

## Graphene-based heaters for aeronautical applications

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Commercial aircrafts need protection systems against ice formation to avoid detrimental effects in the airfoils and any related safety problems. Current solutions are mainly based on purges that distribute hot air from the engine to the leading edge to prevent ice accretion on the wing surface. However, these systems have some disadvantages, including incompatibility with composite parts due to the high temperatures used. A promising alternative to the current de-icing system, solving the just mentioned issues, is given by GRM based heaters in which heat is generated by the Joule effect by applying electrical voltage [1-2]. In this work we developed heaters prototypes realized with GRM integrated in Carbon Fiber Reinforced Polymers (CFRP). The devices prepared showed good functionality and uniform heating without hotspots. Graphene heaters can achieve a wide range of operation temperatures in function 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.

### References

- [1] Valorosi, Filippo, et al., *Composites Science and Technology* 185 (2020): 107848.
- [2] Blanco-Varela, María Tamara, et al. *Materiales Compuestos* 3.4 (2 019): 22-27.

### Figures



**Fig. A:** Typical de-icing process of an airplane through propylene glycol spray.

**Fig. B and C:** Graphene heater integrated in CFRP with ice accretion on the surface A) before and B) after de-icing process.

**Fig. D:** Curved panel (HTP leading edge shape) with integrated graphene heater by co-curing.