Wavelength matching between growth and computation of a strain compenstated 4.8 ㎛ InGaAs/InAlAs quantum cascade laser structures

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Strain-compensated InGaAs/InAlAs/InP material system for quantum cascade lasers (QCLs) were grown by molecular beam epitaxy (MBE). Samples were examined by high resolution X-ray diffraction (HRXRD). The composition and thickness of each InGaAs and InAlAs layers composing active and injector regions of QCL were extracted from the HRXRD data. Additionally, the QCLs were fabricated by normal fabrication process and exhibited a lasing wavelength of ~4.8 μm.

Meanwhile, based on the extracted composition and thickness, the lasing wavelength of the QCLs was calculated through a strain-modified effective two-band model [1]. The difference in lasing wavelength between the measured and calculated ones was in the range of 0.05 μm.

Similar results were obtained from two other structures. These results mean that we can grow InGaAs/InAlAs epilayers with sub-nanometer thickness well, and also prove the accuracy of our model once again.

[1] Kim SJ and Kim JH. Strain-modified effective two- band model for calculating the conduction band structure of strain-compensated quantum cascade lasers: effltct of strain and remote band on the electron effective mass and nonparabolicity parameter. Optics Express. 2021; 29:40957-40980.