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.

Neutron Radiography, Proceedings of the First World Conference, San Diego, California, December 7-10, 1981

Editors	John P. Barton and Peter von der Hardt
Publisher	D. Reidel Publishing Company, Hingham, Massachusetts (1983)
Pages	1073
Price	$136.00
Reviewer	Raymond L. Murray

It has been suggested that the applications of radiation and radioisotopes might someday be more important economically than nuclear power. This book tends to support that thesis, at least in the case of neutron radiography, which appears to be well and prospering. It is being applied in many interesting and beneficial ways, ranging from the study of seed germination and root growth in the soil to the observation of a running gas turbine engine at Rolls-Royce, with a great deal of bread-and-butter work in nuclear fuel inspection. Although the principle has been known for several decades, the application has grown rapidly in only the last few years.

A good conference proceedings starts with an elementary review of the subject, including historical background. This allows the reader to determine the degree of his interest in the topic, to gain a smattering of knowledge, or to learn enough to be able to read the papers profitably. This book admirably meets those criteria by providing several introductory papers by authorities in the field, including the two editors of the volume.

We learn from the book that neutron radiography is related to ordinary photon radiography as neutron diffraction is to x-ray diffraction. It is the wave property of particles that is exploited to reveal new and different aspects of the interior of the medium through which the neutrons pass. The scattering of neutrons in hydrogenous materials or absorption in certain isotopes gives a different view than the interaction of photons with heavy elements. As discussed in the book, the principal neutron sources are nuclear reactors, accelerators of deuterons, and radioisotopes, such as ^{124}Sb, ^{241}Am, ^{242}Cm, and especially ^{252}Cf. Neutrons of several energies may be used—"cold," thermal, epithermal or resonance, and fast—each having special virtues in applications. The image detectors incorporate strong neutron absorbers, such as (a) boron, which yields alpha particles that activate phosphors, or (b) gadolinium, which releases gamma rays that produce electrons by internal conversion. An alternative is the track-etch method, using alpha particles or fission fragments to cause damage in nitrocellulose films. This technique has the advantage of being insensitive to gamma rays (as from irradiated nuclear fuel) and ordinary light.

The proceedings consist of a total of 140 papers from 80 centers in 20 countries. The papers are generally brief and are grouped into 13 parts. Among these are: experiences at laboratories around the world; fuel inspection studies, biological applications; and real-time studies. A workshop was held at the end of the conference, with sessions discussing standards for the general industry and the nuclear industry.

Neutron radiography is routinely applied to the inspection of both new fuel and spent fuel. It can detect defects in fresh fuel, such as variations in size or enrichment, and can provide details in irradiated fuel on internal cracking or melting and on hydriding or failure of cladding. It is widely used in industry in conjunction with ordinary x rays to provide complementary views of an opaque object. Displayed in the proceedings are a number of contrasting photographs made by the two methods. One dramatic example is an explosive bolt used in the Apollo space program. The bolt contains plastic, glass, metal, and explosive compounds, each of which reacts differently to x rays and neutrons. Neutrons are also beginning to be used for computerized axial tomography ("CAT scans") for inanimate objects, such as nuclear fuel. It appears that the fast neutron dose is too high for the radiography of living human beings.

The proceedings appear to be a valuable contribution to the literature in several ways—(a) as a record of a historical event, the first international conference on the subject, (b) as a compendium of information on uses, techniques, and problems, (c) as a source of useful theoretical methods, both analytic and Monte Carlo, and (d) as a bibliographic source, with special value in providing names of organizations and people throughout the world that are working in the field.

Many different type styles and formats are represented in the book, since it was prepared by photographing the authors' contributed papers. Although not as attractive as some proceedings, these contain the important information, and thus the heterogeneity is acceptable. However, use of the book would have been enhanced by including a subject index, admittedly an additional onerous chore for the editors.

Some of the interesting applications one finds by scanning the volume are:

1. study of hydrogen absorption by palladium
2. determination of aluminum corrosion in aircraft structures
3. nondestructive testing of complex laminated composites for flaws in the adhesives being used
4. control of the assembly of test reactor components
5. preparation of the burnup profiles of reactor control rods and blades
6. study of two-phase flow
7. investigation of bone tissue in animals.

The scope and variety of the applications reported in the proceedings suggest that there are many other applications waiting to be made by imaginative and enterprising researchers. In contrast with the situation in basic neutron and nuclear physics, which requires a high-flux reactor, it appears that an intermediate power research/training reactor in the 5- to 250-kW range is adequate to do many valuable studies in neutron radiography.

The cost of the book is prohibitive for many individual readers, and even a university departmental library would think twice before buying it. Science historians tell us that Gutenberg invented the printing press to eliminate the high cost of books that were copied by hand, sometimes as much as a half-year's income to a professional to acquire a large reference book. The modern era needs a similar breakthrough. Perhaps the computer will soon serve that function by providing convenient and inexpensive access to needed information.

Dr. Raymond L. Murray received his first degree in science education at the University of Nebraska, where he also took a master's degree in physics. His doctorate was from the University of Tennessee. During World War II, he contributed to uranium isotope separation research and production at Berkeley and Oak Ridge. He has been a faculty member at North Carolina State University since 1950, assisting in the establishment of the first nuclear engineering curriculum and the first university nuclear reactor. He served as Burlington Professor of Physics, as head of the nuclear engineering department for 11 years, and currently is Professor Emeritus. He has published a number of research papers on reactor theory and design analysis, has written textbooks in nuclear engineering and basic physics, and serves as a consultant to industry on reactor design and nuclear safety. He has been a member and chairman of the North Carolina Radiation Protection Commission. His current studies involve nuclear reactor analysis related to the Three Mile Island-2 recovery and to uranium resource extension, the application of microcomputers to nuclear problems, and public information on nuclear energy, especially radioactive waste management.

Irradiation Technology

Editors Peter von der Hardt and Heinz Röttger

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Reviewer K. Linga Murty

This book is a collection of papers presented at the International Topical Meeting at Grenoble, France, September 28-30, 1982, with the main theme of in-pile testing. These conference proceedings concentrated on thermal reactor experiments, while the earlier American Nuclear Society conference held in Salt Lake City, Utah, in April 1982, emphasized fast and fusion reactor experiments. The papers contained information on various aspects of nuclear reactor instrumentation, facilities available throughout the world for radiation experiments, as well as some typical in-pile test results on fuel, structural, and other materials. Since the main thrust of the proceedings is on irradiation testing—facilities, techniques, etc.—very few results are presented. Thus, some of the articles were quite general with descriptions of the available facilities, while others contained relatively more in-depth technical information. The book is divided into seven major sections: Light Water Reactors (Sessions I through IV), LWR Instrumentation (Session V), Fast Breeder Reactors (Session VI), Instrumentation (Session VII), Gas Cooled and Fast Breeder Reactors (Session VIII), Miscellaneous (Session IX), followed by papers presented in a poster session—a total of 110 papers. The majority of articles was from European countries and Japan; there are two papers from Canada and only one from the United States. A range of reactor-related topics including thermal-hydraulics, neutronics, and materials aspects were included in the proceedings, and thus this is an excellent book for people looking for facilities for irradiation testing. The book was excellently produced and often contains some detailed drawings of instrumentation as well. The disheartening aspect of the book is that there are many papers in German and French, albeit the majority of them are in English. It would have been better if at least the summaries or abstracts were printed in all three languages. Researchers in the nuclear reactor field will find the book very informative and useful. Some of the technical details are interesting and informative. I enjoyed reading, in particular, the varied experiences of nuclear reactor fuel following in-pile testing and the different techniques and approaches of various organizations. Distinctly absent in the papers are studies on nuclear pressure vessel steels, perhaps since data on these are available through reactor surveillance capsule programs.

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