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Graphene based heating mats as anti-icing system on aircrafts

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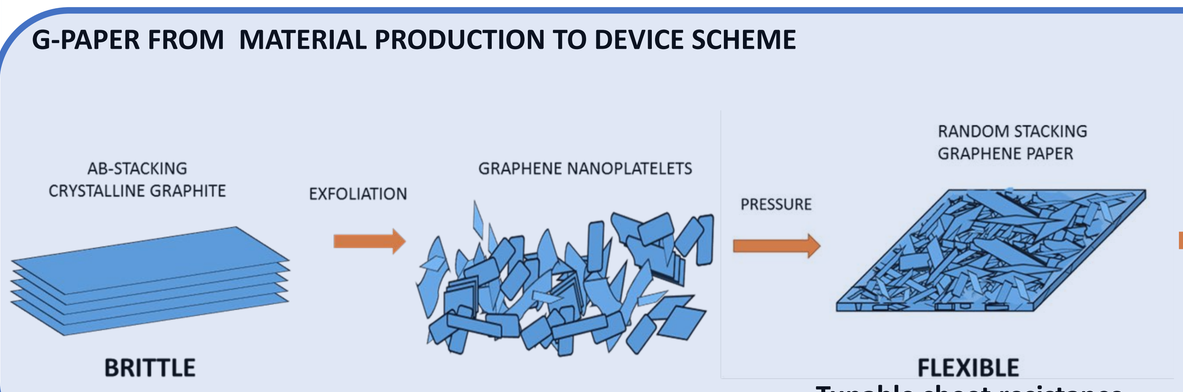
ABSTRACT

A key target for modern technology is to replace metals with lighter, cheaper, less energy-consuming materials. This "metal replacement" goal is already well established for structural applications in aeronautics and automotive, where the search for higher efficiency and reduced CO_2 emission is pushing toward the use of carbon-based materials (e.g. carbon fiber composites and high-performance polymers), replacing up to 50% of the metal parts of the vehicle [1]. The advantages in the use of carbon-based composite materials does not stop to structural reinforcement and weight loss: carbon based materials such as graphene may help to overcome some limitations in electronic applications as well. Due to its unique properties such as low weight, mechanical strength, thermal and electrical conductivity, graphene could be a promising material for the development of electrothermal heaters for efficient anti/de- icing system in aircrafts.

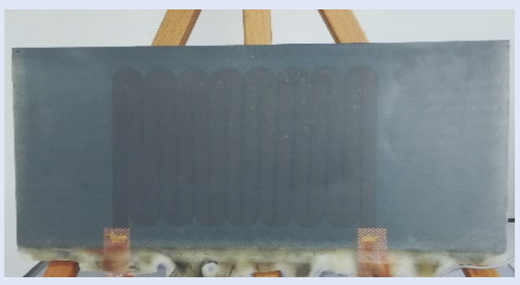
In this presentation we will show the development of heaters prototypes realized with GRM integrated in Carbon Fiber Reinforced Polymers (CFRP) or flexible substrates with different design and configurations. The devices prepared showed good functionality, uniform heating without hotspots also in bended configuration. Graphene heaters can achieve a wide range of operation temperatures with respect of the system configuration, even capable of melting ice at -30°C in few seconds, showing promising results for anti-icing and de-icing applications.

G-PAPER FROM MATERIAL PRODUCTION TO DEVICE SCHEME



ENCAPSULATION

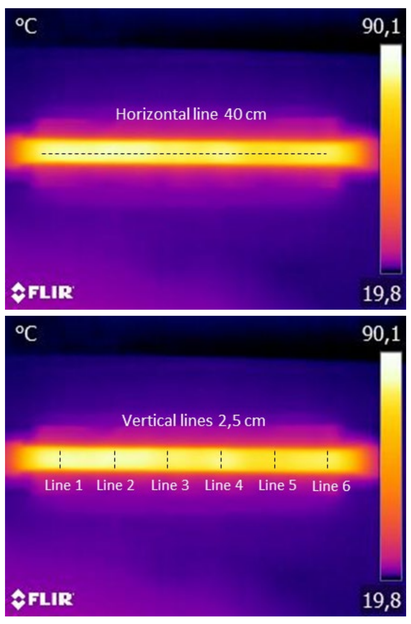
Kapton (flexible)

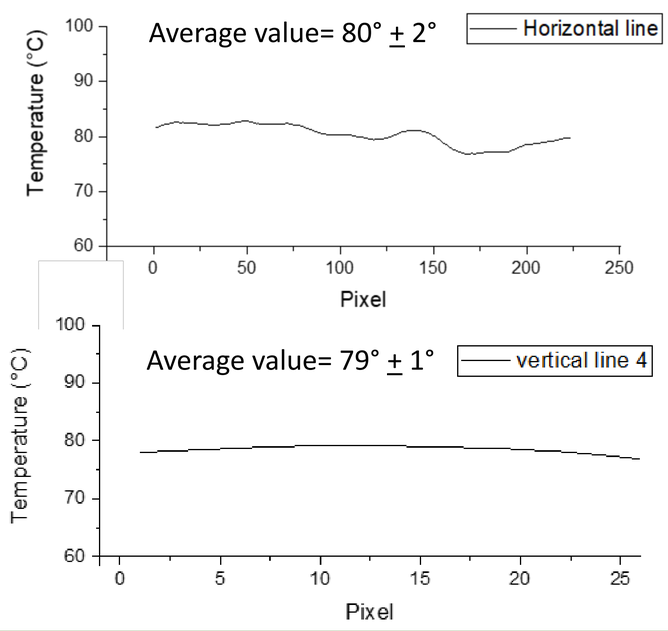


Carbon fiber reinforced polymer (CFRP) (rigid)

EVALUATION OF THERMAL HOMOGENEITY

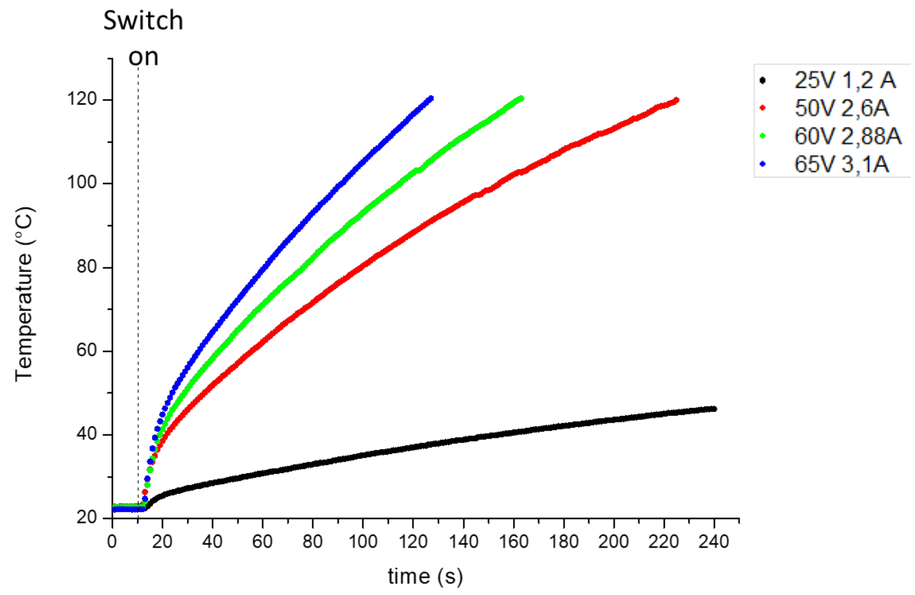
IR thermography is used to evaluate horizontal and vertical thermal homogeneity of the kapton heating modules showing a standard deviation of ~1-2°C on both the directions.





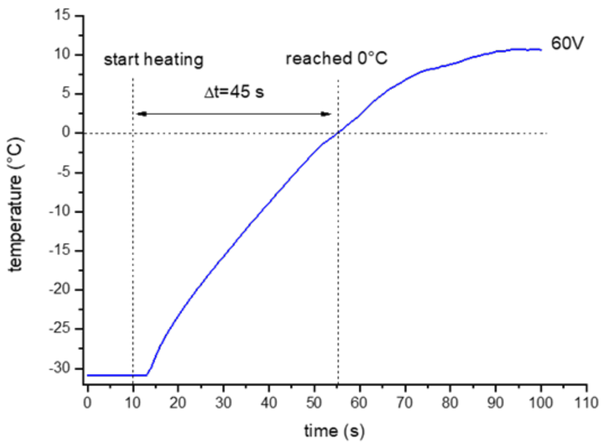
EVALUATION OF THERMAL EFFICIENCY

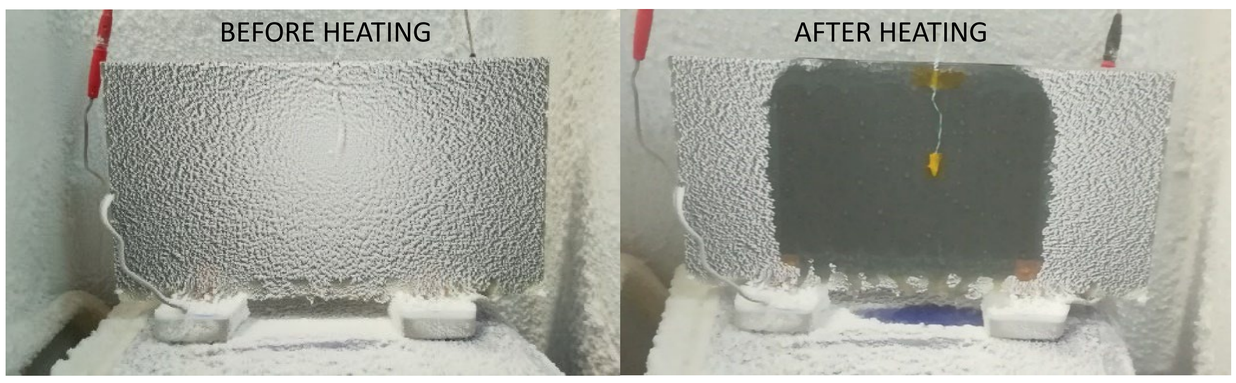
The heating module in CFRP was tested with DC current input at different power densities showing fast heating.



EVALUATION OF ANTI ICING CAPABILITY IN CLIMATIC CHAMBER

The heating module integrated in CFRP is tested in the climatic chamber at a constant temperature of -30°C. The temperature evolution is monitored via thermocouple. The heater reaches 0°C in 45 seconds





CONCLUSIONS

- G-Paper showed good integration capability in composite materials such as glass fiber/ carbon fiber reinforced polymer
- The prototypes built showed uniformity of heating and promising de-icing capability, melting ice at -30°C in few seconds

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REFERENCES

[1] Valorosi, Filippo, et al., *Composites Science and Technology* 185 (2020): 107848.

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