InAsSb/GaAsSb/InAsSb W-type Quantum Wells for Interband Cascade Lasers

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Interband cascade lasers (ICLs) are mid-infrared emitting devices that can be used for various applications such as environmental sensing, industrial process control, breath analysis and detection of explosives [1]. In state of the art ICLs with best device figures of merit use a technique called carrier rebalancing in which the excess of holes in the active quantum well is amended by heavily n-doping the electron injector [2].

We propose a design for an active region of $InAs_{0.8}Sb_{0.2}/GaAs_{0.2}Sb_{0.8}/InAs_{0.8}Sb_{0.2}$ based ICL of 3.3 µm target wavelength. This material combination provides a flexibility in hole level alignment between the hole injector region and the W-type active quantum well (WQW) and thus may help to reduce the amount of excess holes mitigating the need for carrier rebalancing by heavily doping.

We present room temperature photoluminescence (PL) measurements on this type of WQW. The samples consist of 7 periods of a (**3.5 nm**/4.3 nm/**3.5 nm**) thick $\mathbf{InAs_{0.8}Sb_{0.2}}/GaAs_{0.2}Sb_{0.8}/\mathbf{InAs_{0.8}Sb_{0.2}}$ WQW (Figure 1.a) separated from each other by 3.8 nm thick AlSb layers. The samples were grown by molecular beam epitaxy (MBE) on Te-doped (100) GaSb substrate at different substrate temperatures between 430 ºC and 470 ºC and with varying soak times between 2s and 6s (Figure 1.b). The highest intensity was achieved for 455 ºC substrate temperature. Soak time of 6s has shown approximately 50% higher intensity in comparison to 2s and 4s. Here, we assume a better interface quality and hence lower non-radiative losses. Material composition mixing is assumed to be negligible as the emission wavelength remains unaffected by variation of soaking time.

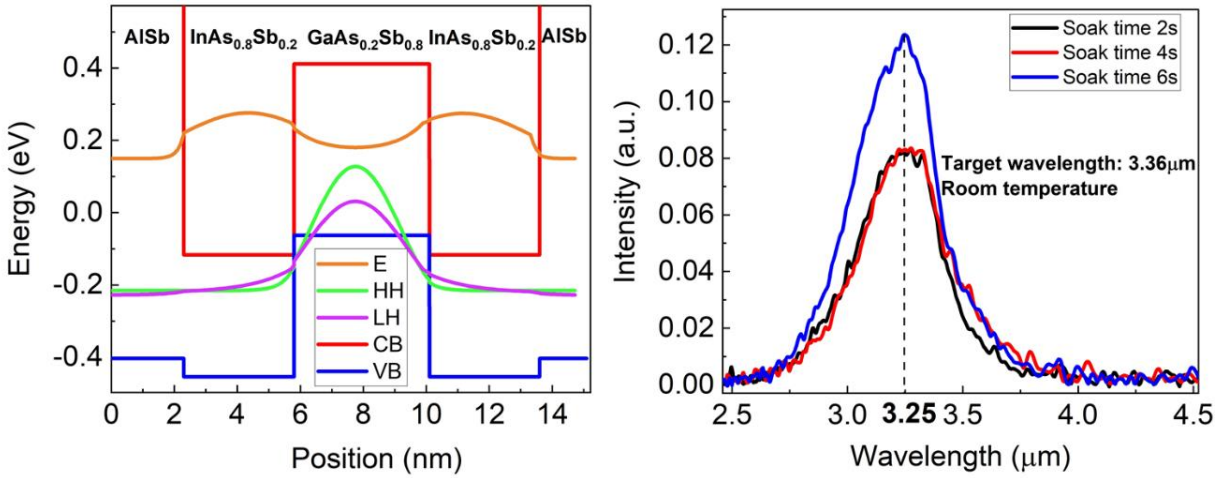

Figure 1. a) Band structure of a single $InAs_{0.8}Sb_{0.2}/GaAs_{0.2}Sb_{0.8}/InAs_{0.8}Sb_{0.2}$WQW b) PL of soak time series of 7 $InAs_{0.8}Sb_{0.2}/GaAs_{0.2}Sb_{0.8}/InAs_{0.8}Sb_{0.2}$WQWs

[1] J.R. Meyer, W.W. Bewley, C.L.Canedy, C.S. Kim, M. Kim, C.D. Merritt, I. Vurgaftman, *Photonics*, **7**,34 (2020).

[2] I.Vurgaftman, W.W. Bewley, C.L.Canedy, C.S. Kim, M. Kim, C.D. Merritt, J. Abell, J.R.Lindle, J.R. Meyer, *Nature Communications*, **2**, 585 (2011).