Borophenes made easy: Distinct polymorphs and heterostructures

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\textbf{Abstract:}

Surface-supported two-dimensional (2D) materials keep attracting considerable interest. For example, borophene, a synthetic, boron-based 2D material, offers intriguing anisotropic electronic and mechanical properties \cite{1,2}. Here, we present a versatile chemical vapor deposition (CVD) approach to grow atomically-thin 2D polymorphs of borophene by using diborane. This precursor originates from byproducts of commercial borazine, a popular material for growth of hexagonal boron nitride (hBN). Specifically, borophene polymorphs with large single-crystalline domains are synthesized on Cu(111) and Ir(111) supports. Additionally, atomically-precise lateral interfaces or vertical van der Waals heterostructures combining borophene and hBN can be achieved by sequentially dosing different precursors from the same supply (Fig. 1). Thereby, borophene is protected from immediate oxidation by encapsulation with a single hBN overlayer. The borophene polymorphs and interfaces with hBN are comprehensively characterized by low-temperature scanning tunneling microscopy and spectroscopy, x-ray photoelectron spectroscopy, low energy electron diffraction and complementary density functional theory modeling \cite{3}. The ability to synthesize high-quality borophenes by a straight-forward, scalable CVD approach opens up opportunities for the study of their fundamental properties and for device incorporation.

\textbf{Fig. 1.} Scheme (left panel) and atomically-resolved STM image (right panel) of a vertical heterostructure with h-BN covering borophene on Ir(111).

\textbf{References:}