Exfoliation of graphite to graphene for energy, water and biomedical applications

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Abstract
The exfoliation of van der Waals bonded solids has been of great recent interest with the formation of graphene from graphite the most notable[1]. Other materials such as the transition metal dichalcogenides have received less attention however MoS_2 and WS_2 also display interesting properties in the limit of 2D[2, 3]. In principle, any layered solid material held together through weak dispersion forces can be exfoliated to single sheets[4] using a range of techniques such as the "scotch tape method", solvothermal and intercalation routes, chemical oxidation and reduction as well as surfactant assisted liquid phase exfoliation[5]. All of these techniques have advantages and limitations, indeed few are capable of generating large volumes of exfoliated sheets whilst maintaining sheet integrity. One method that shows great promise and can be scaled to meet industry needs is the aqueous based surfactant assisted liquid exfoliation technique[6]. Here, the properties of material such as graphene will be discussed as will potential applications of exfoliated surfactant stabilised sheets generated in this manner. Whilst complete removal of adsorbed surfactant from the graphene surface can be problematic in some applications, in others the presence of surfactant is a distinct advantage[7].

A particular focus of this presentation will be the interaction of light with graphene .All atoms and molecules within the material are freely available to absorb light upon exfoliation. Graphene absorbs strongly across the spectrum, particularly in the infrared region which makes it suitable as photothermal agents. Furthermore, forming into a film with exposed edges induces bactericidal action. The anti-bacterial activity of graphene films will also be discussed.

References:
1. Geim, A.K., Graphene: Status and prospects. Science, 2009. 324: p. 1530-1534.
2. Splendiani, A., et al., Emerging photoluminescence in monolayer MoS_2. Nano Lett., 2010. 10: p. 1271-1275.
3. Notley, S.M., High yield production of photoluminescent WS_2 nanoparticles. J. Colloid Interface Sci., 2013. 396: p. 160-164.
4. Coleman, J.N., et al., Two-dimensional nanosheets produced by liquid exfoliation of layered materials. Science, 2011. 331: p. 568-571.
5. Cheng, C. and D. Li, Solvated Graphenes: An Emerging Class of Functional Soft Materials. Adv. Mater., 2013. 25: p. 13-30.
6. Notley, S.M., Highly concentrated aqueous suspensions of graphene through ultrasonic exfoliation with continuous surfactant addition. Langmuir, 2012. 28: p. 14110-14113.
7. Quinn, M. D. J.; Ho, H. N.; Notley, S. M., Aqueous dispersions of exfoliated molybdenum disulfide for use in visible light photocatalysis. ACS Applied Materials and Interfaces, DOI: 10.1021/am404161k.