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FTP/P1-27: Fusion Material Irradiation Test Facility at SNS

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Computational modeling and experimental studies provide compelling evidence that displacement damage formation induced by fission neutrons and the 14.1 MeV neutrons representative of D-T fusion are quite similar. However, helium and hydrogen production levels with a D-T neutron energy spectrum are much higher. The impact of these gaseous transmutation products is a critical unresolved issue which is being addressed by combining numerical models and specialized ion and neutron irradiation experiments. Because of the uncertainties associated with both modeling and ion irradiation experiments, there is a clear need for an accessible irradiation facility that can provide near prototypic levels of helium and hydrogen. A modest range of He/dpa ratios is desirable to help calibrate and verify the modeling studies. The scientific understanding obtained would also enable more effective use of a future large-volume fusion engineering irradiation facility (such as IFMIF) when it becomes available.

A conceptual level design for a fusion materials irradiation test station (FMITS) for installation at the Spallation Neutron Source (SNS) has been completed. Samples would be located within two horizontal tubes in front of the mercury target. For these specimen locations, the back-scattering neutron flux spectra should be close to the ITER fusion spectrum. The PKA spectra at the FMITS samples were also compared to those for ITER, and the results show good agreement. Material damage rates would be 1.6–5.5 dpa/yr for steel, and 1.8–3.4 dpa/yr for SiC.

The test station would be water-cooled with a variable inert-gas blanket for temperature control. Thermal analysis shows that the sample temperatures can be maintained as high as 600℃ even if average beam power varies by 50%. The FMITS assembly is designed to be installed over a target module and can be reused with multiple targets. The paper describes the design concepts for the FMITS gas system with additional hardware and controls, the mechanical layout of the FMITS assembly including an example experiment, revisions to the existing target shroud, target carriage modifications for FMITS utilities, and remote handling procedures and logistics. Safety and reliability impacts were also evaluated and appear to be acceptable.

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