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Use of Positron Annihilation Spectroscopy for Stress-Strain Measurements: Quarterly Progress Report (June 1 – August 31, 2002)

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Quarterly Progress Report
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Use of Positron Annihilation Spectroscopy for Stress-Strain Measurements
AAA 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, and welded materials using a nondestructive method based on positron annihilation spectroscopy. 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 generated data will be compared to those obtained by other methods such as neutron diffraction (for thin specimens) and ring-core (destructive) methods. During the initial phase, residual stresses induced in experimental heats of austenitic Type 304L stainless steel, and martensitic Alloy EP-823 will be determined by all three techniques. Later, irradiated materials may be evaluated.

Personnel

The current project participants are listed below.

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Accomplishments

- Two 100 lbs experimental heats of Alloy EP-823 and Type 304L stainless steel have been vacuum induction melted (VIM) at the Timken Research, Canton, OH. They have been forged, and are currently undergoing rolling to be reduced to the desired specimen thickness prior to being heat treated and further-processed.

Problems

No problems are anticipated.

Status of Funds

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

Plans for the next quarter

- Complete rolling of plate materials to achieve the desired sizes, followed by proper thermal treatments. Type 304 stainless steel will be austenitized, followed by air cooling (solution-annealing). Alloy EP-823 will be austenitized, followed by oil quenching. Subsequently, the quenched material will be tempered to produce fully-tempered martensitic microstructure. All these operations will be performed at the Timken Research.
- The metallurgical microstructures of heat-treated materials will be analyzed at UNLV using the Leica optical microscope.
- Tensile specimens will be made from heat-treated plates to evaluate their ambient temperature mechanical properties using the MTS unit at UNLV.
- A part of these heat-treated plates of both materials will be sent to Lambda Research to be bent by a three-point-bending fixture. These bent plates will then be analyzed at Lambda Research, ISU and LANL for evaluation of residual stresses generated due to bending.
- Send a part of heat-treated plates to LANL for welding of similar and dissimilar materials.
- Perform cold reduction of a few heat-treated plates to reduce thickness by 5% and 10%, and subsequently measure the residual stresses induced.