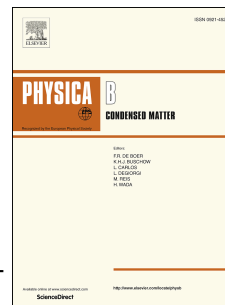


Accepted Manuscript

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PII: S0921-4526(18)30071-1

DOI: [10.1016/j.physb.2018.01.041](https://doi.org/10.1016/j.physb.2018.01.041)

Reference: PHYSB 310688

To appear in: *Physica B: Physics of Condensed Matter*

Received Date: 25 October 2017

Revised Date: 16 January 2018

Accepted Date: 17 January 2018

Please cite this article as: Q.-Q. Guan, H.-J. Zhou, P. Ning, P.-C. Lian, B. Wang, L. He, X.-S. Chai, An ultrahigh pressure homogenization technique for easily exfoliating few-layer phosphorene from bulk black phosphorus, *Physica B: Physics of Condensed Matter* (2018), doi: 10.1016/j.physb.2018.01.041.

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An Ultrahigh Pressure Homogenization Technique for Easily Exfoliating Few-Layer Phosphorene from Bulk Black Phosphorus

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Abstract: We have developed an easy and efficient method for exfoliating few-layer sheets of black phosphorus (BP) in N-methyl-2-pyrrolidone, using ultra-high pressure homogenization (UPH). The BP was first exfoliated into sheets that were a few atomic layers thick, using a homogenizer for only 30 min. Next, a double centrifugation procedure was used to separate the material into few-layer nanosheets that were examined by X-ray diffraction, atomic force microscopy (AFM), transmission electron microscopy (TEM), high-angle annular dark field scanning transmission electron microscopy (HAADF-STEM), and energy-dispersive X-ray (EDX) spectroscopy. The results show that the products are specimens of phosphorene that are only a few-layer thick.

Keywords: Ultrahigh Pressure Homogenization; Phosphorene; 2D materials; Syntheses and exfoliation

1. Introduction

Graphene, a two-dimensional sheet of carbon atoms, has attracted considerable attention in recent years, due to its exceptional electronic properties, carrier transport, and mechanical properties^[1-3]. Phosphorene is an analogous two-dimensional semiconducting material composed of phosphorous atoms, in which its bandgap is thickness-dependent, suggesting the potential for many advanced applications in nano-electronic,

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