Graphene-hBN Electro-Optical Modulator in a Polymer Waveguide

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Abstract

Electro-optical (EO) polymer modulators have been investigated for many years due to their fast EO response, which enables a broadband modulation rate of >100 GHz [1]. Graphene-based modulator has been integrated into a polymer waveguide with a simple spin-coating process enabling a flexibility positioning of the graphene layers [2]. In this work, we report an electro-absorption modulator by using two monolayers graphene with hexagonal boron nitride (hBN) as a dielectric layer under a polymer waveguide. Each graphene layer is connected by a gold electrode where is possible to apply a voltage-commutation. It is possible to see the cross section scheme in the Figure 1.
Each material was chosen considering the refraction index for the light to be confined in the waveguide with small part in the polymer bottom cladding (height = 0.15 µm). This setup can improve the graphene-light interaction and the result is a high modulation depth. Figure 2 shows the TE mode extinction ratio (ER) as a function of dielectric thickness (*d*) from 5 to 50 nm. The ER varies positively in relation to *d* and does not need an extreme switching voltage (ΔV). When it was used *d* = 15 nm, the device need a ΔV = 9.4 – 5.7 = 3.7 V. It was used the Fermi energy variation at 0.35 to 0.45 eV. The device operates in a modulation frequency of *f* = 9.8 GHz to a capacitance-system length of *L* = 29 µm, presenting 3 dB of modulation depth. The modulator is applicable in optical systems at 1210 to 1610 nm.

References

[1] H. Huang *et al.*, Journal of Lightwave Technology 30(23), 3647 (2012).
[2] M. Kleinert *et al.*, Optical Materials Express 6(6), 1800 (2016).

Figures

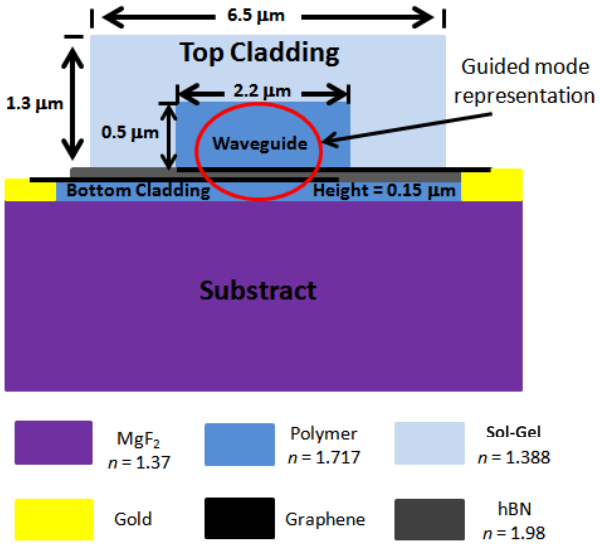

Figure 1: Graphene-hBN modulator cross section on MgF_2 substrate.

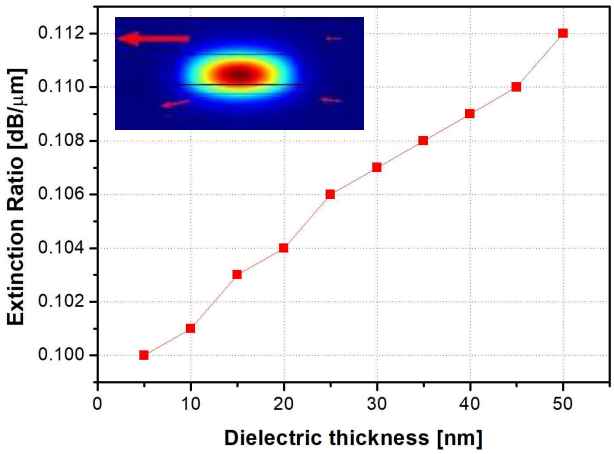

Figure 2: Extinction-ratio as a function of dielectric thickness. Inset: TE mode (*d* = 15 nm).

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