



OAK RIDGE
NATIONAL LABORATORY

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FOR THE DEPARTMENT OF ENERGY

Deep Burn Team



Coated Particle Fuel and Deep Burn Program

Monthly Highlights

March 2011



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

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Coated Particle Fuel and Deep Burn Program

Monthly Highlights for March 2011

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1. Project Management and Planning

1.1. Program reporting (*ORNL*)

During FY 2011 the CP & 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 February 2011, ORNL/TM-2011/71, was distributed to program participants on March 8, 2011. As reported previously, the final Quarterly for FY 2010, Deep Burn Program Quarterly Report for July – September 2010, ORNL/TM-2010/301, was announced to program participants and posted to the website on December 28, 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

2.1 Thermochemical Modeling

Thermochemical behavior (*ORNL*)

Thermochemical modeling is being performed to clarify the nature of palladium in the fuel particle and possible transport processes. In addition, a Si-O-H database is being refined to allow computation of possible recession rates of the Fully Ceramic Microencapsulated (FCM) SiC matrix under LOCA conditions.

2.2 Thermomechanical Behavior

Thermomechanical behavior of TRISO in SiC matrix (*ORNL*)

Samples of a SiC matrix with TRISO particles in both the as-sintered and preliminary polished conditions were obtained for mechanical properties characterization. A double cantilever beam or biaxial disc test of miniature specimens with fine polished surfaces is being designed and prepared to investigate crack interactions with TRISO particles. In-situ observation will use optical microscopy or scanning electron microscopy. This is a first step toward analyzing the thermomechanical properties of TRISO particles in a SiC matrix.

2.3 Actinide and Fission Product Transport

Transport through coating layers (*University of Tennessee*)

A meeting was held to discuss the modeling framework for assessing the transport of Pd, Cs and Ag from the fuel kernel to the SiC coating layers. The information will be used to develop and parameterize the model in the coming month.

2.4 Radiation Damage and Properties

Thermal conductivity of SiC (ORNL)

Work continues on calculating the effect of defects on the thermal conductivity of silicon carbide. We are in the process of changing the code to incorporate a modified Tersoff interatomic potential that more accurately calculates defect formation energies.

3. TRU TRISO Development

3.1 TRU Kernel Development

Glovebox installation at the REDC (ORNL)

Work to qualify the new glove boxes at the ORNL Radiochemical Engineering Development Center (REDC) that will be used to fabricate the TRU fuel kernels was suspended due to budget constraints. It is expected that the two glove boxes for the internal gelation system will receive operational approval by July.

Testing of the alternative sintering furnace at REDC showed that it achieved a maximum temperature of 950°C, even though it has previously been able to reach 1340°C. The furnace will need to be repaired, modified, or replaced to be able to test (Pu, Np)O₂ kernels.

Fabrication of urania kernels containing SiC (ORNL)

A new internal gelation system was installed in ORNL Building 4501. The system was used twice this month to fabricate uranium microspheres with 4 mol% silicon carbide to serve as an oxygen getter. The test runs indicated that relatively minor equipment modifications such as silicone oil flow rate and needle size are needed to make high yields of quality 500 μm diameter fuel kernels. Some of these modifications may be applied to the TRU system at REDC. Calcination tests up to 1265°C in argon and in argon-4% hydrogen are underway.

3.2 Coating Development

TRISO coating system (ORNL)

Progress continues in the fabrication and procurement of furnace and control components for the new coater system. The furnace components are in fabrication, but work is moving cautiously because of the complexity of the components. The power supply for the new coater is on order with expected delivery in mid-April, 2011.

A purchase order is in place between ORNL and Flanders Filters Inc. for the fabrication of five standard glove boxes in accordance with ORNL supplied specifications. The purchase order with Flanders satisfies the deep burn program milestone M2N11OR130202-7.2.7 "Procure glove boxes for TRU-TRISO coating."

4. Advanced TRISO Applications

4.1 Metal Matrix Fuels for LWR (ORNL)

Nothing to report this month.

5. LWR Fully Ceramic Fuel

5.1 FCM Fabrication Development

FCM pellet fabrication (ORNL)

A number of Fully Ceramic Microencapsulated (FCM) fuel pellets were fabricated with continued focus on microstructure optimization. Geometrical optimization to achieve near-final dimension prior to centerless grinding of the pellets was also performed. A centerless grinder for final pellet fabrication was fabricated.

FCM fabrication development (ORNL)

The Zeta potentials of individual components of the FCM nanopowder were measured to help understand the dispersion behavior of the powder mix.

5.2 FCM Irradiation Testing (ORNL)

A report has been issued documenting the final design of the vehicle for the irradiation of fueled and surrogate FCM fuel samples in HFIR reactor core positions. This completes milestone M31AF080307.

6. Fuel Performance and Analytical Analysis

6.1 Fuel Performance Modeling (INL)

Completed and delivered Level-4 Milestone on "Intermediate report on scoping studies for the performance of inert matrix fuel under selected design basis accident scenario compared to standard uranium dioxide - Continued Work."

Completed and delivered Level-4 Milestone on "Intermediate report on impact of volumetric loading of FCM fuel on void coefficient of reactivity and implications for commercial LWR operations and safety."

Completed and delivered Level-3 Milestone and Final Report on "Final Report on Utilization of TRU TRISO fuel as applied to HTR PBR Systems."

Work continued on the preparation of dpa cross sections for TRISO fuel layers in DB-LWR spectra.

INL received from LOGOS, reviewed and obtained revision, then transmitted to DOE Level-3 Milestone from LOGOS on "scoping studies on the performance of TRISO-based inert matrix fuel under selected design basis accident scenarios compared to standard uranium dioxide fuel."

Appendix I

Coated Particle and Deep Burn Fuels Program - ORNL FY2011

Milestone Status March 31, 2011

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	Completed
2	M31AF080105 - Model physical properties of TRISO fuel and fuel matrix to high dose.	M3	7/20/2011	35
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	20
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	30
5	M31AF080103 - Submit report summarizing progress and path forward on thermochemistry of high-burnup fuel including experimental path-forward.	M2	9/30/2011	30
6	M31AF080204 - Report on Operational Approval to fabricate transuranic-bearing kernels in Bldg. 7920.	M3	6/30/2011	80
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	40
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	35
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	30
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	Completed
12	M31AF080307 - Report on final design of rabbit irradiation vehicle for fueled and surrogate FCM fuel.	M3	3/17/2011	Completed
13	M31AF080306 - Issue report on FCM optimization with surrogate TRISO.	M3	8/12/2011	35
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	10
15	M2N11OR130202 - 7.2.7 Procure glove boxes for TRU-TRISO coating	M2	3/31/2011	Completed

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