

Hyperdoped Silicon Photodiode Sets Efficiency Record

A new light-trapping architecture could lead to CMOS-compatible night-vision technology.

By **Rachel Berkowitz**

Short-wave-infrared (SWIR) light can penetrate materials that absorb or scatter visible light, such as plastic and fog. SWIR imaging therefore reveals details invisible to conventional cameras, making it a valuable tool for night-vision and industrial applications. But high-performance SWIR cameras rely on specialized sensors that require cryogenic cooling and whose creation is both environmentally harmful and incompatible with mature complementary-metal-oxide-semiconductor (CMOS) fabrication processes. Eric Garcia-Hemme of the Complutense University of Madrid and his colleagues have now presented a CMOS-compatible photodiode for room-temperature SWIR detection [1].

The researchers created their photodiode using a 250- μm -thick silicon wafer. On one side of the silicon, they implanted extremely high concentrations of tellurium ions, which are known to improve bulk silicon's sub-band-gap optical absorption. On top of that, Garcia-Hemme and colleagues added pyramid-like structures etched on the surface, topped by

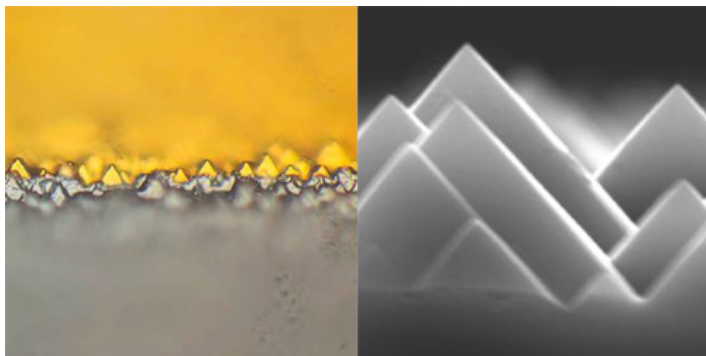
a 200-nm-thick gold back reflector. These light-trapping features were intended to extend the optical path within the hyperdoped layer, thereby boosting absorption at energies below silicon's band gap. To complete the device, they added an electrode on the opposite face.

Measuring the device's transmission and absorption at different wavelengths revealed two improvements compared to standard photodiode designs. First, the structured surface increased absorption from 25% to 85%. Second, the device's quantum efficiency—how comprehensively it transforms incident photons into an electrical signal—at SWIR wavelengths exceeded that of state-of-the-art silicon sensors by more than an order of magnitude. The researchers found the mechanism behind this high quantum efficiency when they analyzed the device's charge-transport properties. They discovered that an applied voltage caused photoexcited electrons to tunnel between the tellurium band and the host silicon. This quantum shortcut meant that charges were extracted quickly—before they could recombine with the residual holes in the tellurium.

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REFERENCES

1. E. García-Hemme *et al.*, “Breakthrough in short-wavelength infrared quantum efficiency in Te-hyperdoped silicon photodetectors via light-trapping strategies,” *Phys. Rev. Lett.* **137**, 057002 (2026).



Credit: E. García-Hemme *et al.* [1]