Macroscopic Singe-Layer Borophene Sheets on Arbitrary Substrates

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Ever since the discovery of first 2D materials, there is intensive interest to find and investigate as many different types of 2D materials as possible. In such a vast quest, until recently most of the research has been dedicated to materials that could be found in bulk form in nature, such as graphene or various TMDs (transition metal dichaclogenides), leaving many other 2D materials scarcely investigated despite the predicted potential for different applications. One of those types of materials is borophene, 2D sheet of boron atoms with high conductivity [1] and properties suitable for flexible electronics. Borophene was experimentally obtained for the first time in 2015. but since then most of experiments were dedicated to in situ characterizations and small scale samples. Our work is based on borophene which is obtained by performing segregation-enhanced epitaxy on Ir(111), with millimeter size and a full surface coverage [2]. After in situ confirmation of high quality by low energy electron diffraction (LEED), single-layer borophene samples were removed from ultra-high vacuum (UHV) and characterized under ambient conditions with atomic force microscope (AFM) and Raman spectroscopy. Subsequently, borophene has been delaminated from the substrate via electrochemical delamination and placed on Si/SiO_2 wafer where it was characterized by scanning electron microscope (SEM) (Fig. 1.), AFM (Fig. 2.) and Raman spectroscopy. Results confirm successful growth and transfer of large scale single-layer borophene sheets with minimum defects and ambient stability.

[1] B. Feng et al., Phys. Rev. B 94, 041408 (2016).
[2] A.J. Mannix et al, Science 350, 1513 (2015),
[2] K. M. Omambac et al., ACS Nano 14, 7421 (2021).

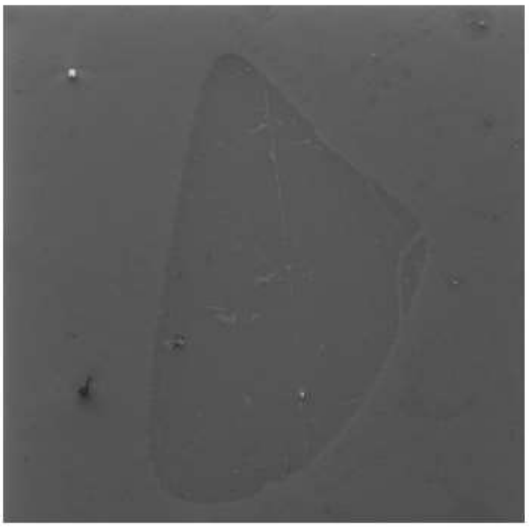

Fig. 1. SEM image of a transferred borophene flake

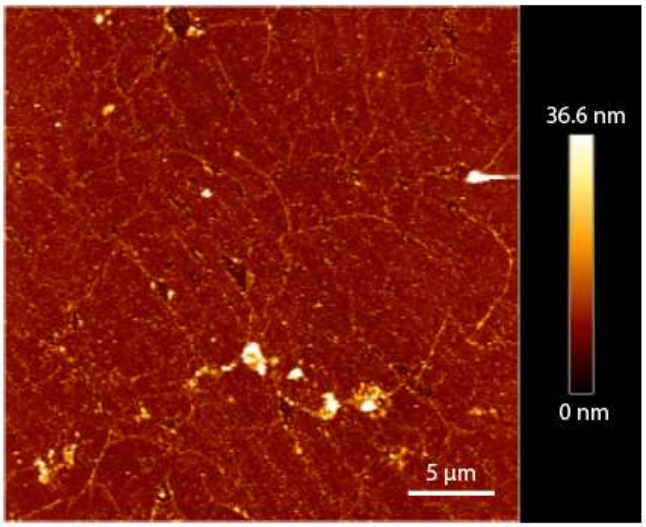

Fig.2. AFM image of borophene surface after the transfer.