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Graphene Dispersions Prepared with Pyrene Derivatives and use in Cell Internalisation and siRNA Complexation Assays

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Liquid-phase exfoliation (LPE) is a simple, mass-scalable and cost effective method to produce solution processed graphene [1,2]. To effectively disperse defects-free graphene in water, which is needed in biological applications, a stabilizer must be used [3]. Anionic pyrene derivatives have been shown to be very effective at exfoliating graphite, compared to traditional surfactants [4-6]. However, only very few studies have reported the use of cationic pyrene derivatives, giving rise to low concentration and/or limited dispersion stability [7.8]. Amphoteric pyrene-derivatives were also reported, however with limited stability at neutral pH [9]. In this work we produced and tested various cationic pyrene derivatives as stabilizers in LPE in water. By designing pyrene derivatives with different functional groups and variable distance between pyrene and the charged group, we have been able to get insights on the exfoliation mechanism and to understand how to design the pyrene derivative to achieve efficient exfoliation [10]. The graphene dispersions produced with such pyrene derivatives show excellent biocompatibility, cell internalization capacity, and colloidal stability even in the biological environment [10]. By taking advantage of the positive charge of such graphene flakes, we have tested the material for siRNA complexation, obtaining better siRNA complex formation than with negatively charged graphene, including graphene oxide [10,11]. In conclusion, in this work we demonstrate that highly concentrated, stable and biocompatible graphene dispersions with positive charge can be easily produced by LPE in water by using designed cationic pyrene derivatives. This material shows great potential for biological applications.

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