Waveguide-integrated modulators and photodetectors based on high mobility 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 the experimental results and numerical simulations on waveguide-integrated photodetectors and electro-absorption (EA) modulators, both based on high mobility hexagonal boron nitride (hBN) encapsulated graphene.

In order to reach a low voltage drive, the double layer graphene modulators have been fabricated in combination with a high-K dielectric material, e.g. hafnia (HfO_2) [2]. The resulting hBN-HfO_2-hBN insulating layer (see Fig. 1a) ensures increased breakdown voltages and low operation fields while maintaining the high carrier mobility and low doping levels intrinsic to hBN-encapsulated graphene [3]. During this work, we systematically studied the dielectric characteristics of this hBN-HfO_2-hBN insulating combination.

Owing to recent advances in fabrication techniques [4], we achieved large-scale exfoliated hBN-graphene-hBN photodetectors with active areas up to 100 μm^2. These large scale devices (see Fig. 1b) allow for the systematic study of the responsivity as a function of the devices' dimension. Specifically, we investigate the effect of the source-to-drain distance and the length of the absorption area (Fig. 1b). The experimental results are compared to simulations.

References

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Figures

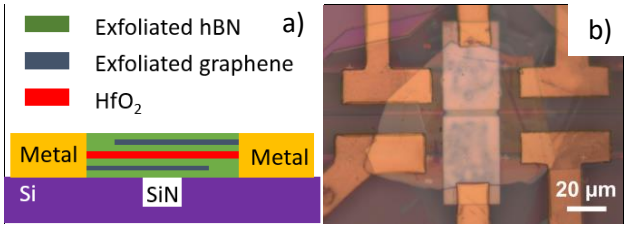

Figure 1: a) Sketch of a double layer graphene EA modulator with a hBN-HfO_2-hBN dielectric serat. b) hBN-graphene-hBN based photodetector transferred over an optical waveguide. The length of the active area is around 30 µm.