ORNL/TM-2010/323

OAK RIDGE NATIONAL LABORATORY
MANAGED BY UT-BATTELLE
FOR THE DEPARTMENT OF ENERGY

Deep Burn Team

Coated Particle and Deep Burn Fuels

Monthly Highlights

November 2010

TRISO-Coated Particle with Mixed Pu, Th Oxide Kernel after High Pu Burnup

UT-BATTELLE
ORNL-27 (4-00)

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ORNL/TM-2010/323

Coated Particle and Deep Burn Fuels

Monthly Highlights
for
November 2010

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Table of Contents

Acronyms and Abbreviations

DB	Deep Burn
DOE	Department of Energy
DSC	Differential Scanning Calorimetry
FCM	Fully Ceramic Microencapsulated fuel
FRAPCON	Computer code for calculating the behavior of fuel rods
HTR	High Temperature helium-cooled Reactor
INL	Idaho National Laboratory
Logos	Logos Nuclear Systems
LWR	Light Water Reactor
ORNL	Oak Ridge National Laboratory
REDC	Radiochemical Engineering Development Center (ORNL)
SEM	Scanning Electron Microscope
TGA	ThermoGravimetric Analysis
TRISO	tri-structural isotropic
TRU	transuranic elements

1. Project Management and Planning

1.1. Program reporting (*ORNL*)

During FY 2011 the DB Program will report Highlights on a monthly basis, but will no longer produce Quarterly Progress Reports. Technical details that were previously included in the quarterly reports will be included in the appropriate Milestone Reports that are submitted to FCRD Program Management. These reports will also be uploaded to the Deep Burn website www.ms.ornl.gov/deep_burn/index.shtml

The Monthly Highlights report for October 2010, ORNL/TM-2010/300**,** was distributed to program participants on November 29, 2010.

1.2. Archiving program records (*ORNL*)

Program participants are requested to send reports, milestone documents and other pertinent documents to the webmaster, Shirley Shugart, shugartsa@ornl.gov, for uploading to the website.

2. Thermochemical Data and Model Development *(ORNL)*

Took receipt of TGA/DSC instrument, designed benchtop installation, and initiated work needed to supply power and cooling water. Planning was initiated for installation of the TGA/DSC in an ORNL glovebox train and detailed budgeting was done.

3. TRU TRISO Development

3.1 TRU Kernel Development *(ORNL)*

Deep Burn TRU TRISO Development:

Preparation of work control documentation for the TRU kernel fabrication task continued this month. The review of two Research Safety Summaries with corresponding procedures was initiated. This documentation covers the preparation of TRU solutions, use of the internal gelation system, and the novel wash procedure for the TRU gel spheres. Preparation of similar documentation for the qualification tests (size and sphericity), calcination, and sintering is also underway.

Work this month was focused on items that must be completed on the new TRU kernel fabrication glove boxes in Lab 109 at the ORNL Radiochemical Engineering Development Center (REDC) before the Readiness Assessment can be performed. During November, weld joint tests on the new glove boxes were performed to address quality assurance requirements implemented after the glove boxes were purchased. A 20% inspection of the window studs and dye penetrant testing of all other accessible weld joints has been performed. Only one potential defect was identified; a weld in the maintenance glovebox enclosing the high-temperature sintering furnace failed the dye penetrant test. Work is underway to assess whether a weld defect requiring repair is indeed present. Installation of the gas lines running from the supply manifold to the inert glove boxes and the high-temperature furnace were completed. Finally, a new glove port was acquired and it will be installed once the hole in the window is cut.

3.2 Coating Development *(ORNL)*

TRISO Coating System:

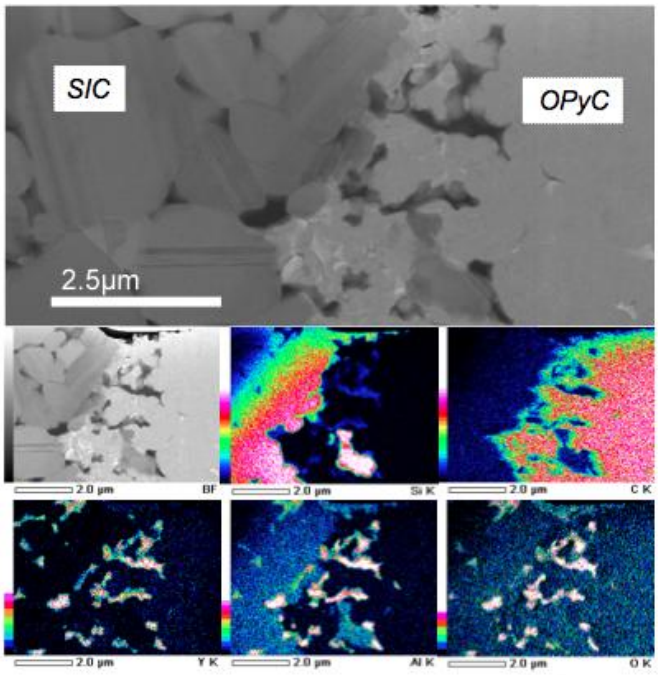
Work continued this month on the construction of the new particle coating furnace in the surrogate coating laboratory. The flammable gas cabinet has been received, but we are still waiting to receive additional furnace system components under fabrication in local shops. The design and procurement of the custom coating glove box is also ongoing. The designs are in final review and procurement will be initiated as soon as the approved drawings, specifications and capital funds assignment are complete.

The design, component procurement, and Safety Basis Supplement preparation related to the Deep Burn TRU Coating Laboratory in ORNL Bldg. 3525 has been placed on hold pending approval of the final FY 2011 budget.

4. LWR Fully Ceramic Fuel *(ORNL, INL, Logos)*

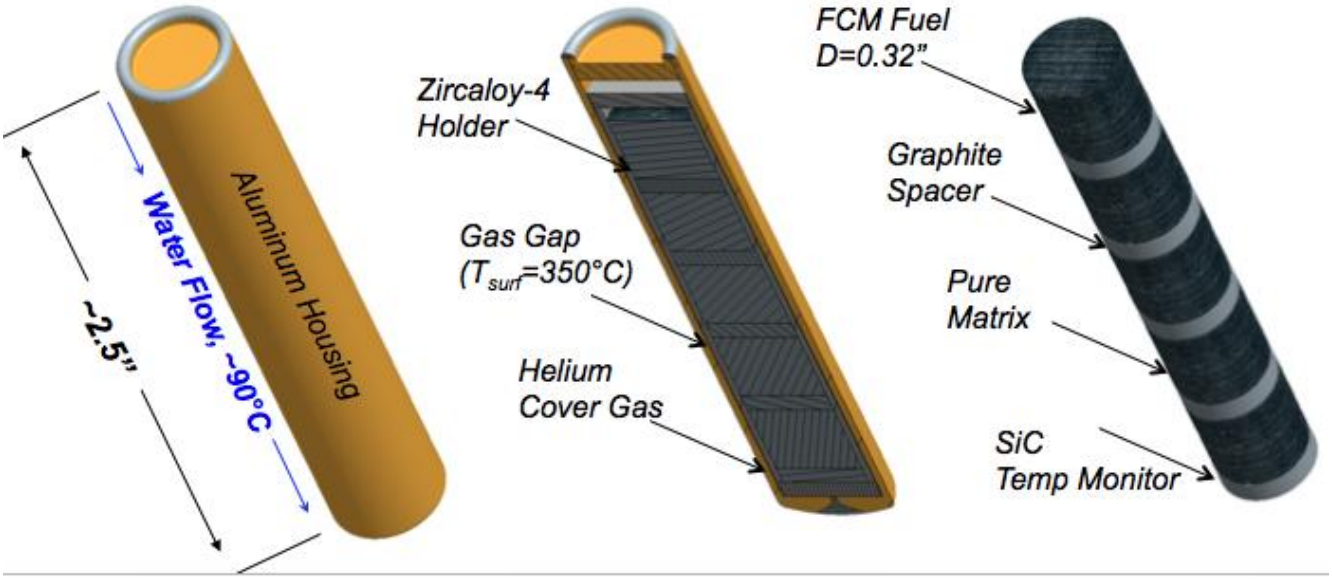
4.1 FCM Fabrication Development

Investigation of the first series of compacted surrogate FCM (fully ceramic microencapsulated fuels) continues. Particular emphasis was on the state of the interface between the SiC matrix and the outer pyrolitic carbon of the TRISO (OPyC). As the process for sintering the nano-powders of SiC utilizes percent levels of silica and yttria the final state and location of this materials is of particular interest and in particular whether it degrades the SiC/OPyC interface which would have implications on irradiation performance and thermal transport. The figure below shows both an SEM image of this interface and an electron back-scatter detector image of a typical interface. Preliminary indications are that, at this particular processing condition, the yttria and silica show some preferential sequestration to the interface and reside in what appears to be pores (upper image of pore.) While such pockets should be minimized, the fact that the process has resulted in a highly crystalline SiC matrix with a well bound SiC/OPyC interface and widely dispersed small pockets of sintering aids is quite positive.



4.2 FCM Irradiation Testing

Within this reporting period plans and designs for irradiation of fully ceramic microencapsulated fuels have begun. This irradiation is to be carried out in High Flux Isotope Reactor fixed rabbit conditions and will include materials selected from the FCM processing optimization effort. In particular the irradiation campaign in FY-11 will focus on surrogate TRISO particles at varied particle volume fractions and varied processing conditions. Additionally, process conditions of starting powder, pressure and temperature will be examined. A cartoon representation of the rabbit capsule is shown in the figure below. Of note is that the holder for the FCM fuel will be a Zircaloy-4 holder (defining a gas gap with the outer aluminum holder.) Therefore this experiment will probe the effect of irradiation on the FCM matrix itself, the upper limit of TRISO which can be accommodated within the matrix, and the extent (if any) of SiC matrix/Zircaloy interaction which must be investigated for LWR applications.



Appendix I

Deep Burn - ORNL FY2011 Milestones– Status November 30, 2010

Item No.	Milestone number and description	Level	Due Date	% Complete
1	M31AF080104 - Report on Completed Design and Procurement of Simultaneous Thermal Analyzer.	M3	2/5/2011	70
2	M31AF080105 - Model physical properties of TRISO fuel and fuel matrix to high dose.	M3	7/20/2011	5
3	M31AF080106 - Issue report on thermochemistry and fission product transport and attack of high-burnup fuel including experimental verification path-forward.	M3	9/23/2011	**
4	M31AF080102 - Simultaneous thermal analyzer is to be installed in a glove box to be used for identification and characterization of evolving fuel chemistry.	M2	9/23/2011	10
5	M31AF080103 - Submit report summarizing progress and path forward on thermochemistry of high-burnup fuel including experimental path-forward.	M2	9/30/2011	10
6	M31AF080204 - Report on Operational Approval to fabricate transuranic-bearing kernels in Bldg. 7920.	M3	2/23/2011	35
7	M21AF080202 – Demonstrate fabrication of Transuranic kernels of Plutonium-239/3.5at% Neptunium-237 using newly installed glove box facilities in ORNL 7930 Hot Cell Complex.	M2	4/25/2011	25
8	M21AF080203 - Complete fabrication and assembly of new coating furnace and issue letter report summarizing status of planned glovebox coating facility. Document work to date on installation of in-cell TRU-coating facility. Develop plan for continuation of in-cell installation of coating equipment in 2012.	M2	6/30/2011	20
9	M31AF080205 - Issue report documenting initial PIE of fuel compacts from the FTE-13 irradiation experiment focusing on Deep Burn relevant aspects of fuel.	M3	12/31/2011	25
10	M41AF080302 - Incorporate SiC and graphite matrix physical properties models into FRAPCON and perform preliminary analysis.	M3	12/17/2010	Completed
11	M31AF080303 - Issue report documenting the results of FRAPCON calculations comparing the fuel-clad physical interaction of SiC and graphite matrix options for fully ceramic matrix fuel form.	M3	2/25/2011	10
12	M31AF080307 - Report on final design of rabbit irradiation vehicle for fueled and surrogate FCM fuel.	M3	3/17/2011	5
13	M31AF080306 - Issue report on FCM optimization with surrogate TRISO.	M3	8/12/2011	5
14	M31AF080305 - Issue report documenting work performed to expand parameters beyond initial point design economic analysis of the Deep Burn fuel system to understand critical drivers which may impact fuel design.	M3	11/25/2011	**
15	M2N11OR130202 – 7.2.7 Procure glove boxes for TRU-TRISO coating	M2	3/31/2011	70

** status not reported

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