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Versatile, Low-Cost, and Portable 2D Material Transfer Setup with a Facile and Highly Efficient DIY Inert-Atmosphere Glove Compartment Option

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Research in van der Waals heterostructures has been rapidly progressing in the past decade, thanks to the art of sequential and deterministic placement of one two-dimensional (2D) material over another. The successful creation of heterostructures however has relied largely on expensive transfer systems that are not easily accessible to researchers. Although a few reports on low-cost systems have recently surfaced, the full functionality, portability features, and overall effectiveness of such systems are still being explored. In this work, we present an "all-in-one"low-cost transfer setup that is compact, lightweight, and portable and which can be quickly installed with a facile and do it yourself (DIY)-style anaerobic glovebox option that performs at par with commercial anaerobic systems. The "installable"glovebox option means the user has the convenience of quickly converting the working environment into an inert one when air-sensitive 2D materials are used. The lowest RH values obtained in our glovebox is <3%, and the O2 levels rapidly drop from 21% to less than 0.1% in just a few minutes of purging the chamber with inert gas. The transfer system is also equipped with a light-weight PID-controlled substrate heating option that can be easily assembled within just a few hours. We test the versatility of our low-cost system by the successful creation of hexagonal boron nitride (hBN)-encapsulated graphene and hBN-encapsulated molybdenum disulphide (MoS2) heterostructures using the hot pickup technique and graphene-hBN, MoS2-hBN, twisted MoS2, and twisted MoS2 on hBN stacks using the wetting technique, and a MoS2-hBN-graphene vertical tunneling heterostructure was formed using a combination approach. The effectiveness of the DIY glovebox is proven with the demonstration of extended stability of freshly exfoliated black phosphorous (BP) flakes, their encapsulation between thin hBN layers, and the formation of electrically contacted BP devices with a protective hBN top layer. At an overall price point of approximately 1000 $, the versatile setup presented here is expected to further contribute to the growth of research in 2D materials, in particular, for researchers initially faced with overcoming a huge entry-level threshold to work in the field of 2D materials and van der Waals heterostructures.

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