Solar Assistant Liquid Phase Exfoliation of Graphene and its Thermal Properties

Shanavas Shajahan[1,2*], Rami Elkaffas[1], Dhinesh Babu Velusamy[1,2,] Yarjan Abdul Samad[1,2,3*]
[1]Department of Aerospace Engineering, Khalifa University of Science and Technology, 127788, Abu Dhabi, United Arab Emirates.
[2]Research & Innovation Center for Graphene and 2D Materials, Khalifa University of Science and Technology, 127788, Abu Dhabi, United Arab Emirates.
[3]Cambridge Graphene Centre, Department of Engineering, University of Cambridge, Cambridge, UK
Shanavas.shajahan@ku.ac.ae

Abstract
Graphene generally exhibits exceptionally high thermal conductivity (~2000 W/mK). This is due to its unique two-dimensional structure, where carbon atoms are arranged in a honeycomb lattice, allowing for efficient phonon transport [1,2]. Hence, it can be used as an efficient thermal management material in high-power-density batteries (e.g., Li-ion batteries), mobile communications, consumer electronics, and automotive industries [3-6]. We produced graphene sheets with a lateral size of about ~4 microns through a novel solar light-assisted liquid phase exfoliation technique. The production of few-layer graphene sheets is confirmed by Raman analysis Figure 1 [7]. The SEM image (Fig.1b) confirms the production of graphene sheets in large lateral sizes around ~4 µm. The graphene sheets exhibit an in-plane thermal conductivity (λ) of about 220.3 W/mK, which is almost similar to a traditional heat transfer material aluminum (237 W/mK) [8,9]. The thermal management capability of graphene is demonstrated by recording the difference between the temperature of a bare electrothermal plate and an electrothermal plate with graphene film stuck on it (Fig. 1c). The temperature of the bare electrothermal plate is around 89.7 °C after 150 s. While placing the graphene film on the electrothermal plate, the maximum temperature of the electrothermal plate after 150 s is around 69.3 °C; it is due to the rapid heat dissipation through the graphene film. Our work demonstrates that graphene sheets with large lateral size (~4 µm) play a significant role in achieving high thermal conductivity and diffusivity similar to aluminum, which makes it a potential candidate for thermal management applications.

References

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Figures

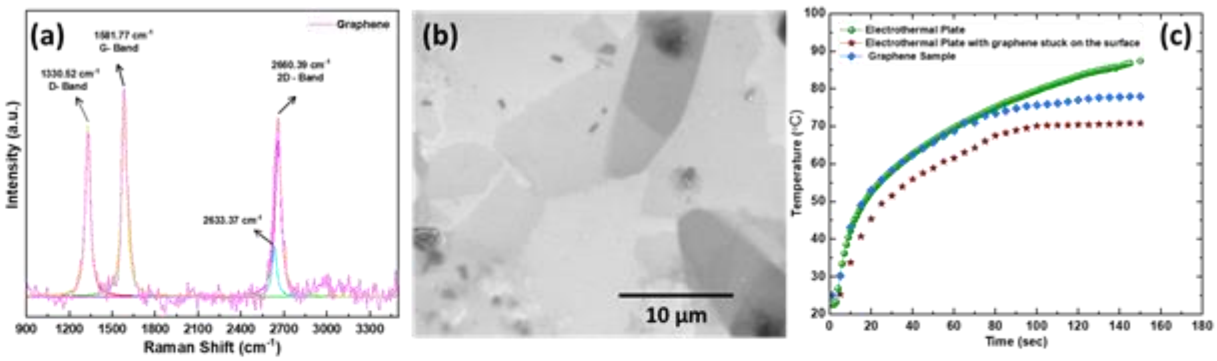

Figure 1: (a) Raman graph of produced graphene; (b) SEM image of produced graphene; (c) Time-dependent temperature profile on electrothermal plate and graphene sheets.