Preface

This book summarises approaches and current practices in actinide immobilisation using chemically-durable crystalline materials such as polycrystalline ceramics and large single crystals. Durable actinide-containing materials have many potential applications, such as in nuclear fuels for burning excess Pu and in chemically-inert sources of alpha irradiation for power supply of unmanned space vehicles or to produce electricity for microelectronic devices. However, currently these elements are considered mostly as waste constituents and actinide-bearing wastes have accumulated in various countries as a result of nuclear weapons' production. Excess weapon and civil Pu from commercial spent fuel awaits environmentally-safe immobilisation. Actinides are chemical elements with unique features that could be beneficially used in different areas of human endeavour including medicine. At present there is no appropriate balance between safe actinide use and disposal and there are difficult ethical questions about their use. Both use and disposal of actinides require their immobilisation in a durable host material. The choice of an optimal actinide immobilisation route is a significant technical challenge. While there is a wealth of information about actinide properties in many publications, there is a dearth of reviews or books summarising the current approach to actinide immobilisation. This book hopes to fill the gap based on the authors' experience and studies in nuclear material management and actinide immobilisation.

The first chapter introduces the actinide series with a brief description of basic physical and chemical properties emphasising

the hazards associated with actinides. Natural actinides and actinide-bearing minerals found in nature are described. Artificial actinides from the nuclear fuel cycle are outlined, along with the most durable crystalline host-phases for them. Chapter Two gives a description of areas of actinide use such as in sealed sources of radiation, transmutation targets and advanced nuclear fuels. Nuclear waste actinide immobilisation is examined in the third chapter with emphasis on the most suitable host-matrices such as Synroc and other ceramics. The core of the book forms Chapters Four and Five, which give detailed descriptions of synthesis methods used to produce chemically-durable crystalline materials containing actinides and practical methods for their analysis. Radiation damage is an important issue for actinides and is examined in Chapter Six, where both ion bombardment and doping with shorter-lived radionuclides methods are analysed. The book concludes with a brief description of the future potential of actinide-containing materials.

This book is intended for nuclear waste management experts, radiochemists, geochemists, geologists, nuclear physicists, materials scientists and engineers, solid state physicists and cancer treatment experts. It will also be useful for a broader range of specialists interested in environmentally-safe use of radionuclides.

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