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SRNL is a DOE National Laboratory operated by Savannah River Nuclear Solutions.

Facts about Savannah River National Laboratory

U.S. DEPARTMENT OF ENERGY • SAVANNAH RIVER SITE • AIKEN • SC

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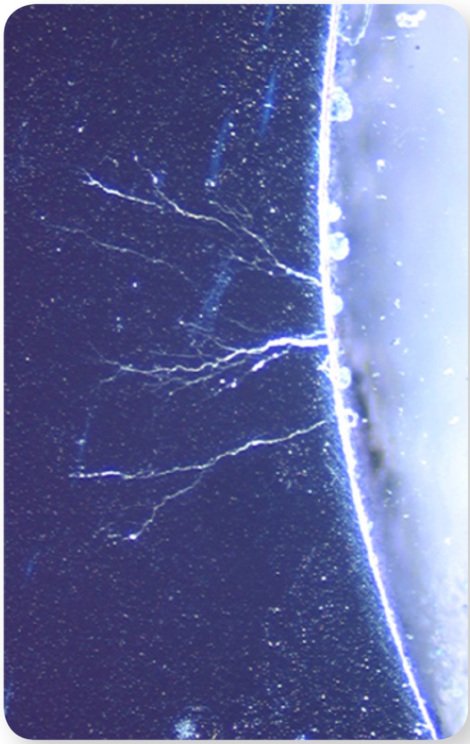
SRNL Fast Facts

- National Laboratory for DOE Office of Environmental Management
- Supporting customers at SRS, DOE and other federal agencies nationally and internationally
- Applied research, development and deployment of practical, high-value and cost effect technology solutions in the areas of national security, clean energy and environmental stewardship
- Operated by Savannah River Nuclear Solutions for the U.S. Department of Energy near Aiken, S.C.

Contact Information

SRNL Office of Communications
803.725.4396

Tritium Effects on Materials



Cracking Thresholds are measured by exposing pre-cracked samples to tritium gas and slowly pulling them apart or by step-loading and holding until crack begins to grow. Crack growth is monitored by using the DC-Potential Drop technique.

In an effort to ensure the safety of the nation's nuclear weapons stockpile, the Savannah River National Laboratory (SRNL) maintains an active role in the research of tritium's impact on metal and the functionality of weapons systems. Not only does SRNL closely examine the material durability used in the construction of weapons, it examines performance quality in an effort to make certain the weapons stockpile is operating in a safe manner and at its best level. SRNL has been deeply involved in tritium research for over 50 years. Not only do we have the ability, we invented the science.

Putting Our Stockpile to the Test

Tritium reservoirs used in nuclear warheads are constructed of stainless steel and are used for the long-term containment of tritium gas. Tritium and its decay product, helium-3, can cause cracking in these vessels. The tritium embrittlement phenomenon is an aging process that occurs over a long period of time. At SRNL, we have the specialized tools for the delicate testing of reservoirs and tritiated materials. Through an extensive suite of specialized equipment and skilled researchers, SRNL has a unique capability unlike any other laboratory in the world. By investigating the Hydrogen/Helium embrittlement of materials, SRNL is able to drive the design codes for new technology.

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This research provides data for Design Agencies for use in Materials Engineering Models for Tritium Containment Vessels:

- Develop models for crack initiation and propagation
- Develop microstructural models for bulk regions, weld regions and heat-affected zones
- Include region's unique properties: tritium solubility & diffusivity, helium build-in from decay, and fracture.
- Use Finite Element Method analysis for performance prediction

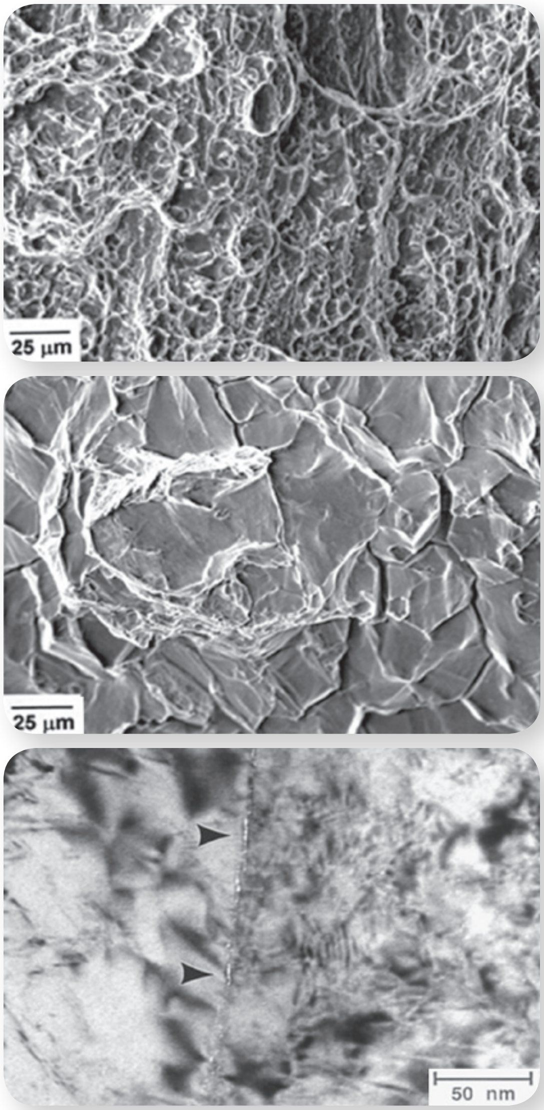
How it's Done

SRNL has been the sole NNSA laboratory conducting research and development on the effects of tritium and decay helium on the structural properties of materials for more than twenty years. Embrittlement by helium-3, the decay product of tritium, was discovered at SRL in 1980. During the 1980's, the effects of hydrogen isotopes and helium on tensile properties and permeability of stainless steels were measured and characterized. During the 1990's, fracture toughness properties were first determined and the tritium compatibility of various steels evaluated. Today, the fracture mechanics approach developed by SRNL is used by the Design Agencies in their Tritium Reservoir Design Guides and fracture models.

Today, SRNL is primarily focused on providing required data for firmly establishing and extending tritium reservoir lifetimes. Materials are tested by first fabricating fracture mechanics specimens from tritium reservoir forgings and components and then exposing the samples to hydrogen or tritium gas. The samples are then aged to build-in helium from tritium decay. Fracture toughness properties are measured over time to elucidate the combined effects of tritium and decay helium. Electron microscopy is then used to determine the effects of hydrogen and helium on the fracture process.

Reservoir Structural Materials Testing Labs

- Mechanical Testing Laboratory 773A-B061: Used for conducting mechanical and fracture toughness tests on as-received and tritium-exposed samples and components.
- Fracture Toughness Test Facility 774A: Used for thermally charging and mechanical testing samples in high-pressure hydrogen.
- Electron Microscopy Laboratories 773A: Used for scanning and transmission electron microscopy for characterizing tritium and decay helium effects on fracture processes.
- Future Enhanced Fracture Toughness Test Facility Project 774A: Used for measuring fracture toughness properties of tritium-exposed samples in high-pressure hydrogen gas.
- Materials Laboratory, 773A: Used for Electric Discharge Machining of As-Received and Tritium-Exposed Components and Samples.



Tritium and decay helium change fracture process.

Unexposed (top), Tritium-exposed and aged (middle), Transmission Electron Microscopy observation (bottom)

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AUGUST 2013 13CC00015_FS018