



## Borophenes made easy: Distinct polymorphs and heterostructures

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### 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 [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 (*h*BN). 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 *h*BN 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 *h*BN overlayer. The borophene polymorphs and interfaces with *h*BN 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 [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.

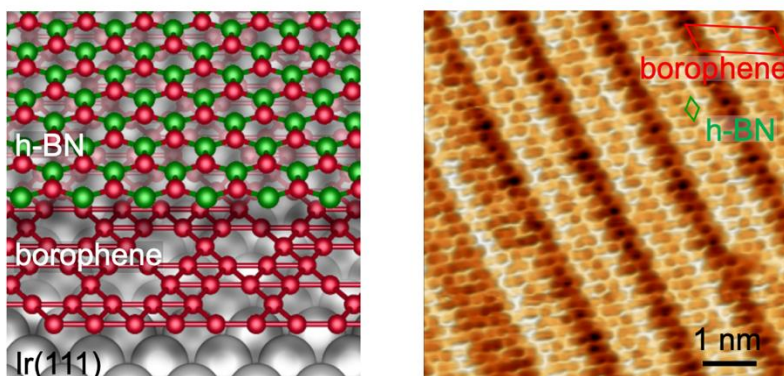


Fig. 1. Scheme (left panel) and atomically-resolved STM image (right panel) of a vertical heterostructure with *h*-BN covering borophene on Ir(111).

### References:

- [1] A.J. Mannix *et al.*, Nat. Rev. Chem. 1, 1 (2017).
- [2] P. Ranjan *et al.*, Adv. Mater. 32, 2000531 (2020).
- [3] M. G. Cuxart *et al.*, Sci. Adv. (Accepted for publication).