Waveguide-integrated high mobility modulators and photodetectors based on hBN-graphene-hBN heterostructures

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Photodetectors and optical modulators are key components in today's communication systems[1] for which graphene promises a broadband response, high switching rates and an extremely small footprint. In this work we report on numerical simulations and experimental results on waveguide-integrated high mobility modulators and photodetectors based on hexagonal boron nitride (hBN) encapsulated graphene devices. Such hBN-graphene-hBN devices have been showing high values of charge carrier mobility and low levels of electrical doping, both in transport[2] as in optical[3] measurements.

Our numerical simulations on high-mobility hBN-graphene-hBN waveguide-integrated devices reveal achievable responsivity values up to 0.5-1A/W, a frequency response of ~40 GHz and a noise equivalent power (NEP) figure of ~10^{-11} W.√(Hz), for a contact resistance of 0.1 kΩ.μm and mobilities of 50 000 $cm^2/(V.s)$ at room temperature.

Owing to recent advances in the fabrication techniques[4], we achieved large-scale double hBN-graphene-hBN devices with an active area up to 400 μm^2. These large scale devices (see Fig. 1) allow for the systematic study of the devices' dimension. Specifically, we investigate the effect of the source-to-drain distance and the length of the active absorption area on the responsivity and absorption values of the graphene photo-detectors and modulators, respectively. The experimental results are compared to our simulation results.

References

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Figures

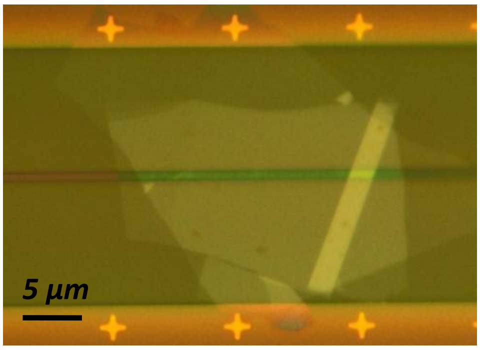

Figure 1: hBN-graphene-hBN stack transferred over an optical waveguide. The active area between graphene and waveguide has a length >15 μm.