ATR
National Scientific User Facility

The Energy of Collaboration

February 2011 Bimonthly Report

Accomplishments and Look Ahead

February 2011

- ISU experiment insertion scheduled
- NSUF attended the TMS Annual Meeting with an exhibit February 28 – March 3, 2011
- NSUF sponsored the Microstructural Processes in Irradiated Materials Symposium at the TMS Annual Meeting, February 28 – March 3, 2011
- NSUF hosted a session on using test reactors to perform material testing at the TMS Annual Meeting, February 28 – March 3, 2011

March 2011

- University of Illinois and Drexel capsule irradiations in the ATR Hydraulic Shuttle Irradiation System (HSIS)
- Host Raymond Cao from Ohio State University as the NSUF/CAES colloquium speaker March 17
- ATR-NSUF Industry Advisory Committee (ANIAC) meeting to be held in Charlotte, NC

April 2011

- ATR-NSUF Workshop at Student ANS meeting at Georgia Tech on April 14

Noteworthy News

User Week 2011 Registration is Now Open!

The Advanced Test Reactor (ATR) National Scientific User Facility (NSUF) Users Week and combined Energy Frontier Research Center (EFRC) Summer School will be held the week of June 6-11, 2011.

This year's courses include a workshop on advanced characterization of irradiated materials, an experimenters' course on conducting irradiation projects, and a half-day research forum. ATR NSUF is also pleased to offer a CMSNF (Center for Material Science of Nuclear Fuel) four and a half-day course which will focus on microstructural development in systems exposed to extreme environments. As always, a tour of ATR NSUF facilities will be available to those interested. We look forward to seeing you there!

For additional details, visit: http://atrnsuf.inl.gov/Home/tabid/118/Default.aspx

University of Florida experiment: INL's first thermal diffusivity measurement of an irradiated material

Researchers are always seeking novel ideas and new ways of doing things, and the ATR NSUF experiment with the University of Florida is no exception. So when Idaho National Laboratory (INL) researcher Pavel Medvedev realized there would be an opportunity for thermal diffusivity measurements of irradiated materials as part of the UF experiment, he was thrilled. According to Medvedev "These types of measurements have not been done at INL previously. Not only is this a new capability for INL, but the UF experiment is generating new scientific data."

The post-irradiation examination (PIE) of the University of Florida experiment titled, "Irradiation of Potential Inert Matrix Materials"

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was initiated in June of 2010 and has thus far utilized both the irradiation and PIE capabilities of the ATR NSUF by using the Advanced Test Reactor and various PIE facilities at the INL Materials and Fuels Complex. Medvedev has worked closely with University of Florida PI Juan Nino and students Donald Moore and Peng Xu and talks about his positive experience working as the INL investigator for this ATR NSUF experiment. “The user facility has been very efficient managing the project,” he commented. “User facility support consistently exceeds my expectations.”

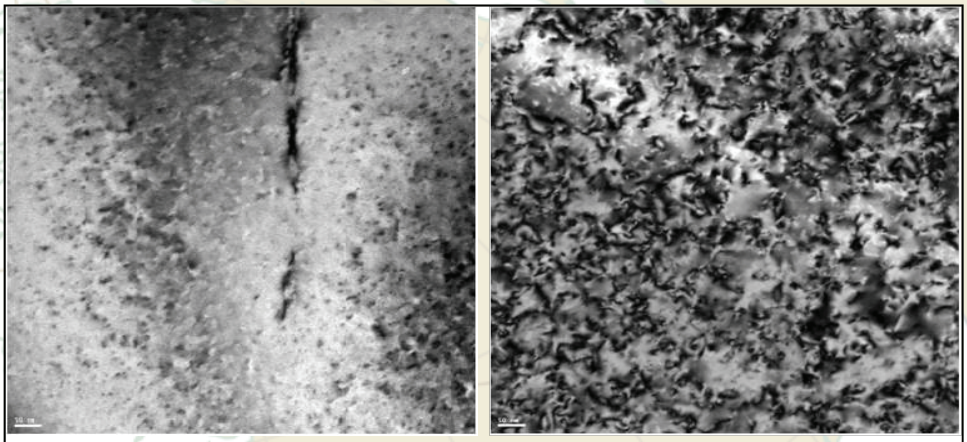

Figure 1. TEM images of MgO ceramics before (left) and after (right) irradiation in the Advanced Test Reactor. The irradiated sample features extensive neutron damage in the form of dislocations.

The objective of the experiment is to characterize the in-reactor damage to the ceramic materials proposed as inert matrices for advanced fuels, and use the results to pick the best performers. Transmission electron microscopy (TEM) and thermal diffusivity measurements completed last fall provided early insight on the condition of magnesium oxide (MgO) ceramics evaluated in this experiment; the MgO has suffered significant neutron damage that lead to considerable degradation of thermal diffusivity. The neutron damage is evidenced by the TEM images shown in Figure 1. Results so far are very exciting since the values of magnesium oxide (MgO) thermal diffusivity irradiated at elevated temperatures have not been previously published.

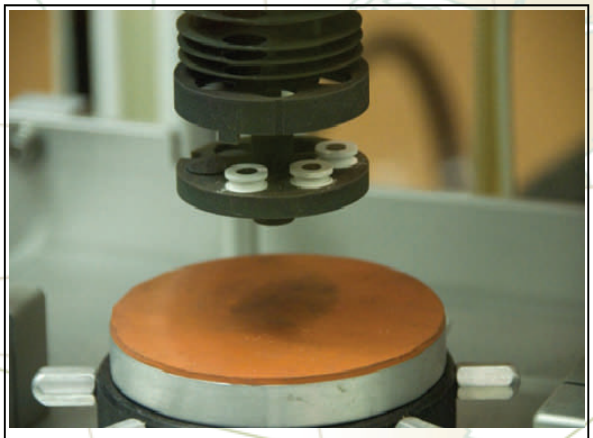

Figure 2. Ceramic samples irradiated during University of Florida experiment are positioned in the carousel of the Flashline 5000 thermal properties analyzer in a glovebox at the INL’s Materials and Fuels Complex. The measurements generated are displayed in Figure 3.

Figure 2 shows irradiated University of Florida ceramic samples positioned in the carousel of the Flashline 5000 thermal properties analyzer that generated the measurements displayed in the thermal diffusivity degradation shown in Figure 3 (next page).

In addition to MgO the UF experiment intends to evaluate the following inert matrix candidate materials: Mg_2SnO_4, $MgO{\cdot}1.5Al_2O_3$, $MgAl_2O_4$, $0.7MgO\text{-}0.3Nd_2Zr_2O_7$, and Nd_2O_7.

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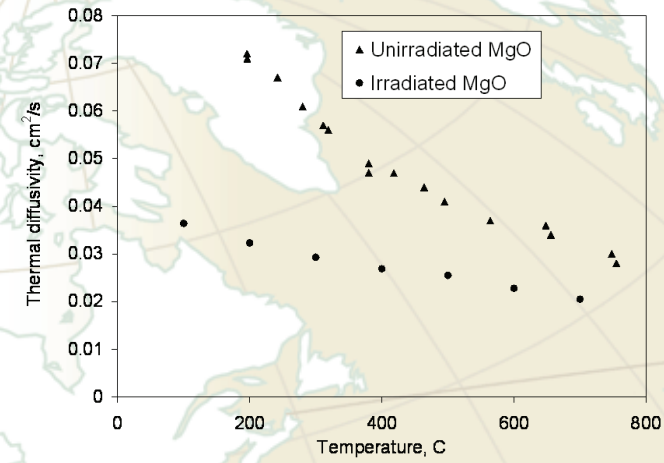

Figure 3. Effect of neutron damage on thermal diffusivity of MgO. Thermal diffusivity is a key property of the nuclear fuel. Degradation of thermal diffusivity during irradiation signifies loss of the performance.

University experiments begin analysis of irradiated samples

Twenty four university test capsules were shipped from the Advanced Test Reactor (ATR) to the Materials and Fuels Complex (MFC) in mid-July 2010. The test capsules included one from the University of Wisconsin, one from North Carolina State University, two from the University of Florida, ten from the University of Illinois, and ten from the University of California-Santa Barbara. Disassembly and cataloging of the capsules has been ongoing in the Hot Fuel Examination Facility (HFEF) containment box since early October. During the disassembly and cataloging process, sample capsules are machined open and the contents carefully removed. The test samples are located in holders or rods within the outer capsule. Figure 1 shows three rods from the University of Wisconsin experiment, one shown open and emptied (on the right) with the other two waiting for disassembly (on the left).

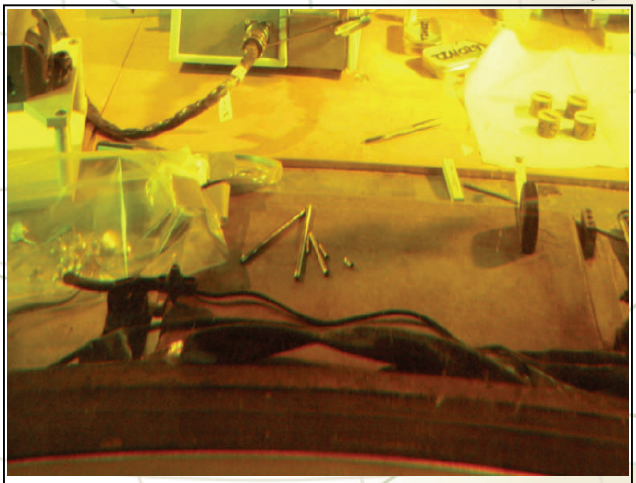

Figure 1 – University of Wisconsin Rods

The samples often consist of transmission electron microscopy (TEM) disks (~3 mm) and tensile test specimens. These small specimens require careful identification (visually recording the sample identification numbers) and loading into small holding capsules called KGTs. Figure 2 (next page) shows the process of loading a TEM disk, located at the end of the vacuum holding tool, into a KGT.

To date, the UW, NCSU, and UF capsules have been disassembled and the contents cataloged.

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Figure 3 shows the loaded KGTs located in the library. In addition, all 10 of the University of Illinois capsules have been opened and 4 of the 10 have been catalogued. Samples from the experiments will be removed and sent to other facilities for analysis as requested by the Principal Investigators.

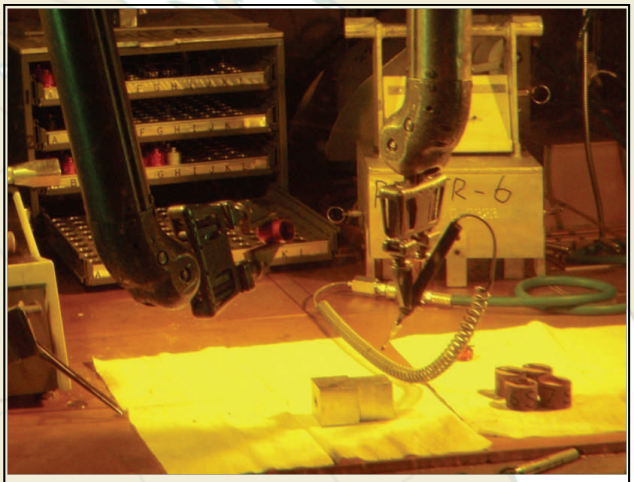

Figure 2 – University of Wisconsin TEM disk being loaded into KGT

The sorting, identifying and cataloging process requires skilled hot-cell operators, using special vacuum holding tools, binoculars, spot lights, and a cell periscope. Figure 4 shows the operators working at the containment box window (Workstation 2M) while sorting and loading a UW specimen.

Once loaded in a KGT, samples from the different university experiments can be transferred out of the HFEF hot cell to other laboratories to undergo various analyses using many high precision instruments including TEM, scanning electron microscopy (SEM), x-ray diffraction (XRD), differential scanning calorimeter (DSC), laser flash, and hardness testing. From the latest ATR shipment, 10 KGTs from the NCSU capsule have transferred to the Electron Microscopy Laboratory (EML) for preparation and analysis. Analyses will include TEM as well as tensile testing. Follow-on work will include DSC analysis and hardness testing. In addition to this work, four University of Wisconsin TEM disks have been sent to the National Institute of Standards and Technology (NIST) and eight samples to the Los Alamos Neutron Science Center (LANSCE) for further research. Analysis of the NIST samples has been completed and these samples have been returned to EML. Initial analysis of the LANSCE samples is complete and two samples will be returned to the INL for further analysis. The remaining samples will be held at LANSCE for follow-on analysis. Operations in HFEF will continue until all twenty four capsules have been disassembled and cataloged.

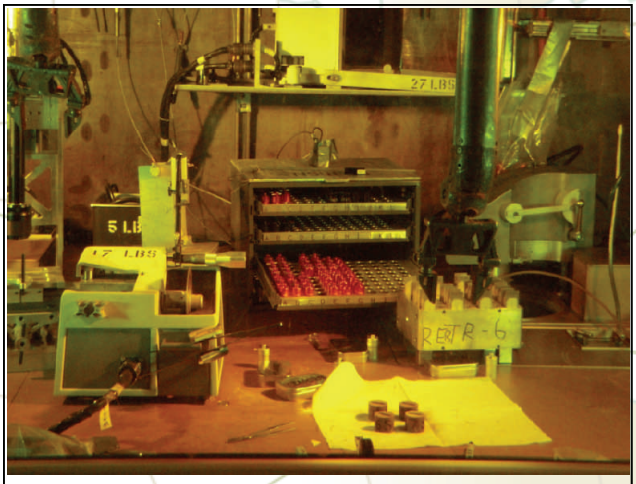

Figure 3 – KGT Containers Located in the hot cell.

Figure 4 – Operators Loading TEM Sample in KGT