ESRF	**Experiment title:** Large area strain and phase mapping of an austenitic steel plate with a three-pass TIG weld bead	**Experiment number:** MA600
Beamline: ID15A	**Date of experiment:** from: 05/02/2009 to: 10/02/2009	**Date of report:** 12/02/2010 *Received at ESRF:*
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Report:

Finite Element weld residual stress modelling involves complex non-linear analyses where many assumptions have to be made. In this context the aspect of through-thickness resolved experimental data is of particular interest, because fracture assessments for welded components are closely linked to the stress depth-profiles.

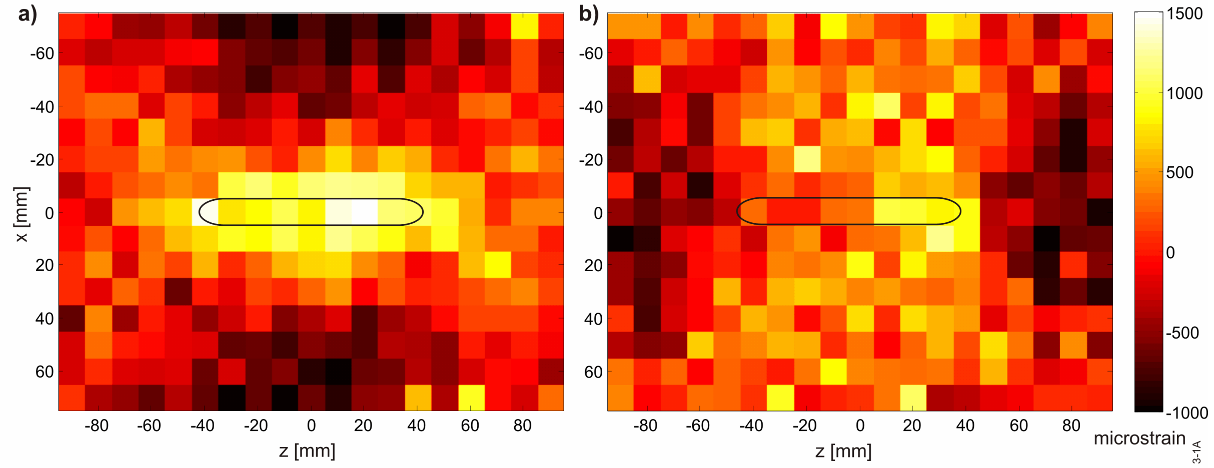

Fig. 1: Experimental results from depth-resolved residual strain measurements in an 18 mm thick austenitic steel plate with three weld beads in a slot (slot outline indicated by solid line). The strain components parallel (a) and perpendicular (b) to the weld line are shown for a 3 mm thick layer just underneath the top surface. Weld start is at z=-40 mm.

The specimen investigated was an 18 mm thick plate made from austenitic steel AISI 316L with three weld beads in a slot. The welding was produced with a semi-automated Tungsten Inert Gas welding process. During the manufacturing process an extensive monitoring of welding parameters, specimen distortion and specimen temperature was carried out. The specimen was created as a weld-modelling benchmark within the network on neutron techniques standardization for structural integrity (NeT).

The 3D spatial distribution of the residual stress in the entire specimen was investigated by applying the spiral slit technique available at the beamline ID15A. Along with the weld specimen a set of strain-free reference cubes were investigated. The cubes were manufactured from different regions in the weld and in the parent material. The beam energy was 108.5 keV and the beam was focussed with Compound Refractive Lenses to a size of 14 x 14 μm^2 at the specimen position. A Pixium flat panel X-ray detector system was placed about 1200 mm behind the specimen to record the diffraction patterns. The beam energy had been optimized taking into account the undulator spectrum, the photon absorption by the specimen and the efficiency of he detector.
A unique data set of the 3D spatial distribution of the in plane residual strain in the entire specimen was obtained from these measurements. A novel full pattern analysis approach, based on the evaluation of distinct diffraction spots from individual grains, was developed. Residual stresses were calculated based on the plane stress assumption. Figure 1 shows a small fraction of the experimental results. High tensile transverse stresses were observed within the bead deposited first. The maximum longitudinal stresses were found beneath the slot. Furthermore significant weld start- and stop-effects were observed. The validity of the results was checked with respect to the possible impact of intergranular strains due to plastic deformation.

Publications resulting from this experiment:

René V. Martins, Carsten Ohms, and Koenraad Decroos: *Full Depth-Resolved Strain Mapping of a Three-Pass Slot Weld Specimen in Austenitic Stainless Steel Using the Spiral Slit Technique*, Mater. Sci. Forum, accepted February 2010

René V. Martins, Carsten Ohms, and Koenraad Decroos: *Full 3D spatially resolved mapping of residual strain in a 316L austenitic stainless steel weld specimen*, Mater. Sci. Eng. A, submitted December 2009