Science of Advanced LMFBR Fuels

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(Elsevier North-Holland, 1986)

This book represents a monumental compilation and review of a materials technology which has seen several cycles of high to low emphasis and financial support. The attractive properties and performance potential of carbide and nitride nuclear reactor fuel materials brought considerable research and development focus in the mid-1960s, followed by decline in the early 1970s with another surge of emphasis in the late 1970s and early 1980s. In liquid metal cooled fast breeder reactor (LMFBR) technology, the promise of more efficient conversion of abundant ^{236}U to fissionable ^{237}Pu can provide significant economic incentive to employ these advanced fuels. This is the context in which most of the research reported in this book occurred. It is a context which has supported both the essential development for large-scale application (synthesis, processing, fabrication, performance testing) and significant fundamental materials research (thermal and mechanical properties, defect structures and stoichiometry effects, optical and electronic properties). This scope is succinctly illustrated by two sequential entries in the subject index, where "Ball Milling" is immediately followed by "Band Structure." The full range of the actinide element carbide and nitride science and technology is authoritatively presented here by an author who has contributed continuously to this research since the mid-1960s.

Indicative of the author's zeal and dedication to his subject are the first two chapters: an introduction to LMFBR technology and a historical background on carbide/nitride fuel materials research. These provide a brief but authoritative survey on the significance of this technology for world energy resources, the status of commercial deployment of these reactors, and the economic incentives for the advanced fuels. The historical perspective traces the emergence of these materials to a prominent place in the reactor development world, including alternative applications such as gas-cooled and space nuclear power devices.

From this point forward, the book's contents are logically organized, taking the reader progressively from crystal structures and thermodynamic data through preparation and fabrication into details of fundamental physical properties, with development of relationships to defects and characteristic solid-state reactions. This is followed by detailed reviews of phenomena significant in the nuclear applications, including: porosity restructuring, radiation damage, fission product chemistry, swelling and gas release. With this basis in fundamentals established, the in-reactor, integral fuel element irradiation test and performance experience is reviewed, along with the modeling which allows calculation of operating conditions and prediction of performance and safety limits. The final chapter completes the LMFBR fuel cycle with coverage of reprocessing schemes which would allow recovery of the fissile actinides and refabrication into fresh carbide or nitride reactor fuels.

A major strength of this book is the extensive references cited with each chapter. Matzke has done a great service to the materials community in preparing this summary of the advanced fuels technology with such a comprehensive bibliography. There are 17 pages of author index, compared to 7 pages of subject index. References are current to 1985, but the vast majority of the work on these materials was reported from the late 1960s through the 1970s. European sources are strongly represented, with a somewhat less complete coverage of some U.S. work reported mainly in topical and progress reports sponsored by the U.S. Department of Energy and its forerunners (ERDA, AEC).

Among notable features is the wealth of data covering effects of compositional variations on the thermodynamics, properties and fuel behavior of these materials. Because of the extent of solid solubility and nonstoichiometry in the actinide metal carbide and nitride systems, there has been considerable work on ternary and pseudobinary composition ranges such as U-C-N and UC-PuC, UN-PuN. Also, the technological realities of fabricating large quantities of these materials in densified fuel forms can introduce significant oxygen impurity. It is unusual to find such a wealth of data in one place showing effects of composition variations on both properties and such complex processes as fission gas release and swelling. As might be expected from the author's prominent research on diffusion processes in actinide materials, the section covering defect structures, diffusion and deformation is particularly authoritative.

For the nuclear materials technologist, this book can take a rightful place on the same shelf with such classical references as J. Belle's *Uranium Dioxide* and D.R. Olander's *Fundamental Aspects of Nuclear Reactor Fuel Elements*. For the materials scientist seeking data and insights on a representative class of refractory compounds, the comprehensive research results compiled by Matzke from the world's best nuclear research facilities represents a substantial resource.

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Science of Ceramics, Vol. 14

Edited by D. Taylor
(Institute of Ceramics, 1988)

This volume contains approximately 170 papers from the 14th International Conference on the Science of Ceramics, Canterbury, United Kingdom, 1987. It provides a sampling of research, primarily from European researchers, under the following headings: powder preparation and characterization, fabrication, sintering, characterization, microstructure, phase equilibria, joining, membranes, creep, mechanical properties, thermal properties, wear, bioceramics, composites, and electrical ceramics. For the most part the papers are short (approximately 6 pages) and thus provide a relatively brief summary.

The quality of the book suffers from the use of thin, almost translucent paper, which often resulted in bleed-through of text and figures from the opposite side. One assumes this was a result of the desire to keep the proceedings in one volume with minimum mass, not an easy task to accomplish. In addition, a few pages are scrambled, and the legibility of some of the figures is quite poor. Difficulties in uniformity in text and figures, though, are frequently a problem with camera-ready manuscript publications (which we as authors are responsible for).

The technical community will still find this a useful resource. It is not intended to cover a single topic in great depth but to summarize the results of several researchers within each topic. This approach does provide a very good overview of ceramic research activities as of 1987, and the papers and their references could prove to be a very useful resource.

Reviewer: Paul Becher is a group leader, Metals and Ceramics Division, Oak Ridge National Laboratory. His current research centers on the mechanical behavior of ceramic materials. □

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