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Book Reviews

Plutonium 1960, EMMANUEL GRISON, WILLIAM B. H. LORD, AND ROBERT D. FOWLER, eds. Cleaver-Hume, London, 1961, Interscience, New York, 1961. 804 pp. $29.50.

This book records the proceedings of the Second International Conference on Plutonium Metallurgy held at Grenoble, France, April 19–22, 1960, and organized by the Societe Francaise de Metallurgie and the Commissariat a l'Energie Atomique. It contains 42 papers written by workers in laboratories concerned with the study of plutonium, its alloys and compounds, and in the development of plutonium containing materials for nuclear reactors. Thus, the book may be taken as a reasonable representation of the knowledge concerning these materials thought to be most important by persons intimately involved in this field of work. In addition, there are summaries of groups of papers along with discussion and commentary on the knowledge presented. Each contribution is in the language of its originator, French or English. Summaries in each language precede each contributed paper.

For the Conference, the papers were grouped into sessions. The sessions themselves consisted of the brief survey, already mentioned, of all the papers in each of the scheduled sections by a rapporteur, an expert in the field in question. Following this summary, authors and other contributors participated in discussions of the topic of the section. The best way to indicate the contents of the book is to list the titles of the thirteen sections:

1. Allotropic Transformations
2. Physical Properties
3. Alloying Theory
4. Preparation of the Metal
5. Measurement Techniques
6. Binary Alloys
7. Ternary Alloys of Uranium-Plutonium-Molybdenum
8. Physical Properties of the Oxide
9. Plutonium-uranium Mixed Oxides
10. Mechanical Properties of Plutonium
11. Plutonium Fuels for Fast Reactors
12. Properties of Plutonium-based Fuels
13. Aluminum-plutonium Fuels

In the book, the papers for each section are followed by the survey and the discussions.

The papers, the surveys by the rapporteurs, and the subsequent discussion all are addressed to experts in the field. The book, therefore, is little more than so many papers in the literature, but with the great convenience that the information is collected in one place. This type of book is becoming more common, and apparently serves as an intermediary between knowledge in periodicals and the organization of this knowledge into a coherent form expected in the usual book. From the first two sections, one learns something about the properties and behavior of plutonium. Of considerable concern is the knowledge of and the effect of impurities. Sections 3, 6, and 7 continue with a rather spotty treatment of relation between composition, constitution, and the behavior of metallic plutonium base systems of two or more components. Inserted in this sequence are sections 4 and 5 which give some of the latest procedures for preparing and handling the metal and its alloys. Sections 8 and 9, respectively, give some recent information on the physical and chemical properties of plutonium oxide and the preparation or production, along with some items of behavior, of bodies of mixed oxides of plutonium and uranium. Section 10 tells one about the mechanical forming of plutonium metal with some information on the relation between mechanical behavior and the forming processes. Sections 11 and 12 appraise plutonium containing fuel systems for fast reactors and describe some of the work done to ascertain behavior of plutonium-rich alloy systems in a reactor. Included in this collection are discussions of the reactions between fuel alloys and their jackets and the viscosity of molten plutonium iron alloys. The final section concerns an evaluation of dispersion fuels or fuel systems based on plutonium-uranium compound in an aluminum matrix.

It is extremely difficult to review such a book. It is clearly of great value to workers in the field. The data, the techniques, the knowledge of what systems have been studied, and the information available on them are all indispensable to a person doing or intending to work with plutonium containing materials. The reactor designer can find much information of value in the book but he would not be led directly to it; he would have to search through the papers for the information he might happen to need. The summaries are, as mentioned already, addressed to experts in the field and, moreover, were written for persons who presumably had read all the papers in question. Thus, one finds more questions raised than settled. The papers and the subsequent discussion do settle some questions of observation, technique, and measurement. Very few questions of principles, understanding, or basic quantitative description are resolved, however.

The editing and production of the book are good. There are copious illustrations. By and large, the micrographs are clear and most of them are informative. A reasonably large number of photographs gives one a rather clear idea as to the kind of equipment and apparatus used. There are erros; a few of them are as follows: page 27, the word "data" is used with a singular verb. On page 115, a symbol is mislabeled. Pages 159–60, there is a slight discrepancy in the comments on five elements affecting the retention of the delta phase. Page 315, an "o" is capitalized wrongly in the symbol for Cobalt. Page 316, the chemical symbol "Cl" is substituted for "Cu." Page 493, one wonders what is meant by the chemical symbol "$PuUO_2$." One exception to the statement about the clarity of the micrographs

occurs on pages 516 and 517. Here the factors pertinent to the question of cracking are not displayed well. One wonders about the role of grain size in this phenomenon.

Altogether the book represents the state of the work and knowledge on material systems based on and containing plutonium. One might have hoped for a better organization of our understandings of the relations between composition, structure, and behavior. More association of the subject of alloys, that is to say, the composition variable, with the question of impurities, which is only one end of the composition range, would have been useful. At least, plutonium as a substance is moving from the state of being a mysterious or sacred entity into the status of providing an objectively evaluated class of materials.

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Methods of Mathematical Physics, Volume II, Partial Differential Equations. By R. COURANT and D. HILBERT. Interscience Division of John Wiley and Sons, Inc., New York, 1962. 850 pp., $17.50.

Richard Courant's work and stature are widely and firmly planted in contemporary mathematical physics. We may expect that such a volume as this, with eight hundred pages of text and a bibliography of twenty pages, will be definitive and thorough in the topics taken up.

Since it has "only six chapters," a few remarks will be made regarding each of these. Chapter I sets forth general information and definitions on partial differential equations and their solutions: examples are given for several types of equations, the corresponding solutions, and solution techniques. These examples are presented clearly, without a burden of detail that would obscure their general features.

Some pervading characteristics of the book are noticeable in the first chapter. As stated in the preface, its purpose is to deal with the *theory* of partial differential equations: though originating sometimes in specific physical situations, the equations are discussed chiefly to display mathematical ideas. Nonetheless, Professor Courant does not ignore the nonmathematician. Following a purely analytic existence proof for power series solutions, obtainable only under highly restrictive circumstances, he mentions less idealized conditions which continually confront a physicist—or mathematician. The over-all style of writing is often that of a casual discourse, avoiding monotony which can accumulate in a mathematical treatise, and yet establishing rigorous statements.

In Chapter II, considerations are limited to first order equations (linear and nonlinear) and broadened to exhibit solutions under some of the less idealized conditions mentioned. Solutions are developed formally, with concrete examples, via methods involving characteristic curves and strips: these permit the application of simple integration techniques employed with ordinary differential equations. A few well-chosen figures here would add much to the description of characteristic curves, Monge cones, etc.—particularly since the text emphasizes the utility of geometric interpretations.

Leading into studies of higher order equations (about 80% of the volume), Chapter III contains, first, several major sections on elliptic, hyperbolic, and parabolic classifications. Under the inclusive title "Differential Equations of Higher Order" there are explorations into several topics such as wave propagation, and superposition solutions of homogeneous and inhomogeneous boundary value problems. An interesting final section on "typical problems" identifies origins of differential equations and discusses the role of initial or boundary conditions in usually (not always) establishing unambiguous descriptions of nature. Reaching the end of this chapter, one is quite aware of numerous forward and backward references. The stated aim of presenting problems at various levels of sophistication is definitely met.

The development of solutions of Laplace's and Poisson's equations, with appropriate boundary conditions, appears in Chapter IV on elliptic equations. Ample space is given to average value theorems for these solutions and for functions which satisfy more general elliptic equations.

In two final and long chapters on hyperbolic equations, an outstandingly complete treatment is provided for the solution of initial value problems involving two independent variables. Wave propagation, especially in hydrodynamics and electromagnetic theory, is examined very thoroughly for two or more space-time coordinates. An appendix on transient analysis with integral representations and Heaviside calculus will have special appeal for applied scientists.

This review does not adequately show the extent to which theoretical developments of the last few decades (in some cases, few years) have been included or referenced. The book will doubtlessly become a standard: I believe that many professionals, including those with no more than a reasonably thorough undergraduate course in ordinary differential equations, will use it for reference or in systemized study. Its price precludes wide private ownership, however. Interscience Publishers should consider a paperback edition, perhaps in two volumes. Running heads including section numbers would facilitate use of the extensive internal referencing. Consistency of notation and scarcity of errors are both gratifying in such a long volume.

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(About the Reviewer: The reviewer, formerly manager of Theoretical Physics at Knolls Atomic Power Laboratory, received his Ph.D. in Theoretical Physics from Cornell University in 1951. Both during and after World War II he was a staff member with the theory division at Los Alamos, leaving to join KAPL in 1951. His work has been primarily in mathematical physics, with applications to reactor analysis. Contributions to the literature have appeared in The Physical Review, Journal of Applied Physics, *and* Nuclear Science and Engineering.)