Quantum Infrared Photodetectors for Long Wavelength Infrared Imaging Applications

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Long wavelength Quantum Well Infrared Photodetector (QWIP) cameras developed at the Jet Propulsion Laboratory demonstrate the potential of GaAs/$Al_xGa_{1-x}As$ QWIP technology for highly sensitive, low power, low cost, and highly uniform large format FPA imaging systems. These cameras utilize FPAs as large as 640x486 based on optimized GaAs/$Al_xGa_{1-x}As$ multi-quantum-well (MQW) structures coupled with random or two dimensional periodic grating reflectors. FPA uniformity better than 99.95% after two point correction has been reported. Other advantages of GaAs/AlGaAs based QWIPs are higher yield, durability, radiation hardness, and no 1/f noise till 30 mHz. In addition, QWIPs afford greater flexibility than the usual extrinsically doped semiconductor IR detectors because the wavelength of the peak response and cutoff can be continuously tailored by varying layer thickness (well width,) barrier composition (barrier height), and carrier density (well doping density). The GaAs/$Al_XGa_{1-X}As$ material system allows the quantum well parameters to be varied over a range wide enough to enable light detection at any wavelength range between 6-20 μm. The spectral band width of these detectors can be tuned from narrow ($\Delta\lambda/\lambda \sim 10$ %) to wide ($\Delta\lambda/\lambda \sim 40$ %) allowing various applications. Also, QWIP device parameters can be optimized to achieve extremely high performances at lower operating temperatures (~ 40 K) for low background long-wavelength infrared applications in strategic arena as well as in Astronomy. In the presentation, the operating principles of GaAs/AlGaAs multi quantum well structure designed for long wavelength infrared detection will be discussed. Device physics, optimization and new developments of the MQW structure to meet requirements set by different applications will also be discussed. Performance of the QWIP cameras including images from different applications will be presented.

The research described here was performed by the Center for Space Microelectronics Technology, Jet Propulsion Laboratory, California Institute of Technology, and was jointly sponsored by the Ballistic Missile Defense Organization/ Innovative Science & Technology Office, and the National Aeronautics and Space Administration, Office of Space Science.