Mid-Infrared Network Newsletter

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InAs/GaSb Type-II Superlattices: New Possibilities for Infrared Photon Sensing

High performance III-V long wavelength detectors have been designed and demonstrated by the Centre for Quantum Devices of Northwestern University, with potential for use in focal plane array (FPA) applications. The devices were based on type-II InAs/GaAs superlattices grown on GaAs and GaSb substrates by MBE. The optimum layer thickness in the superlattice was calculated using k.p modeling, in order to achieve low Auger resonance and a high electron - hole wavefunction overlap. In parallel, the optimum number of layers in the superlattice was calculated for a maximum detectivity at room temperature. Lithography, etching, and metalization were used to process the grown material into photoconductive and photovoltaic devices. The spectral response for a range of different InAs/GaSb superlattice photodiodes is presented in Figure 1. The thickness of the InAs layers in the superlattice was varied between 51 and 66A whilst that of the GaSb layer remained constant. In this way, a maximum cut off wavelength of 25μm. was achieved.

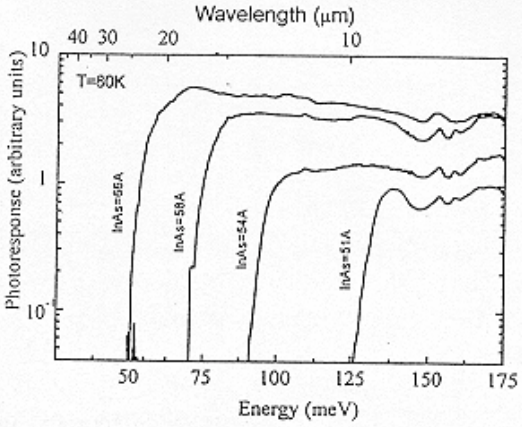

Figure 1. Spectral response of photodiodes with different InAs/GaSb superlattices in their active layer. The thickness of GaSb layer is 40Å for all of the superlattices, while the thickness of the InAs layer is shown for each device. The 90%-10% cutoff energies of all of the devices are below 2kT.

Room temperature photodiodes with a cut-off wavelength of 12μm, exhibited high R_oA values: some two orders of magnitude higher than room temperature HgCdTe photodiodes. High values of R_oA are important for focal plane array (FPA) applications, since the read-out integrated circuits (ROIC) can work efficiently only with high impedance devices. Additionally, type-II photoconductors showed a higher detectivity than the existing photon detectors, such as HgCdTe, at room temperature due to the suppression of Auger recombination and longer carrier lifetime. The extracted carrier lifetime from the responsivity and noise measurements was nearly an order of magnitude longer than HgCdTe and InAsSb with similar bandgaps.

Whilst the detectivity of these uncooled type-II photoconductors and photodiodes was comparable to the detectivity of uncooled thermal detectors, they were more than five orders of magnitude faster. The response time of the detectors, measured with a quantum cascade laser at λ=8μm, was below 40nsec at room temperature.

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