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Application focused GaAsBi based NIR emitters grown on AlAs sacrificial layer

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Novel solutions are necessary to enhance the efficiency, accuracy and minimization of sensor devices. This study focuses on GaAsBi laser diodes grown on AlAs sacrificial layer for blood oximeters operating at 1.1 μm. The AlAs layer is necessary for substrate removal, which in turn allows for integration onto a silicon platform. GaAsBi is attractive for its advantages over other alternatives for near infrared. Bi rapidly decreases the bandgap of GaAs, replacing 1% of As with Bi results in a reduction of up to 88 meV [1]. Consequently, a small amount of host atoms needs to be replaced to achieve the desired emission. This helps in maintaining structure homogeneity, avoiding lattice mismatch dislocations. Furthermore, incorporation of Bi reduces the bandgap temperature sensitivity and increases the spin-orbit split off energy, which in turn suppresses the non-radiative Auger recombination path, when >10% Bi is incorporated [2, 3]. Despite the positive features of the material its growth requires special conditions, namely a stoichiometric As:Ga ratio and growth temperatures lower than 420 °C.

A series of GaAsBi quantum well structures were grown to determine the Bi incorporation dependance on substrate temperature, while working in the temperature limited regime, where growth temperature is the only condition that governs the Bi content. Several GaAsBi quantum well base emitters were fabricated on p- and n-doped GaAs substrates buffered by AlAs sacrificial layers. Different designs of polarity were employed to determine the influence of p-type dopant (Be) diffusion during high temperature growth.

The temperature limited regime is identified to be suitable for growth of structures with large Bi content and allows to precise control of the emission energy. The luminescence and lasing spectra of GaAsBi structures and devices were recorded via both optical and electrical pumping and revealed the emission of devices in the region from 1000 to 1144 nm at room-temperature. Temperature dependent measurements (30-300 K) were used to confirm the emission temperature stability.

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