High-Performance Broadband Photodetector (#7963)

Offers applications for communications, medical imaging, and more

This broadband photodetector offers enhanced sensitivity, responsivity, and stability operating over a wide range of light wavelengths—from near-ultraviolet to near-infrared—at low power consumption.

Georgia Tech's innovation has a 3D photodiode structure that features a specially designed textured top electrode with nanowire arrays to maximize light absorption. A conformal alumina layer is inserted between two constituent semiconductors of a p-n junction to form dual inversion layers. This unique structure leads to significant enhancement of photo-excited charge carrier separation and collection efficiency. The photo-sensing responsivity and sensitivity are nearly one order of magnitude higher than that of a reference device of p-Si/N-ZnO nanowire arrays.

This innovation potentially paves the way for a practical and efficient approach to converting light to electricity, resulting in high-performance broadband photodetectors and other optoelectronics.

Benefits/Advantages

- **Enhanced sensitivity**: Functions over a wide range of wavelengths—from near-ultraviolet to near-infrared
- **High performance**: Operates at high-speed response conditions in wide spectral bandwidth for various applications
- **High stability and repeatability**: Offers significant photo-sensing ability with no deviation or degradation observed after one year
- **3D structure**: Leverages superior properties of nanowires—high surface area, longer optical paths, wider acceptance angles, and low surface reflection—to increase sensitivity and enhance electrode transmission
- **Low power consumption**: Operates at a negative bias of only -2 volts, with high output values

Potential Commercial Applications

- Optical-fiber communications systems
- Medical imaging
- Thermal imaging
- Environmental monitoring
- Defense technology

- Nano-robotics

Background/Context for This Invention

Though silicon photonics have revolutionized numerous applications in communications, biomedical diagnostics, and more, silicon possesses many shortcomings as a photonic material. For example, its indirect energy band and highly reflective surface limit light absorption. And when incident optical power increases, silicon photonic devices reach a saturation limit and responsivity decreases significantly.

Georgia Tech's innovation employs a unique 3D structure with a textured top electrode that works as an anti-reflection layer to improve light absorption. This structure also takes advantage of the superior properties of nanowires to enhance electrode transmission and increase broadband photo-sensing.

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Patent/IP Information

U.S. Application Filed

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Publications

Dramatically Enhanced Broadband Photodetection by Dual Inversion Layers and Fowler-Nordheim Tunneling, ACS Nano, January 24, 2019

Dramatically Enhanced Broadband Photodetection by Dual Inversion Layers and Fowler-Nordheim Tunneling, Poster

For more information about this technology, please visit:
https://licensing.research.gatech.edu/technology/high-performance-broadband-photodetector