Overview of IMET (Bldg. 3025E) Hot Cells

The Irradiated Materials Examination and Testing (IMET) hot cell facility is a Class III nuclear facility located in Building 3025E at Oak Ridge National Laboratory. These hot cells are the primary mechanical testing and examination facility at ORNL for highly irradiated structural alloys and ceramics. The IMET facility is utilized by a number of programs, including DOE Office of Science (fusion energy sciences, HFIR surveillance program, SNS surveillance program), DOE Office of Nuclear Energy, Science and Technology, the Nuclear Regulatory Commission Heavy Section Steel Initiative, and NNSA Naval Reactors advanced materials programs. The six interconnected (shielded drawers/doors) steel-lined hot cells contain 320 square feet of work space and are maintained as a low alpha contamination facility (<70 dpm per 100 cm^2) to facilitate transfer of specimens to other radiological laboratories after testing or sorting. An additional 600 square feet of work space for test equipment control systems and R&D staff work stations is located in a contamination-free area in front of the hot cells. The cells offer easy access for equipment installation and maintenance via removable roof plates for large equipment and doors at the rear of the cells for smaller equipment and personnel entry. A bottom-loading carrier is used to transfer large quantities of radiological specimens into the cells via removable roof ports. The hot cells are connected to the ORNL low-level liquid waste system. All of the cells are equipped with Level 8 (or better) manipulators. Video cameras and/or Kollmorgen wall periscopes are located in most of the cells to assist in visual identification of specimens and for equipment troubleshooting. The building exhaust is connected to a HEPA filtered ventilation system. Plant air, process water, liquid nitrogen, inert gas, and electrical power are available in all cells. Internet connections are used to transfer data from the equipment to internal and external users.

The IMET facility also contains 60 storage wells capable of storing seven cans (~0.2 cu ft) in each well. A 5-ton capacity overhead crane is used for transferring the carrier between cell roof ports and the storage area. A second overhead crane (1-ton capacity) is available in Cell 6 for handling equipment and large pressure vessel sections. The building has a convenient loading area for receiving and shipping carriers.

A radiological specimen preparation area is located adjacent to the hot cells, consisting of three shielded glove boxes and a chemical hood with HEPA ventilation and connections to the ORNL low-level liquid waste system. This specimen preparation facility is used for preparation of transmission electron microscopy specimens and other specialized activities.

IMET Facility Capabilities

Functions that can be performed include tensile testing, laser profilometry, creep testing, Charpy impact and fracture toughness testing, fatigue testing, capsule disassembly, density measurements, microscopic examination, grinding, polishing, welding, shearing, machining, sawing, photography, and video examination. A listing of the equipment capabilities in the six IMET hot cells is given in the following.

Cell1 is heavily used for specimen sorting and identification. It contains video equipment and specialized fixtures to enable rapid determination of specimen identification codes. A laser profilometer (BETA LaserMike Model 162) is periodically installed in Cell 1 for several-month campaigns to measure radiation-induced creep in pressurized creep tube specimens. A precision densitometer based on Archimedes principle is used to determine the density (radiation-induced swelling) of metallic specimens with an accuracy of $\pm$0.2% for transmission electron microscopy specimens (~15 mg mass).

Cell 2 contains a screw driven Instron machine (20 kip load frame) with a turbopumped high temperature (up to 1350 C) furnace chamber that is capable of achieving pressures below 10^{-7} torr. A variety of load cells and specimen grip systems are used for testing standard and miniaturized sheet and rod tensile specimens. An automated ball indentation flow properties test system (screw driven frame) is also located in Cell 2 for room temperature tension or compression testing. The equipment is capable of testing at very low strain rates, and a variety of ball indenters are available for determination of the yield and plastic flow properties of irradiated materials. The equipment is upgradable for testing at temperatures below or above room temperature. A Mitutoyo automated microindentation hardness tester (model AAV-500, capable of Vickers or Knoop indentations) is periodically installed in either Cells 1, 2, or 4 on a campaign mode. The hardness tester is capable of performing automated user-defined indentation patterns at loads from 10 to 1000 grams, and the indentations are automatically analyzed with a 0.3 s reading speed.

Cell 3 contains a Tinius-Olsen Charpy impact machine and an MTS servohydraulic 100 kip capacity universal testing machine. The Charpy impact tester consists of a semi-automatic loading system that enables consistent control of test temperatures with rapid throughput. The Charpy impact machine has a 265 ft-lb capacity and is used to test full-size, 1/2-size, and 1/3-size Charpy V-notch specimens at temperatures from –196 to 400 C. The MTS machine is used for fracture toughness, 3-point bend, large tensile, and fatigue crack growth and crack arrest measurements in air at temperatures from –175 to 400 C.

Cell 4 is equipped with an MTS servohydraulic 20 kip capacity universal testing machine. A high vacuum furnace chamber is available for performing tests between room temperature and 700 C at pressures as low as 1.5×10^{-8} torr. Strain and load control extensometry are routinely used while conducting these tests. An air-environment annealing furnace capable of operation up to 1000 C is also located in Cell 4. Electrical resistivity measurements on a variety of specimens have been performed in Cell 4 on a campaign basis utilizing coaxial and triaxial cables that are fed from the hot cell through lead-shielded cable ports to the R&D work area. A Cortest slow-strain-rate corrosion/fatigue testing machine is available for installation in Cell 4 on a campaign basis. This equipment consists of a 2 liter, 3.5 ksi @ 320˚C Ti autoclave that can measure electrochemical corrosion potential and electrochemical noise as well as perform tension-tension fatigue tests on specimens under stress or strain control.

Cell 5 houses an FEI (Philips) XL30 scanning electron microscope equipped with a LaB_6 filament. The microscope operation is computer controlled, with internet-interfaced data transfer. All control functions for the microscope can be fully controlled by remote users.

Cell 6 contains an EMCO TM02 computer-numerically controlled (CNC, CAD/CAM) milling machine that is programmable for fully automated machining operations. Ten tool stations are available for milling, drilling, etc. It can be used for fabrication of Charpy impact, compact tension, and tensile specimens from bulk irradiated material, and can also be used for minor capsule disassembly. A Wachs guillotine saw and a slow-speed diamond saw are also located in Cell 6, along with a specimen sorting and identification station. The cell is equipped with a 1-ton bridge crane for positioning of heavy equipment.