Waveguide Integrated Double Layer Graphene-SiN Modulators For On-chip Optical Interconnects

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Optical modulators are essential components of optoelectronic links [1]. Si-photonics is an emerging technology for short-reach optical interconnects [1]. On-chip integrated Si electro-refractive (phase) and Si-Ge electro-absorption (amplitude) modulators are currently employed to encode information into guided light [1]. However, Si-based optical modulators are unlikely to meet future requirements of power consumption, insertion loss, and device scaling [1]. Here, we design power efficient Si-graphene amplitude and phase modulators, Fig.1, operating at telecom wavelengths with 10 dB extinction ratio and <1 dB insertion loss with an applied 1V AC voltage around a DC operating point. Their performances in terms of induced phase-shift and loss modulation are shown in Fig.2. Graphene integration on a low-loss SiN platform enables us to reduce insertion losses by tuning the Fermi level [2], miniaturize the device footprint by exploiting the electro-refractive modulation [3], and achieve <1 pJ/bit energy cost [3].

References

[1] G. T. Reed, G. Mashanovich, F. Y. Gardes, and D. J. Thomson, Nature Photonics, 4 (2010) 518-526.

[2] M. Liu, X. Yin, E. Ulin-Avila, B. Geng, T. Zentgraf, L. Ju, F. Wang, and X. Zhang, Nature, 474 (2011) 64-67.

[3] V. Sorianello, M. Midrio, and M. Romagnoli, Optics Express, 23 (2015) 6478-90.

Figures

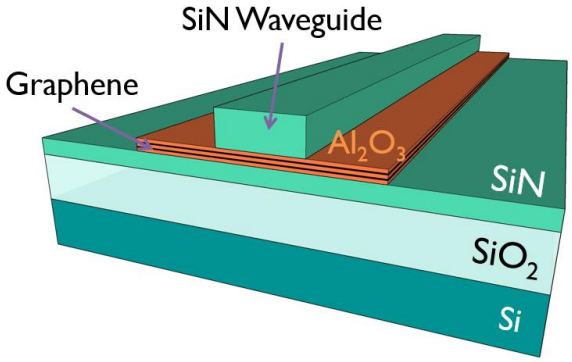

Figure 1: Waveguide-integrated double-layer electro-absorption graphene modulator on SiN

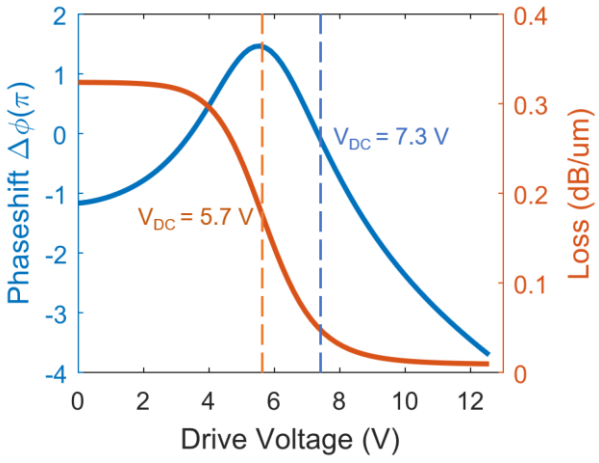

Figure 2: Simulated modulation of phaseshift and loss of the propagating optical mode with applied gate voltage for electro-refractive and electro-absorption configurations