Size Dependent Interaction of Graphene Oxide Sheets with Biomolecules

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Two-dimensional materials such as graphene have had a significant impact on the advancement of different areas of scientific and technological research including nano-electronics, materials science as well as biomedicine [1,2]. The oxidised form of graphene, graphene oxide (GO), is functionalised with different oxygen species (carboxylic acids, hydroxyls, carbonyls) that render it more hydrophilic. GO has an enormous potential to help leverage some of the unique properties of graphene to further various aspects of biomedical science [3]. For example, GO sheets can be non-covalently functionalised with different biomolecules such as peptides and proteins. This serves as one strategy to design nano-formulations for the delivery of biologics or even tailored tissue engineering platforms.

In this study, the physicochemical properties of complexes of GO sheets of different lateral dimensions with peptides or proteins were investigated. To synthesise these complexes, peptides or proteins were incubated with GO sheets at different mass ratios for 7 hours. The formed complexes were isolated by centrifugation. A battery of characterisation techniques was applied to interrogate changes in the structure of the adsorbed biomolecules as well as the physicochemical properties of the overall complexes.

Atomic force microscopy and transmission electron microscopy demonstrate the adsorption of peptides and proteins onto the surface of both large and small GO sheets. Proto-fibril structures were observed to form when peptides were exposed to GO sheets, whereas proteins preserved their overall globular appearance. Spectrofluorimetry, Fourier transform infrared spectroscopy, Raman spectroscopy, electrophoretic mobility measurements and circular dichroism support our microscopy observations but also demonstrate significant changes in the secondary and tertiary structure of the proteins.

Our results provide a fundamental contribution that helps inform the development of GO sheets in biomedicine.

References

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