PREPARATORY INDUSTRIAL PROJECT

Measurement of residual stresses on aerospace components using neutron diffraction technique

THE INDUSTRIAL CHALLENGE

Within the aerospace industry there is a trend to replace large casted ring structures with smaller arc-shaped sections. These are assembled into ring structures using electron beam welding. This approach increases the flexibility in manufacturing and reduce costs. However, the welding process may introduce unfavourable residual stresses that cause geometric distortions and out of tolerance problems. In order to minimize those welding stresses it is of great importance to adjust the welding parameters. This can be accomplished using simulation, but in order to use the numerical tools in an industrial context there is a need to make sure that the simulation results have a sufficient accuracy.

WHY USING A LARGE SCALE FACILITY?

The accuracy of simulations can be verified on the surface using e.g. X-ray diffraction measurements. The challenge is however to verify residual stresses deeper into the thickness of components. The only possibility to measure residual stresses on thick walled components in a non-destructive approach is to utilise neutron diffraction technique. This equipment is today only available at large scale facilities.

THE RESULTS AND EXPECTED IMPACT

The preparatory work was performed by GKN Aerospace AB and RISE IVF AB. A Scopus search detected more than 2300 publications within the field of residual stress measurement and neutron diffraction. The affiliation is wide spread between universities and large scale facilities all over the world. Some selected publications also addressed measurement of welding processes in titanium (Ti-6Al-4V) and indicated promising results.

Based on this survey an experimental measurement test, using a test object with two thick-walled titanium substrates joined with electron beam welding was developed together with Engin-X at ISIS Neutron and Muon Source. Based on those discussions we plan to conduct experiments at this experimental station.

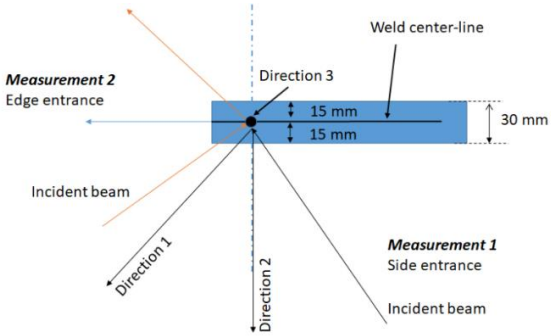

Figure. Overview of the measurement setup for the planned experiment.

The pre-study was a first step in the ambition to introduce neutron diffraction technique as a tool for measurement of in-depth residual stresses after electron beam welding. This will improve the possibilities minimize residual stresses and out of tolerance problems of components and structures. For future means the vision is to use neutron diffraction technique as a support tool when optimizing other processes like casting, forging, heat treatment and additive manufacturing and as a tool for calibration of residual stress simulations.

"The project has developed beneficial knowledge within the area of residual stress measurements"
/Robert Lundberg, GKN

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