GaSb-based Type-I QW LEDs and addressable arrays operated at wavelengths up to 3.66 μm

Type I GaSb-based quantum wells (QW) light emitting diodes (LED) and LED arrays operating at room temperature at wavelengths up to 3.66 μm with approximately 700 μW of quasi-CW optical power at 3.13 μm was developed and fabricated in Optoelectronics group [1].

These devices combine the advantages of precise wavelength control, possibility of strain engineering and high radiative efficiency. The LED active area comprises four 14 or 16 nm strained InGaAsSb quantum wells surrounded by quinternary AlInGaAsSb barrier material. The emission wavelength is mostly controlled by In content in quantum well material and quantum well width, while strain is adjusted through As content (Figure 1, left).

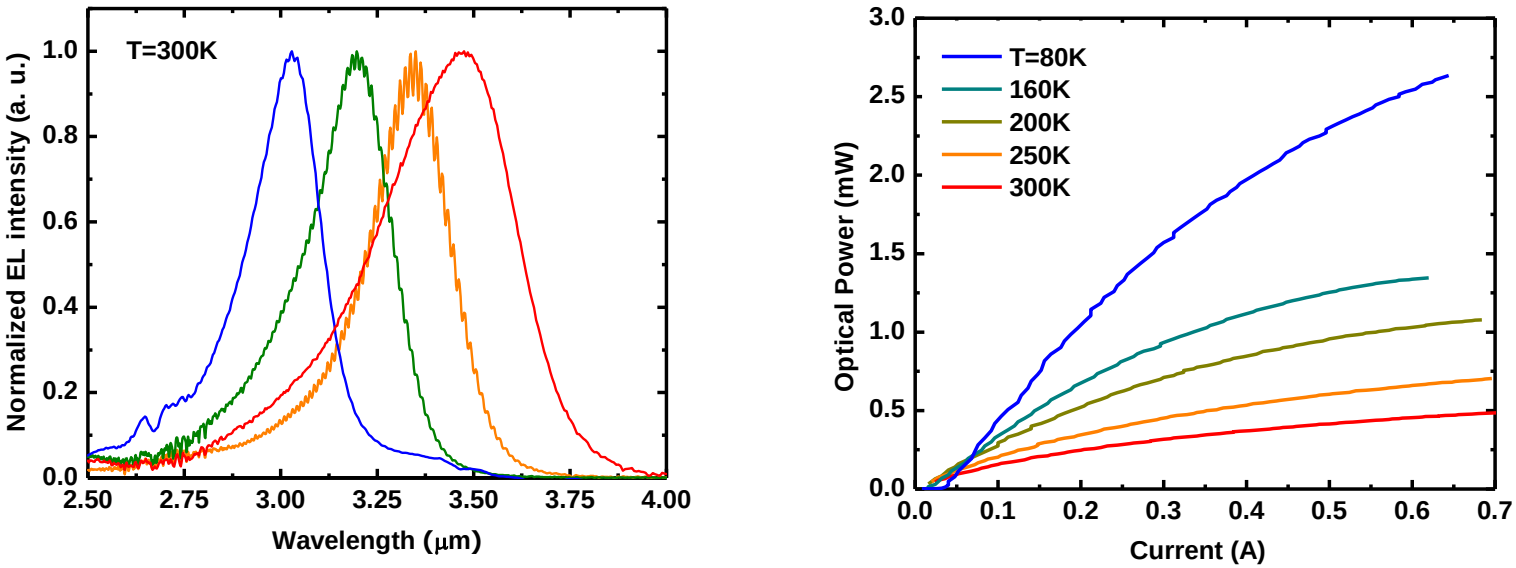

Figure 1. LED spectra (left) and output power vs. bias current (right) of the LED emitting at 3.21 μm. The devices are 3x3 arrays with pixel size 100x100 μm.

[1]. S. Suchalkin, S. Jung, G. Kipshidze, L. Shterengas, T. Hosoda, D. Westerfeld, D. Snyder, G. Belenky, Appl. Phys. Lett., **93**, 181107 (2007).

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An important advantage of quinternary barrier is possibility of independent control of strain in the barrier material and valence band offset between the barrier and quantum wells. This allows increasing the depth of the hole quantum wells and, hence, the injection efficiency while keeping the barrier material lattice matched to the substrate. The dependence of output power on the bias current for 3.2 μm LED is shown in Figure 1 (right).The measurements were done at repetition frequency of 3000Hz and duty cycle 50 %.

Mid-IR LEDs as elements of an emitter array for thermal imaging combine the advantages of high brightness, high dynamic range, uniformity, temperature stability, fast modulation (high frame rate), low cost and high reliability. We used GaSb based type I quantum well LEDs to design and demonstrate a 6x6 addressable emitter array operated at 3.6 μm [2] (Figure 2).

The design is scalable to larger arrays. Both n- and p- contacts of the array pixels are at the epilayer side so device has the potential for increasing brightness and output power through the application of a lens array or modification of the device substrate.

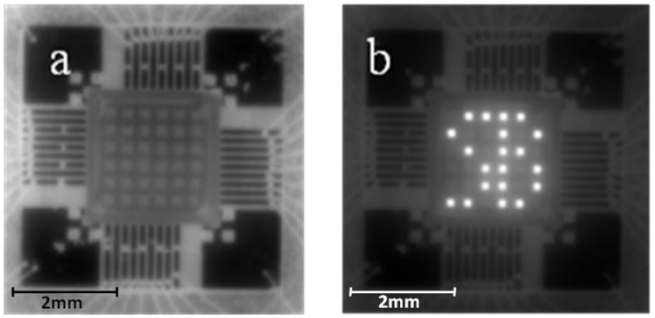

Figure 2. Mid IR images of 6x6 addressable LED array without bias (a) and under bias (b), room temperature.

[2]. S. Jung, S. Suchalkin, G. Kipshidze, D.Westerfeld, D. Snyder, M.Johnson, G. Belenky, “GaSb-Based Type I Quantum Well Light Emitting Diode Addressable Array Operated at Wavelengths up to 3.66 μm”, IEEE Photonics Technol. Lett. 21, 1087 (2009).