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Development of a Mechanistic Understanding of High-Temperature Deformation of Alloy EP-823 for Transmutation Applications TRP Task-10: Quarterly Progress Report (March 01 – May 31, 2003)

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Quarterly Progress Report
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TRP Task-10

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Introduction

The purpose of this project is to evaluate the elevated temperature tensile properties of Alloy EP-823, a leading target material for accelerator-driven waste transmutation applications. This alloy has been proven to be an excellent structural material to contain the lead-bismuth-eutectic (LBE) nuclear coolant needed for fast spectrum operations. Very little data exist in the open literature on the tensile properties of this alloy. The test material will be thermally treated prior to the evaluation of its tensile properties at temperatures relevant to the transmutation applications. The deformation characteristics of tensile specimens, upon completion of testing, will be evaluated by surface analytical techniques using scanning electron microscopy (SEM) and transmission electron microscopy (TEM). The overall results will lead to the development of a mechanistic understanding of the elevated-temperature deformation processes in this alloy as a function of thermal treatment. The resultant data may also provide guidance in developing future target materials possessing the improved metallurgical properties, and enhanced LBE corrosion resistance.

Personnel

The current project participants are listed below.

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Accomplishments

- The Materials Testing System (MTS) machine to perform tensile testing has been modified to accommodate high-temperature testing in the presence of an inert gas (nitrogen) using a custom-made chamber. The testing temperature using this hot chamber can be monitored by two K-type thermocouples.
- A laser extensometer having a scan rate of 100 scans/second has also been added to this MTS unit to measure the elongation in the gage section of test specimen during the plastic deformation under tensile loading at the desired strain rate.
- A pair of custom-built water-cooled specimen grips made of maraging steel (M250) has been attached to the MTS machine to prevent these grips from being heated during high-temperature testing.
- Testing has been performed at ambient temperature and 100^{o}C using tensile specimens fabricated from vacuum-melted and heat-treated (at the Timken Company, OH) bars of martensitic Alloy EP-823. Preliminary data indicate that both the yield strength (YS) and the ultimate tensile strength (UTS) of the tested material were slightly reduced at the elevated temperature. However, no significant reduction in ductility in terms of percent elongation (%El) and percent reduction in area (%RA) was observed in these tests.
- Temperature profiles have been developed to determine the times needed to achieve the desired test temperature, as a part of the furnace calibration process. Tests are in progress.

Problems

The MTS unit has finally been made operational to accommodate the desired testing at elevated temperatures. Thus, no problems are anticipated.

Status of Funds

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

Plans for the Next Quarter

- Perform testing at 300, 400, 500, and 600^{o}C using smooth tensile specimens having different thermal treatments.
- Perform a limited number of experiments by loading the test specimens up to some selected stress levels beyond the YS without breaking the specimens.
- Perform detailed metallographic evaluations of the tensile specimens before and after testing.
- Perform fractographic evaluations (extent and morphology of failures) by SEM.
- Determine the deformation characteristics versus the testing temperature using TEM.
- Perform high-temperature tensile testing using cathodically-charged specimens.