



CompoSurf™ Coating Technology for Increased Functionality of Composite Materials



**PUBLISHABLE
SUMMARY**

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Background

The use of composites as structural components is increasing due to good strength to weight ratios, electrical insulation properties, resistance to corrosion, increased fatigue lifetimes and ease of use. There are many types and forms of composites that have been developed over the years including glass, carbon and Kevlar® reinforced materials. However their limited surface properties prevent their use in applications where thermal management is required such as aeroengines. TWI has developed an advanced coating technology (CompoSurf™), employing thermal spraying processes, which offers increased functionality of composite materials.

This project evaluated the CompoSurf™ technology for selected potential industrial applications. Work at TWI has shown that by careful control of the selection of spraying process, surface preparation, coating consumables and substrate materials, well-adhered coatings can be produced. A new approach has enabled the deposition of metallic coatings to thicknesses in excess of one millimetre and the development of coatings for thermal management. To expand the range of potential applications and bring the technology to higher technology readiness levels (TRLs), work has been undertaken to improve the understanding of materials selection, spraying process and parameter selection to produce coatings for more extreme environments. This work is of benefit to OEMs, Tier 1 and Tier 2 suppliers.

Objectives

The main objective of this project was to validate CompoSurf™ coatings with good adhesion and added functionality for selected applications on a range of composite substrates. Specifically, the project:

- Identified the factors which determine the level of coating adhesion to a range of composite materials (eg CFRP materials using different thermoset and thermoplastic resin systems).
- Developed procedures using selected coating processes to enable a range of coating materials to be applied to a variety of composite materials.
- Evaluated the characteristics and properties of selected, advanced CompoSurf™ coating systems to provide thermal protection to a range of composites.
- Identified further steps required to industrialise the CompoSurf™ technology for specific applications.

Project Outcome

- Task 1: One final report (Technology Survey).
- Task 2 / 3: One final report comprising:
 - Results of thermal spray coating trials, coating adhesion data, and spraying procedures for application of CompoSurf™ coatings to a range of composites.
 - Data pertaining to CompoSurf™ coating technologies for thermal performance of composite materials.
 - Recommendations on application of CompoSurf™ coating technologies for selected industries.

Benefits

- Increased functionality, reliability and durability in terms of thermal performance.
- Reduced costs due to the use of less expensive composite substrates and post composite manufacture coating technologies.
- Increasing technology readiness level (TRL) for CompoSurf™ coated composite materials to enable composite material manufacturers and end users to utilise coated composites in product development and production environments.

Participants

The Sponsor Group comprised:

- Rolls-Royce
- Embraer
- TWI

Scope of Work

The project was split into three tasks:

- Industrial review and technical survey (to identify current best practice, experience and concerns which influence the use of coated composites in various applications & environments).
- Evaluation of coatings for high temperature applications and thermal management.
- Definition of the further steps required for industrialisation of CompoSurf™ technology.

Task 1: Industrial review and technical survey

Discussion with the Sponsors identified their experiences and concerns related to the use of composites and coated composites in various applications and environments, and confirmed priorities for the project. Using six engineering search databases, 147 articles from technical, commercial (including patents) and academic literature have been reviewed. The following topics are included in the technical review:

- Identification of the range of substrate materials of interest.
- Identification of a range of potential applications for coated composites.
- Service conditions / requirements for coated composites.
- Coating process selection.
- Coating material selection.
- Preparation of substrates prior to coating.
- Coating adhesion.
- Summary of TWI exploratory research in this field, and the technical challenges associated with coating composites.

Task 2: High temperature applications and thermal management

The Sponsors' technical requirements for coated composites in high temperature applications were defined in Task 1 as part of the industrial review and technical survey. On this basis, Task 2 comprised:

- Confirmation of service environments
- Selection of substrate materials and other relevant consumables.
- Selection of spraying processes suitable for application of CompoSurf™ coatings for thermal management applications.
- Production of test coupons comprising reflective and thermal barrier coatings deposited onto a variety of composite substrates.
- Microstructural assessment of deposited coatings.
- Thermal performance evaluation (thermal cycling and hot air resistance).
- Mechanical performance (coating adhesion, 4-point bending, fatigue and erosion).

Trials were undertaken to deposit a selection of thermal barrier and heat reflective coatings. Consideration was given to surface preparation of the selected substrate materials and application of coatings with or without a bondcoat to maximise coating adhesion. Trials were undertaken to maximise coating adhesion via optimisation of the spraying process and parameter selection for the selected spray processes. Coatings were deposited in two stages:

- Direct thermal spraying of metallic materials onto selected composites.
- Thermal spray coating onto selected composites subject to the CompoSurf™ surface modification method.

The properties of the deposited coatings were evaluated in a series of tests comprising basic coating characterisation (microstructure, oxygen content, surface finish), mechanical testing (adhesion, fatigue, bend, and erosion) and thermal performance (hot air testing and thermal cycling).

Task 3: Definition of route to industrialisation of CompoSurf™ technology

This task comprised:

- Cost comparison for the various coating types based on coating deposit efficiency, coating consumable and process costs.
- Supply of a limited number of test coupons to Sponsors.
- Identification of the steps required for industrialisation of CompoSurf™ technology.

Project Budget

The project had a duration of two years and a budget of £150,000. It was funded by two Sponsors each making a contribution of £50,000 and TWI contributed £50,000. The fee for additional companies buying back into the project results is £50,000.

Further Information

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

<http://www.twi-global.com/capabilities/research-and-innovation/joint-industry-projects/>

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