Dry transfer of large-scale two-dimensional materials

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Large-area two-dimensional (2D) layered materials synthesized with chemical vapor deposition (CVD) are promising functional materials for a variety of device applications with superior performance and new features[1]. One of the challenges of 'lab-to-fab' transition arising from using these atomically thin materials is to integrate them into the conventional manufacturing process while maintaining their clean surfaces[2]. This is particularly difficult for van der Waals (vdW) heterostructures, which even for microscale exfoliated flakes requires sophisticated lamination procedures[3] In this work, we use prefabricated polyvinyl alcohol (PVA) film to transfer 2D materials synthesized by CVD method and assemble van der Waals (vdW) heterostructures on up to wafer scale. The method utilizes a commercial nanoimprint tool to achieve dry transfer of 2D materials at scale from sacrificial PVA supporting films onto silicon wafers or other rigid substrates. In particular, we investigate different process parameters and find that the key role in determining the efficacy of transfer is played by the parent growth substrate. For the case of CVD graphene, this is determined by the oxidation kinetics of the copper films.

We demonstrate an effective means of transferring CVD grown graphene and hBN films in a manner that shows good cleanness and uniformity of the materials. This is validated using microscopy, spectroscopy and metrology characterization. We also demonstrate ultrathin field effect transistors produced using our approach and study their electrical properties.

References

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