Nuclear Energy University Program FY18 CINR FOA

Program Supporting: Nuclear Reactor Technologies

Materials for Advanced Reactor Technologies (RC-1)

Oxidation Behavior of HTGR TRISO Fuel Materials (RC-1.3)

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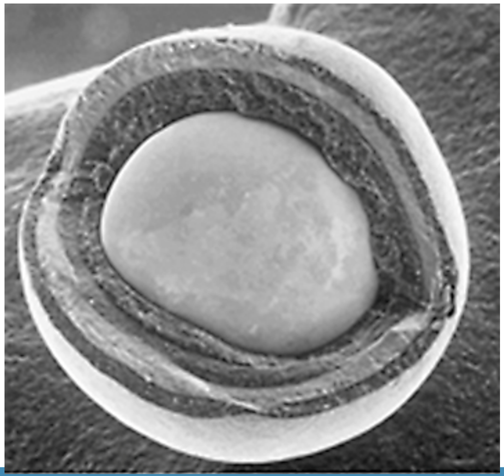
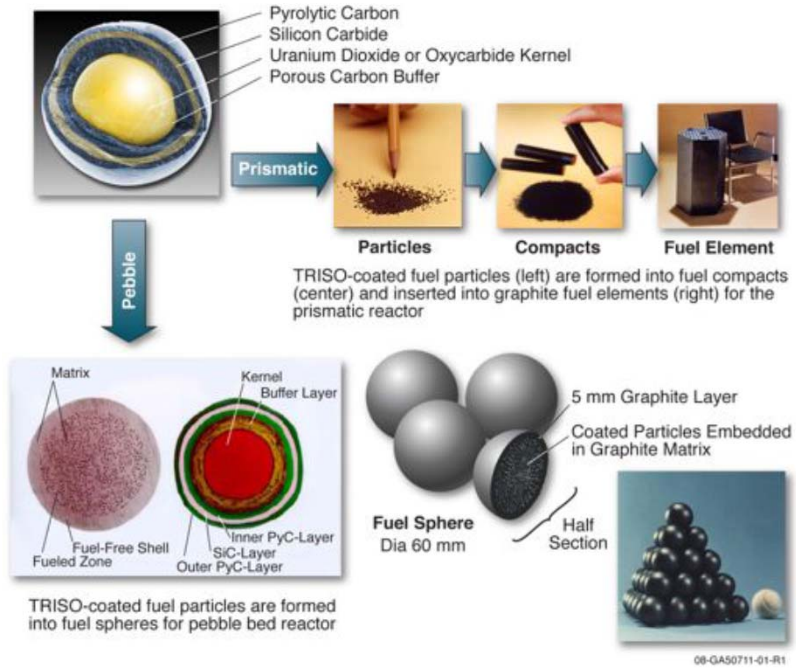


Oxidation Behavior in HTGR TRISO Fuel Materials (RC-1.3)

Motivation for getting oxidation behavior in TRISO fuels:

- **HTGRs use pure helium as reactor coolant, but trace quantities of oxidants (air, moisture, CO, CO_2) may be present during normal operations**
- **If a steam generator tube leak occurs, large amounts of moisture can be introduced into the helium coolant and reactor core.**
- **Air can be introduced during some accident conditions, e.g., depressurization of the helium cooling loop from coolant line break.**
- **Understanding the effects of oxidants (air, moisture, CO, CO_2) on TRISO fuel integrity and fission product transport is essential for HTGR safety analysis.**
- **Fuel particle, compact matrix oxidation experimental data are needed to model HTGR core accident behavior.**



Eligible to Lead:	**Universities Only**
Maximum funding	**$800,000**
Duration:	**Up to 3 years**

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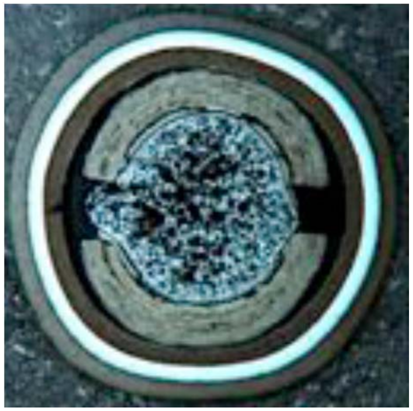
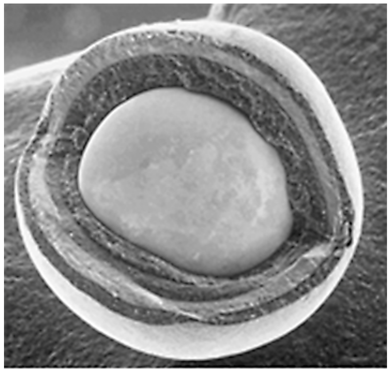
Proposals MUST:

- **Experimentally test moisture oxidation of graphitic matrix and/or air or moisture oxidation of SiC in the passive to active transition regime**
- **Use the most prototypic available, e.g., un-irradiated and irradiated TRISO, SiC, matrix materials available from AGR TRISO program sample archives**
- **Emphasize carefully designed experiments that can be used to compare with current, future, or develop new oxidation models**
- **Produce useful results that can simulate oxidation of the fuel during air or moisture ingress accidents and predict partial pressures of oxidants transported to the TRISO fuel particles.**



Irradiated TRISO



Proposals MUST NOT focus only on developing computational models or correlations, without performing any new oxidation experiments.

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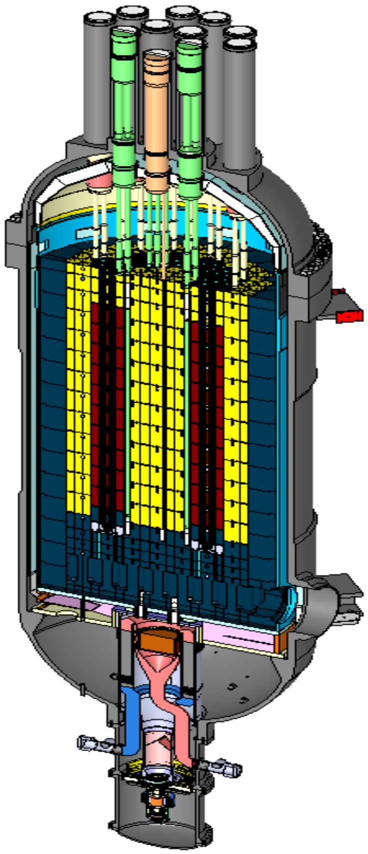
Proposals should:

- **Consider the effect of irradiation on SiC and matrix oxidation properties using irradiated specimens**
- **Focus on oxidation experiments using the results to develop correlations for air and/or moisture ingress accidents.**
- **Use realistic ranges for HTGR temperatures, gas flow rates, core geometries, oxidant partial pressures, etc.**
- **Provide data about the level of SiC damage that could potentially occur during air/moisture ingress accidents.**
- **Provide useful information about the transition from active to passive (and passive to active) oxidation of chemical vapor deposition (CVD) SiC in TRISO particles at the temperatures of interest (~ 1000°C - 1600°C) under relevant atmospheres, e.g., those containing O_2 or, especially, H_2O vapor**



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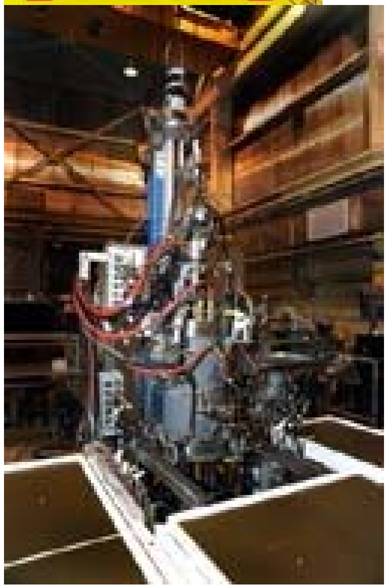
Proposals must NOT repeat earlier tests performed by NEUP grants, ART, AGR TRISO, and AGC graphite programs:**

- **Chronic oxidation of nuclear graphite (only) during air/moisture ingress conditions.**
- **Previous TRISO fuel matrix material (graphitic material composed of many graphite types, carbonized phenolic resin) experiments in air**
- **Recent tests on the silicon carbide layer of surrogate (non-uranium bearing) coated particles at high temperatures (~1600°C) in high steam or air partial pressures**
- **SiC oxidation in air at high oxidant partial pressures, high temperatures**

****See INL Advanced Reactors Technology, AGR TRISO fuels, NGNP, NEUP websites at: https://art.inl.gov/default.aspx; https://neup.inl.gov**

ORNL CCTF

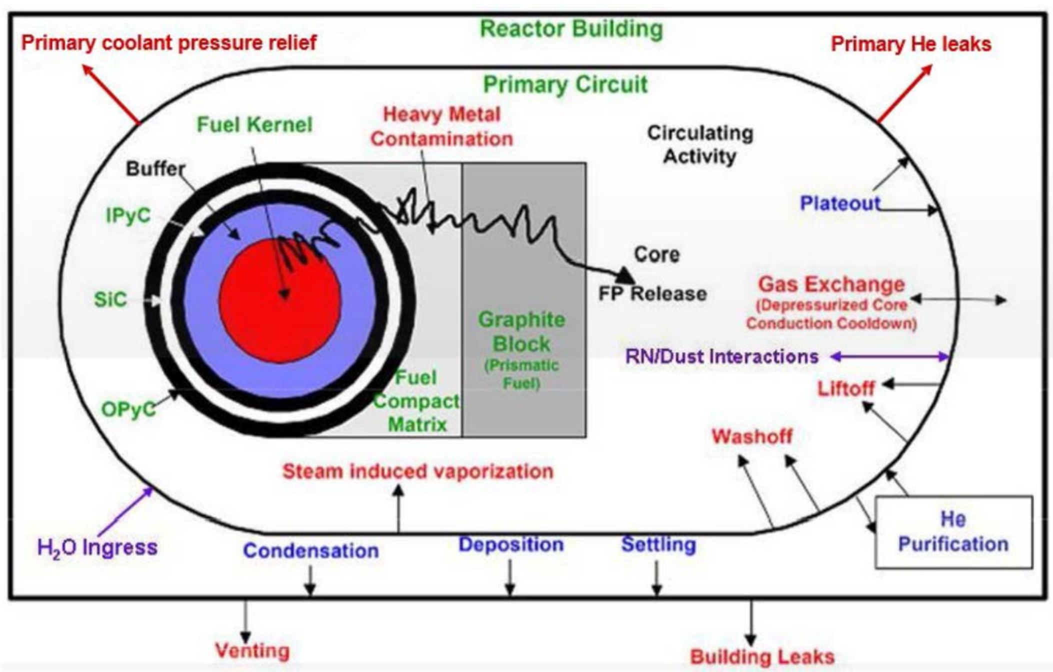


INL FACS Furnace

Oxidation Behavior in HTGR TRISO Fuel Materials (RC-1.3)

Proposals could perform new separate effects experiments with air/moisture ingress oxidation conditions not tested so far:

- **Oxidation of fuel particles and matrix material in water vapor with varying oxidant partial pressures to determine reaction kinetic parameters behavior**
- **Determine the effect of TRISO fuel matrix burn-off on the rate of oxidation and reaction kinetic effects**
- **SiC oxidation at lower oxidant (moisture, air) partial pressures where active/passive oxidation transition occurs.**
- **TRISO graphitic matrix oxidation under varying moisture/water vapor conditions**



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Proposals may:

- Use in-situ university laboratories for surrogate, non-radioactive specimen and material experiments.
- Demonstrate experiments, test rig configurations that may be practical for using radioactive isotopes and materials in hot cells.
- Use existing specimens from Advanced Gas Reactor (AGR) TRISO fuel experiments and/or Advanced Graphite Creep tests at NSUF locations for hot-cell PIE, SEM, TEM, FIB microscopy, etc.

Suggestions:

- Coordinate with AGR TRISO Fuel Program staff to get appropriate irradiated, un-irradiated specimens.
- Interaction with HTGR fuel and reactor designers on their system requirements is highly encouraged.

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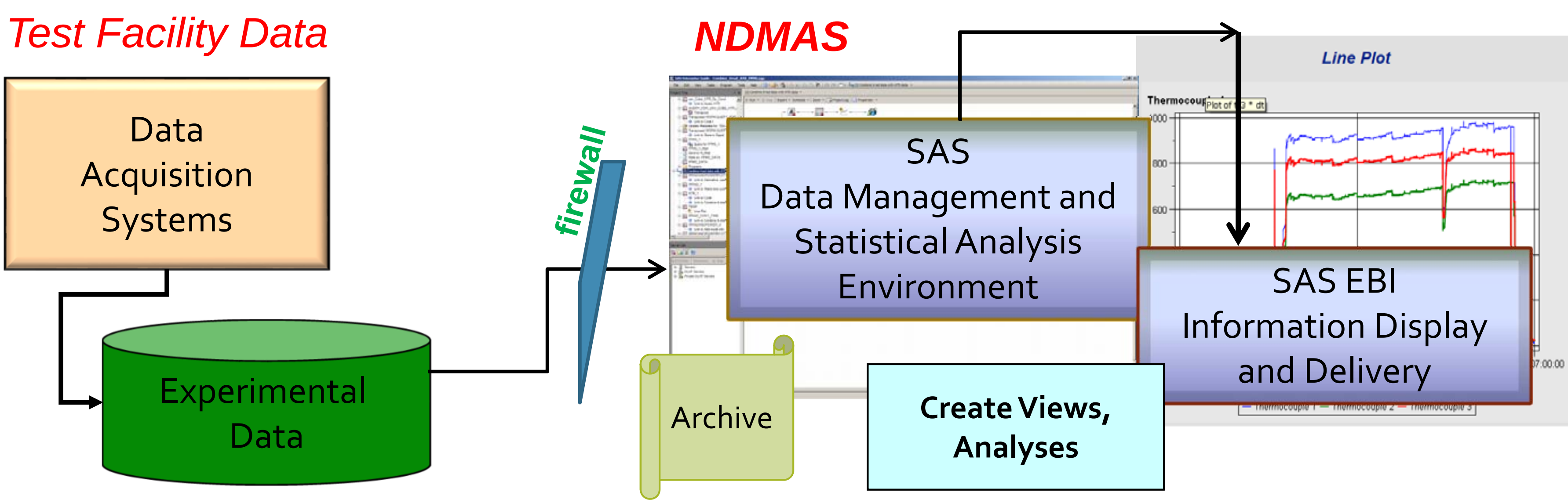
Quality Assurance Compliance

Quality Assurance and Data Retention:

- **Data collection, experiments, data validation, and verification may require compliance with NQA-1 2009 and 2009 NRC accepted paragraphs.**
- **Archiving data and simulation results in the INL Nuclear Data Management and Analysis System (NDMAS) may be required**



Interested university applicants may contact:

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