4-27-2005

Use of Positron Annihilation Spectroscopy for Stress-Strain Measurements: Quarterly Progress Report (December 01, 2004 – February 28, 2005)

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Quarterly Progress Report
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Use of Positron Annihilation Spectroscopy for Stress-Strain Measurements

TRP Task-14

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April 27, 2005

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Introduction

The purpose of this collaborative research project involving the University of Nevada Las Vegas (UNLV), the Idaho State University (ISU), and the Los Alamos National Laboratory (LANL) is to evaluate the feasibility of determining residual stresses in cold-worked, plastically-deformed (bent), and welded materials using a nondestructive method based on positron annihilation spectroscopy (PAS). This technique uses γ-rays from a small MeV electron Linac to generate positrons inside the sample via pair production. This method is known to have capabilities of characterizing defects in thick specimens that could not be accomplished by conventional positron technique or other nondestructive methods. The data generated by the PAS method has been compared to those obtained by other methods such as neutron diffraction (ND), X-ray diffraction (for thin specimens), and ring-core (destructive-for thick specimens) techniques. During the initial phase of this task residual stresses induced in experimental heats of austenitic type 304L stainless steel, and martensitic Alloy EP-823 have been determined by X-ray diffraction (XRD), PAS and ring-core (RC) techniques. More recently, residual stress measurements have been performed on Alloy HT-9 subjected to cold deformation and welding using all four techniques. The current testing is focused on the evaluation of residual stresses in irradiated materials (welded/plastically-deformed), and welded specimens, with and without post-weld-thermal-treatment (PWTT). Measurements of residual stresses in cold-worked and welded specimens of Alloys EP-823 and HT-9 are planned to be performed at the Atomic Energy of Canada Limited (AECL) by using the ND technique. Development of calibration curves using the PAS method are also being planned at ISU involving Alloy HT-9. Transmission electron microscopic (TEM) analyses are also being continued.

Personnel

The current project participants are listed below.

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Accomplishments:

- A technical paper titled "Residual Stress Characterization in Structural Materials by Destructive and Nondestructive Techniques" has been published in the *Journal of Materials Engineering and Performance*, ASM International, Ohio, in April 2005, Vol. 14, No. 2, p. 203-211.

- A technical paper titled "Residual Stress Measurements in Welded and Plastically Deformed Target Structural Materials," has been accepted for publication in June 2005 issue of the *Journal of ASTM International*.

- Cold-worked and welded specimens of Alloys EP-823 and HT-9 have been machined to measure residual stresses by ND and PAS techniques. Some tensile specimens have also been prepared for development of calibration curves for residual stress/strain by the PAS technique.

- TEM studies to analyze defects/imperfections in cold-worked Alloys EP-823 and HT-9 are in progress.

- A technical paper based on the recent PAS measurements has been presented at the ANS students' conference held in Columbus, Ohio.

Problem:

No problems are anticipated.

Status of Funds

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

Plans for the next quarter

- Continuation of planned testing and analyses of the resultant data.
- Performance of additional residual stress measurements by ND and PAS methods at AECL and ISU, respectively.
- Continuation of literature search
- Standardization of the PAS technique for residual stress evaluation in specimens of different configurations.