Suppression of Intrinsic Roughness in Suspended van der Waals Heterostructures

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Suspended graphene is known to show intrinsic corrugations on the nanometer scale [1] that have previously been measured to have a RMS roughness of ~1.7 Å [2]. Intrinsic roughness is a suspected key source of scattering and thus a limiter of the carrier mobility in clean graphene samples [3, 4]. Suspending graphene flakes has proven to increase the electron mobility drastically compared to graphene supported on silicon oxide [5], as adverse effects on the mobility from the silicon oxide is eliminated. Similar improvements in mobility are obtained by encapsulating the graphene in hexagonal boron nitride (hBN) [6]. In this study we measured the intrinsic roughness of suspended exfoliated graphene flakes and compare to suspended graphene/hBN heterostructures, from electron diffraction patterns measured by diffraction studies in a transmission electron microscope. While we measure similar RMS roughness values for suspended graphene samples as that reported in literature, suspended graphene/hBN heterostructures show a strong suppression in the measured RMS roughness down to ~0.2 Å. Since the thickness dependence of the RMS roughness of hBN is reported to plateau at ~1 Å for hBN thicker than ~20 nm [7], these results may lead to new fabrication strategies for obtaining high electron mobility graphene devices, since suspended heterostructures may be flatter than heterostructures placed on SiO_2.

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