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Environment-Induced Degradation and Crack-Growth Studies of Candidate Target Materials: AAA Task-4 Quarterly (December 1, 2001 – February 28, 2002) Report

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MEMORANDUM

To: Drs. Anthony Hechanova and Gary Cerefice, HRC
From: Drs. Ajit Roy and Brendan O'Toole, MEG
Date: March 24, 2002

Subject: AAA Task-4 Quarterly (12/1, 2001 – 02/28, 2002) Report

Introduction

The primary objective of this task is to evaluate the effect of hydrogen on environment-assisted cracking of candidate 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 HT-9, EP 823 and 422. The susceptibility to stress corrosion cracking (SCC) and hydrogen embrittlement (HE) of these alloys will be evaluated in environments of interest using tensile specimens under constant load and slow-strain-rate (SSR) conditions. The extent and morphology of cracking of these alloys will further be evaluated 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 Investigators: Dr. Ajit K. Roy
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Investigators (UNLV): Dr. Zhiyong (John) Wang, Department of Mechanical Engineering
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Highlights of Accomplishment

- Design of the “Materials Performance Laboratory (MPL)” has been finalized to accommodate numerous materials and corrosion testing related to both the Yucca Mountain (YM) and UNLV AAA projects. A formal request (inter-departmental-requisition) has been submitted to the UNLV Planning and Construction Department for necessary modifications of the existing facilities/utilities in room #B129 so that all desired experimental activities can be performed in MPL in the most efficient and timely manner. It is anticipated that the construction of MPL would be completed by the middle of April 2002. Meanwhile, tests are currently being performed in room #B113.
- Equipment ordered as part of infrastructure development have started arriving at UNLV. It is anticipated that a major portion of these equipment will be installed in MPL by the end of April 2002.
- Nine experimental heats of desired target materials (three each of Alloys HT-9, EP-823 and 422) have been melted and processed at the Timken Research Laboratory, Canton, Ohio. One heat of each material has been heat treated to produce quenched and tempered metallurgical microstructures typical of martensitic stainless steels. Rockwell hardness measurements of some of the heat-treated materials have been done. Efforts are well underway to send these heat-treated materials to an off-site facility to machine tensile specimens for evaluating their ambient temperature mechanical properties, and their susceptibility to SCC/HE in aqueous environments of interest.
- Evaluation of the SCC behavior using proof rings (at constant load) and cladding materials (YM Project) has now been well established. A similar approach will be used to evaluate the cracking susceptibility of target materials upon availability of the machined tensile specimens.
- Meanwhile, trial tests involving slow-strain-rate (SSR) units and electrochemical equipment (potentiostat) are being performed to establish the testing techniques and related parameters. It is anticipated that all testing techniques will be standardized prior to their implementation in MPL.
- Mr. Konstantin Zobotkin has recently joined this task as a research associate to expedite the construction of MPL and experimental activities.
- Mr. Mohammad Kamal Hossain will soon be joining this task as a research assistant in the Mechanical Engineering Department to fill the empty position vacated by Mr. Raymond Kozak.
- Finally, Mr. Aaron Tippetts, an undergraduate student in mechanical engineering, has joined this task in January 2002 to assist in experimental work.

Problems

Assuming that the modification of the room #B129 and the installation of the major equipment in this location are completed by the desired timeframe (April 2002), no problems are envisioned.

Status of Funds

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

Plans for Next Quarter

- Consolidate all testing activities in room #B129 (MPL). Install equipment according to the final design.
- Perform SCC tests using constant load and SSR techniques without applied electrochemical potentials (E_{cont}).
- Perform electrochemical polarization tests using calibrated potentiostats.
- Initiate metallurgical characterization of tested specimens using optical microscopy and SEM.