Wavelength dependence of the performance of GaInAsSb/GaSb mid-infrared lasers

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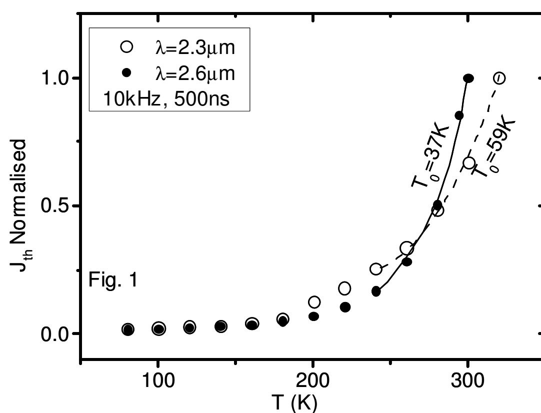
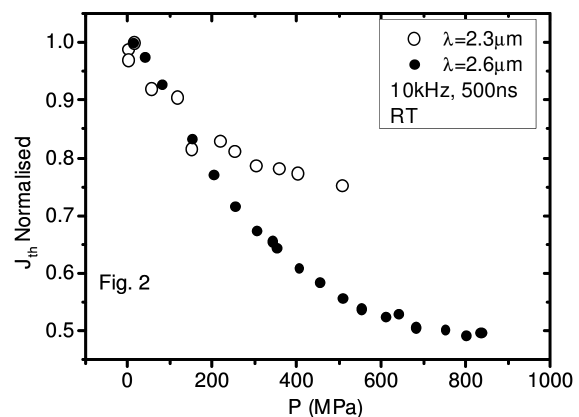
Diode lasers operating in continuous wave (CW) at room temperature (RT) emitting in the spectral range of 2-3 µm are in demand for medical applications, gas analysis and tunable diode laser absorption spectroscopy. Type-I Sb-based quantum well interband diode lasers have yielded good performance in this spectral range, but are still highly temperature sensitive [1]. The main proposed cause of the temperature sensitivity is the dominance of non-radiative Auger recombination with increasing temperature. Other possible loss processes include hole leakage, Shockley-Read-Hall recombination and optical losses due to intervalence band and free carrier absorption [2]. In this work we have studied recombination processes in 2.6µm and 2.3µm mid-infrared edge emitting lasers comprising a single GaInAsSb/GaSb quantum well and two GaInAsSb/AlGaAsSb quantum wells in their active region, respectively. The results show that the threshold current density, J_{th}, of both devices is relatively high at room temperature and temperature sensitive. The J_{th} of the 2.6µm device is more temperature sensitive with a T_0 of 37 K while the T_0 for the 2.3µm is significantly higher at 59K around RT (Fig. 1). Using high pressure techniques, we find that J_{th} decreases with increasing band gap for both devices (Fig. 2). This decrease suggests that non-radiative Auger recombination dominates the threshold current [3]. A stronger decrease is observed in the 2.6µm lasers suggesting that the longer wavelength devices are more temperature sensitive due to a higher contribution of non radiative Auger recombination rather than an increase in hole leakage. The extent to which such processes may be controlled via device optimisation will be discussed at the conference.





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[2] W. Lei et al., J. Appl. Phys., 104, 091191 (2008).
[3] S.R. Jin et al., J. Sel. Topics Quant. Electronics, **9**, 1196 (2003).