

Abstract

Graphene and 2D Materials: Fabrication and Applications

Hui-Ming Cheng^{1,2*}

¹Shenyang National Laboratory for Materials Science, Institute of Metal Research,
Chinese Academy of Sciences, Shenyang 110016, China

²Shenzhen Institute of Advanced Technology, Chinese Academy of Sciences,
Shenzhen 518055, China

Corresponding author: cheng@imr.ac.cn or hm.cheng@siat.ac.cn

Graphene and other 2D materials have unique properties and is expected for various applications. But there are challenges of how to realize large-scale fabrication of high-quality graphene and other 2D materials.

First, we developed a green electrochemical exfoliation process to produce graphene materials with high quality and in large quantity. Second, we developed an ambient pressure CVD to synthesize single crystal graphene grains and films. Moreover, we invented an electrochemical bubbling method to transfer these grains and films. Large area and continuous graphene transparent conductive films are produced by an integrated R2R process of CVD and bubbling transfer. Third, we have developed a template-directed CVD. With Ni foam as template, a 3D graphene macrostructure, so-called graphene foam (GF), has been synthesized.

Both CVD and exfoliation are also powerful methods to obtain other 2D materials such as transition metal disulfides and h-BN. For example, we developed a grinding exfoliation technology with the assistance of intermediaries for efficient 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. By using CVD, we have grown high quality monolayer WS₂ and WSe₂ single crystals and films, ultrathin carbide crystals, and a new 2D material of MoSi₂N₄, which show excellent physical properties.

Finally, these graphene and 2D materials can be used in energy storage, composites, thermal management, and opto/electronic applications.