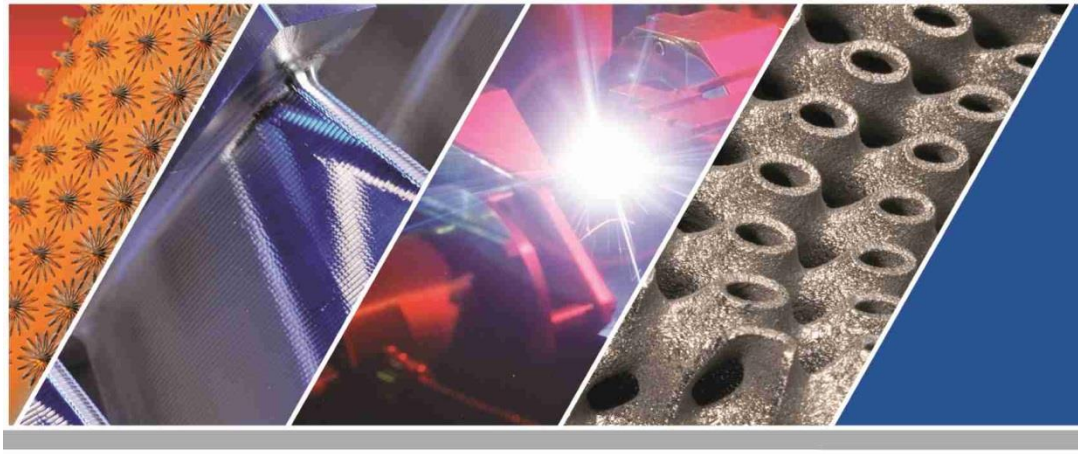
Improving and Industrialising Cold Spray Repair



JOINT INDUSTRY PROJECT OUTLINE

PROP310955

Summary

Current repair technology

Many components are retired from service due to relatively minor damage resulting from corrosion, wear or foreign object damage. Implementing a reliable, repeatable, cost effective repair strategy putting components back into service could result in significant cost savings by eliminating the need to install new parts, thereby reducing the need for holding stock or taking platforms out of service while new components are manufactured. Repair also reduces the embodied energy and CO2 emissions associated with replacing parts with newly build.

Current fusion/weld-based repairs of metallic components add significant heat input into the material, which alters the underlying microstructure, often leading to unacceptable degradation to mechanical properties. Weld-based repairs can also be challenging for highly oxygen sensitive materials, such as aluminium, magnesium and titanium, and require inert environments which may be impractical. Weld-based repairs also result in residual stresses, which can lead to unacceptable part distortions or that degrade the fatigue life of the part.

Parts can also be repaired using polymer fillers (such as epoxy), which only provides limited mechanical properties and restrict the lifetime of the repair. The upper temperature limit of such repair is also significantly constrained.

Cold spray repair

Cold spray is a solid-state deposition technology that results in little to no heat input to the component, thereby retaining the original mechanical properties in the parent material. Oxygen-sensitive materials can be processed without the need for inert conditions and the resulting deposition generally results in compressive residual stresses that do not degrade the fatigue life of the component. Process variants exist that mean the process is highly flexible, allowing a range of different materials to be deposited at high rate across a range of cost-quality measures.

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Project Concept

Innovation and Industrialisation

Cold spray technology is capable of depositing well-bonded, dense metallic layers without significant heat input that might affect underlying parent material microstructures. The process is entirely solid state (no melting/solidification of parent or feedstock materials), enabling the processing of materials that would otherwise be challenging, due to factors such as oxidation, segregation, or cracking. This makes cold spray an excellent candidate for repairing high value components and returning them into service.

This JIP aims to support TWI members in the adoption of the technology by developing repair frameworks, template repair instructions and understanding quality assurance tools available.

Objectives

The primary objectives of the project are:

- Develop a framework for classifying repair scenarios, considering various factors such as damage severity, required material properties, and service conditions.
- Establish quality assurance and control measures for cold spray repairs to ensure reliability and consistency in repair processes, including in-situ process monitoring tools, post-deposition non-destructive evaluation, and validation using witness coupons for destructive testing/examination.

- Develop training material and a template repair instruction for cold spray repair to ensure adherence to industry standards and best practice.

Benefits

The successful completion of this project may lead to several significant benefits:

- Sponsors could potentially gain a route to repair structures that would otherwise have been challenging with conventional methods, offering an enhanced efficiency in repair processes. This could result in cost savings, waste reduction, decreased requirements for spares/inventory, and increased uptime of equipment/platforms.
- Sponsors will have access to structured frameworks, and will be able to make informed decisions about repair options, improving decision-making processes and optimising resource allocation.
- Rapid adoption of cold spray technology will be facilitated through the implementation of a common framework and adaptable document packs tailored to individual needs. This streamlined approach will save sponsors time and costs associated with qualifying and approving new repairs.

Track Record

TWI have been active in cold spray research since 2007, running research and development projects for industrial members and leading large-scale programmes of work for government organisations. As an active member of the global cold spray community, TWI have pioneered new developments on powder modification and hybrid laser processes. In the past 2 years, TWI have invested heavily in new cold spray equipment (>£1.5m) and have access to world class facilities, including our newly commissioned TKF-1000. TWI has experts with deep technical knowledge and a broad understanding of the benefits and limitations that cold spray can bring to repair and remanufacture.

Approach

The project comprises three main work packages:

- WP1: Frameworks for classification of repair scenarios
  - Assessment methods for repair suitability and classification
  - Review of defect preparation methods
  - Repair process using cold spray
- WP2: Quality assurance and control measures
  - A state-of-art technical review
  - Implementation of quality assurance and control measures
  - Non-destructive evaluation (NDE) trials and repair validation assessment
- WP3: Template repair instructions and operator training
  - Development of a template repair instruction
  - Development of cold spray training materials for operators, integrating best practice guidelines
  - Outline of potential qualification pathways and exploration of engagement opportunities with classification bodies

Deliverables

The project will yield the following deliverables:

- D1.1 – A report on frameworks for classification of repair scenarios (WP1)
- D2.1 – A report on quality assurance and control measures (WP2)
- D2.2 – A report on NDE trials and repair validation assessment (WP2)
- D3.1 - A report on review of existing guidelines for repair (WP3)
- D3.2 – Training course materials (WP3)

Further Information

TWI welcome feedback from potential sponsors on the scope of work and will seek to tailor the final proposal to maximise value for TWI Members.

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

https://www.twi-global.com/what-we-do/research-and-technology/current-research-programmes/joint-industry-projects#/

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