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Hydrogen-Induced Embrittlement of Candidate Target Materials for Applications in Spallation-Neutron-Target Systems: Quarterly Progress Report (June 01 – August 31, 2002)

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Quarterly Progress Report
(June 01 – August 31, 2002)

Hydrogen-Induced Embrittlement of Candidate Target Materials for Applications in Spallation-Neutron-Target Systems
AAA Task-4

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August 31, 2002
Hydrogen-Induced Embrittlement of Candidate Target Materials for Applications in Spallation-Neutron-Target Systems

Introduction

The primary objective of this task is to evaluate the effect of hydrogen on environment-assisted cracking of candidate target materials for applications in spallation-neutron-target (SNT) systems such as accelerator production of tritium (APT) and accelerator transmutation of waste (ATW). The materials selected for evaluation and characterization are martensitic stainless steels including Alloy HT-9, Alloy EP 823 and Type 422 stainless steel. The susceptibility to stress corrosion cracking (SCC) and hydrogen embrittlement (HE) of these materials are being evaluated in environments of interest using tensile specimens under constant load and slow-strain-rate (SSR) conditions. Further, the localized corrosion behavior of these alloys is being evaluated by electrochemical polarization techniques. The extent and morphology of cracking and localized corrosion of the tested specimens are being determined by optical microscopy and scanning electron microscopy (SEM). The concentration of hydrogen resulting from cathodic charging will be analyzed by secondary ion mass spectrometry (SIMS).

Personnel

The current project participants are listed below.

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Accomplishments

- The Materials Performance Laboratory (MPL) having numerous metallurgical and corrosion testing capabilities has been fully functional in TBE Building, Room No. B129 since June 2002.
- SCC tests using calibrated proof rings and smooth tensile specimens of martensitic Alloy EP-823 (Heat number 2054) are ongoing at constant applied loads in two aqueous environments of interest. Results indicate that this alloy became susceptible to SCC in a 90°C acidic brine (pH = 2.62) when subjected to an applied stress of 95% of the material’s yield strength value. However, no cracking has yet been observed in the neutral solution. The extent and morphology of cracking are currently being evaluated by using both optical microscopy and SEM.
- In contrast to constant-load SCC testing, slow-strain-rate (SSR) tests are well in progress using smooth tensile specimens of similar alloy in two salt solutions at a strain rate of 3.3 x 10^{-6} sec^{-1}. Results indicate that, as anticipated, the time to failure was significantly reduced as the testing temperature was increased from ambient to 90°C. Further, both the maximum load and the failure load were reduced at the elevated temperature. As expected, the ductility parameters (% elongation and % reduction in area) were also substantially reduced. The tested specimens are currently undergoing metallographic evaluations.
- Some of the smooth tensile specimens have been notched at the center of the gage section to study the effect of stress concentration on the SCC/HE susceptibility of candidate alloys.
- Specimens for electrochemical polarization studies are machined. Testing using potentiostats will be initiated soon.
- New adapters for reference electrodes have just been received, that will be used to evaluate the effect of cathodic charging during HE tests under potentiostatic controls.

Problems

No problems are anticipated.

Status of Funds

Expenditures incurred during this quarter are within the target amount allocated.

Plans for the next quarter

- Continue SCC/HE testing of all three types of martensitic stainless steels.
- Perform heat treatments of remaining heats of all three test materials.
- Perform localized corrosion testing using electrochemical techniques.
- Perform metallurgical evaluations including microstructural characterizations.
- Conduct failure analyses using SEM.
- Prepare technical/scientific papers for presentations and publications (ECS, NACE, IHLRWM).