BOOK REVIEWS

Selection of books for review is based on the editors' opinions regarding possible reader interest and on the availability of the book to the editors. Occasional selections may include books on topics somewhat peripheral to the subject matter ordinarily considered acceptable.

Title Water Coolant Technology of Power Reactors

Author Paul Cohen

Publisher Gordon & Breach Science Publishers

Pages 439

Price Reference $27.50
Professional $13.75

Reviewer John A. Ayres

This book discusses water chemistry, principally of pressurized water reactors, although relatively brief mention is made of boiling water reactors and those operating at low temperature or low power.

The dust cover states that the purpose of the book is "to assist the Nuclear Power Plant operator by presenting the elements of the scientific and engineering disciplines supporting water technology of power reactors, and (to serve) as an interpretative summary of the specialized literature of the field."

The nine chapters composing this book treat: survey of coolant technology problems, fluid flow and heat transfer, physical chemistry of water and aqueous solutions (especially those used in pressurized water reactors), radiation chemistry, behavior of gases in reactor systems, radiochemistry and nuclear chemistry of water reactor systems, chemical shim control, pH effect on reactivity, corrosion of reactor materials, and plant contamination.

It is obvious that in one relatively short volume (429 pages), all of these subjects can not be discussed in depth. The author surveys most of these subjects adequately to give the reader a general view and furnishes numerous references for a more thorough study. He discusses in fairly complete detail certain subjects, including: corrosion of zirconium alloys, plant contamination, chemistry of dilute basic solutions, chemical shim control, pH effects on reactivity, and formation of films and particulate impurities in primary systems of pressurized water reactors.

The author is at present a consultant in coolant technology at Westinghouse Advanced Reactors Division and formerly was manager of technical groups that investigated problems related to coolant chemistry in pressurized water reactors. Much of the information in this book was developed at Westinghouse by Cohen and his associates. Anyone attempting to obtain additional information by checking the references will realize the service Cohen has done. This is especially evident in the chapter on chemical shim control and pH effect on reactivity, which is presented in an integrated, logical form and includes all the pertinent information, formerly available as scattered excerpts in reports, publications, and notebooks.

Cohen states in his Preface, "The present state of the technology includes numerous unanswered questions. Many of these must be answered by the informed interpretation of plant operating experience." Some of the problems discussed in this book are still the subject of active research. Not everyone will agree with all of Cohen's conclusions, but these represent opinions by one recognized as an international expert on the subject, and are based on the information available at the present time.

In summary, this is a necessary and welcome addition to the literature and should be on the desk of anyone working with coolant systems of water-cooled reactors.

J. A. Ayres, PhD, Iowa State University, was previously associated with Pacific Northwest Laboratory of Battelle Memorial Institute and with General Electric Company as senior research associate and manager of groups investigating problems of corrosion, coolant chemistry, and reactor decontamination. He is editor and principal author of a book, Decontamination of Nuclear Reactors and Equipment, *published by Ronald Press in 1970.*

Title Radiation Damage in Reactor Materials (Proceedings of a Symposium, Vienna, June 2-6, 1969)

Editor International Atomic Energy Agency

Publisher Unipub, Inc., 1969

Pages Vol. I - 463, Vol. II - 605

Price $13.00 and $17.00

Reviewer Robert A. Weeks

One of the ostensible reasons for scientific symposia is the presentation of papers on the current status

of a given area of research. It is also evident that such papers could be published in the usual manner without an oral presentation to those in attendance. Another, and to my mind, a more compelling reason for symposia is the opportunity to exchange views and ideas in a personal interaction with others who are interested in one's research. It is this personal interaction, recognized by most attendees at symposia when they say they learn more in the hallways than they do in the lecture rooms, which give symposia their importance. It is this important characteristic that is missing from published proceedings. In some cases, editors attempt to pass on to the reader of the published proceedings some of this personal interaction content by including a portion of the exchanges between a speaker and his audience following the presentation of a paper. Although the words used by speaker and audience may be correctly transcribed, all of the nuances that are carried by tone, inflection, and all the other subtle forms of personal interaction are missing, and hence, much of the meaning of such exchanges is lost to the reader. If there is a value to published proceedings, it lies in the collection of a large number of papers concerning the current status of research on a particular subject. In many cases they have only a transitory value because of their current status aspect, but in other cases in which review papers of significant content are included they may have more than transient value.

The proceedings of the symposium on *Radiation Damage in Reactor Materials* sponsored by the International Atomic Energy Agency in Vienna, June 2-6, 1969 has just this value. The two volumes contain over 50 papers presented in nine sections: four sections in Vol. I titled "Fundamental Processes," "Techniques and Applications," "Radiation Hardening," and "Fracture and Creep;" four sections in Vol. II titled "Damage Models and Spectral Effects," "Voids," "Rare Gases in Solids," and "Fuels and Graphite;" and the concluding session in Vol. II is a panel discussion between the participants. The two sections, "Voids" and "Rare Gases in Solids," are concerned with another of those problems unique to nuclear reactor design and currently of widespread interest. The volume expansion which has been observed after fast neutron fluences $>10^{19}$/cm^2 in aluminum, stainless steels, and other metals used in reactor structures is attributed to the formation of voids in the metals. The maximum integrated fast-neutron fluences which are given in the experimental papers are approximately one-fifth of that to which core components will be exposed in fast breeder reactors of economic value. Hence, it is still necessary for designers to make extrapolations on the basis of theoretical models, none of which adequately and accurately describes current data. These papers give a useful and interesting survey of some of the current experimental and theoretical research on the relation between void formation and dimensional changes in structural metals.

The value of these volumes to specialists and the general reader is enhanced by several excellent review papers. One of these by J. T. E. Nihoul, "Radiation Damage and Recovery in Metals," begins Vol. I with a critical evaluation of the "interstitial" and "conversion-2-interstitials" models for the recovery of radiation damage. These models and their consequences are compared with the data available on recovery in face-centered cubic, hexagonal close-packed, and body-centered cubic metals. The comparison leads Nihoul to an expected conclusion that more research is needed before either model can be eliminated or appropriately modified. The transition from fundamental investigations in pure materials to investigations of actual reactor materials is considered in the paper by J. Diehl and G. P. Seidel, "Effect of Alloying and Cold Work on the Neutron Irradiation Hardening of Metals." The effects of pre-deformation, substitutional alloying, and single crystal to polycrystal transitions upon radiation hardening in copper are considered in detail as a typical example of the f.c.c. metals. The effects of interstitial impurities upon radiation hardening in single crystal and polycrystalline iron are presented as typical examples of the b.c.c. metals. M. Rühle reviews the application of transmission electron microscopy to the investigation of small defect clusters in irradiated materials. This discussion illustrates very clearly the inferential basis upon which much of the interpretation of those shadowy patterns which one obtains from electron microscopy is based.

This diverse group of papers covering experimental and theoretical investigations of fundamental processes, the relation between fundamental and applied investigations, and investigations which produced data of immediate value in present reactor designs are of interest to many different specialists. However, the significance of this symposium was characterized by R. Smith in the Panel Discussion, "...Most will agree that nuclear materials technology has two important features which distinguish it from other materials technology. The first, of course, is that the materials which can be used are limited by reason of their nuclear properties—because of the nuclear physics requirements. The second is that we must contend with radiation damage from fission fragments, neutrons, gamma radiation, fast electrons, etc. Thus, the study of radiation damage is clearly vital to nuclear technology as it can place severe restrictions on the feasibility of reactor designs. We must remember that over the next ten to fifteen years many power reactors are due to be installed in many countries and that these will generate hundreds of thousands of megawatts of electricity. This means, of course, that many tons of material amounting in value of many millions of dollars will undergo severe radiation damage..." It should be added that the security of people and their environment must be ensured by reactor designs that are essentially fail-safe over their lifetime. Hence, the import of these two volumes must be well understood by those involved in this rapidly evolving area of nuclear power reactors. New knowledge of materials and their behavior under the influence of intense reactor radiation is a necessity if the introduction of nuclear power into the world's societies is to be accomplished. These proceedings furnish a small fraction of that knowledge necessary for rational engineering decisions and the subsequent public policy decisions which may not be as rational.

Robert A. Weeks earned a BS degree from Birmingham-Southern

College, a MS degree from the University of Tennessee, and a PhD from Brown University. He joined the staff at ORNL in 1951 and is now a senior research physicist and group leader in the Solid State Division of the Laboratory. His research interests have been in the areas of dielectric, optical, and magnetic properties of solids, and the alteration of these properties by radiation. He has authored many papers on these topics and has contributed to several national and international symposia. In 1968 he was appointed Distinquished Visiting Professor at The American University in Cairo, Cairo, Egypt, UAR. At the present time he is a principal investigator in the Lunar Material Analysis Program sponsored by the National Aeronautics and Space Administration. Currently he is an associate editor of the Journal of Geophysical Research *and a member of the Editorial Committee of the* Journal of the American Ceramic Society. *He is in a year's leave of absence from Oak Ridge National Laboratory.*

Title Molecular Quantum Mechanics

Author P. W. Atkins

Publisher Oxford University Press

Pages 471

Price $17.75

Reviewer F. A. Matsen

Molecular Quantum Mechanics is written for advanced undergraduate students in chemistry. Dr. Atkins tries very hard and on the whole succeeds in making quantum mechanics reasonable. To this end he introduces many skillfully drawn illustrations. It compares very favorably with other books in the field and should be quite widely adopted.

The following remarks will exhibit a personal prejudice. I feel that the book is not tough enough philosophically; it tends to stress the reasonableness and pictorial aspects of quantum chemistry. This approach, it is true, delights the student. But the student may in his later years pay for his delight by the difficulty he may encounter in accepting any idea that is not reasonable or pictorial. The author's desire to be reasonable occasionally leads him into making statements that can be misleading to the student. As an example, the footnote on p. 242 concerning the Thomas Precession, and his remark on p. 257 that parallel spins tend to avoid each other.

F. A. Matsen received his PhD from Princeton University in 1940. He became a member of the faculty of the University of Texas at Austin in 1940, becoming a full professor in 1951. That year he also became a Guggenheim Fellow at the University of London and Oxford. In 1961 he was an NSF senior postdoctoral fellow at the Institut de Henri Poincaire, Paris. In 1954 he established and staffed the first computation center at the University of Texas. Since then he has served on the computation center committee and has played an important role in computer selection and financing by the National Science Foundation.

Title Thermal Neutron Diffraction

Editor B. T. M. Willis

Publisher Oxford University Press 1970

Pages xiii + 229

Price $10.40

Reviewer Hugh F. Henry

Since this volume presents papers given at an international summer school on neutron diffraction, its primary audience will be the practitioner in the field who is looking for an up-to-date summary of current activities; for him, it is most valuable as it covers remarkably well the current developments in the field. On the other hand, the beginner or a specialist in another field will probably not find this as helpful as he might wish. Although the respective articles in the book are obviously the work of several authors, its style and notation are remarkably consistent, thus indicating a very competent editing effort, and the book is as readable as might be expected. There appeared to be no obvious bias in the topics covered or in the presentation of any particular viewpoint or model. Overall, the book is heavily theoretical in treatment.

The three basic divisions of the book are identified as Experimental, Nuclear Scattering, and Magnetic Scattering. The first of these, Experimental, appears to be the weakest in the entire volume, since it is here that the non-specialist might reasonably expect to become acquainted with experimental techniques, equipment, and perhaps results. Unfortunately, this is not the case, even though someone did consider it necessary to define the units of the "barn" and the "fermi." Thus, it is particularly in this section that an individual must be knowledgeable in the field to appreciate its coverage which appears to be much more heavily theoretical than experimental. It also seems that considerably more attention is given to such perturbing effects as thermal diffuse scattering than is given to the basic phenomena which they tend to mask or even the precision with which actual results are obtainable. Perhaps this merely reflects the interests and current problems of the authors themselves as they warn other experimenters of difficulties to be expected.

Perhaps more valuable to the non-specialist are the sections on nuclear and magnetic scattering wherein there are indications of the types of problems amenable to investigation by neutron diffraction, comparisons of the respective results obtainable by neutron and x-ray diffraction, and hints of the specific results obtained in certain cases. The implications of the experimental results obtainable were indicated in many instances, such as in determining covalency parameters, structures of certain magnetic materials, charge density distribution in molecules, and the accurate location of hydrogen atoms in solid-state studies. However, such clear-cut treatment was not universally available and it was frequently difficult to distinguish between factors and quantities that had been observed experimentally, those that had been theoretically determined, and some that might wishfully be observed. For the audience to which this book is particularly directed, prior knowledge will provide the necessary evaluative distinctions.