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Use of Positron Annihilation Spectroscopy for Stress-Strain Measurements: Quarterly Progress Report (September 01 – November 30, 2004)

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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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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). Transmission electron microscopic analyses are also being performed.

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 accepted for publication in the *Journal of Materials Engineering and Performance*, ASM International, Ohio.

- The PAS method has been applied to develop calibration curves for line shape parameters (S and T) using unstressed and stressed (different magnitude) tensile specimens of martensitic stainless steels. These curves will enable the determination of residual stresses in plastically-deformed materials once the magnitude of S or T parameter is determined by the PAS technique.

- The tensile and welded specimens have been irradiated by low energy photon beam at ISU to compare the residual stresses, with and without radiation.

- Measurements of residual stresses have been performed by the PAS technique on both welded and post-weld thermally-treated specimens to evaluate the effect of thermal treatment on the residual stresses generated due to welding.

- Use of transmission electron microscopy (TEM) has been initiated to analyze voids and dislocations in cold-worked/welded materials.

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 method at AECL
- Continuation of literature search
- Standardization of the PAS technique for residual stress evaluation in specimens of different configurations.