

Radioactive Materialography Preparation Systems

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The Idaho National Laboratory (INL) performs materialography on irradiated materials and irradiated nuclear fuel at the Materials and Fuels Complex (MFC) in the Hot Fuel Examination Facility (HFEF)- an argon atmosphere hot cell. Because of the dose rate of these materials, this requires remote systems in a shielded hot cell to prepare samples with the desired surface finish for examination. Remote materialographic sample preparation systems have been developed to replace the existing, aging remote sample preparation systems in HFEF. These systems allow sample preparation of irradiated materials in an inert atmosphere by removing surface deformation with grinding and polishing the material surfaces. This allows researchers to analyze the deformation free microstructure with remote light microscopy, microhardness testing, and other analytical techniques available at MFC. The system consists of two benchtop semi-automatic grinding and polishing machines that are commonly used at materialographic laboratories. The machines have undergone modification by the INL for maximum efficiency for remote use and remote maintenance in HFEF.

Radioactive Materialography

Remote Sample Preparation. Following non-destructive examination techniques in HFEF, materials such as irradiated hardware or irradiated nuclear fuel are destructively examined at microscopic levels for microstructural changes during irradiation. This practice, known as radioactive materialography, requires sample preparation of irradiated materials and is achieved by performing the preparation techniques inside of an inert shielded hot cell. Sample preparation involves the steps of sectioning, mounting, grinding, cleaning, and polishing. Equipment for these steps must be modified for reliability in the hot cell environment and remote use, while maintaining the performance and efficiency of the equipment.

Radioactive Materialographic Grinding and Polishing Systems. INL has procured two Struers Tegra Semi-automatic grinding and polishing machines to replace existing semi-automatic grinding polishing machines that are aging. The Struers Tegra system consists of a base that rotates the platen with the abrasive and a head that provides sample rotation and force. The machines were modified to maximize efficiency for remote operation, prolong system life in a radioactive environment, and for integration with current facility systems in the HFEF hot cell. The system modifications included replacing components that can be degraded by radiation, modifying pneumatics, and adding features to allow operation and maintenance with remote manipulators.

Modification for Remote Operation. Features have been added to the Struers Tegra system to maximize efficiency with remote hot cell use and maintenance. Manipulator grips were added to aid with remote operation. Electrical cables were replaced with radiation resistant cabling with Amphenol® connections that are manipulator friendly. Engineered lifting fixtures to integrate with remote lifting and handling equipment were added to both the base and the head to allow for in cell installation and maintenance of both the head and base. The INL designed a water dosing system for rough grinding that filters and recirculates the water to minimize liquid waste.

The Struers Tegra system utilizes pneumatics on the head to provide a specified force on mounted samples. The pneumatic system was modified to integrate with in-cell compressed argon supply manifolds. This modification included separating the in-cell pneumatics from the control system to mitigate exhausting contaminated argon from the machines into the control system on the operating corridor.

Some components in the Struers Tegra system are susceptible to radiation damage. Components such as electronics and plastic components need to be replaced or relocated in order to ensure system reliability. Electronics were relocated to the control system outside of the hot cell. Plastic components were replaced with compatible metal components.



Figure 54: Remotized Struers Tegra Semi-automatic grinding and polishing machine.

Conclusion

INL has successfully modified two Struers Tegra Semi-automatic grinding and polishing machines for remote operation in HFEF. The system has undergone an out-of-cell qualification process and is now ready for installation in HFEF.