Design optimisation of plasmonic enhanced waveguide integrated graphene p-n junction photodetector for telecom wavelengths

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Graphene integration with silicon photonics [1-4] holds great promise for telecom and Datacom applications. For graphene-based on-chip optoelectronic links, power-efficient waveguide integrated photodetectors (PDs) are among the key components. PDs based on the photo-thermoelectric (PTE) effect [3] could directly generate a photo-voltage without dark current [4], thus removing the need of a transimpedance amplifier. Here, we present optical and thermal simulations of plasmonic enhanced graphene p-n junction PDs coupled to silicon (Si) and silicon nitride (SiN) waveguides. Two metal gates form a p-n junction in graphene and simultaneously support plasmonic guiding in a metal-dielectric-metal structure (Fig. 1a). The light is coupled from the optical waveguide mode to a gap plasmon mode, resulting in enhanced light-graphene interaction and a “localized” hot electrons distribution that contributes to a higher PTE effect (Fig. 1b).

Using full FDTD and thermal simulations, the expected external responsivity is ~ 25V/W at 1550nm, one order of magnitude higher than currently achieved with waveguide integrated PTE-based graphene PDs [4].

References

Figure 1: a) Schematic of a plasmonic enhanced waveguide-integrated graphene PD. b) Simulated increase in electronic temperature in the graphene channel.