How graphene can enable the development of near-infrared silicon-based resonant cavity enhanced photodetectors

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Abstract

Resonant cavity enhanced (RCE) photodetectors (PDs) are established structures capable of overcoming the classic efficiency-bandwidth trade-off by placing a thin active absorbing material within a Fabry-Pèrot optical microcavity. Unfortunately, the transparency of silicon (Si) over 1100nm hinders its employment as an active material in RCE-PDs, so their manufacture is mainly based on III-V semiconductors for the detection of light in the near-infrared (NIR) regime and in particular at the wavelength of 1550nm (a standard of the long-distance fiber optic communication). Our research activity is focused on the design, fabrication and characterization of a new family RCE PDs based on graphene/silicon Schottky junctions embedded in a Fabry-Pèrot (F-P) optical microcavity able to enhance the graphene absorption and consequently the device efficiency at 1550nm. These devices show high spectral selectivity at the resonance wavelength which can also be tuned by changing the cavity length.

We have already reported a wavelength-dependent external responsivity of ∼20 mA/W in a planar F−P microcavity provided of a low finesse of only 5.4. Furthermore, we have proposed and theoretically investigated a very high-finesse Si-based RCE PD characterized by a graphene optical absorption, responsivity and finesse of 100%, 0.43A/W and 172, respectively. The measurements on a simplified prototype of the proposed device have shown responsivities of the order of a few tens of mA/W paving the way for the development of a new family of high-performance PDs to be employed in silicon photonics.