

Two-color Quantum Well Infrared Photodetectors

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Two-color quantum well infrared photodetectors (QWIPs) are important for temperature sensing [1]. Voltage tunable two-terminal QWIPs based on transfer of electrons between ground states of coupled QWs under voltage bias V_b have been investigated in the past [2]. The voltage switching of photoresponse peaks in these detectors suffers from the problem of the presence of the shorter wavelength peak at all bias voltages. To investigate this problem, we had studied the V_b -dependence of absorption coefficient α and gain g for a similar AlGaAs/GaAs based QWIP with a 50 Å AlGaAs barrier between the coupled wells [3]. We attributed the persistence of the shorter wavelength peak to insufficient electron transfer between the coupled QWs due to the small potential difference between these wells.

To enhance electron transfer between the QW pair under bias, we need a larger potential difference between them. This could be achieved by having a thicker AlGaAs barrier. Here, we report photoresponse measurements and absorption spectrum calculations for a similar two-color QWIP with a 200 Å AlGaAs barrier. The responsivity R of this detector, shown in Fig. 1 for 10 K, has a pronounced peak at 8 μm with smaller peaks at 6.4, 7.3 and 10.3 μm for $V_b > 0$. For small negative V_b (-1 V), there are two broad peaks at 8.2 and 9.7 μm . At higher negative V_b (-3 V), the 8.2 μm peak develops into two peaks at 7.8 and 8.9 μm while the 9.7 μm peak shifts to 10.5 μm . There is also a small peak at 6.3 μm for $V_b < 0$.

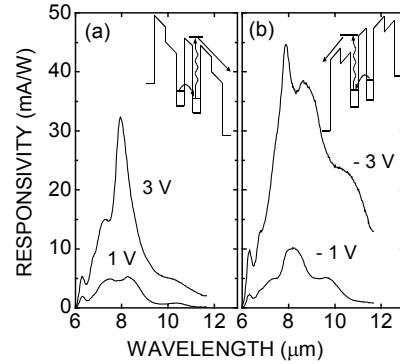


FIGURE 1: Bias dependence of spectral responsivity for (a) $V_b > 0$ and (b) $V_b < 0$. Inset: Conduction band diagram.

We calculate the spectrum of absorption coefficient α of this QWIP for different values of V_b . At $V_b = -3$ V, the calculated α peaks from the left well are at 7.4, 8.9 and 10.5 μm while the corresponding peaks in measured R are at 7.8, 8.9 and 10.6 μm . We obtain similar good agreement for other values of V_b if the absorption peaks are assumed to be from the ground state of the right (left) QW to a series of resonant states in the continuum above the barrier for positive (negative) V_b . This indicates that there is significant electron transfer between the two QWs in this detector under a bias. Despite the efficient electron transfer, the similar oscillator strength between the ground states in the two QWs to the continuum states continues to limit the wavelength tunability of this detector design.

[1] C. J. Chen, K. K. Choi, W. H. Chang and D. C. Tsui, Appl. Phys. Lett. **72**, 7 (1998).

[2] K. K. Choi *et al.*, Appl. Phys. Lett. **52**, 1979 (1988); V. Berger *et al.*, Appl. Phys. Lett. **61**, 1898 (1992).

[3] Amlan Majumdar *et al.*, submitted for publication.