BOOK REVIEWS

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

Thermal Analysis of Pressurized Water Reactors

Authors	L. S. Tong and J. Weisman
Publisher	American Nuclear Society, La Grange Park, Illinois (1979)
Pages	417
Price	$39.50
Reviewer	K. Almenas

Books that summarize the state of knowledge of a given technological field are not written easily. Usually the enduring ones are not written in one try, they evolve through a number of sequential editions. With their second edition of *Thermal Analysis of Pressurized Water Reactors*, L. S. Tong and J. Weisman have taken a big step toward producing such a lasting reference text.

A relevant question is thus in what direction has the book evolved since its first edition in 1970. It has increased in volume by 100 pages (~30%) and in general the additional material has been well chosen.

The first chapter (Power Generation) has remained relatively intact. It is a summary overview rather than an in-depth analysis, but then many excellent and extensive treatises of the subject are available. The real subject material starts with Chap. 2 (Fuel Elements). This has been expanded considerably by including an extensive treatment of UO_2 behavior under irradiation. The chapter is now sufficiently complete that it should be able to serve as a major reference on the subject. Like the other chapters (this is a general characteristic of the book) it is very extensively referenced—over 160 items. The next two chapters—Hydrodynamics and Heat Transport—form the core of the book. They have been amplified rather than rewritten. Newly included are subsections on post-critical heat flux heat transfer and operational problems in steam generators. The last chapter (Chap. 5) is somewhat of a catchall. It has been augmented by the description of several relevant thermal-hydraulic codes and has brief mentions of some subjects that have gained prominence in the past ten years such as anticipated transients without scram and the Rasmussen study.

As the very brief overview suggests, the book has essentially remained what it was originally, that is, a reference book for practicing engineers engaged in the nuclear power field. Its purpose is to present an organized overview of the relevant theoretical and empirical data available and to list the analysis methods and pertinent past experience. It catalogs rather than explains. Within this framework it is not easy to fault. Certainly, if he so desired, a specialist in any of the broad fields covered could find some gaps or maybe misplaced emphasis. But they are of a secondary nature. Tong and Weisman have a commanding overview of their subject. The extent of their knowledge is demonstrated by the profuse documentation of even some secondary areas. Thus, for example, the question of a proper thermal-hydraulic diameter in rod clusters is backed up by data from 12 references and flow-induced vibration of fuel rods by 10. Considering that the book is limited to pressurized water reactors (PWRs), a fair amount of attention is paid to boiling. This includes also aspects of two-phase flow and other phenomena that could take place under abnormal reactor operation conditions, although in this respect the authors have remained (and properly so) quite selective. Abnormal operating regimes are outlined rather than exhaustively presented. This is, after all, a subject in its own right and in this respect there is no basis to separate PWR and boiling water reactor behavior. The book focuses on PWR design and operation and, judged in this respect, it is exhaustive, complete, and indispensible.

And yet, reservations remain. It is probably unfair to fault the authors for writing one type of book rather than another, but a review is also a wish list. In this case the wish is that the book had evolved more in the direction of a synthesis—that it would not only catalog but also explain. The assembled knowledge is indispensible for the person with the experience and judgment to use it, but there is little effort made to point the way for those who lack the experience. With the passage of time a technology not only expands, it also consolidates. That is, time, practice, and a more comprehensive understanding show which aspects are more important than others, which references incorporate the cornerstone ideas. There is a winnowing out of details and a hierarchical ordering of those that remain. There is little evidence of evolution in this direction in the second edition. True, a summary section has been added to each chapter, but it is really too brief to alter the predominantly reference nature of the book. Maybe a synthesis is still premature for PWR thermal hydraulics. Then all that remains is to wait for the third edition of "Tong and Weisman."

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Physics of Modern Materials (Vols. I and II)
Lectures presented at an international course,
Trieste, Italy, March 29–June 24, 1978

Publisher	Unipub, New York (1980)
Pages	530 (Vol. I), 690 (Vol. II)
Prices	$58.75 (Vol. I), $78.50 (Vol. II)
Reviewer	J. C. Corelli

Physics of Modern Materials is a two volume series on lectures presented at an international course in Trieste, Italy, March 24-29, 1978. The two volumes are based on lectures of two dozen authors from a dozen different nations.

Volume I

The paper by Eades contains a valuable introduction to the study of diffraction in solids by x rays, neutrons, and electrons followed by an easily readable discussion of electron beam microscopy and its usefulness in yielding insights on the nature of defects generally in solids. The paper also contains a useful bibliography on a contemporary group of specially selected review papers on characterization of materials by electron microscopy (transmission electron microscopy, scanning electron microscopy, etc.).

A review of basic theory and experimental methods of crystal growth and doping including growth by pulling from liquid solutions, zone melting growth from vapor phase, epitaxial growth, and chemical methods from liquid phase is presented in an easily understandable fashion with ample illustrations making it easy for the reader to follow the arguments made by the author, C. Paorici, on the theory of ingrown defects in crystals (dislocations, diffusion, etc.). The paper contains a very good overview of descriptions of experimental methods used in crystal growth and crystal refining of electronic materials and semiconductors (CdTe, silicon, CdS). The addition of materials fabrication for nuclear reactor applications, e.g., Zircaloy and oxide fuel elements, would have greatly enhanced the usefulness of the paper by Paorici for persons interested in nuclear materials. However, the inclusion of nuclear metallurgy may have been outside the scope of the conference, and thus was omitted. Overall the paper is extremely helpful in bringing the uninitiated researcher in the field of crystal growth up to speed easily.

The paper by J. Friedel is a well-written description of extended defects of one and two dimensions. Dislocations and grain boundaries and magnetic walls are treated and their geometry and electronic structure and mobility are analyzed. An adequate bibliography is given for the reader wanting more specific details. Beginning with a review of simple defects, Friedel proceeds in an orderly and clear manner to direct the reader to the treatment of more complex defects of amorphous structures, stacking faults, and grain boundaries. After an easy to follow discussion of bonding in crystals, Friedel treats the various types of disorder in different crystal types including liquid and amorphous phases, then proceeds to the next level of complexity, which includes such planar defects as magnetic walls and direction of magnetization in ferromagnetic solids, grain boundaries, dislocation lines, and stacking faults. The method to calculate energy of a grain boundary as "a wall" (in stacking faults) is treated using electronic structure properties of valence electrons for metals, transitional metals and solids having covalent and ionic bonding. The methods for calculating strain energies due to various dislocations in both isotropic and anisotropic elastic solids and single crystals is clearly described and easy to follow with adequate illustrations.

Friedel treats stress-strain curves for various metal crystal structures and their relationship to plastic properties (creep, hardening, slip). Dislocations and covalent bond structures of diamond-type lattices (germanium, silicon) are treated briefly, and the paper concludes with a brief discussion of the interaction of line and wall "defects" and the plastic properties of amorphous phases of materials at low temperature.

The chapter on "Radiation Damage in Metallic Reactor Materials" by H. Ullmaier and W. Schilling contains an informative and relatively complete introduction and description of the terms, concepts, and theory of atomic displacement effects in metals including a discussion of helium and hydrogen gas production by neutron transmutation reactions. The chapter is written in a succinct manner. These authors give an interesting discussion of dynamic properties of interstitials and vacancies and their interaction with impurities complete with understandable models and illustrations. Calculations on the elastic interaction of defects and kinetics of annealing are outlined and then conveniently followed up by experimental evidence on the influence of radiation-induced defects on structure sensitive properties such as swelling, voids and dimensional changes, microstructure, and creep. The inclusion of examples of radiation-enhanced diffusion, fatigue and embrittlement of Type 316 stainless steel and molybdenum-base alloy (TZM) is useful in providing the nonspecialist a quick survey of the field albeit taken from papers published prior to June 1978. The chapter concludes with a brief and concise statement on the requirements on materials to be used in light water, breeder, and fusion reactors of the future.

The chapter by D. McLean entitled "Fracture Mechanics—The Physics of How Things Break" treats classical linear fracture mechanics starting with Griffith's criteria for crack growth and fracture. A detailed discussion and numerous examples are given in the method and tests for obtaining experimental data on fracture for comparison to calculation specifically for various ductile steels. The test methods for fracture mechanics include, for example, *R* curves (that is, resistance to extension by a crack grows as the extension grows), crack-opening displacement (that is,