weapons development. Since 1956, at General Atomic, he has been successively chairman of the Theoretical Physics Department, Senior Research Advisor, and Consultant. His activities have covered both basic nuclear physics as well as numerous aspects of reactor physics. From 1963 to 1972 he has served on the Advisory Committee for Reactor Physics of the U.S. Atomic Energy Commission. He is a fellow of the American Nuclear and Physical Societies and a member of the Editorial Advisory Committee of Nuclear Science and Engineering.

Promethium Technology. Edited by E. J. Wheelwright. American Nuclear Society (1973). 416 pp. $22.50.

"Promethium Technology" is a monograph published under a cooperative program of the U.S. Atomic Energy Commission (USAEC) and the American Nuclear Society (ANS) in which special technical subjects are covered that are primarily of interest to the nuclear community. In this volume, work done primarily in USAEC laboratories on promethium and its compounds is summarized by Earl Wheelwright and nine other contributors who have special knowledge concerning various aspects of promethium research and development.

The volume is divided into 13 chapters covering the history of the discovery and identification of element 61, later named promethium, the chemical and physical characteristics of the element, the nuclear and radiation characteristics of the isotopes, separations chemistry, health-physics data, preparation and properties of the metal and oxide, analytical chemistry, fabrication of source, and the applications in medicine and industry.

On the whole, I liked the book. It gives a wealth of information on promethium (primarily ^{147}Pm, of course), and it should be a good reference for anyone planning to work with promethium. The literature search appears to have been quite thorough; the references cited are numerous and appear to be easily obtainable. It is doubtful that most researchers will be interested in much of the detail given, but it is helpful to have such a well-researched source document available to cover most questions that might arise in working with promethium.

While the monograph is an excellent source of specific information on promethium, several sections are also quite valuable as general references on basic nuclear technology. Chapters 3 and 4 by Van Tuyl on promethium formation, nuclear properties, dose rates, and shielding calculations are particularly noteworthy in that they are more clearly written and easily understandable than most textbooks and handbooks that I have seen on similar subject matter. For this reason, teachers may wish to consider this monograph as an auxiliary text, even though it is written about a specific element.

Wheelwright's Chap. 2 on chemical processing is similarly a good review of the general chemical technology encountered in separating and purifying fission products, including precipitation and several techniques of solvent extraction and ion exchange. Here again, the nonspecialist reader will find the descriptions of various kinds of elution techniques, the use of complexing agents, and the effects of process variables quite clear and easier to understand than those given in the average textbook.

That promethium is one of the more innocuous common radioisotopes is borne out by Chap. 7 on biological considerations. The 2.62-yr ^{147}Pm radiation is 100% soft beta (0.2246 MeV) plus a small amount of bremsstrahlung so that external exposure problems are minimal. Ingestion via aerosols into the lungs is the chief hazard. More data are given on ingestion studies than I have seen previously, most of which should be reassuring to the prospective promethium user. Practical radiation protection measures are discussed and useful data for controlling personnel exposure are given in Chap. 8.

The analytical chemistry section is short, to the point, and well referenced. As is always the case, an abundance of useful general chemistry of the element is brought out in the discussion of analytical chemistry. It was noted that this section deals only with the chemistry and does not mention the instrumentation and procedures needed for measuring isotopic contamination from 5.53-yr ^{146}Pm, 5.4-day ^{148}Pm, and 43-day ^{148m}Pm.

Promethium is customarily used in the form of the oxide. Chapter 10 is devoted to the prepartion of the oxide and a detailed description of its physical properties, ranging from thermal diffusivity to surface tension of the molten oxide. Most of these data were developed for calculations needed in safety and environmental impact statements. Information is also included on promethium-samarium systems (^{147}Sm is the nonradioactive daughter that grows in as ^{147}Pm decays) and the reactions of Pm_2O_3 with water.

Promethium metal was also needed to determine physical properties and for nuclear experiments. Wheelwright and colleagues prepared the metal by reacting $PmCl_3$ with calcium metal and iodine in a reduction bomb; a 92% yield of 96% pure promethium was obtained, which was cast, machined, and used for physical properties tests. The preparation of promethium metal by simultaneous reduction with thorium metal and distillation of promethium by Kobisk and Grisham at the Oak Ridge National Laboratory is also described. (Kobisk found that high-purity promethium metal, as with other high-purity rare earth metals, is quite ductile and can be easily cold-rolled into thin films.) The measurements of the melting point of promethium varied with test samples and methods but appears to be ~1100°C.

The uses of ^{147}Pm are chiefly for small heat sources or to generate milliwatts of electricity either by thermocouples or semiconductor devices. In all cases the oxide is compacted, usually pressed into cylindrical shape, and encapsulated in noble metals or superalloys. The final chapters are devoted to these operations and short descriptions of the applications up to this time.

I would recommend the monograph as a reference book to those interested in handling and using promethium. It also would be useful as a supplementary textbook, as was pointed out earlier in this review.

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About the Reviewer: A. F. Rupp (BSChE, Purdue, 1933) was assigned by the DuPont Co. to the University of Chicago's Manhattan Project in 1943; he worked on the original graphite reactor and plutonium processes at Clinton Laboratories (now the Oak Ridge National Laboratory) and at Hanford. In 1946 he organized the radioisotope program at Oak Ridge National Laboratory, which later also encompassed the stable-isotopes separations program. He was director of the isotopes program until retirement in 1973 and is now a consultant on radioisotopes, radiochemical processing, and waste management. He is a member of the American Chemical Society, and the American Institute of Chemical Engineers and is a Fellow of the American Nuclear Society and of the American Institute of Chemists.