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Use of Positron Annihilation Spectroscopy for Stress-Strain Measurements: Quarterly Progress Report (March – May 2005)

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Quarterly Progress Report
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TRP Task-14

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University of Nevada Las Vegas

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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:

- Analyses of defects (dislocations) in martensitic Alloy EP-823, cold-reduced to different levels, have been performed by using transmission electron microscopy. The dislocation density has been related to the degree of cold-reduction and residual stress in terms of a line-shape parameter determined by the positron annihilation spectroscopy (PAS).

- Additional PAS measurements are ongoing on tensile, welded and cold-worked specimens of Alloys EP-823 and HT-9 at the Idaho Accelerator Center of ISU. Both Subhra and Silpa are involved in these measurements.

- Silpa is performing neutron diffraction (ND) measurements at the Atomic Energy of Canada Limited (AECL), Chalk River Laboratory using Cold-worked and welded specimens of Alloys EP-823 and HT-9.

- TEM studies involving welded specimens of Type 304L stainless steel and Alloy EP-823 are being performed by Srinivas to characterize defects at the fusion line, heat-affected-zone and base metal.

- A several technical papers based on the recent experimental data have been accepted for conference presentations and publications.

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