Long Wavelength 256x256 Quantum Well Infrared Photodetector Portable Camera

S. D. Gunapala, J. K. Liu, C. A. Shott*, T. Hoelter*, M. Sundaram, J. S. Park, S. Laband*, and J. James*

Center for Space Microelectronics Technology, Jet Propulsion Laboratory, California Institute of Technology, Pasadena,CA91109, USA

*Amber, A Raytheon Compan y, Goleta, CA 93117

We have developed a first 9 μm cutoff portable (Amber RADIANCE™) GaAs/AlGaAs 256x256 quantum well infrared photodetectors (QWIPs) camera, The bound-to-quasibound photoconductive QWIPS of the 256x256 focal plane arrays (FPAs) were then fabricated by wet chemical etching through the photosensitive GaAs/AlGaAs multi quantum well layers into the 1 μm thick doped GaAs contact layer. The pitch of the FPA is 38 μm and the actual pixel size is 28x28 μm^2. Then the random reflectors were fabricated on the top of the detectors and were covered with Au/Ge and Au for Ohmic contact and reflection. Then In bumps were evaporated on top of the detectors for Si multiplexer (Amber AE- 166) hybridization. A single QWIP FPA was chosen (cutoff wavelength of this sample is 8.9 μm) and bonded to a 256x256 Si multiplexer and biased at V_b = -2.0 V. The FPA was back-illuminated through the flat thinned substrate (thickness ≈ 1300 Å). Typical dark current-voltage curve and spectral response were measured at T=70 K. This initial array gave excellent images with 99.98% of the pixels working, demonstrating the high yield of GaAs technology. The uncorrected photocurrent non-uniformity (which includes 1 % non-uniformity of ROC and 1.4% non-uniformity due to the cold-stop not yielding the same field of view to all the pixels in the FPA) of the 65,536 pixels of the 256x256 FPA is about 6.8% (= sigma/mean). The uniformity after correction was 0.05%. As mentioned earlier this high yield is due to the excellent GaAs growth uniformity and the mature GaAs processing technology.

Video images were taken at various frame rates varying from 60 Hz with f/2 germanium optics at temperatures high as T = 70 K, using a multiplexer having a charge capacity of 9x106 electrons. However, the total charge capacity was not available during the operation, since the charge storage capacitor was partly filled to provide the high operating bias voltage required by the detectors (i.e., V_b = -3 V). The measured noise equivalent temperature difference NEAT of the 9 pm imaging system is 26 mK at T=67 K for 300 K background, No band pass filters were used and are unnecessary in QWIP camera systems because of the narrow spectral response of QWIPs. It should be noted that these initial unoptimized FPA results are far from optimum. The gratings were not optimized (as described earlier) for maximum light coupling efficiency; no microlenses were used; no antireflection coatings were used on the backside of the FPA; and finally the multiplexer used was a photovoltaic InSb multiplexer which is certainly not optimized to supply the proper bias and impedance levels required by photoconductive QWIPs. Implementation of these improvements should significantly enhance the QWIP FPA operating temperature (i.e., 77 K for 9 μm).

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