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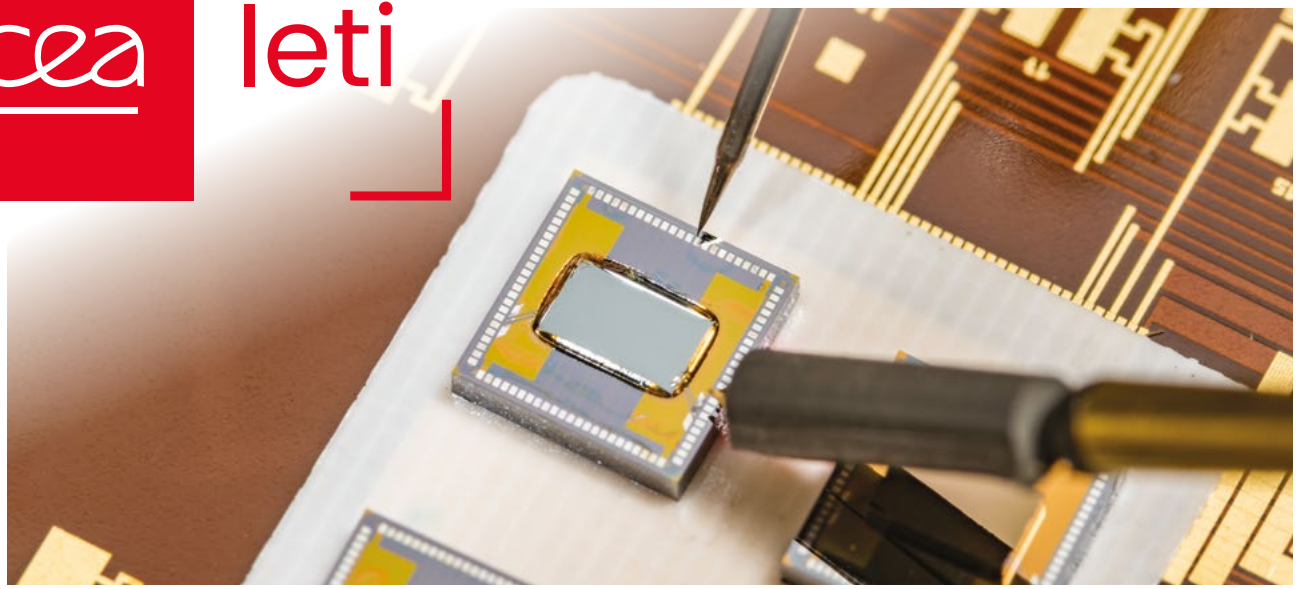
cea leti



HOT avalanche photodiodes

PATENTS 6 PATENTS

High-operating-temperature infrared detection of low numbers of photons with no information loss

What it is

CEA-Leti's HOT (high operating temperature) APDs (avalanche photodiodes) open the door to very-high-performance time-resolved infrared detection.
The APDs are made from a mercury cadmium telluride (MCT) semiconductor absorber layer with a unique amplification process resulting in signal amplification gains of up to 1,000 without adding noise to the signal.

This technology has been demonstrated to operate at high performance up to ambient temperature, opening the door to high-sensitivity detection that can be integrated into a variety of detection systems to create new capabilities, enhance performance, and/or enable system optimization.

What it can do

This HOT APD infrared detector is well-suited to low-SWaP-C (size, weight, power, and cost) detection products addressing premium and/or high-volume markets:

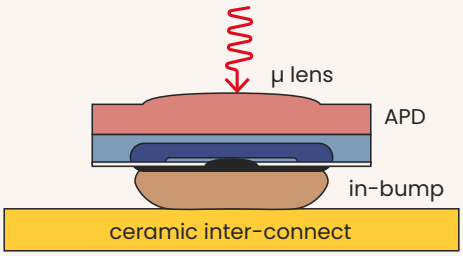
- LiDAR for industrial detection, robot guidance, topographical imaging, defense, space, and mobility.
- FSO (free-space optical) communications for tomorrow's ultra-fast data transmission needs.
- Time-resolved infrared detectors for New Science (biomedical research, materials science).

As device operating temperatures decrease, quantum optical applications will also be possible.

What makes it unique

CEA-Leti's HOT APDs enable simpler systems and new detection capabilities:

- With APD detectors like this one, the signal can be amplified without adding noise. Very weak signals—normally drowned out by noise from the circuit—can be detected down to a single photon.
- This property is conserved at record-high signal amplification gains of up to 1,000, for electronic-noise-free detection with spectral sensitivity extending into the SWIR and MWIR ranges.
- Monolithically-integrated micro-lenses can enhance the active optical area to meet the requirements of free-space optical coupling.



▲ *HgCdTe APD technology flip-chip hybridized onto a ceramic interconnection circuit and back-side illuminated through a monolithically integrated microlens.*

Working with CEA-Leti

CEA-Leti plans to commercialize its HOT APD technology and invites companies of all types and sizes interested in integrating this technology into their products to inquire about partner programs.
This technology also opens the door to SWaP-C single-photon counting for quantum optics, with high bandwidth, higher operating temperature, and GHz-rate photon counting.

With a proven R&D partnership management processes and robust intellectual property policies, CEA-Leti is poised to bring new ideas from the lab to fab securely and efficiently.

Key facts

- 1.2 noise factor at multiplication gains > 100 (1 = no noise)
- Amplification gains of 100 (typical) to 1,000 for detection down to single photons
- High temporal resolution below 200 ps
- Low noise equivalent current NEI=15 to 150 fA/√Hz between -30 °C and +30 °C

Scientific publications

- Rothman, J., et al. (2024). "Avalanche Gain Modeling Revisited in HgCdTe APDs." J. Electron. Mater. 53, 5829–5841.
- Rothman, J., et al. (2020). "Meso-photonic Detection with HgCdTe APDs at High Count Rates." J. Electron. Mater. 49, 6881–6892.

Interested in this technology?

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