An Investigation of Electronic Transport Processes in Quantum Well Infrared Photodetector (QWIP) Structures

Abstract

Quantum well infrared photodetector (QWIP) structures are important for devices for the detection of long wavelength infrared detection radiation in the range of 8µ to 12µ. Therefore, they have been developed rapidly over the past decade from the fundamental-physics point of view towards to large-area focal plane arrays. Due to this progress high resolution high-performance large-format focal plane arrays (FPA's) are available. On the other hand improvement of multicolor infrared detectors is important for advanced sensing and imaging system. Infrared detectors with more than two colors are highly desirable for temperature registration, chemical analysis, and target discrimination [6]. Variation from the standard QWIP structure has been recently proposed by Ergün et al. The structures of this original designs are:

1. Structure- The device structure reported here involved 20 period repeated layers of GaAs three-quantum wells units. Each unit consists of 40, 50, and 55A GaAs quantum wells separated by 400A $Al_xGa_{1-x}As$ barriers with Al concentrations of 0.35, 0.30, 0.24, and 0.21 respectively. Each unit is separated by 500A GaAs layer with the doping concentration of $1x10^{18}cm^{-3}$. Doping concentration of quantum wells are $1x10^{18}cm^{-3}$ and barriers are undoped. The whole period is sandwiched between two 0.5µm GaAs ($1x10^{18}cm^{-3}$ Si doping) contact layers.

2. Structure- The unit of device structure consisted of 3 wells and 4 barriers. Barrier thicknesses are 35 A and the wells are 50Aº, 55Aº and 65Aº respectively. In the structure doping concentration of the two n+ GaAs contact layers and first quantum well (GaAs) were chosen to be $1x10^{18}cm^{-3}$. Second quantum well ($Al_xGa_{1-x}As$ x=0.025) and third quantum well (x=0.045) were doped $5x10^{17}cm^{-3}$ and barriers were undoped. (Al concentration of barriers are x=0.32, 0.29, and 0.26 respectively.) This choice of the doping level avoids the band bending at opposite end. The last barrier (x=0.23) thickness has been chosen to be 500A for preventing the electron escape from the ground state of the last barrier.

The purpose of this project is that in order to characterize these structures by magnetotransport and high and low electric field transport methods for the improvement of the device performance. For these methods, it is necessary to employ in-parallel transport configuration rather than vertical one. In order to these studies, the proposed QWIP structures will be identically grown on semiinsulating substrates and measurements will be taken in-plane configuration.