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Silicon photodetectors operating at 1.55 μm and 2 μm using graphene

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Silicon photonics offers the potential for low-cost integration of optical and electronic functionalities on the same chip. In this context, the near-infrared (NIR) range is probably the most investigated, in particular the wavelength of 1.55 μm : a standard for the long-distance optical communications. Recently, many research groups have demonstrated several silicon-based components operating in the mid-wave infrared (MIR) wavelength range of 2–20 μm , including low-loss waveguides, couplers, splitters and multiplexers, as well as some with hybrid active functionality. There are compelling reasons to migrate silicon photonics from the telecom wavelength region into the MIR. First, the undesired nonlinear loss, two-photon absorption (TPA), which is a limiting factor for nonlinear optical processes in the near-infrared vanishes at longer wavelengths as the energy of two photons is not enough for a band-to-band transition. Second, silicon photonics have many potential applications in chemical and biological sensing for realizing the lab-on-a-chip concept. Although Si optical detectors are widely used for visible light (400–700nm), they can not work at wavelengths longer than $\sim 1.1 \mu\text{m}$ due to the Si bandgap of 1.12 eV. An interesting alternative approach is to take advantage of the wide absorption spectrum of graphene that, integrated on Si, can realize a hybrid structure able to detect NIR and MIR wavelengths. In this work we report on the design, the fabrication and the characterization of a vertically-illuminated hybrid graphene-silicon photodetectors operating at both 1.55 and 2 μm .

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