



The laser welder allows for high precision closure welding on materials that are difficult to weld.

Advanced Fuels Facility

Fuel and Material Fabrication

The Advanced Fuels Facility (AFF) is a 4,920 square-foot facility located at Idaho National Laboratory's Materials and Fuels Complex (MFC). This less than hazard category 3 radiological facility has been repurposed for nuclear fuel fabrication. AFF features a range of material handling and fuel fabrication capabilities used for advanced manufacturing processes. It supports INL's mission as the nation's lead nuclear energy lab.

AFF's operations involve research and development primarily with uranium-bearing fuels and associated surrogate materials to increase MFC's advanced fuel manufacturing capabilities.

Equipment and processes in AFF support customers in the Department of Energy's Office of Nuclear Energy and private industry

partners. AFF hosts a wide range of INL's new lab-scale capabilities for supporting the nation's need to develop advanced nuclear fuels.

ENGINEERED SPACES

AFF is a radiological space where uranium nuclear fuel is routinely handled. This material is safely contained in gloveboxes, hoods, and other contamination areas where the equipment and processes are protected from contamination spread by engineered systems. Inert gloveboxes are also employed to prevent metal fuels from oxidizing in air. The equipment includes:

- 2 fume hoods, one radiological
- Inert radiological gloveboxes
 - » Experiment vehicle assembly glovebox to provide a large inert volume for experiment assembly. It can maintain an
- Inert, non-radiological glovebox
 - » Mockup glovebox providing a test bed to evaluate equipment prior to installation in a radiological glovebox

atmosphere of helium, argon, and helium/argon mixtures to aid in targeting specific irradiation conditions.

- » Spark plasma sintering glovebox
- » Laser welding glovebox containing a 700W laser and capable of helium, argon, or mixed helium/argon environments.
- » Advanced manufacturing machine glovebox housing the LENS laser 3-D printer
- » Advanced manufacturing feedstock glovebox which houses powder handling and powder processing equipment



The SPS glovebox provides the capability to press radiological and nonradiological powder compacts while passing electric current through the material being compacted.



ADVANCED MANUFACTURING

AFF employs new fabrication technology for nuclear fuel and other nuclear components. This results in materials that have properties and geometries that cannot be achieved through traditional fabrication methods. The manufacturing is done through advanced powder metallurgy in the case of the SPS and the dry bag isostatic press and through 3D printing with the various systems in the facility. Key equipment includes:

- Spark plasma sintering (SPS)/field assisted sintering (FAS) system
- Dry bag isostatic press system to manufacture unique material shapes from constituent powders using a high-pressure fluid.
- Feedstock preparation and processing
- LENS laser 3D printer
- Direct energy deposition (DED) additive manufacturing system
- Digital light processing (DLP) additive manufacturing system

EXPERIMENT ASSEMBLY

AFF is also used to assemble irradiation experiments that will be tested in various nuclear reactors. The experiments range from rodlet specimens consisting of fuel and cladding to capsule assemblies which often integrate a suite of instrumentation and fuel specimens of various types and geometries. This involves tightly controlled tolerancing, complex assembly of the sample and the various instrumentation needed for monitoring, targeted atmospheric control, and novel welding methods to ensure proper closure and specimen atmosphere. The key equipment supporting this work includes:

- Laser welding system for fuel cladding and irradiation test vehicles.
- Micro-TIG welding system for assembly of delicate capsule instrumentation
- Leak testing equipment to support helium leak checks of specimens up to 7 ft long and 5.5" in diameter

- Weld under pressure system (WUPS) used to seal-weld rodlet and capsule specimens pressurized up to 500psig with any inert gas.
- Capsule assembly pressurization system (CAPS) used to pressurize experiment capsules through a one-way valve integral to experiment assemblies
- Custom lathe welder for rodlet instrumentation and development of techniques applicable to pre-irradiated fuel specimens.

OTHER EQUIPMENT/ PROCESSES

- Small metallographic station for optical analysis
 - » Medium speed saw
 - » Hot mount press
 - » Rotary polisher
 - » Leica optical microscope for examination of metallography mounts or other specimens
- Plunge EDM for processing fuel specimens requiring a high degree of precision.
- Czochralski method crystal puller to obtain pure, single crystals for scientific analysis

FOR MORE INFORMATION

General contact
Timothy Hyde
 208-533-7509
timothy.hyde@inl.gov

www.inl.gov

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