is concerned with mechanistics of reactions.

Edwin J. Hart, the conference chairman, and his colleagues at the Argonne National Laboratory are to be congratulated for sponsoring this interesting conference, and promoting the speedy publication of the papers.

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Fabrication of Thorium Fuel Elements. By L. R. Weissert and G. Schileo. American Nuclear Society (1968). 204 pp. $10.00.

This monograph, one of a series on *Metallurgy in Nuclear Technology* prepared under the auspices of the American Society for Metals in cooperation with the Division of Technical Information of the U.S. Atomic Energy Commission, is a well written primer on technology of fabricating reactor fuel elements containing the fertile material thorium. The subject matter of this 200-page monograph is covered in ten chapters entitled, 1) Sources of Thorium, 2) Thorium in Power Reactors, 3) Thorium Fuel Properties, 4) Radioactivity of Thorium Based Fuels, 5) Alloy Fabrication, 6) Oxide Fabrication, 7) Carbide