Waveguide-integrated Ge p-i-n Photodetectors on a Si Platform
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The combined integration of electronic and photonic circuits has become an increasingly promising technology for the high functionality extension of traditional technology shrink. For an electronic-photonic integrated circuit (EPIC) on-chip, an essential component is the waveguide-integrated photodetector on a Si CMOS platform to convert optical signals to electrical ones. We demonstrate high performance Ge p-i-n photodetectors integrated with waveguides on a Si platform with two coupling schemes: vertical coupling and butt-coupling. In the vertical coupling scheme, the light couples evanescently from the waveguide to the Ge detector below it, while in the butt-coupling scheme, the output end of the waveguide directly inputs to the Ge photodetector. With the vertical coupling scheme, a high responsivity of ~1.0 A/W in the wavelength rage of 1470-1570 nm and a 3dB bandwidth of ~7.2 GHz have been demonstrated. With the butt-coupling scheme we have achieved a high responsivity of 1.0 A/W at 1520 nm and a 3dB bandwidth greater than 4.5 GHz. The devices were fabricated completely with a CMOS process, and they can be integrated with CMOS circuitry to achieve electronic and photonic integration on Si.

**Figure 1:** Frequency response at different reverse biases of a Ge p-i-n photodetector on Si vertically coupled to a silicon nitride waveguide. The inset of the figure schematically shows the structure of the device.

**Figure 2:** Frequency response at 3V reverse bias of a Ge p-i-n photodetector on Si butt-coupled to a silicon waveguide. The inset of the figure schematically shows the structure of the device.

**REFERENCES**