

Thermonanomechanics of Graphene Oxide-M13 Bacteriophage Nanocomposites

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The self-assembly of graphene oxide (GO) and M13 bacteriophage yields GraPhage13 aerogels (GPA), porous nanocomposites with an ultra-low density and high surface area. GPA's cost-effective, eco-friendly, and scalable production, coupled with its tuneability through the functionalisation of GO and M13, offers potential applications e.g., sensors, energy storage and absorbents [1]. Given the limited applications of aerogels in industry due to their suboptimal nanomechanical properties, along with the previously observed temperature-dependent characteristics in graphene-based nanocomposites, a thorough exploration of the thermosensitive nanomechanical properties of GPA is essential. Therefore, a comprehensive characterisation of the morphology, composition, and spectroscopic analysis of the GPA for a range of temperatures has been conducted and correlated with its nanomechanical properties. Elevated temperatures have been found to lead to gradual removal of oxygen-containing functional groups (OCFGs) from GPA, resulting in increased structural defects and reduced stiffness. Notably, unique nanomechanical behaviours of GPA have been further identified, where the thermal expansion of sp^3 bonds exceeds that of a crystalline sp^3 structure, while the thermal contraction of sp^2 bonds in GPA is found to be between graphite and GO. This underscores the impact of GO functionalisation on the thermal expansion behaviour of GPA. The obtained insights enhance the overall comprehension of the temperature annealing impact on GPA and highlight the tunability of its nanomechanical properties, showcasing a broad potential of this novel nanocomposite across a diverse range of applications [2].

References

[1] P. Passaretti *et al*, *Nanoscale*, 11:28 (2019) 13318-13329.

[2] K. Stokes *et al*, *Carbon Trends*, 15 (2024) 100343

Figures

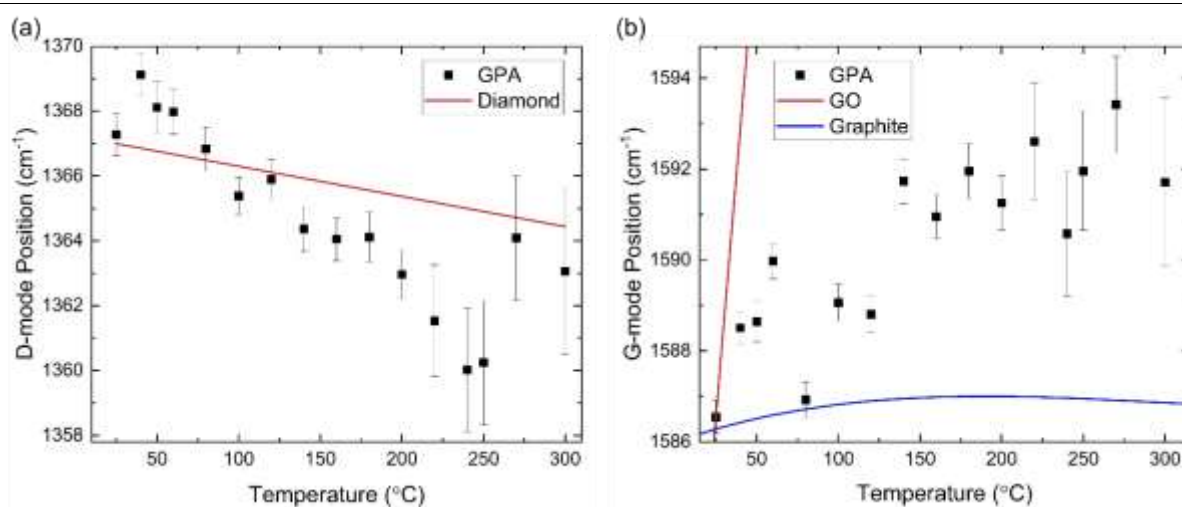


Figure 1: Position of Raman peaks for GraPhage13 aerogels with temperature: (a) Position of D-mode compared to the Raman shift resulting from thermal expansion of diamond and (b) position of the Raman shift resulting from thermal expansion of graphene oxide and graphite.