Chemical and Ceramic Methods Toward Safe Storage of Actinides Using Monazite

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Executive Summary

The program will address more particularly the section, "Plutonium behavior in mixed matrices - specialized waste forms", with the concept that monazite ceramic will provide the most safe, most secure, geologically tested, very long term, containment for actinides. That monazites are the ideal crystal hosts for containment of actinide or transuranic elements (extremely stable geologically and resistant to radiation damage) is well established. They were proposed a number of years ago as high level nuclear waste forms at Oak Ridge National Laboratory.

Following the deliberations of the Hench Panel in 1984, and the decision to proceed with borosilicate glass as a low level waste, organized research on monazite and other "alternative waste forms" came to an end. As pointed out in a current National Academy of Science Panel report, approximately fifteen years of potential progress in the development of alternative nuclear waste forms were then lost.

We therefore seek to do basic studies of the ceramic nature of monazite utilizing two groups that have a serious previous background in research concerning monazite and radwaste encapsulation. These are complicated fields and, to avoid unnecessary duplication and waste, it should be important to utilize and to extend that already hard won experience.

The group headed by Lynn Boatner at Oak Ridge National Lab has many years of preeminent experience in studying monazite, while that laboratory is, naturally, in a fine position to transfer basic study results to later engineering application.

The group at the Rockwell Science Center, including Alan Harker and Peter Morgan, became well known for its work in the area of ceramic radwaste hosts and contributed considerable basic understanding to the ceramic problems and advantages, particularly pointing out to the community the key role of the grain boundary leaching phenomena (possible glasses, precipitated grain boundary phases, etc.).

The recent discovery by the Rockwell group, including also David Marshall, that monazite provides weak stable interfaces for ceramic matrix composites has stimulated widespread, renewed interest in the properties of monazite as a ceramic.

The main outstanding fundamental research issues facing the use of monazite as a waste form necessitate the development of fundamental understanding of: sintering mechanisms involved in forming high density monazite ceramics; physical and chemical properties of grain boundaries in these ceramics; interactions with impurities and additives used to promote densification; physical properties of polycrystalline monazite ceramics; and the precipitation of monazite phases in an efficient, simple and economical manner. We propose to address these issues to serve as a knowledge base for using monazite as a nuclear waste form.