High Responsivity Silicon-Graphene Schottky Avalanche Photodetectors for Visible and Telecom Wavelengths

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Abstract

We present a high (A/W range) responsivity Si-graphene Schottky avalanche photodetector (PD) for visible (642nm) and telecom (1550nm) wavelengths. The device is fabricated by contacting chemical vapor deposited (CVD) graphene with a p-type Si substrate forming a Schottky junction [1,2]. Upon device illumination with photon energy above the Si bandgap (1.12eV), photodetection happens due to direct (band-to-band) photo-generation of electron-hole pairs in Si [3]. At 1550nm the photon energy (0.8eV) is below the Si bandgap, and the PD operation relies on internal photoemission, where photoexcited free carriers are injected from the graphene electrode to Si above a Schottky barrier [3]. To achieve a photogain, the PD is designed to perform under avalanche multiplication of the photoexcited carriers in the Si depletion region for elevated (higher than 4V) reverse biases. As a result, the device has an external responsivity up to ~1A/W for 642nm and ~0.5A/W for 1550nm. The latter responsivity is the highest achieved so far amongst Si-PDs for telecom wavelengths [4], and comparable with state-of-the-art Si-Ge devices currently employed in Si photonics [5,6]. Our device paves the way towards graphene-Si optoelectronic integration.

References

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Figures

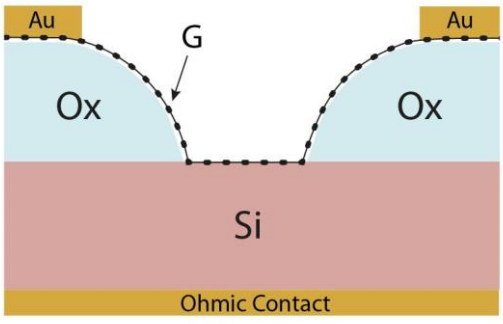

Fig 1. Schematic of Graphene-Si Schottky PD.

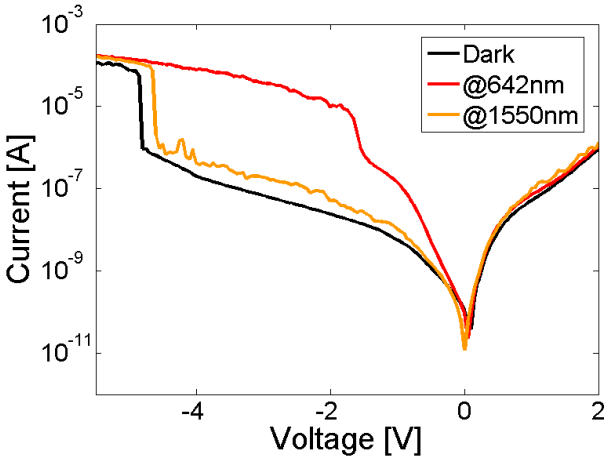

Fig 2. I-V characteristics under illumination showing photoresponse for visible and telecom wavelengths.