URANIUM POWDER PRODUCTION VIA HYDRIDE FORMATION AND ALPHA PHASE SINTERING OF URANIUM AND URANIUM-ZIRCONIUM ALLOYS FOR ADVANCED NUCLEAR FUEL APPLICATIONS

A Thesis

by

DAVID JOSEPH GARNETTI

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

December 2009

Major Subject: Nuclear Engineering

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Approved by:

Chair of Committee,	Sean M. McDeavitt
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ABSTRACT

Uranium Powder Production via Hydride Formation and Alpha Phase Sintering of Uranium and Uranium-Zirconium Alloys for Advanced Nuclear Fuel Applications. (December 2009)

David Joseph Garnetti, B.S. Physics, Florida State University

Chair of Advisory Committee: Dr. Sean M. McDeavitt

The research in this thesis covers the design and implementation of a depleted uranium (DU) powder production system and the initial results of a DU-Zr-Mg alloy alpha phase sintering experiment where the Mg is a surrogate for Pu and Am. The powder production system utilized the uranium hydrogen interaction in order to break down larger pieces of uranium into fine powder. After several iterations, a successful reusable system was built. The nominal size of the powder product was on the order of 1 to 3 μm.

The resulting uranium powder was pressed into pellets of various compositions (DU, DU-10Zr, DU-Mg, DU-10Zr-Mg) and heated to approximately 650˚C, just below the alpha-beta phase transition of uranium. The dimensions of the pellets were measured before and after heating and *in situ* dimension changes were measured using a linear variable differential transducer (LVDT).

Post experiment measurement of the pellets proved to be an unreliable indicator of sintering do the cracking of the pellets during cool down. The cracking caused increases in the diameter and height of the samples. The cracks occurred in greater frequency along the edges of the pellets. All of the pellets, except the DU-10Zr-Mg pellet, were slightly conical in shape. This is believed to be an artifact of the powder pressing procedure. A greater

density occurs on one end of the pellet during pressing and thus leads to gradient in the sinter rate of the pellet. The LVDT measurements proved to be extremely sensitive to outside vibration, making a subset of the data inappropriate for analysis.

The pellets were also analyzed using electron microscopy. All pellets showed signs of sintering and an increase in density. The pellets will the greatest densification and lowest porosity were the DU-Mg and DU-10Zr-Mg. The DU-Mg pellet had a porosity of 14 ± 2.%. The DU-10Zr-Mg porosity could not be conclusively determined due to lack of clearly visible pores in the image, however there were very few pores indicating a high degree of sintering. In the DU-10Zr-Mg alloy, large grains of DU were surrounded by Zr. This phenomena was not present in the DU-10Zr pellet where the Zr and DU stayed segregated. There was no indication of alloying between the Zr and DU in pellets.

DEDICATION

I would like to dedicate this thesis to my family. Without their support I would not have been able to make it this far.

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I would like to thank my committee chair, Dr. McDeavitt, for his guidance and support throughout the course of this research.

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I would like to thank Grant Helmreich and Julie Borgmeyer for their help on this project and their microscopy work.

I would like to thank Alissa Stafford for her support in the writing and editing of this thesis.

NOMENCLATURE

TRU	Transuranics
DU	Depleted Uranium
EBR II	Experimental Breeder Reactor II
IFR	Integral Fast Reactor
LVDT	Linear Variable Differential Transformer
SEM	Scanning Electron Microscope

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