Scalable High Yield Exfoliation of Monolayer Nanosheets

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Abstract:

Although two-dimensional (2D) materials have grown into an extended family that accommodates hundreds of members and have demonstrated promising advantages in many fields, their practical applications are still hindered by the lack of scalable high-yield production of monolayer products. In our developed technique, we show that scalable production of monolayer nanosheets can be achieved by a facile ball-milling exfoliation method with the assistance of viscous polyethyleneimine (PEI) liquid. As a demonstration, graphite is effectively exfoliated into graphene nanosheets, achieving a record-high monolayer percentage of 97.9% at a yield of 78.3%. With a scale-up trial, 41 g of graphene was produced in one batch even using a small lab mill. Great universality of this technique is also proven by successfully exfoliating other four types of representative layered materials with different structures, carbon nitride, covalent organic framework, zeolitic imidazolate framework and hexagon boron nitride. This scalable exfoliation technique for monolayer nanosheets could catalyze the synthesis and industrialization of 2D nanosheet materials.

Keywords: Graphene, Two-dimensional, Nanosheets, Exfoliation, Polyethyleneimine