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PROGRESS UPDATE IN ADVANCED MATERIALS AND INSTRUMENTATION IRRADIATION TESTS AT THE MIT RESEARCH REACTOR

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ABSTRACT

The Massachusetts Institute of Technology Reactor (MITR) is a 6 MW university research reactor that is part of the Nuclear Reactor Laboratory (NRL). It is well-suited for carrying out both basic and integrated studies because of its relatively high power density (similar to that of a LWR), its capability to control chemistry and temperature to reflect prototypic conditions, its easy-access geometric configuration, its in-core space for up to three independent irradiation tests, and the proven capability of the MITR staff to design and execute proof-of-concept experiments more quickly and cost effectively than at other test reactors. The MITR became the first partner facility of Department of Energy's Nuclear Science User Facilities (NSUF) in 2008, and has been utilized by a wide user base from universities, national labs and the nuclear industry. Current research programs at the NRL are centered on irradiation tests of advanced materials and sensors in support of current and next generation nuclear reactors. Building on the NRL research staff's expertise, other synergistic research projects have led to first-of-its-kind irradiation experiments. Four major programs are highlights of the in-core irradiation program over the last few years. A set of four fluoride salt (Flibe) irradiation experiments at 650-700 °C to study materials corrosion, tritium generation and control to support FHR development were completed with support from a DOE integrated research project. Accident Tolerant Fuel cladding such as SiC-SiC composites and coated Zircaloy materials have been tested at prototypic PWR chemistry and operating conditions in pressurized water loop. These ongoing campaigns are sponsored by the DOE GAIN program, NSUF, and industry sponsors (Ceramic Tubular Products, Toshiba and Westinghouse). Several instrumentation irradiation tests have been carried out at high-temperature for ultrasonic and fiber optic sensors to support radiation experiments and advanced reactor developments. These experiments are sponsored by DOE and the NSUF, with sensors provided by Idaho National Laboratory (INL), the French Commission d'Energie Atomique and several universities. Steady-state and transient tests of nuclear instrumentation being developed for the INL TREAT transient test facility were performed by both in the MITR and at TREAT. MIT-NRL has also expanded its Post Irradiation Examination (PIE) infrastructure to enable irradiated materials handling and characterization. There are two hot cells in the reactor containment building. Standard metallurgical sample preparation can be carried out on activated samples in a dedicated hot laboratory. Macro-photography, optical and SEM microscopy, and optical profilometry of irradiated specimens are also completed in this space. Other equipment used with radioactive at the NRL include a xenon-flash thermal diffusivity instrument, HPGe gamma spectrometers, a liquid scintillation counter, and gaseous ^{3}H and ^{14}C collection and measurement instruments.