Cold Spray Technology

Cold spray is a solid state process by which a fine powder is projected at high velocity by a carrier gas onto a substrate surface, to build up a coating or a near net shape free-form deposit. The powder particles deform on impact and bond with the surface, in a mechanism similar to explosion welding. Usually, both the powder and the substrate are metals, but this is not always the case. The main applications of cold spray include:

- functional coatings,
- cosmetic/dimensional repairs,
- load-bearing/structural repairs of high-value components,
- near net shape additive manufacturing.

The main advantages of cold spray include

- No heat affected zone (HAZ) in the coated substrate; unweldable materials can be repaired/coated.
- The powder consumable is at a low temperature relative to its melting point; oxygen-sensitive materials can be deposited under ambient conditions without significant $O_2$ or $N_2$ pickup.
- In many cases, very thick layers (several mm or cm) can be built up.
- Cold spray systems can generally be divided into 'low pressure' and 'high pressure' systems, the main difference being the injection point of the powder (pre or post nozzle throat).
- Both portable and fixed cold spray systems are available, but at the current time their capabilities differ.
Confidential project work for industrial clients
Since 2010, TWI has completed over 40 individual cold spray projects for some 30 TWI Industrial Member companies in sectors as diverse as oil and gas, renewable energy, aerospace and medical implants.

More than half of these projects have been for the aerospace and defence industries and have involved cold spray deposition of materials of interest to these sectors, including Al, Ti and Ni alloys.

Core Research Projects
TWI’s Industrial Members have exclusive access to the Members’ Reports of the following cold spray research work to the value of over £600k which has been funded by TWI Industrial Members:

<table>
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<tr>
<th>CRP Report Title</th>
<th>Report Number</th>
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<tr>
<td>A new approach to structural cold spray repair of Ti–6Al–4V components</td>
<td>To be published 2019</td>
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<tr>
<td>Structural cold spray repair using thermally treated precipitation hardenable Al alloy powders</td>
<td>To be published 2019</td>
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<tr>
<td>A new epoxy–free adhesion test method for cold spray coatings</td>
<td>To be published 2019</td>
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<tr>
<td>Assessment of Cold Spray Systems for the Deposition of Nickel Alloy 718 Coatings</td>
<td>1063/2015</td>
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<td>Corrosion Behaviour of Cold Sprayed Tantalum coatings</td>
<td>1016/2012</td>
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<tr>
<td>Preliminary evaluation of spray–formed Ti and Ti coatings prepared by cold spray</td>
<td>0995/2011</td>
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<tr>
<td>Cold spray technology update and TWI facility installation</td>
<td>0947/2010</td>
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<tr>
<td>Preliminary evaluation of metallic coatings deposited using the cold spray process</td>
<td>0787/2004</td>
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Industry sector case studies
Recently, TWI was a key partner in Europe’s largest collaborative cold spray project, CORSAIR. This 3½ year, €4m project significantly advanced the understanding of cold spray deposition of structural Al alloys as well as Ti–6Al–4V for aeronautical component repairs.

TWI was also a key partner in the COLA (http://www.cola-project.eu/) project working on laser–assisted cold spray. TWI is still active in this area and has developed a laser–assisted cold spray and has subsequently developed a new laser–assisted cold spray capability in Cambridge.

In late 2017, TWI started work on a 2½ year Innovate UK–funded collaborative project with two UK–based SMEs. The aim of the project is to establish a European supply chain for proprietary thermally treated Al alloy powders. A small-scale powder heat treatment capability is also being established at TWI as part of this project. The work is expected to facilitate industrial uptake of structural cold spray repairs of high strength Al alloys.
Cold spray equipment
TWI owns two cold spray systems and has invested in a large-scale spray booth so that coatings development work can extend to prototype component scale. These systems include:

- A state-of-the-art Impact 5/11 system with maximum pressure/temperature capability of 50–60 bar and 1000–1100°C, commissioned in December 2015
- A CGT Kinetiks 4000/47 system with maximum pressure/temperature capability of 40 bar and 800°C, commissioned in 2007

Our large scale thermal and cold spraying facility factsheet is available as a PDF download from our website, www.twi-global.com/capabilities/equipment-directory/

Cold spray training
TWI offers bespoke cold spray training. Presented over two days, the course is intended for materials and design engineers who are considering the use of cold spray as a coating, repair or additive manufacturing technology. Course attendees will gain a detailed appreciation of where cold spray fits into the wider field of thermal spray technology, surface engineering and coating processes.

Please contact us for more information.

Industrial mentoring and sponsorship of PhD students
TWI currently sponsors three PhD students through TWI’s National Structural Integrity Research Centre (NSIRC). They are working on the following cold spray related topics:

- Cold Spray Deposition of Precipitation-Hardenable Aluminium Alloys for Structural Repairs
- Cold Spray Additive Manufacturing
- Fatigue and Fracture Properties of Cold Spray Additive Manufactured Materials

Intellectual property
TWI holds intellectual property in-house relating to methods for evaluating coatings during cold spray parameter development, methods for handling of oxygen-sensitive powders and the heat treatment of powders.
Selected papers and publications (TWI authors are in bold)


Barnett R., Harvey M.D.F., McNutt P. and de Villiers Lovelock H.L.: 2015. Variation in Nickel Alloy 718 coating properties deposited using a variety of cold spray systems and spray conditions, 10th Colloquium on High Velocity Oxy–Fuel Flame Spraying, publ. DVS Germany, October 2015


