High bandwidth graphene photodetector with ultrafast, high efficiency performance

While graphene photodetectors offer great potential as next generation devices over current semiconductor based photodetectors, graphene’s low optical absorption results in low efficiency photodetection. This technology resolves the issue of graphene’s low optical absorption by integrating a graphene photodetector onto a silicon waveguide, which improves optical absorption and photoresponsivity. This photodetector maintains all of the advantages of graphene-based devices, such as high bandwidth detection abilities and ultrafast carrier dynamics.

Graphene photodetectors offer high bandwidth and photoresponsivity for spectrally resolved photodetection

In contrast to band-gap limited semiconductors which have a limited absorption spectra, graphene is a zero band-gap material that absorbs light from a wide spectral range from the visible to far infrared. While this is a broad light spectrum for absorption, the cross section of light absorption in graphene is relatively weak. This technology addresses graphene’s inherent weak absorption by integrating it onto a silicon waveguide. A strong intensity wave of light generated at the interface of graphene and the silicon waveguide leads to enhanced light absorption by graphene. Thus broadband absorption using this technology is more efficient than in previously reported graphene-based photodetectors.

Additionally, this technology achieves improved photoresponsivity (efficiency of electrical signal output relative to input light) without the noise that plagues similar photodetector configurations. Electrical contacts placed asymmetrically on either side of graphene for photodetection induces an electric field that drives efficient current extraction. In contrast, existing configurations rely on an external voltage bias, and thus suffer from extra noise. Consequently, this technology provides a more reliable, high photoresponsive photodetector as compared to current devices. The waveguide can also serve to spectrally resolve incoming light into distinct wavelengths. The dispersed light can then be detected individually by graphene photodetectors integrated at wavelength specific positions on the waveguide.

The increased photoresponsivity and absorption has been demonstrated in the laboratory.
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Applications:
• Photodetectors for integrated optoelectronics
• Photodiodes
• Bioimaging devices
• Biosensing devices

Advantages:
• Ultrafast photodetection
• Broad spectral absorption range
• Enhanced light absorption from graphene
• Enhanced photoresponsivity
• Improved photocurrent at zero bias (no added noise)
• Spectral resolution
• Enhanced photoresponsivity

Patent Information:
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Related Publications:

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