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.

Advances in Metal Processing

Editors	J. J. Burke, R. Mehrabian, and V. Weiss
Publisher	Plenum Publishing Corporation (1981)
Pages	388
Price	$45.00
Reviewer	Massoud T. Simnad

The 25th Sagamore Army Materials Research Conference, held in 1978, was devoted to advances in metal processing. The proceedings of this conference are still timely, although significant advances have been made in many of the areas that were reviewed at the conference. Experts from academia, industry, and the national laboratories contributed in-depth discussions of advances in metal processing. The six sections in this book cover the following topics: rapid solidification processing, powder processing and consolidating, welding, thermal and mechanical processing, metal removal, and process modeling.

An excellent perspective of materials processing is included in the introductory section by Flemings and Mehrabian. They point out that the future of materials will depend in large measure on our response to the classical laws of supply and demand, to such national problems as energy, environment, regulation, productivity, and to such international problems as the rapidly changing third world nations. Materials processing is defined as the development and the synthesis of concepts of materials science and engineering. Materials, energy, and the environment interact strongly at virtually every point in the materials cycle. The energy that goes into value added to materials by production and fabrication is about one-third of the energy consumed by industry in the United States, and, in turn, materials are crucial to making energy available.

The first session of the conference was devoted to the topic of rapid solidification processing. The three papers in this session reviewed the following subjects: heat flow limitations in rapid solidification, laser processing of materials, and electrodynamic techniques in metals. The rapid solidification process (RSP) is addressed in terms of some general relationships between cooling rates, during crystalline and noncrystalline solidification, and process variables in different RSP techniques. Calculations are presented to show the heat flow characteristics and limitations in the general areas of RSP, namely, atomization and solidification against substrates with and without significant resistance to heat flow at the liquid/substrate interface. The specific heat flow limitations on the maximum achievable cooling rates in different RSP techniques are defined.

The laser processing of materials is reviewed with an overview of developments in this field since the mid-1960s. These include transformation hardening and surface alloying, welding, cutting, drilling, RSP, pulse annealing, shock hardening, laser-assisted machining, and laser-controlled surface reactions. The laser systems are now commercially important materials processing tools, which are in use in production environments. In the electrohydrodynamic technique, a tabletop rapid quenching process was developed to generate a wide range of metals and alloys at extremely rapid cooling rates. It is a continuous process that can include radiation, convection, and splat cooling techniques as well as the production of extremely fine atomized droplets (down to submicron sizes). Uniform coatings have been deposited on various substrates.

The second session included a review paper on fundamentals of particulate metallurgy, including the science and technology of powder production and consolidation. The effects of rapid cooling rates in powder processing were also examined.

Welding and joining with high-power lasers was reviewed in a paper that described this relatively new technique, which is finding wide acceptance as a versatile, cost-effective method for industrial welding. Lasers have the unique ability to deliver accurately a precisely controlled amount of energy to a highly localized region of a workpiece.

The section on thermal and mechanical processing includes excellent critical reviews of superplasticity and of advances in heat treatment of steels. Superplasticity is defined as the ability of certain metallic materials to extend plastically to very large strains when deformed in tension in specific temperature and strain rate regions. These characteristics are ideal for the fabrication of a material into a complex but sound body with a minimum expenditure of energy.

The advances in metal removal by grinding processes and by machining are surveyed in three papers. The development of new grinding materials (e.g., alumina-zirconia) and the models developed for materials removal processes are well covered.

The final section is on process modeling. It addresses the modeling of macrosegregation in electroslag remelted ingots, the analysis of magnetohydrodynamics and plasma dynamics in metals processing operations, and the computer simulation of solidification.

Massoud T. Simnad received his BS from the Imperial College of Science and Technology, London University, and his PhD from Cambridge University. He was a research associate at Cambridge University from 1946 to 1949, a senior research and faculty member at Carnegie-Mellon University from 1950 to 1956, a visiting professor at the Massachusetts Institute of Technology in 1962/1963, and held senior positions at GA Technologies Inc. from 1956 to 1981. Since 1982 he has been a consultant and an adjunct professor of materials science and technology and nuclear energy at the University of California in San Diego. Dr. Simnad is the author of a monograph and the author or coauthor of over 90 papers and 14 patents on nuclear fuels and materials.

Advances in Nuclear Science and Technology—Vol. 14, Sensitivity and Uncertainty Analysis of Reactor Performance Parameters

Editors	Jeffery Lewins and Martin Becker
Publisher	Plenum Publishing Corporation (1982)
Pages	372
Price	$49.50
Reviewer	Raymond L. Murray

This book is refreshing for its frankness in pointing out deficiencies in our methods of using basic data to calculate reactors. It notes, for example, that by depending on computers we have tended to lose the ability to interpret the physical meaning of trends. Experimenters are chided for failing to document their uncertainties adequately. The parameter evaluator is also urged not to introduce improper bias. The book is appealing because of the occasional philosophical commentary. The authors suggest, for example, that the urge to improve methods causes a bewildering proliferation that competes with the desire for standardization.

On a technical basis, the authors provide an orderly and logically structured discussion of several important connected aspects of uncertainties in the process of reactor design. The principal chapter topics reflect the sequence: nuclear data calculation methods, integral experiments, sensitivity functions, and the combination of all information. These chapters were obviously well planned and are well executed. The authors use as simple a language as is appropriate to a reader who has a good background in reactor physics but wants to understand sensitivity methods. For example, the treatment of two independent measurements with their separate uncertainties precedes the analysis of a general matrix representation of many data. Nume ical illustrations are used liberally to give substance to the theoretical and calculational methods described. However, to fully appreciate the book, the reader should be familiar with matrix algebra, basic statistical analysis, and neutron transport theory.

In the beginning chapter on uncertainty, the important concept of covariance is explained clearly. In contrast to the variance as an expected value of the error in a quantity, the covariance is the expected value in the product of errors in two quantities. It is straightforward to generalize to an array of quantities, in which a covariant matrix represents the interactive effect of errors. This chapter reviews least-squares methods, pointing out both virtues and pitfalls. The matrix theory is displayed for initial evaluations of data and incremental improvements. The problems that exist in the resonance region are stressed, and the status of the covariance uncertainty files for ENDF/B-V is discussed.

The chapter on sensitivity functions describes the perturbation theory that uses ordinary fluxes and adjoint fluxes from the Boltzmann equation. Application is made to performance parameters of various types, including reactivity, reactivity worth ratios, cross sections for capture, fission, and scattering, neutron production data, neutron group representations, and breeding ratios.

The large chapter on calculation of reactor design and performance parameters covers cross sections, with special attention to resonances and Doppler effect, group constant formation, diffusion theory, transport theory, burnup programs, and mesh effects. Emphasis is placed on uncertainties, of course.

The chapter on integral experiments is restricted to data on fast reactors. It gives a survey of facilities and measurement techniques for critical experiments and describes the methods of interpreting critical masses and reaction rates, ending with an expression of need for new data. This plea is now particularly apt because operating critical facilities are unfortunately being abandoned.

One important chapter explains how differential and integral data are combined using least-squares methods and covariances. The description of the basic process is followed by the treatment of uncertainties. Special attention is given to the "k-reset" concept, in which results for a case with multiplication factor not equal to unity are treated.

The book ends with a challenging chapter entitled "New Developments in Sensitivity Theory," in which a generalized theory is presented, applicable to the transient neutronics, thermal-hydraulics, and fuel performance aspects of the reactor. The science and engineering of nuclear reactors would clearly be advanced if the suggested ambitious treatment could be fully implemented.

The book differs from many in this familiar series. Rather than providing a smattering of isolated new developments, it concentrates on one subject, seeking to provide a unified review. Its format, using typewritten pages, is easy to read. There are relatively few typographical errors. Each chapter contains a large but not excessive number of references, going back as far as Bayes (1763), up through Gauss (1821), and Laplace (1886), but leaping into the 1970s for the relevant material on what is obviously a new subject. Casual inspection indicates that the right references are present. Although written by experts, the book seeks to meet tutorial needs.

To this reviewer, one disappointing aspect of the book is its preoccupation with fast reactors. The reader continues to ask the question: "Does this all apply to thermal reactors?" This defect might have been resolved by inclusion of a special chapter that discussed differences between the approaches for fast and thermal reactors. Also, the reader may find it difficult to ascertain the degree of conformity of actual and expected values of multiplication of systems designed using sensitivity methodology. In spite of these