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Fabrication of Graphene and Other 2D Materials by Exfoliation

Graphene and other 2D materials have unique properties and is expected for various applications. Mass production of 2D materials is a prerequisite for their commercial use, but there are great challenges. Exfoliation of natural graphite and other layer materials are the most efficient method for fabricating 2D materials in powder or suspension form on large scale. However, currently, only graphene and graphene oxide can be produced on a ton scale, while it is difficult to mass produce other 2D materials.

We developed intercalation-expansion-liquid phase exfoliation and electrochemical exfoliation processes to produce graphene materials with high quality in large quantity from natural graphite, which may have wide applications in composites, energy storage, conductive inks, etc. Very recently, we have developed a grinding exfoliation technology that uses micro-particles as intermediaries to distribute an applied compressive force into a multitude of smaller shear friction forces that induce exfoliation of layered materials. This method can be used for mass production of many 2D materials, such as h-BN, black phosphorus, and MoS₂, with very high yield and high efficiency, indicating its universality in preparing 2D materials with a wide range of properties. These 2D materials can be used to fabricate polymer matrix composites and in many other applications.