Quantum Dot Photodetectors for THz Detection

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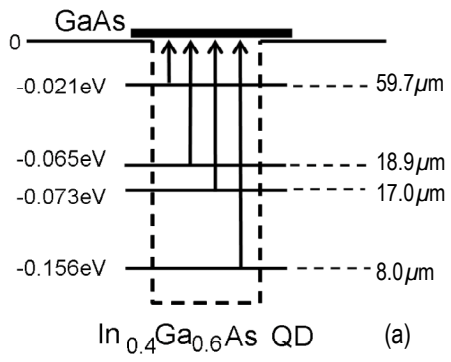
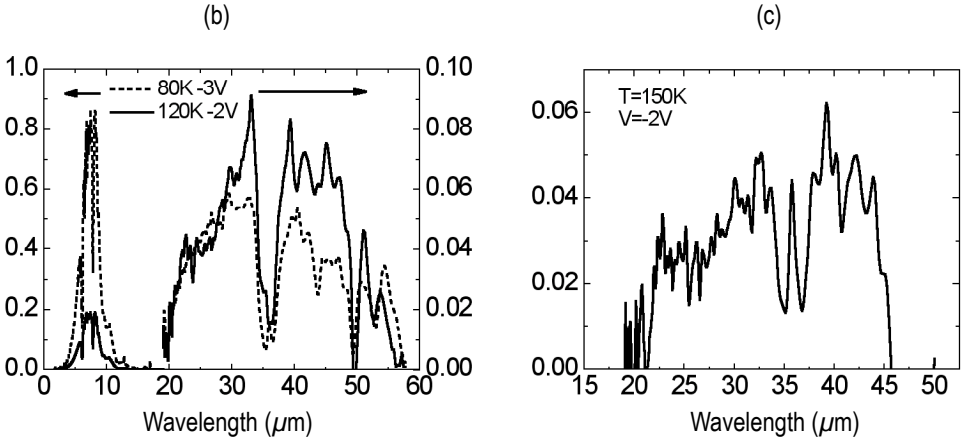
The quantum dot intersubl evel photodetector (QDIP), incorporating In(Ga)As/GaAs quantum dots in the active (absorbing) region, has emerged as a very promising device for detecting electromagnetic radiation across a broad range from near infrared to terahertz regions. The advantages of QDIPs result from three-dimensional carrier confinement in quantum dots. The associated advantages include: i) intrinsic sensitivity to normal-incidence light, ii) long lifetime of photo-excited electrons due to reduced electron-phonon scattering, and iii) low dark current. We recently demonstrated a multi-color QDIP with a simple quantum dot heterostructure active region. The device exhibits strong absorption peaks in the 3–13μm (MIR) and 20–55μm (THz) ranges with large responsivity and detectivity at temperatures up to 150K. The multi-color characteristic of this detector originates from the existence of different electron energy states in the quantum dots. By tuning the dot size, alloy composition, and barrier layer bandgap, it should be possible to extend the terahertz absorption into the 1–3THz range. This project is being supported by the Air Force Office of Scientific Research under award number FA 9550-06-1-0500 and by the National Science Foundation under award number ECS 0620688.





(a) Electron energy levels in an $In_{0.4}Ga_{0.6}As$/GaAs self-organized quantum dot; Spectral responsivity of QDIPs measured at (b) 80K and 120K, and (c) 150K.