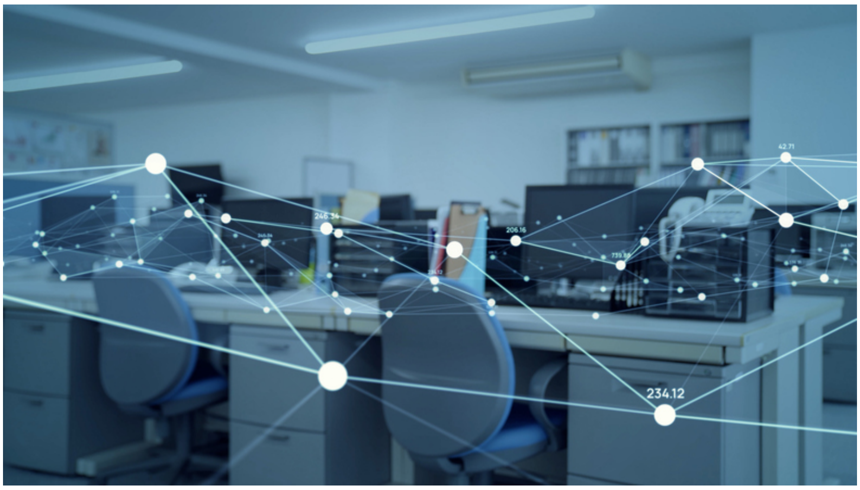
Uncooled, Highly Sensitive Bowtie Nano-antenna Embedded IR Detector

TECHNOLOGY NUMBER: 5934



OVERVIEW

Enhanced infrared detection with bowtie nanoantenna integrated InGaAsSb detector

- Improves sensitivity and detectivity via field enhancement and impedance matching
- High-resolution imaging, polarimetric sensing, and small-scale IR detection

BACKGROUND

Infrared (IR) detectors are critical in various fields such as imaging, sensing, and communication. Traditional IR detectors often employ anti-reflection coatings to minimize losses at the interface between air and semiconductor materials, which marginally enhances their performance by improving signal absorption with some enhancement in signal-to-noise ratio. However, the efficiency of conventional IR detectors is significantly limited by the absorption properties of the active semiconductor material. To counter these limitations, thicker layers of active material are used for materials with low absorption coefficients, leading to an increase in size and complexity. A significant breakthrough came with the introduction of antenna-coupled detectors, where antennas, taking advantage of surface plasmons, focus incoming signals into a small volume, enhancing the field at the antenna's terminals and improving the overall absorption. However, these devices often suffer from impedance mismatch issues, leading to suboptimal power transfer and increased noise, which necessitates an improved design for high-sensitivity applications.

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Category
Hardware
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Semiconductors, MEMS, and Electronics

Inventor
Kamal Sarabandi
Sangjo Choi

Further information
Joohee Kim
jooheek@umich.edu

View online

INNOVATION

Researchers at the University of Michigan have developed an advanced IR detection system integrating a high-impedance bowtie nanoantenna with an InGaAsSb (Indium Gallium Arsenide Antimonide) infrared detector. The bowtie antenna exploits its anti-parallel resonance mode, optimized for maximum field enhancement at its terminals, and is matched with an InGaAsSb PN junction characterized by a low bandgap ($E_g = 0.52$ eV). By incorporating impedance matching techniques such as an inductive transmission line stub, the new design ensures maximum power transfer, significantly boosting sensitivity. The detectivity of this design improves by a factor roughly equal to the field enhancement factor (>20).

ADDITIONAL INFORMATION

US10333457 "Bowtie nanoantennas for efficient thermophotovoltaics and enhanced sensitivity IR photodetectors"