The True Amphipathic Nature of Pristine Graphene Flakes

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Commercialization of graphene is slower than anticipated. Graphene due to their extraordinary electronic, thermal and mechanical properties, holds great promise for applications ranging from optoelectronic, through environmental to biomedical technologies. However, the conflicting reports about its chemical character [1,2,3,4,5] hinder potential applications. For many potential large scale processing routes to efficiently manufacture and commercialize graphene based devices, composites, coatings, membranes or inks it is essential to understand the fundamental colloidal properties of pristine graphene flakes (GF).

Our recent studies into colloidal properties of pristine GF [6] revealed why and how they can be used as emulsion stabilizers without using any additional surfactants. The rigorous quantum-mechanical, molecular dynamics and Monte Carlo calculations supported by wet-chemistry testing, optical and electron microscopies, Raman spectroscopy and thermogravimetric analysis, explained the physico-chemical mechanism governing their amphiphatic nature. In contrast to commonly used graphene oxide flakes, pristine graphene flakes possess well-defined hydrophobic and hydrophilic regions in the basal plane and edges, respectively. These properties allow small flakes to be utilized as stabilizers with an amphipathic strength that depends on the edge-to-surface ratio. The interactions between flakes can be also controlled by varying the flake thickness and the oil-to-water ratio. Our findings reconcile all previous results on the chemical nature of graphene flakes. In addition, it is predicted that graphene flakes can be efficiently used as a new generation surfactants that is active under high pressure, high temperature, and in saline solutions, greatly enhancing the efficiency and functionality of applications based on this material. The direct applications of GF stabilized emulsions will be also discussed [7].

References

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