Graphene-based heating mats

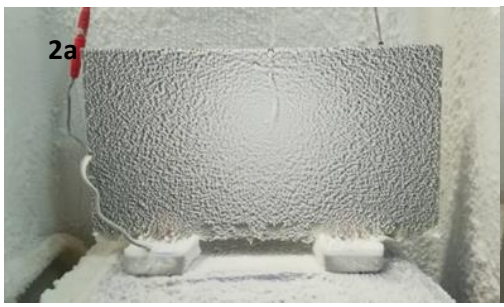
Alessandro Porciello
Alessandra Scidà, Andrea Candini, Filippo Valorosi, Emanuele Treossi, Vincenzo Palermo
CNR-ISOF Via Piero Gobetti 101, Bologna, Italia
alessandro.porciello@isof.cnr.it

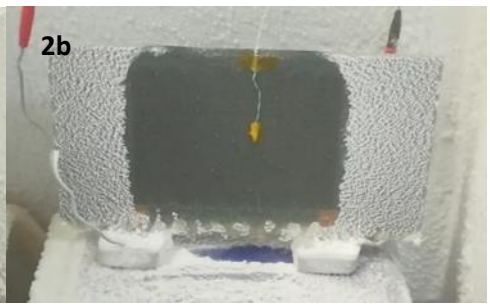
A key target for modern technology is to replace metals with lighter, cheaper, less energy-consuming materials. This "metal replacement" goal is already well established for structural applications in aeronautics and automotive, where the search for higher efficiency and reduced CO_2 emission is pushing 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.
In this work, we describe heaters mats realized with GRM (Graphene Related Material) integrated in Carbon Fiber Reinforced Polymers (CFRP) or flexible substrates with different design and configurations. The flexible devices prepared showed good functionality, uniform heating without hotspots with a standard deviation of 1,5°C among the data, even after >1000 bending cycles. As a proof of concept of the potential of this technology, the CFRP heater mats developed can provide 4KWatt/m2 with 60V, allowing the de-icing of a thin layer of ice in 50 seconds in a chamber at -30°C. Graphene heaters can achieve a wide range of operation temperatures with respect of the system configuration, showing promising results for heating applications from automotive to aeronautics.

References

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

Figures





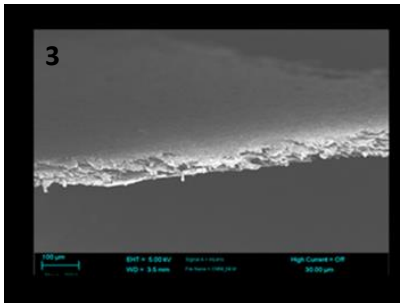


Figure 1: Typical de-icing process of an airplane through propylene glycole spray
Figure 2: Graphene heater integrated in CFRP with ice accretion on the surface **a)** before and **b)** after the de-icing process
Figure 3: SEM image of the graphene-based material used to fabricate the heating module