Interface Cleaning in Layered Material Heterostructures

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Heterostructures formed by stacking layered materials (LM) require atomically clean interfaces. During their assembly, contaminants such as polymers, water, or air, can become trapped between the heterostructure layers, aggregating into isolated pockets commonly known as 'blisters' [1,2,3]. Single Layer Graphene (SLG) encapsulated in h-BN is a widely investigated layered material heterostructure (LMH) both for fundamental physics and applications [4-6]. However, the presence of blisters at the SLG/h-BN interface limits the maximum lateral dimensions of devices to ~10μm [2]. Here we report a process to physically remove such blisters, enabling clean interfaces throughout the entire heterostructure, despite contaminants being initially present at the heterostructure interfaces. Using this technique we fabricate blister free regions of graphene encapsulated in hexagonal boron nitride of 5000μm^2 the largest reported to date, limited only by the size of our exfoliated flakes. Four terminal geometries fabricated from our encapsulated graphene exhibit mobilities up to 180 000cm^{2}V^{-1}s^{-1}at room temperature, and 1.8x10^{6}cm^{2}V^{-1}s^{-1} at 9K.

We showcase the effectiveness of our approach by cleaning heterostructures assembled using graphene exposed to a polymer and solvents before being encapsulated, which show equivalent mobilities. This demonstrates that exposure of graphene to processing related contaminants is not incompatible with the realisation of ultra-high mobility samples. We also show that is possible to manipulate blisters in other heterostructures based on MoS_2, indicating the general applicability of this approach.

References

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Figures

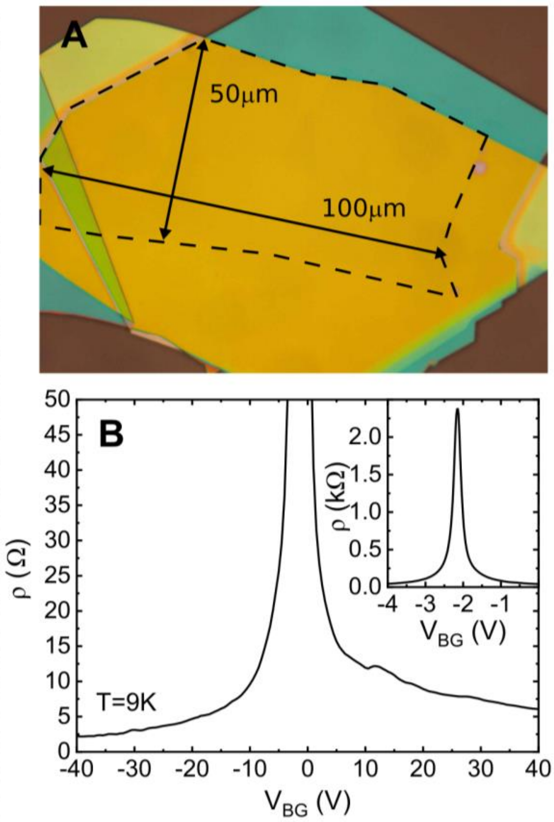

Figure 1: A: hBN/SLG/hBN heterostructure cleaned of blisters, with a blister free area of ~5000μm^2. The location of the SLG is marked by the dashed black line. B: resistivity vs. gate voltage of an encapsulated SLG Hall bar (with channel width 24μm) measured at 9K, with a mobility of ~1.8x10^{6}cm^{2}V^{-1}s^{-1}.