Temperature dependence of 2.3µm and 2.6µm GaInAsSb based BTJ VCSELs and edge emitting lasers.

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250 words:
There is a growing interest in electrically pumped lasers that emit in the 2-3µm wavelength region for applications such as gas sensing, pollution monitoring and medical diagnosis. GaSb based type-I quantum well edge-emitting lasers (EELs) provide room temperature continuous wave operation but are limited by Auger recombination and inter-valence band absorption. For most applications, Vertical Cavity Surface-Emitting Lasers (VCSELs) are a preferred option because of lower power consumption, cheaper fabrication and improved beam quality. However, self-heating and the presence of fundamental loss processes necessitate careful design to provide gain peak - cavity mode alignment at a particular temperature and wavelength for optimum performance. In this study we have investigated 2.3µm and 2.6µm VCSELs. Edge-emitting lasers with nominally identical active regions were used to look at the effects of non-radiative recombination and to extract information about the gain peak which was then used to analyse the VCSEL behaviour. A combination of high hydrostatic pressure and temperature dependence techniques were used to investigate the wavelength dependence of non-radiative processes and cavity mode – gain peak detuning. From these measurements we find that 85% (97 %) of the threshold current of 2.3µm (2.6µm) edge-emitting lasers is due to non-radiative recombination. Our results suggest that temperature insensitive VCSEL operation around room temperature could be achieved with a larger gain – cavity de-tuning, offsetting the effect of increasing non-radiative recombination with increasing temperature, as shall be discussed in further detail.

100 words:
Temperature and hydrostatic pressure tuning techniques were used to investigate the temperature sensitivity of GaInAsSb VCSELs emitting at 2.3µm and 2.6µm at RT for gas sensing applications. We show that 85% (97 %) of the threshold current of 2.3µm (2.6µm) edge-emitting lasers is due to non-radiative recombination. In the VCSELs, non-radiative recombination couples with gain-cavity mode de-tuning and determines the overall temperature stability. Our results suggest that improved temperature insensitive VCSEL operation around room temperature may be achieved with a large gain – cavity de-tuning whereby the increasing non-radiative current is offset by improved gain, as shall be discussed further.