

Public Abstract

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Title:Asymmetric Quantum Well Structures for Enhanced Infrared Photon Absorption

Infrared (IR) photodetectors play vital roles in thermal imaging and sensing, which has important commercial and defense applications (sensitive to 2-10 μm radiation). These detectors have many important applications such as remote temperature sensing, target identification and discrimination, and chemical analysis. Understandably, mechanisms and material considerations and characteristics that may lead to improved photodetection in the infrared regime have been rigorously investigated. Among the devices that are being explored, quantum well structures have been shown to be the most versatile for infrared detection, as by merely changing the material composition, one can tune the detection wavelength anywhere from 2 to 35 μm and beyond. The quantum well photodetectors are fabricated using Molecular Beam Epitaxy (MBE), which is a well matured materials growth and process technology capable of producing ultra-pure and thin films on larger substrates.

In this dissertation, we have investigated quantum well structures, with a particular emphasis on the asymmetric ones that can be used as QWIPs, composed of high electron mobility material like InGaAs, that has certain asymmetry introduced through either stepped well formed by of different materials (can be varied in terms of composition) or spatial variation of doping in the well region. Use of stepped quantum wells, for example, formed through AlGaAs/ $\text{In}_x\text{Ga}_{(1-x)}\text{As}/\text{In}_y\text{Ga}_{(1-y)}\text{As}/\text{AlGaAs}$ structure can also improve the wavelength tunability of the QWIP. The high electron mobility and hence drift velocity in InGaAs, along with low carrier recapture lifetime, is expected to improve the absorption efficiency of the device.