DEPARTMENT OF NUCLEAR SCIENCE AND ENGINEERING

Research Facilities

The department's programs are supported by a number of outstanding experimental facilities for advanced research in nuclear science and engineering.

The MIT Research Reactor in the Nuclear Reactor Laboratory operates at a thermal power of 6 MW and is fueled with U-235 in a compact light-water cooled core surrounded by a heavy-water reflector. This reactor provides a wide range of radiation-related research and teaching opportunities for the students and faculty of the department. Major programs, sponsored by industry and government, to study materials performance and degradation under irradiation are currently in place. Details of the laboratory's research programs and facilities are given at Research | MIT Nuclear Reactor Laboratory.

The department's theoretical and experimental research in plasma physics and fusion energy is primarily carried out through the Plasma Science and Fusion Center (PSFC) with faculty leadership in key areas of astrophysical plasma science, magnetic confinement fusion physics, high energy density physics, fusion materials science, and superconducting magnet engineering. The department's faculty, research scientists, and students have access to on-campus midscale experimental facilities at the PSFC to carry out their research, including particle accelerators, neutron generators, linear plasma devices, high energy density physics devices, and magnet fabrication and test facilities, and three large high-bay experimental halls for experiments. A full range of shops (welding, vacuum, electronics, etc) as well as a professional engineering and technical staff support the reseach. In addition, the PSFC theory group has significant computational resources to support departmental research in these areas.

The thermal hydraulics laboratory is equipped with state-of-the-art instrumentation for measurement of fluid thermo-physical properties, fabrication facilities to engineer surfaces at the micro and nano scale, and flow loops for characterizing convective heat transfer and fluid dynamics behavior. A particularly novel facility uses high-speed infrared thermography to study fundamental phenomena of boiling, such as bubble nucleation, growth, and departure from a heated surface over a broad range of operating pressures, flow rates, and heat fluxes.

The study of nuclear materials plays a central role in the department. Research in the Laboratory for Electrochemical Interfaces centers on understanding the response of surface structure and physical chemistry when driven by dynamic environments of chemical reactivity and mechanical stress. This laboratory is equipped with surface science tools including scanning tunneling microscopy and X-ray photoelectron spectroscopy as well as electrochemical and electronic characterization tools. The H. H. Uhlig Corrosion Laboratory investigates the causes of failure in materials, with an emphasis on nuclear materials. The Mesoscale Nuclear Materials group studies reasons for material property changes due to radiation and rapid ways of measuring them. The Cambridge Laboratory of Accelerator Study of Surfaces provides unique capabilities for studying synergistic radiation effects in various environments, including plasma-facing materials, molten salt and liquid metal corrosion, and superconductors at cryogenic temperatures. This lab is also used for ion beam analysis, implantation, and self-ion damage studies.

The Cappellaro lab is located in the Research Laboratory of Electronics and consists of a 1,200 sq-ft-space dedicated to magnetic resonance and spin physics. One laboratory houses a 7 Tesla superconducting magnet with a wide bore and in-house-made probes, equipped with a spectrometer providing RF modulation and detection for the manipulation and detection of nuclear spins. Two other laboratories are dedicated to NV-based research. The laboratories house three state-of-the art confocal photoluminescence setups with all of the necessary microwave electronics, RF electronics, and control hardware for manipulating NV quantum spins and one confocal microscope for imaging only.

The Quantum Measurement Group is located in Building NW13 and boasts a state-of-the-art laboratory facility, complete with advanced crystal growth and quantum materials measurement systems. The laboratory is equipped with a range of crystal growth techniques, including flux and vapor transport growth capabilities, with a specially designed tetra-arc furnace being a particular highlight. The arc generators can produce temperatures up to 3000 degrees Celsius, streamlining single crystal growth and making it especially suitable for synthesizing high-melting-temperature materials. The laboratory's characterization capability features a Physical Property Measurement System (PPMS) with a temperature range of 1.8 Kelvin to 400 Kelvin and an external magnetic field up to 9 Tesla. The PPMS system is equipped to conduct a wide range of measurements, including DC/AC electrical transport, Hall measurement, heat capacity, thermal transport, and thermoelectric measurements, with the additional advantage of angular-resolved capability from the horizontal rotator. The laboratory also features angular-resolved dilatometry and magneto-restriction capabilities, along with a custom-made steup for high-precision nonlinear electrical transport measurements.

In addition to the above facilities, the department has a nuclear instrumentation laboratory and a 14 MeV neutron source and a tunable-energy proton cyclotron source up to 12 MeV. Laboratory space and shop facilities are available for research in all areas of nuclear science and engineering. A state-of-the-art scanning electron microscope with an integrated focused ion beam that can be used to study irradiated specimens is available. The Department of Nuclear Science and Engineering owns high performance computing resources that are part of the Engaging cluster housed at the

MGHPCC facility and maintained by the Office of Research Computing and Data, and also leverages other shared campus computing resources for research and education.