

Volume I

An Update: Plutonium and Quantum Criticality George *Chapline* and James L. Smith 1

Historical Introduction, Condensed-Matter Physics, and Plutonium Aging

Historical Introduction

Plutonium-A Historical Overview *Siegfried* S. Hecker with the Los Alamos Science staff 2

In the Beginning 3

A Factor of Millions-Why We Made Plutonium-with *André F. Michaudon* and *Ileana G. Buican* 4

Plutonium in Use-From Single Atoms to Multiton Amounts 10

Plutonium-An Element at Odds with Itself 16

The Plutonium Challenge-Stockpile Stewardship 24

The Plutonium Challenge-Avoiding Nuclear Weapons Proliferation 28

The Plutonium Challenge-Environmental Issues 36

The Taming of "49"-Big Science in Little Time 48

Recollections of Edward F. Hammel

Reflections on the Legacy of a Legend-Glenn T. Seaborg (1912-1999) 56

David L. Clark and David E. Hobart

From Alchemy to Atoms—The Making of Plutonium 62

André F. Michaudon

Plutonium and Health-How Great Is the Risk? 74

George L. Voelz as told to Ileana G. Buican

Plutonium Condensed-Matter Physics

Plutonium Condensed-Matter Physics-A Survey of Theory and Experiment 90

A. Michael Boring and James L. Smith

Actinide Ground-State Properties---Theoretical Predictions 128

John M. Wills and Olle Eriksson

Basics of the Density Functional Theory (DFT) Approach 135

Electronic Structure of α - and δ -Plutonium--Theory vs Experiment 152

Aloysius J. Arko, John J. Joyce, and John M. Wills

A Possible Model for δ -Plutonium—Self-Induced Anderson Localization, δ -Phase Stability,

and the Melting Temperature of Plutonium 154

Bernard R. Cooper

Photoelectron Spectroscopy of α - and δ -Plutonium 168

Aloysius J. Arko, John J. Joyce, Luis A. Morales, Jeffrey H. Terry, and Roland K. Schulze

Laser-Plasma Light Source-Design and Operation 186

John J. Joyce, Aloysius J. Arko, and Luis A. Morales

Actinide Photoemission Measurements at the Advanced Light Source 188

Roland K. Schulze and Jeffrey H. Terry

Atomic Vibrations and Melting in Plutonium 190

*Andrew C. Lawson, Barbara Martinez, Joyce A. Roberts, James W. Richardson, Jr.,
and Bard L. Bennett*

Equations of State-Theoretical Formalism 192

Bard L. Bennett

Microstrain in δ' -Plutonium 201

Andrew C. Lawson

Vibrational Softening in α -Uranium 202

Michael E. Manley

Elasticity, Entropy, and the Phase Stability of Plutonium 208

Albert Migliori, Joseph P. Baiardo, and Timothy W. Darling

Preparing Single Crystals of Gallium-Stabilized Plutonium 226

Jason C. Lashley, Michael S. Blau, and Roger L. Moment

A Single-Crystal Saga 233

Roger L. Moment

Plutonium Aging

Aging of Plutonium and Its Alloys 238

Siegfried S. Hecker and Joseph C. Martz

A Tale of Two Diagrams 244

Siegfried S. Hecker and Lidia F. Timofeeva

Surface and Corrosion Chemistry of Plutonium 252

John M. Haschke, Thomas H. Allen, and Luis A. Morales

Catalyzed Corrosion of Plutonium: Hazards and Applications 266

John M. Haschke and Joseph C. Martz

Radiation Effects in Plutonium—What Is Known? Where Should We Go from Here? 274

Wilhelm G. Wolfer

Transmission Electron Microscopy of Plutonium Alloys 286

Thomas G. Zocco

Volume II

Plutonium Metallurgy, Actinide Chemistry and the Environment, and the Yucca Mountain Project

Plutonium Metallurgy

Plutonium and Its Alloys—From Atoms to Microstructure 290

Siegfried S. Hecker

Mechanical Behavior of Plutonium and Its Alloys 336

Siegfried S. Hecker and Michael F. Stevens

Where Is the Gallium?—Searching the Plutonium Lattice with XAFS 356

Steven D. Conradson

Actinide Chemistry and the Environment

The Chemical Complexities of Plutonium 364

David L. Clark

Computational Studies of Actinide Chemistry 382

PI Jeffrey Hay and Richard L. Martin

The Chemical Interactions of Actinides in the Environment 392

Wolfgang H. Runde

Spectroscopies for Environmental Studies of Actinide Species 412

Wolfgang H. Runde

Siderophore-Mediated Chemistry and Microbial Uptake of Plutonium 416

Mary P. Neu

Characterizing the Plutonium Aquo Ions by XAFS Spectroscopy 418

Steven D. Conradson, David L. Clark, Mary P. Neu, Wolfgang H. Runde, and CI Drew Tait

XAFS-A Technique to Probe Local Structure 422

Steven D. Conradson as told to Jay A. Schecker

A Vision for Environmentally Conscious Plutonium Processing 436

Larry R. Avens and P. Gary Eller

Salt Distillation 449

Eduardo Garcia, Vonda R. Dole, James A. McNeese, and Walter J. Griego

Hydrothermal Processing 450

Laura A. Worl, Steven J. Buelow, and Dennis D. Padilla

Enhanced Pyrolysis for Converting Polystyrene or Cellulose Polymers 451

Daniel J. Kathios

Treatment of Liquid Wastes 452

Gordon D. Jarvinen, Geraldine M. Purdy, Barbara F. Smith, and Thomas C. Robinson

Electrochemical Decontamination of Metallic Wastes 453

Douglas E. Wedman and Jerry L. Lugo

Molecularly Engineered Resins for Plutonium Recovery 454

S. Fredric Marsh, D. Kirk Veirs, Gordon D. Jarvinen, Mary E. Barr, and Eddie W. Moody

The Yucca Mountain Project

Yucca Mountain-Looking Ten Thousand Years into the Future 464

by Roger C. Eckhardt for David L. Bish, Gilles Y. Bussod, June T. Fabryka-Martin, Schön Levy, Paul W. Reimus,

Bruce A. Robinson, Wolfgang H. Runde, Inés Triay, and David T. Vaniman

Mesh Generation for Yucca Mountain 472

Carl W. Gable

Colloids-Carriers of Actinides into the Environment 490

Analyzing Volcanic Hazards at Yucca Mountain 492

Frank V. Perry, Bruce M. Crowe, and Greg A. Valentine