

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

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## 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

<p>The patent application has been filed</p>:

#### Publications

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

#### Images

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