Back-Illuminated, Modified Silicon Photomultipliers with Largely Enhanced Efficiency for Multiple Applications

Current silicon photomultipliers have major loss of photons

Silicon photomultipliers (SiPM) are the current technological state-of-the-art devices, form the foundation of modern photodetectors and represent a great evolutionary leap over legacy technologies in the field. However, these devices are not without deficiencies of their own. A major deficiency – and an opportunity for considerable improvement - is the loss of photons due to reflection of the incident light at the surface of the photosensitive layer.

The inventors addressed this issue by rendering a specially designed texture to the photosensitive layer and applying specific coating(s) that reduce light reflection in the overall 200 nm – 800 nm range from 19% (current SiPM) to ca 1.5%, thus nearly doubling the incidence of photons onto the photosensitive layer, and greatly enhancing the device's efficiency.

Novel photomultiplier can minimize photo loss and increase efficiency

This invention is comprised of (i) a photomultiplier device containing a texturized photoelectric surface and at least one coating layer, which minimizes photon losses, and greatly enhances the efficiency of the device and (ii) a method of manufacturing the device based on techniques common in the industry.

Summary Bullets

- A novel photomultiplier device has been created that minimizes photon losses, and greatly enhances the efficiency of the device.
- The photomultiplier may improve the fill factor to 100% from 75% for the current SiPM and increases the usable wavelength range to cover the entire UV-Vis spectrum.
- The technology contains a texturized photoelectric surface and at least one coating layer and can be produced using standard manufacturing processes and low extinction coefficient materials.

Solution Advantages

- Much improved efficiency
- Involves standard manufacturing processes, and low extinction coefficient materials
- Fill factor may approach 100% (vs 75% for current SiPM)
- Increases the usable wavelength range to cover the entire UV-Vis spectrum, potentially near IR
- Increased Photon Detection Efficiency
- Manifold decrease to near-zero reflection and scattering of UV

Potential Commercial Applications

- PET and other medical imaging techniques
- Scintillation detectors
- LiDAR
- Microelectronics
- Astronomy cameras and sensors
- V-Vis spectroscopic methods

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IP Status

The patent application has been filed :

Publications

Advanced antireflection for back-illuminated silicon photomultipliers to detect faint light, Sci Rep. 2022; 12: 13906 - 2022

Images

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