

At a glance :

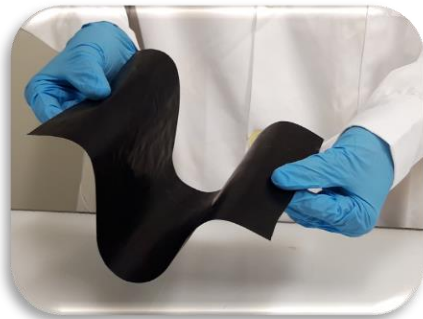
Development of External/Integrated heater elements based on continuous sheets of CNTs “Buckypapers”(randomly oriented self-supporting flexible films of carbon nanotubes) to repair defects or damages occurring in composite structure of aircrafts.

Keywords: Buckypaper; Resistance Heating; Composite Repair; Composite Curing; Flexible External Heater; Integrated Heater Layer; Tailorable Heater Size

Context

Airbus participates in OASIS as an End-user of the aeronautical sector providing its expertise and capabilities to develop alternative composite repair/curing methods based on a resistance heating process.

Buckypaper (BP) (CNT enabled product) is used as a flexible heating element to directly heat the composite part through resistive heating - with no limitation of size and shape.



Buckypaper: Highly flexible nano-material based heater

This heating system can be applied externally or integrated into the structure (as the last ply), thereby avoiding the heating of the complete composite part.

The system has the capability to directly bond precured panels, or to simultaneously cure fresh prepreg whilst bonding adhesive layers to precured panels.

The Challenge:

The partnership between Airbus and OASIS service providers consists of the collaboration between several different partners:

Tecnalía is responsible for the manufacturing of BP heaters to provide a uniform performance according to the required specifications.

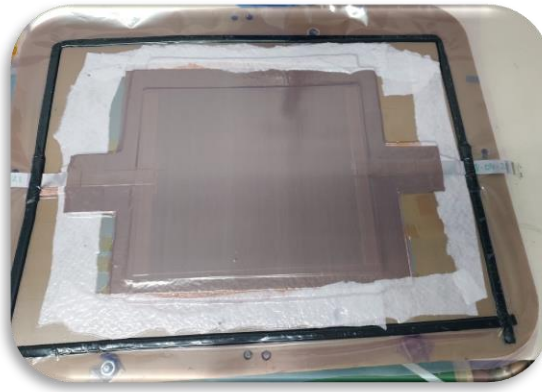
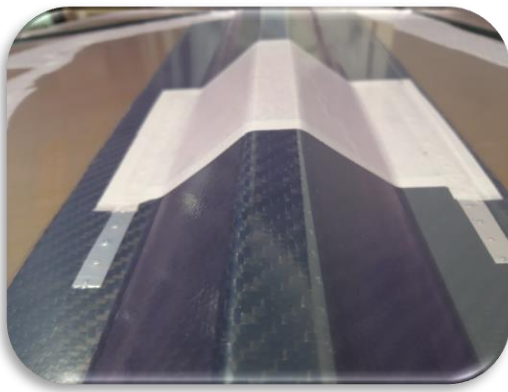
In collaboration with TMBK Partners Sp, the BPs are encapsulated using flexible materials (including polymeric veils), to protect and electrically isolate them for external heating systems.

Adamant Composites is focused on the encapsulation of the BP for the integrated heating system.

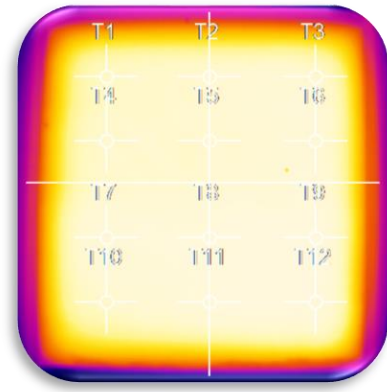
The University of Patras is responsible for the characterisation of test panels manufactured by the BP based heating system. Additional simulation activities are carried out to optimize the heating performances.

The Results:

Uniform heating performances were achieved using buckypaper sheet material as resistive elements for high temperatures (e.g. 180°C) which fulfilled the operational requirements of Airbus. The encapsulation of the BP with a range of optional materials enables the development of flexible external heating systems that are unlimited in terms of size and shape. After several optimization processes, mechanical testing panels have been manufactured using this heating method. The heating system has also been used for curing of composite panels, in which homogenous heating is critical, by integrating it as the last ply of the fresh lay up. The developed external heating system has been employed as a blanket heater system to bond an omega shaped part to a flat panel.

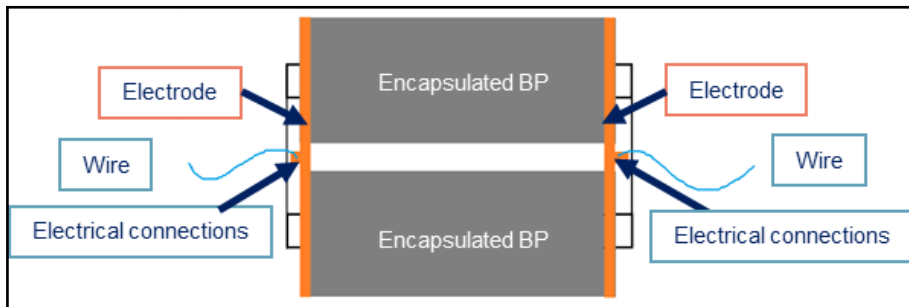


Demonstrator external blanket heaters during trials

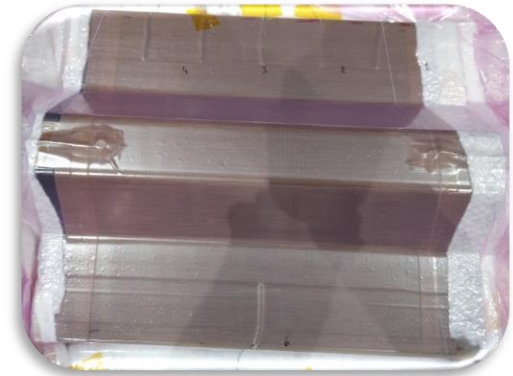


T1	T2	T3	T4	T5
182,1°C	184,7°C	184,3°C	184,5°C	184,7°C
T6	T7	T8	T9	T10
184,7°C	187,1°C	188,7°C	189,9°C	190,5°C
T11	T12	T13	T14	T15
189,1°C	183,7°C	189,2°C		

External CNT blanket - uniform heating capabilities at 180°C



a)



b)

a) Schematic of the developed external blanket for b) secondary bonding of an omega shaped part to a flat panel

Conclusion:

The results in the project have demonstrated the benefits of combining the materials and facilities from three of the OASIS nano-enabled product pilot lines.

The scaled manufacturing of the CNT nano-enabled “buckypaper” sheet product has been used for an application in the aeronautical sector - as the heater element for the repair and cure of CFRP composites, developing and ensuring quality of the product for the aeronautical supply chain.

The project enabled the OASIS partners to increase the maturity of their pilot lines and technologies together with the associated services for the application and qualification of the CNT based heater system.

The collaboration between the partners has been essential for the development of activities to reach the objective.

OASIS Technique:

- PL#4: Buckypapers
- PL#5: Carbon nanotubes doped veils
- PL#6: Functionalised prepregs

Product Process Engineering:

- PPE#2 & PPE#3: Buckypaper for multifunctional layer.

Characterization services:

- TC#7 and TC#8: Microstructure

Simulation services:

- DMS#6 and DMS#7: Thermal, mechanical and combined modelling



Get in touch today for further details:

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