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HgCdTe for NASA Eos Missions and Detector Uniformity Benchmarks

Paul R. Norton
Santa Barbara Research Center
Goleta, CA 93117

Important NASA Eos missions (AIRS and MODIS-N) which require detector spectral response in the range of 14 to 17 μm at medium background flux levels and operation in the range of temperatures between 65 to 95 K will be flown beginning in the next few years. Currently, a prime candidate detector technology for these missions is trapping-mode photoconductive HgCdTe devices. These devices can be tailored to the exact cutoff wavelengths required by those missions, and thus offer the performance advantages of an *intrinsic* detector which is ideally matched to the mission wavelength.

Under the long wavelength-background-temperature conditions of these Eos missions, any detector will at best be thermal generation-recombination noise limited. Photoconductive devices are generally preferred under these circumstances, since at elevated temperatures their performance degrades with n_i while for photovoltaic detectors performance degrades as n_i^2 (n_i is the *intrinsic* carrier concentration which is a function of alloy composition and temperature, but not doping).

Very high performance trapping-mode photoconductive HgCdTe detectors have been developed which can be reproducibly fabricated. Detectivity (D*) at 80K and 16 μm cutoff wavelength in excess of 10^{11} Jones has been measured for these devices. Power dissipation is at least two orders of magnitude less than conventional HgCdTe photoconductors - on the order of 0.12 W/cm^2 compared with 12 W/cm^2.

Eos missions define *thermal noise limited conditions* for the long wavelength operating bands. Trapping-mode photoconductive HgCdTe detectors are linear under such conditions and responsivity is independent of background flux. At lower temperatures or high flux conditions in which background flux limits detector performance, trapping-mode detectors have a responsivity which varies with background flux. Internal calibration must be provided for radiometric measurements under the latter conditions (not an Eos mission concern).

Liquid phase epitaxy is used to grow these HgCdTe device structures. This technique has been shown to give control of the cutoff wavelength on the order of 16 ± 1 µm or less, both from run to run and across wafer dimensions of several centimeters on a side. Responsivity uniformity of linear arrays (300 elements with areas of -2.5×10^{-5} cm^2 and 100 µm center-to-center spacings) of trapping-mode detectors with 12 µm cutoff have shown typcal uniformities of 5-10% one-sigma standard deviation measured at 80 K and 5×10^{16} photons/cm^2/sec background flux. Measurements of PV detector responsivity uniformity shows that uniformity scales as $1/\sqrt{A}$ and can be attributed to ±1mm variations in detector area. Thus, larger area HgCdTe detectors are anticipated to be more uniform.