Simulation study of high efficient graphene electro-absorption modulator based on silicon-nitride waveguide

Ashraful Islam Raju[1]
Pawan kumar Dubey[1], R. Lukose[1], C. Wenger [1,2,] A. Mai [1,3], M. Lukosius[1]
[1]IHP- Leibniz Institut für innovative Mikroelektronik, Im Technologiepark 25, 15236 Frankfurt (Oder), Germany
[2]BTU Cottbus Senftenberg, Platz der Deutschen Einheit 1, 03046 Cottbus, Germany
[3]Technische Hochschule Wildau, Hochschulring 1, 15745 Wildau, Germany
Contact: raju@ihp-microelectronics.com

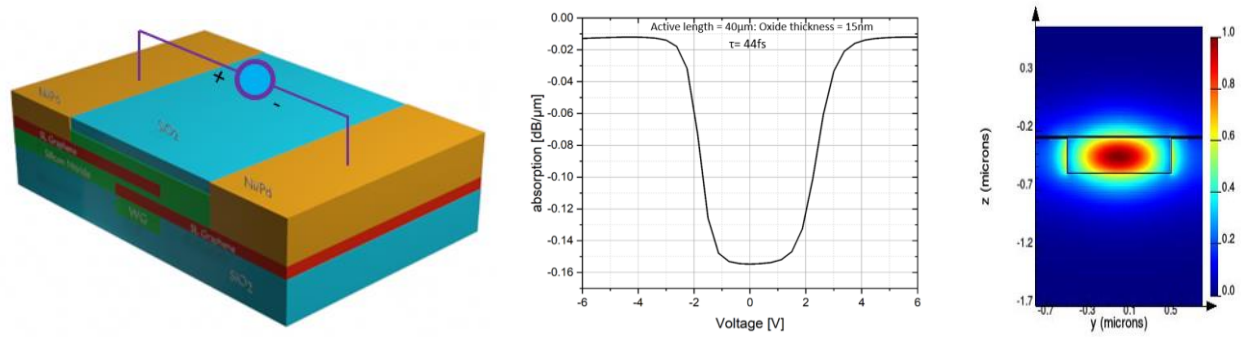
Abstract

Graphene-based optical modulator with high modulation depth, large bandwidth and low power energy is a key components for emerging on-chip optical signal processing [1]. In recent years, the silicon-nitride–on-silicon-dioxide (Si_3N_4-on-SiO_2) [2] platform has gained increasing interest to realize such high performance photonic devices as an alternative to photonic integrated circuits (PIC) platforms based on the Silicon-on-Insulator (SOI) [3] due to its low optical losses, larger wavelength transparency range, high thermo-optic stability and CMOS compatible fabrication facilities. In this work, we present simulated results of a buried waveguide coupled double layer graphene electro-absorption modulator based on silicon-nitride PIC platform. The effect of waveguide dimensions as well as the optical modes of the waveguide on device performances have been comprehensively investigated. Our simulation results demonstrate a large modulation depth of 0.15dB/μm and high modulation efficiency of 0.07dBV^{-1}μm^{-1} at λ=1550nm operating in the TE Mode. The 3-dB bandwidth of 30GHz can be obtained at a small power consumption of 2.5pJ/bit. The simulated electro-absorption modulator can remedy the lack of high speed modulator on the passive silicon-nitride waveguide.

References

[1] Liu, M., A graphene-based broadband optical modulator. Nature 474, 64–67 (2011)
[2] C. T. Phare, "Graphene electro-optic modulator with 30 GHz bandwidth," Nat. Photonics 9, 511–514 (2015)
[3] Mohsin, M., Graphene based low insertion loss electro-absorption modulator on SOI waveguide. Opt. Express 22, 15292–15297 (2014)

Figures



(a) (b) (c)

Figure 1: a) 3D device schematic, b) absorption profile of simulated device, c) TE optical mode

Acknowledgment

This research was funded by the European Union's Horizon 2020 research and innovation programme under Graphene Flagship grant agreement No 952792