U.S. DEPARTMENT OF ENERGY | Nuclear Energy

# Nuclear Energy Enabling Technologies
# Reactor Materials

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# President Obama's Energy and Environmental Goals

*"By 2035, 80 percent of America's electricity will come from clean energy sources. Some folks want wind and solar. Others want nuclear, clean coal and natural gas. To meet this goal we will need them all."*

**2011 State of the Union Address**

*"The United States will continue to promote the safe and secure use of nuclear power worldwide through a variety of bilateral and multilateral engagements… Going forward, we will expand these efforts to promote nuclear energy generation consistent with maximizing safety and nonproliferation goals."*

**President Barack Obama**
**Climate Action Plan, 2013**

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# U.S. Government Nuclear Energy Focus

*"In partnership with our nuclear industry, the U.S. Government is supporting the* ***deployment of passively safe reactors*** *both in the United States and around the world. By incorporating passive systems into the large Gen III designs, and the* ***new small modular reactors*** *being pursued today, the world has a broader set of options for safe, reliable nuclear energy.*

*We are also working toward a* ***next-generation nuclear fuel*** *that will combine higher performance with greater tolerance for extreme events, thus giving operators additional time to respond to unforeseen conditions. This year we've entered into* ***strong partnerships with national laboratories, universities, and industry*** *and we are very pleased with the leadership role of the OECD-Nuclear Energy Agency and the IAEA in* ***expanding international involvement*** *in these efforts."*

*Secretary Moniz*
*2014 IAEA General Conference*

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# Overview

## Vision

- The NEET-RM will enable the development of innovative and revolutionary materials and provide broad-based, modern materials science that will benefit DOE-NE's mission.

## Goal

- Bring about revolutionary improvements in safety, performance, reliability, economics, and proliferation risk reduction and promote creative solutions to the broad array of nuclear energy challenges related to reactor and fuel cycle development through innovative materials development, promoting the use of modern materials science and establishing new, shared research partnerships.

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# Research Awards

- NEET Reactor Materials began in FY2012
- Annual research competition among national laboratories, universities, and industry
- Duration: 3 years
- Value: up to $1M per proposal

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# Ongoing Research

## FY 2012

- Successful completion of awards will provide advanced materials that will show improvement in mechanical performance by a factor of 5-10 over traditional materials, increase in maximum operating temperature of greater than 200° C over an 80 year lifetime, and/or increased radiation tolerance to beyond 300 dpa
- **Funded 9 proposals**

## FY 2013

- Successful completion of awards will provide advanced methods for sample preparation and new tools and techniques for examining and understanding material microstructures in a variety of conditions ranging from as-received to treated or irradiated.
- **Funded 7 proposals**

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# Ongoing Research

- **FY 2014**
  - Successful completion of awards will provide advanced joining techniques for materials for nuclear fission reactor applications.
  - **Funded 3 proposals**

- **FY 2015**
  - Successful completion of awards will provide advanced materials that will show improvement in mechanical performance by a factor of 5-10 over traditional materials, increase in maximum operating temperature of greater than 200° C over an 80 year lifetime, and/or increased radiation tolerance to beyond 300 dpa.
  - **Funded 2 proposals**

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# Descriptions of NEET-RM Funded Research

## Publications section of Energy.gov/ne

- NEET-RM Annual Summaries
- NE Materials Newsletter

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# Research Competition

- **Advanced reactor materials characterization techniques and tools.**
  - Successful completion of awards will provide advanced methods for sample preparation and new tools and techniques for examining and understanding material microstructures in a variety of conditions ranging from as-received to treated or irradiated.
- **Potential Benefits**
  - Understanding of the effects of irradiation, temperature, pressure and corrosive environments on material microstructures and mechanical behavior.
  - More efficient use of existing irradiated materials and enable fabrication of smaller specimens from previously examined materials.
- **High-risk/reward and transformational concepts are appropriate for NEET.**

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# Infrastructure Competition

- **The key components to modern materials science include computational techniques, experience, and modern tools and research techniques.**

- **The objective is to provide resources that will expand capabilities for all programs and efforts.**
  - Strategic investments in new tools for modern materials science will be evaluated to benefit the entire NE portfolio.

# Research Topics

- **NEET-NSUF 1.3a Separate Effects Irradiation Testing of Fission Product Behavior** (Federal POC: Sue Lesica & Technical POC: Rory Kennedy)

  - The objective of this workscope is to study behavior of fission products (gaseous, insoluble solid, soluble solid) and actinide species of relevance to fuel performance. Separate effects testing on transport mechanisms, thermomechanical or thermophysical property influence, and fuel cladding interaction that are strongly related or coupled to modeling efforts are encouraged. All fuel forms specifically relevant to the mission of DOE-NE can be proposed.

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# Research Topics

- **NEET-NSUF 1.3b Irradiation Assisted Stress Corrosion Cracking (IASCC)** (Federal POC: Sue Lesica & Technical POC: Rory Kennedy)
  - Mechanistic studies, data for high fluence conditions, innovative experiment designs, and alternative irradiations. Correlations between irradiated microstructures with IASCC susceptibility, role of precipitates on hardening and cracking, influence of stress/loading history, void/bubbles, fluence, and neutron spectrum on IASCC.

- **NEET-NSUF 1.3c Irradiation Testing of Materials Produced by Innovative Manufacturing Techniques** (Federal POC: Alison Hahn & Technical POC: Rory Kennedy)
  - Products from advanced and innovative manufacturing techniques that offer lower cost and higher performance can be proposed for irradiation testing to demonstrate performance. Coupling to modeling mechanisms predicting performance enhancements is encouraged.

# Research Topics

- **NEET-NSUF 1.3d Experiments with Synchrotron Radiation at the Advanced Photon Source** (Federal POC: Sue Lesica & Technical POC: Rory Kennedy)

  - Proposed research includes the use of facilities at the Materials Research Collaborative Access Team (MRCAT) beamline located in the Advanced Photon Source Facility at Argonne National Laboratory. Proposals requesting the use of these facilities should focus on post-irradiation examination or concurrent use with ongoing irradiations at ATR NSUF. Experiments conducted at MRCAT will be facilitated by the Illinois Institute of Technology. Experiments that can currently be carried out at the MRCAT include x-ray diffraction (XRD), x-ray absorption (XAS), x-ray fluorescence (XRF), and 5 µm spot size fluorescence microscopy.

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# Request for Information

- **Two Request for Information were released in Spring 2015 seeking information, comments, and feedback from interested parties on:**
  - Future work scope areas for the major NE-funded research programs
  - Needed capabilities supporting research, training, and technology demonstration
  - High priority NE related infrastructure needs including information on the potential benefit, location, funding model, and feasibility of establishing, maintaining, and operating such facilities.
- **RFIs are continuously open; for best consideration into the FY 2017 process input should be completed on NEUP.gov by May 2016.**
- **More information can be found at:**
  - **https://www.fedconnect.net/FedConnect/PublicPages/PublicSearch/Public_Opportunities.aspx *(Search DE-SOL-0008246 for R&D or DE-SOL-0008318 for Infrastructure)***
  - **https://neup.inl.gov/SitePages/FY15%20Web%20Archive.aspx**

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# Contacts

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