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

Ajit K. Roy
University of Nevada, Las Vegas, aroy@unlv.nevada.edu

Brendan O'Toole
University of Nevada, Las Vegas, brendan.otoole@unlv.edu

Follow this and additional works at: http://digitalscholarship.unlv.edu/hrc_trp_sciences_materials

Part of the Materials Chemistry Commons, Metallurgy Commons, Nuclear Engineering Commons, and the Oil, Gas, and Energy Commons

Repository Citation
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

Principal Investigator  
Ajit K. Roy, Ph.D.

Co-Principal Investigator  
Brendan J. O’Toole, Ph.D.

Investigators  
David W. Hatchet, Ph.D.  
Zhiyong Wang, Ph.D.  
Konstantin G. Zabotkin  
Mohammad K. Hossain  
Sudheer Sama  
Ramprashad Prabhakaran  
Aaron Tippetts

University of Nevada Las Vegas  
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.

Principal Investigator (PI): Dr. Ajit K. Roy
Co-PI: Dr. Brendan J. O’Toole
Department of Mechanical Engineering, UNLV
Roy: Phone: (702) 895-1463 email: aroy@unlv.edu
O’Toole: Phone: (702) 895-3885 email: bj@me.unlv.edu

Investigators (UNLV): Dr. David W. Hatchet, Department of Chemistry
Dr. Zhiyong (John) Wang, Department of Mechanical Engineering
Mr. Konstantin G. Zabotkin, Department of Mechanical Engineering
Mr. Mohammad K. Hossain, Department of Mechanical Engineering
Mr. Sudheer Sama, Department of Mechanical Engineering
Mr. Ramprashad Prabhakaran, Department of Mechanical Engineering
Mr. Aaron Tippetts, Department of Mechanical Engineering
Hatchet: Phone: (702) 895-3509 email: dhatchet@ccmail.nevada.edu
Wang: Phone: (702) 895-3442 email: zwang@nscee.edu
Zabotkin: Phone: (702) 895-1027 email: Zabotkin@hotmail.com
Hossain: Phone: (702) 895-1027 email: mdkamal71@hotmail.com
Sama: Phone: (702) 895-1027 email: sudheersama@hotmail.com
Prabhakaran: Phone: (702) 895-1027 email: pramprashad@hotmail.com
Tippetts: Phone: (702) 460-6408 email: aartip@msn.com
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).