Spectrally-selective infrared photodetection for real-time hyper-spectral imaging

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Value Proposition

Thermal detectors, such as bolometric, pyroelectric and thermoelectric devices, are uniquely capable of sensing incident radiation for any electromagnetic frequency; however, the response times of practical devices are prohibitively slow limiting its use for real-time imaging.

Technology

Duke inventors have reported a hyper-spectral imaging device with higher frame rates and smaller form factors than existing technologies allow. This invention integrates a plasmonic metasurface with an aluminium nitride pyroelectric thin film. It has demonstrated spectrally selective, room-temperature pyroelectric detectors from 660–2,000 nm with an instrument-limited 1.7 ns full width at half maximum and 700 ps rise time. Heat generated from light absorption diffuses through the subwavelength absorber into the pyroelectric film producing responsivities up to 0.18 V W−1 due to the temperature-dependent spontaneous polarization of the pyroelectric films. Moreover, finite-element simulations reveal the possibility of reaching a 25 ps full width at half maximum and 6 ps rise time rivalling that of semiconductor photodiodes. This design approach has the potential to realize large-area, inexpensive gigahertz pyroelectric detectors for wavelength-specific detection from the ultraviolet to short-wave infrared or beyond for, for example, high-speed hyperspectral imaging.

Advantages

- Improved inexpensive thermal detector technology that can be embedded into new platforms for new applications
- Fast response time orders of magnitude faster than current technology
- Compact size as it eliminates the need for external optical filters, filter wheels, gratings, and other independent selection mechanisms external to the detector

Publications

- Ultrafast pyroelectric photodetection with on-chip spectral filters. (Nat. Mater., 2019)

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