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Use of Ion Irradiation to Emulate Radiation Damage in Reactor Core Materials

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Reactor core materials in both thermal and fast reactors, as well as fusion first wall and blanket materials must withstand irradiation to high doses at high temperature. While test reactors have traditionally been used to evaluate and down select materials that can be used in such harsh environments, they are becoming increasingly scarce, prohibitively expensive, and are much too slow to support the launch of new reactor concepts. Accelerator based irradiation techniques overcome all of these deficiencies as these accelerators are quite common, they can achieve damage levels in days that take years in a reactor, and therefore, they are very inexpensive. The Michigan Ion Beam Laboratory at the University of Michigan is configured to provide a radiation environment that is representative of a reactor core. This is accomplished by the use of multiple accelerators to create radiation damage simultaneously with the simulation of gas production by transmutation. A new 300 keV transmission electron microscope interfaced to two beamlines will provide the capability to observe the evolution of radiation damage and the impact of gas production by transmutation as it occurs. Beam current, irradiation temperature and maintenance of an ultraclean, high vacuum provide for a high degree of control of the irradiation parameters as well as reproducibility. A description of the laboratory and its capabilities will be presented, and some results of the application of accelerators to radiation damage in metallic alloys will be discussed.

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