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Current InP based laser diodes (LDs) are widely used in wavelength division multiplexing (WDM) optical communication system, despite the limitations of the low characteristic temperature (T_0=60 K) and the wavelength fluctuation depending on the ambient temperature. To overcome these limitations, GaAsBi LDs are attracting increasing interest due to the suppressed Auger recombination, inter-valence band absorption (IVBA) [1] and temperature insensitive band gap [2]. These significant properties make GaAsBi LDs a promising candidate for near-infrared devices in the datacom/telecom system. The main challenge to achieve a GaAsBi LD in the range of 1.3-1.6 μm is the relatively high Bi composition (>10%) with good material quality as required for laser structures.

The first electrically pumped GaAsBi laser was demonstrated by Ludewig *et al.* grown by metal-organic vapor phase epitaxy (MOVPE) (containing 2.2% Bi), lasing at room temperature (RT) (~947 nm) [3]. Then, the first molecular beam epitaxy (MBE) grown electrically pumped GaAsBi laser was demonstrated by Fuyuki *et al.* [2] with up to 4% Bi (~1.045 μm). Up to now, the longest wavelength of GaAsBi LD reported was 1.06 μm, demonstrated by Butkute *et al.* [4] using hybrid MOVPE/MBE and containing ~6% Bi.

In this work, we have grown GaAsBi/AlGaAs single quantum well (SQW) LD structures by MBE and fabricate stripe GaAsBi LDs. The quantum well thickness is 15 nm and Bi composition is about 5.8%. The as-cleaved diodes are investigated using both pulsed bias (200 ns 50 kHz) and continuous wave (CW) mode. Lasing oscillation up to 1.136 μm at RT is achieved with a threshold current density about 4.89 kA/cm^2, which is the longest reported lasing wavelength from GaAsBi LDs. Temperature characteristics of GaAsBi LDs is investigated under both pulse and CW excitation mode, respectively. We have achieved electrically pumped pulsed operation up to 350 K and CW mode operation up to 273 K for the first time. The temperature coefficient of the GaAsBi/AlGaAs SQW LD is 0.27 nm/K in the temperature range of 77-350 K, which is lower than that of InGaAsP (0.45 nm/K) and GaAs LDs (0.37 nm/K). Characteristic temperature is extracted to be 139 K in the temperature range of 77-225 K and decrease to 74 K at 225-350 K.

References:

1. Sweeney, S. J. & Jin, S. R. J. Appl. Phys. 113, 043110 (2013).
2. Fuyuki T. *et al.* Appl. Phys. Exp. 7, 082101 (2014).
3. Ludewig, P. *et al.* Appl. Phys. Lett. 102, 242115 (2013).
4. Butkute R *et al*. Electron. Lett. 50, 1155–7 (2014).

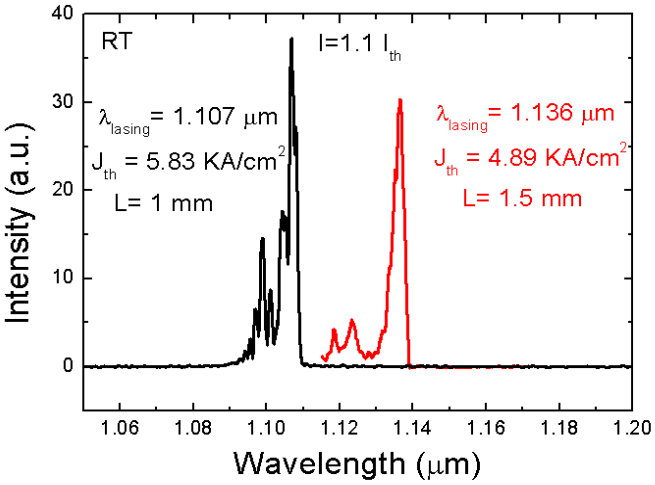

Figure1. Lasing spectra of GaAsBi/ (AlGa)As SQW laser diode with 6x1000 μm (black line) and 6x1500 μm (red line) stripes at room temperature under pulsed excitation.

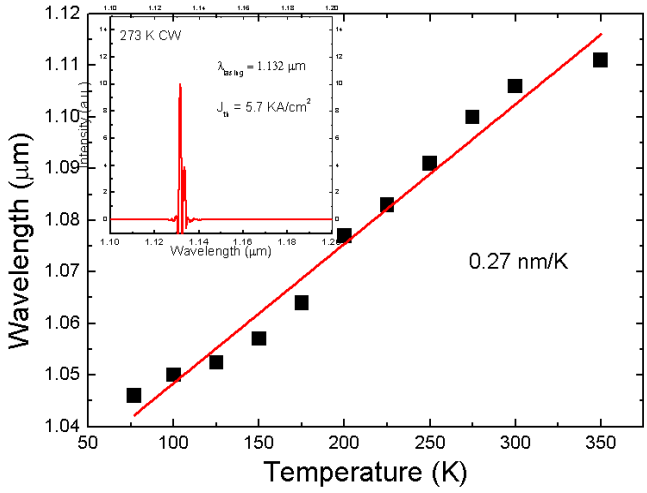

Figure 2. Dependence of lasing wavelength on temperature. The inset shows the lasing spectrum at 273 K under CW mode.

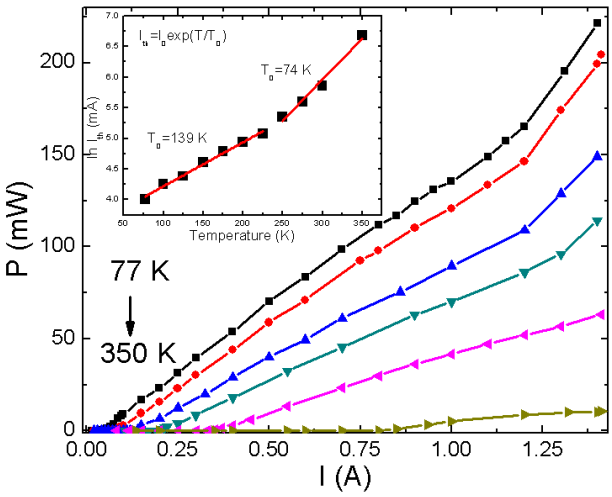

Figure 3. P-I curves at deferent tempertures from 77 K to 350K. The inset shows temperature dependence of threshold current from 77 K to 350 K. T_0 was extracted to be 139 K (77 K to 225 K) and 74 K (250 K to 300 K).