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Strain Engineered Quantum Dots in a Well (DWELL) Photodetectors and Resonant Tunneling Filters in DWELL Photodetectors

Ajit V. Barve[1], J.Shao[1], Y.Sharma[1], R.Shenoi[1], J. O. Kim[2], S. J. Lee[2], S. K. Noh[2] and Sanjay Krishna[2]

[1]Center for High Technology Materials, University of New Mexico,Albuquerque,USA87106
[2]Korea Research Institute of Standards and Science, Daejeon 305-600, SouthKorea

Quantum dot intersubband photodetectors (QDIP) are widely researched owing to their attractive properties such as lower dark current and normal incidence absorption. Quantum-dots-in-a-well (DWELL) detectors, in which InAs QDs are placed in $In_{0.15}$-$Ga_{0.85}As$-GaAs quantum well (QW), combine advantages of QDIP with additional advantages such as reproducible control over the response wavelength, superior optical quality of the QDs. Strain-optimized configuration in which InAs QDs are placed in a double QW formed by $In_{0.15}$-$Ga_{0.85}As$- GaAs - $Al_{0.1}Ga_{0.9}As$ configurations reduce the amount of compressive strain per stack and also reduce the dark current are designed. Focal plane arrays with 320×240 pixel arrays have been fabricated using strain engineered DWELL detectors with excellent detector and imaging performance.

We also demonstrate the use of resonant tunneling filters in the barrier of DWELL detectors in order to suppress the dark current without reducing the photocurrent, to increase the signal to noise ratio. Two resonant tunneling based DWELL detectors (RT-DWELL) have 10 stacks of InAs QDs in 7.5nm $In_{0.15}Ga_{0.85}As$ QW with 50nm GaAs barrier. The RT barrier on the top of the DWELL in each stack has 2nm GaAs, 2nm $Al_{0.3}Ga_{0.7}$-As, d nm $In_{0.15}Ga_{0.85}As$ and 2nm $Al_{0.3}Ga_{0.7}$-As, with d=5.5nm and 5nm respectively, designed to extract the longwave and midwave photocarriers, respectively. The control sample has a same structure except the RT-barrier. 2-3 orders of magnitude improvement in the darkcurrent over the control sample, for a similar peak wavelength has been obtained as a result of resonant tunneling action. The specific detectivity has been improved by factor of 5, as a result of improved signal to noise ratio in the detectors. Spectral tuning by the use of resonant tunneling filters has also been demonstrated.