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Detection of kissing bonds in friction stir welds of aero structures and automotive components.

The StirScan project has developed an ultrasonic non-destructive testing (NDT) prototype system in order to address the challenging problem of detecting kissing bonds in friction stir welds of aero structures (e.g. fuselage and wing skins) and automotive components (e.g. aluminium alloy wheels).

This project addresses the challenging problem of detecting kissing bonds in friction stir welds. Friction stir welding (FSW) is a relatively new solid-state joining technique for aluminium alloys which offers excellent joint performance and consistent reproducibility. The use of FSW is of particular interest to the aerospace and wider transport sector. Compared with the commonly used riveting joining methods for aerospace structures, the adoption of FSW offers opportunities for increased joining speed, higher stress tolerance, and longer service life. In addition, the application of FSW methods has been shown to save up to 10% weight on typical airframe structures, as well as reducing production time by 40 %.

However, 'kissing bonds' are a concern with FSW. A kissing bond is a specific type of defect in solid-state bonding, in which two solid materials are in contact but with little or no metallurgical bonding present. One of the major causes of kissing bond defects in friction stir welds is insufficient penetration of the tool pin into the workpiece material, causing incomplete welding. Such features reduce fatigue performance of joints and currently are very difficult to detect or accurately size using existing NDT methods. The fatigue life of friction stir welds is significantly reduced if kissing bonds exist, as has been demonstrated by mechanical testing of welded coupons with defects of known size.

The StirScan project developed innovative ultrasonic based non-destructive testing (NDT) techniques to enable the detection of kissing bond defects below 0.3mm in size in friction stir welded components. A novel non-linear ultrasonic technique, and an oblique incidence high frequency ultrasonic technique, have been used for the assessment. The technique will lead to a more sensitive measurement of interfacial

defects and will detect small kissing bond flaws.

Effective detection of kissing bonds would open up a much wider range of applications, including safety-critical subcomponents. Enabling the adoption of FSW into the wide, SME dominated, aerospace component market is potentially a EUR 43 billion opportunity.

StirScan is a collaborative project comprising the following organisations:
SMEs:

- Vermon, (France)
- Theta Technologies, (UK)
- Innora Ltd, (Greece)
- ABIS Sp. Z o.o. Spolka Komandytowa (Poland)
- Saint Jean Wheels, (Norway)

RTDs:

- TWI Ltd (UK)
- Katholieke Universiteit Leuven, (Belgium)
- VZLU, (Czech Republic)

The project is co-ordinated and managed by Vermon and is partly funded by the EC under the Research for the benefits of SMEs Project Ref: FP7-SME-2012-315436.

StirScan has developed two advanced ultrasonic techniques:

- A non-linear ultrasonic technique and
- A high frequency ultrasonic technique for the detection of 'kissing bonds' in friction stir welded joints.

StirScan non-destructive testing prototype hardware and software (non-linear and high frequency) contain:

- Three customised ultrasonic probes
- Two multi-axis scanners
- An electronic pulser-receiver instrument to implement both developed techniques and
- Data acquisition and analysis software

By developing the StirScan NDT inspection system, a number of pan-European benefits will be generated through the research collaboration. The developed StirScan system will:

- allow the assessment of high performance aluminium friction stir welded joints for aerospace structures and automotive components;
- enable increased adoption of FSW in the aerospace and automotive industries which will lead to low welding operation costs, clean and safe welding process and new opportunities for product design;
- open up a new inspection market place, targeting on detection of kissing bonds

within friction stir welded joints, for the SME inspection equipment and service suppliers;

- enable manufacturers to supply more high performance and good quality friction stir welded components to be able to increase revenue.

Countries

Belgium, Czechia, Greece, France, Poland, United Kingdom

Contributor

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TWI

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