Diffusion driven layer-by-layer assembly of nanosheets into porous three-dimensional structure

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One of the critical challenges for the practical application of graphene and its derivatives is developing a robust and versatile assembly method which allows the construction of the nanosheets into functional macroscopic structures appropriate for integration with conventional real-life devices. To address this issue, we utilize the fact that graphene oxide is that they often behave as charged macromolecules, and thus can readily interact with an oppositely charged polyelectrolyte to form a stable complex. In this report, we demonstrate how such complexation process could be utilized for directing the self-assembly of nanosheets. Herein, we introduce a novel “diffusion driven layer-by-layer” assembly and demonstrate its application for the construction of graphene oxide (GO) sheets into porous three-dimensional structures. The process utilizes the interaction of GO with branched polyethylenimine (b-PEI), a positively charged polyelectrolyte, to form a stable complex. Interestingly, when this reaction is confined at a liquid/liquid interface, we observe that the diffusion of b-PEI allows the GO/b-PEI complex formed at the interface to continuously grow into a foam-like framework which porosity can be tuned from ultra-light (5.6 mg/cm^3) to tightly packed (~ 1700 mg/cm^3) through simple adjustments. Furthermore, the assembly process can be utilized in various configurations such as to create free-standing architectures with tailored shapes or patterned films on a substrate. The obtained GO structures are quite stable and can be reduced using various methods. This novel assembly method opens pathway to many useful nanosheet superstructures, and may be further extended to other types of nanomaterials in general.

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Education

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Fields of Research

Self-assembly, nanomaterials

Publications

1. J. Zou, F. Kim, *Nat. Commun.* (2014) DOI: 10.1038/ncomms6254
2. J. Zou, F. Kim, *ACS Nano,* **6**, 10606 (2012)