15 μm 128x128 Quantum Well Infrared Photodetector Focal Plane Array Camera

S. D. Gunapala, J. S. Park, T. L. Lin, and G. Sarusi

Center for Space Microelectronics Technology, Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA 91109, USA

We have developed a first generation 15 μm GaAs/AlGaAs 128x128 quantum well infrared photodetectors (QWIPs) focal plane array (FPA) for a staring infrared (IR) sensor system. The photoconductive QWIPs of the 128x128 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 50 μm and the actual pixel size is 38x38 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 hybridization. A single QWIP focal plane array was chosen (cutoff wavelength of this sample is 14.9 pm) and bonded to a 128x 128 Si multiplex and biased at V_b = -2.7 V. The focal plane array was back-illuminated through the flat thinned substrate (thickness ≈ 25 pm). Typical dark current-voltage curve and spectral response were measured at T=55 K. This initial array gave excellent images with 99.9% of the pixels working, demonstrating the high yield of GaAs technology. The excellent uncorrected photocurrent uniformity of the 16384 pixels of the 128x128 FPA with standard deviation of only σ =2.4%. The uniformity after correction was 0.2%. 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 50 to 200 Hz with f/2.6 KRS-5 optics at temperatures high as T = 45 K, using a multiplexer having a charge

capacity of 4x 107 electrons. However, the total charge capacity was not available during the operation, since the charge storage capacitor was partl y filled to provide the high operating bias voltage required by the detectors (i e., V_b = -3 V). The measured noise equivalent temperature difference NEΔT of the 15 µm imaging system is 30 mK at T=45 K for 300 K background. It should bc noted that these initial unoptimized focal plane anay results are far from optimum. The QWI P device structures was not optimized; the gratings were also not optimized for the maximum light coupling efficiency; no microlenses were used; no antireflection coatings were used; no substrate thinning was used (in the case of VWIR imaging the hybrid was thinned to 25 µm, however, it was not sufficient to improve the light coupling efficiency to small pixel); 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 QWI Ps. implementation of these improvements should significant y enhance the QW1 P focal plane array operating temperatures (i.e., 77 K for 10pm and 55 K for 15 pm).