Bilayer graphene electrooptic modulator with rib dielectric enhancing TE mode confinement

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Double-layer graphene on silicon has been proven to show high performance optical modulation [1] and has shown potential experimental possibilities [2]. We report a novel design of bilayer graphene-on-silicon electro-absorption modulator. Our design involves formation of a rib dielectric structure (SiO_2) within core silicon that pushes the mode towards top graphene layers. Dimensions of the dielectric rib can be *h*/2 and *w*/2, where *h* and *w* are height and width of core Si, respectively. Such waveguide enhances the TE mode confinement and improves light–graphene interaction. The TE and TM modal properties of the waveguide are studied using a Finite element method.

Our design significantly improves the TE mode confinement within graphene layers in a graphene-on-silicon rib waveguide configuration compared to that of a vertical air slot design [3]. This structure is possible to fabricate with existing SOI technology and has CMOS compatibility and on-chip integration.

References

[1] M Liu, X Yin, E U-Avila, B Geng, T Zentgraf, L Ju, F Wang and X Zhang, Nature, 474, 2011, 64–67.

[2] M Liu, X Yin and X Zhang, Nano Lett., 12 (3), 2012, pp 1482–1485.

[3] A Phatak, Z Cheng, C Qin and K Goda, Optics Letters, 41(11), 2016, pp 2501-4.

Figures

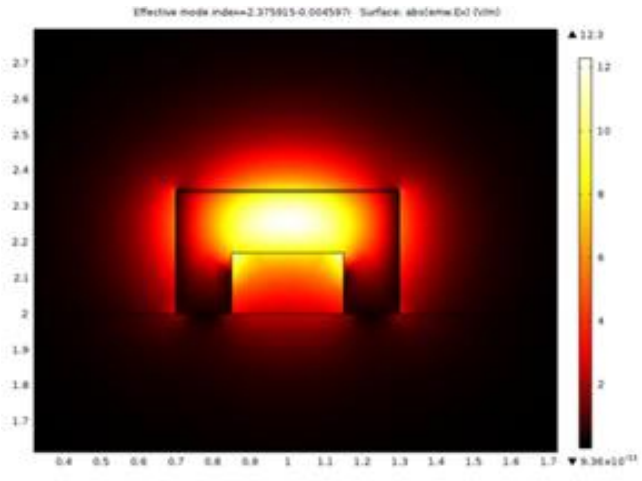

Figure 1: The TE Ex field profile. Waveguide parameters: Si width/height 0.6μm/0.34μm; bilayer graphene 0.69nm; buffer dielectric (Al_2O_3) 0.1μm; rib dielectric (SiO_2) width/height 0.3μm/0.17μm.

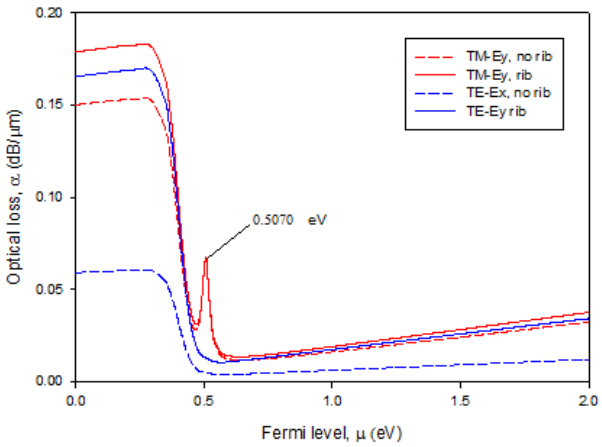

Figure 2: Optical loss (TM, TE) as a function of Fermi level in waveguides with and without SiO2 dielectric rib. Refractive indices of Si, SiO_2 and Al_2O_3 were taken as 3.47, 2.09 and 3.02. In TM plot, a peak at μ = 0.507 eV denotes transition of graphene layer to metallic state, $\varepsilon_{graphene}$ = –0.0839+*j*0.5728, showing epsilon near zero effect in graphene.