Advanced Arc and Laser Fabrication and Repair Welding of Nickel Superalloys

PUBLISHABLE SUMMARY

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Background

Gas turbine original equipment manufacturers (OEMs), maintenance companies and end users all have a stakeholder interest in the joining of high value nickel superalloy components. Both original fabrication, and salvage through build-up are areas of interest. The potential economic benefit gained by improved fabrication and salvage procedures for both aero engines and industrial gas turbine engines can be significant. There can be a number of difficulties with welding of nickel superalloys during fabrication or repair activities, including cracking in the weld and HAZ, porosity, distortion and reduced creep strength.

The general approach taken to overcome the cracking and distortion problems is the minimisation of the heat input and control of the thermal cycle during welding. In the past TWI had undertaken several preliminary developments of low heat input arc and laser welding processes, demonstrating the production of crack-free welds in nickel superalloys, via Core Research Programme (CRP), through appropriate selection of low heat input welding processes and parameters, combined with the choice of suitable consumables (TWI Members Reports 854/2006, and 811/2004). TWI has built on these developments and applied them to a selected set of industrially relevant materials, to address currently encountered difficulties.

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Objectives

- Identify the most promising low heat input welding technologies for nickel superalloys.
- Determine the productivity benefits of advanced arc and laser welding techniques.
- Assess the integrity of the welds made using advanced arc and laser welding procedures.
- Establish practical guidelines to facilitate the industrial application of advanced arc and laser welding techniques.

Benefits

The project developed welding processes giving the possibility of:

- Higher integrity and reduced incidence of in-service failure;
- Life extension of high value items;
- Fewer flaws;
- Greater adaptability to difficult geometries;
- Higher productivity;
- Less requirement for welder skill;
- Lower costs.

Participants

The Sponsor Group comprised:

- BAMTRI
- Baoshan Iron & Steel Co Ltd
- IHI Corporation
- National Aerospace Laboratory NLR
- SNECMA Service

Scope of Work

The following work programme was agreed with the sponsors:

- Arc (high frequency pulsed TIG and powder plasma) and laser welding of Inconel 718 sheet and plate;
- High frequency pulsed TIG and laser welding of HA188;
- Powder plasma arc and laser repair of IN100 castings;
- Powder plasma and laser welding of IN718 to C263;
- Laser welding of GH99 and Inconel 600.

Welds were validated by room temperature and elevated temperature tensile and low cycle fatigue (LCF) tests.

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Deliverables

This project identified preferred processes, procedures and consumables, for welding and repair of nickel superalloys. The results of the welding trials were supported with characterisation and mechanical test data, allowing comparison of welded and parent materials. In addition, an evaluation of state-of-the-art equipment and novel processing techniques will provide valuable future insights for Sponsors.

Price and Duration

The project had a duration of 3 years and a budget of £250,000. On completion of the project, the project results may be available for purchase subject to agreement with current Sponsors.

Further Information

For further information on how a Joint Industry Project (JIP) runs please visit:

http://www.twi-global.com/services/research-and-consultancy/joint-industry-projects/

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