High mobility scalable graphene/h-BN heterostructures

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The high-mobility of graphene can be exploited in several applications, from high-frequency electronics to photonics and opto-electronics[1]. Chemical vapour deposition (CVD)-grown graphene has proved to perform in pair with the highest quality exfoliated flakes, however only when suspended [3] or integrated into heterostructures with hexagonal Boron Nitride(h-BN)[3]. Moreover, h-BN is an ideal dielectric material due to its dielectric constant and high breakdown voltage[4]. In this framework, the research of a growth method of h-BN that is scalable and suitable for integration with graphene and TMDs heterostructures is very active, with different approaches as CVD-growth on metal or sapphire[4].

Here we present the realization of graphene/h-BN heterostructures with scalable techniques. h-BN continuous films were grown by Ion Bean Assisted Deposition (IBAD)[5] directly on Si/SiO_2 substrate, with no further transfer step required. Atomic force microscopy (AFM) analysis reveals the atomic flatness of the material (Fig. 1a and 1b). High-quality graphene single-crystal arrays were grown by CVD[6] on copper and transferred on the target substrates (h-BN and commercially available SiO_2/Si) using a semi-dry approach. Raman spectroscopy reveals a reduction in the graphene strain on h-BN with respect to Si/SiO_2. Moreover, Hall effect devices were realized to investigate the mobility and carrier density, at room temperature and in ambient condition. The residual carrier density in the tested devices results to be in the range between $8X10^{10}$ cm^{-2} and $20x10^{10}$ cm^{-2}, with carrier mobilities around 10 000 cm^2/Vs on h-BN substrate (Fig. 1c), which doubles the average graphene mobility value we measure on SiO_2/Si.

This work represents a first step toward the realization of high-mobility graphene/based scalable devices. The quality of the presented scalable heterostack paves the way to the implementation of high-performing devices in electronics and opto-electronics applications.

References

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Figures

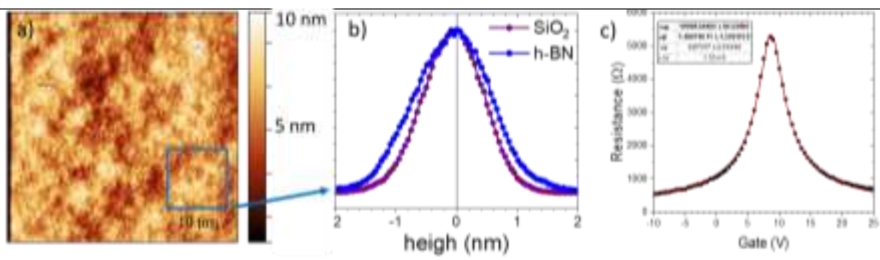

Figure 1: a) AFM characterization of the pristine h-BN film before any treatment. b) Height distribution on an area of 100 μm^2 on h-BN and on SiO_2. c) Electrical characterization of the graphene on h-BN performed in ambient condition, with mobility of 10 000 cm^2/Vs and $n_0 = 1.5X10^{11} cm^{-2}$.

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