TRITIUM AND HELIUM EFFECTS ON MATERIALS FOR FUSION TECHNOLOGY

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Selecting the materials of construction is critical to demonstrating safe operation of ITER, including both the main reactor and the tritium processing facility. Of most concern with respect to the structural materials performance is tritium/helium embrittlement under the fusion reactor operating conditions. Hydrogen (tritium) embrittlement of structural alloys has long been studied. Phenomena such as decreased ductility and reduced resistance to fracture are major concerns in the operation of tritium process systems. An additional concern unique to the tritium service environment is the phenomenon of helium embrittlement. Helium in-growth as a result of tritium decay has been shown to exacerbate the loss of ductility and fracture resistance due to tritium, and also reduces stress-rupture properties.

The Savannah River National Laboratory (SRNL) has supported the Savannah River Site NNSA-Defense programs Tritium Facilities in these areas, and possesses extensive expertise in the field of solute tritium and helium effects on materials of construction (eg. austenitic stainless steels), as well as tritium effects on polymeric materials for valves and seals in tritium facilities. SRNL has also demonstrated the profound effect of decay helium causing porosity and heat affected zone cracking when welding tritium exposed and aged stainless steel. SRNL proposes to leverage this experience in support of the US ITER mission to support the design, demonstration, and implementation of both the ITER tritium processing system and the main fusion reactor. A review of the SRNL experience related to tritium and helium effects on materials will be presented, and tritium exposure and tritiated materials testing facilities at SRS will be reviewed.