Room Temperature InGaAs-InGaAsP Distributed Feedback Ridge Lasers Operating Beyond 2µm

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InGaAs-InGaAsP lasers are widely used in the 1.3 - 1.55 µm wavelength region as sources for fiber-optic based communications. However, lasers from the same material system which operate in the 1.8 to 2.1 pm range are of interest for such applications as LIDAR and chemical sensing applications [1,2]. When used as a source for laser-based spectroscopy, the laser diode should operate CW at room temperature with a single longitudinal mode.

To achieve lasing at wavelengths above 2 µm, one must compromise between carrier confinement and emission wavelength. To obtain low threshold, CW lasers, the electron confinement energy of the quantum wells must be large enough to prevent carrier overflow. This is achieved by increasing the conduction band offset between the highly strained wells and barriers. However, as one goes to larger energy barriers the emission wavelength of the wells decreases due to quantum confinement effects [1]. Recently, a room temperature buried-heterostructure DFB laser with an emission wavelength of 2.03 µm was demonstrated[3]. The laser structure was grown with InGaAsP ($\lambda_g = 1.5$ µm) barriers which lead to a gain peak at 1.995 µm. in this work, we demonstrate that by using InGaAs ($\lambda_g = 1.67$ µm) barriers the gain peak of the lasers was extended to 2.03 µm, and by detuning the grating of the DFB, a room temperature CW emission of almost 2.06 µm was achieved.

The lasers were fabricated using a two-step MOVPE process. The conduction band diagram of the device is shown in Figure 1. The active region of the device consists of three 100Å compressively strained $In_{0.75}Ga_{0.25}As$ wells separated by 200Å thick latticed-matched $In_{0.53}Ga_{0.47}As$ barriers. The wells and barriers are confined on both sides by 1500Å of InGaAsP quaternary with a bulk wavelength of 1.3 µm . To provide the corrugation needed for single mode operation, gratings were generated using a direct e-beam write, and a wet chemical etch was used to transfer the gratings into the upper quaternary layer. After the grating was etched, the upper cladding and contact layers were regrown. 2 µm wide ridges were then defined using a wet chemical etch and polyimide was used to planarize the wafer for top metalization.

To ready the lasers for testing, devices were cleaved, anti-reflection coatings were applied to one facet, and chips were mounted. Figure 2 shows the L-I characteristics of a 750 µm long laser which was mounted in a TO package. This device with an emission wavelength of 2.03 µm operated CW up to 50 °C. At 20°C, the laser had a CW threshold of approximately 22 mA, and an external efficiency per facet of 0.025 mW/mA. By detuning the grating to the short-energy side of the gain peak, we can further extend the emission wavelength of the DFB. Figure 3 shows a spectrum of a DFB laser operating at approximately 2.055 pm. The spectrum was taken under CW operation at 20°C with a bias of 100 mA. We believe this is the longest wavelength yet reported for InP-based DFB lasers.

REFERENCES:

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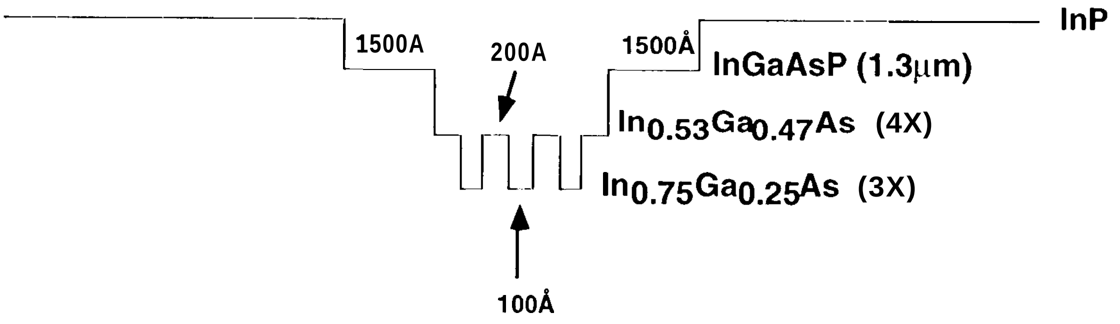
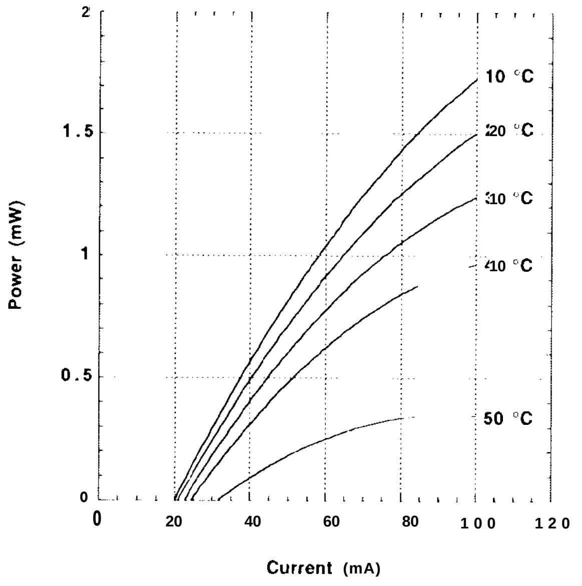


Figure 1. Conduction band profile for InGaAs/InGaAsP DFB laser.



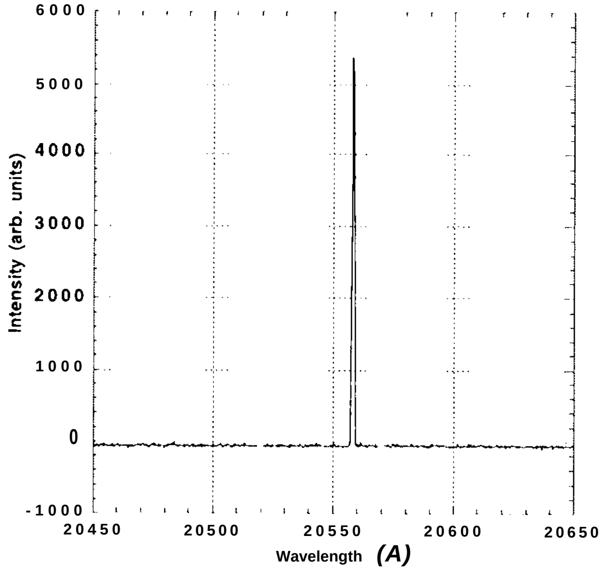


Figure 2. L-1 of **750** μm long ridge laser.

Figure 3. Emission spectra of DFB laser.