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Plasma- and gas-driven tritium permeation in fusion materials

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M. Shimada (INL, USA) reported on the gas-driven hydrogen permeation experiments in fusion materials and the development of the MOOSE-based Tritium Migration Analysis Program (TMAP) version 8. He first discussed the experimental apparatus and methodology used for deuterium (D) permeation studies in Eurofer97 (CRP Round Robin) and summarized previous results on D/T permeation in nitrogen-strengthened stainless steel, H/D permeation in Hastelloy N, and D permeation in FeCrAl alloy. The Eurofer97 study utilized an upstream/primary gas pressure of 100 kPa D_2 and sample temperature ranges from 473 to 823 K. Measured D permeability results were within 66-150% of referenced data, except at 823 K (550 ℃). Surface analysis using Auger electron spectroscopy indicated the formation of chromium oxide on the front/primary surface after the D permeation study.

INL's Fusion Safety Program leveraged INL's computational capabilities to modernize tritium sciences, resulting in the recent release of MOOSE-based TMAP8 for high-fidelity transport and multiphysics modeling with massively parallel computation. INL utilizes experimental and computational capabilities developed by DOE NE (Nuclear Energy) and DOE SC (Office of Science) to advance tritium and fusion nuclear science. All experiments (SGAP, TGAP, TPE, TDS) are operational to support the IAEA CRP with neutron-irradiated tungsten tasks. TMAP8 is open-source and available at https://mooseframework.inl.gov/TMAP8/index.html .

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