Graphene Based Integrated Optical Modulators with High Bandwidth and Low Power Consumption

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Abstract

The use of graphene as an active material in integrated silicon photonic devices is a promising platform for the development of electro-absorption optical modulators with high bandwidth and low power consumption required for application in datacentres and optical interconnections [1]. Graphene absorption can be controlled by electric gating applied on two graphene layers separated by a dielectric in a capacitor-like configuration, as shown in Figure 1, this way graphene's Fermi level can be adjusted turning it transparent for Fermi levels higher than half the photon energy. Graphene is deposited along a waveguide increasing its interaction with the guided light and also the device's modulation depth. The device capacitance determines the modulator performance, lower capacitance allows higher electrical bandwidths (higher bit rates) and can be achieved concentrating light in a smaller area using the slot waveguide [2] configuration shown in Figure 1 and the inset. The dielectric thickness also changes the capacitance and the voltage required for switching the device affecting both the bandwidth and energy per bit consumed, as depicted in Figure 2. With this design, for a 3dB modulation depth, 100GHz bandwidth with 10 fJ/bit consumption can be achieved. This talk discusses the state of art and performance limits for optical modulators in integrated silicon-based waveguides with graphene.

References

[1] Yingtao Hu *et al.*, Laser Photonics Rev. 10, 2 (2016) 307-316

[2] V. R. Almeida *et al.*, Optics Letters 29, 11 (2004) 1209-1211

Figures

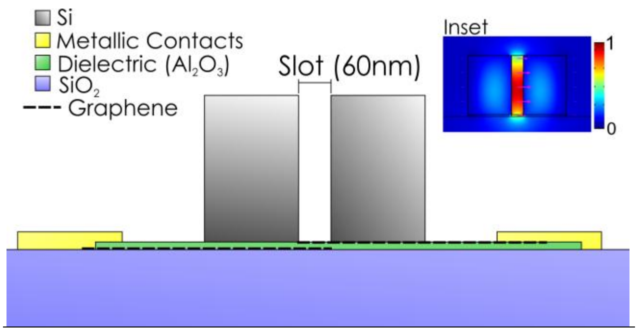

Figure 1: Transversal section of a slot waveguide based optical modulator with graphene. The inset shows the normalized optical power distribution for a 1550nm wavelength light in the slot region (colour scale) and the optical electric field direction (arrows).

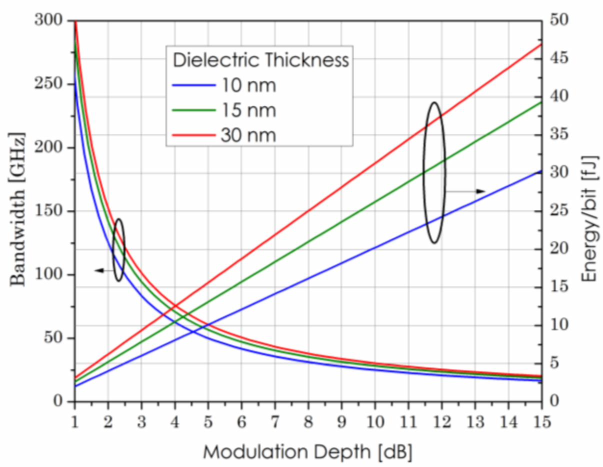

Figure 2: Optical modulator performance with different dielectric thickness showing the electrical bandwidth and energy consumption per bit as function of the modulation depth.

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