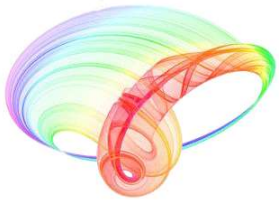
Book of abstracts



PHOTONICA2021

VIII International School and Conference on Photonics

& HEMMAGINERO workshop

23 - 27 August 2021,

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Editors

Mihailo Rabasović, Marina Lekić and Aleksandar Krmpot

Institute of Physics Belgrade, Serbia

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Interband cascade lasers: overcoming intersubband transitions in the valence band

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Interband cascade lasers (ICLs) [1] are gaining increasing attention as reliable laser sources in the mid-infrared spectral region. They are especially valued due to their low threshold current densities and low power consumption. Continuous-wave (cw) operation at room temperature has been demonstrated at wavelengths from 2.8-5.6 µm in the GaSb material system [2,3] with a performance sweet spot around 3-4 µm. However, extending this range towards longer wavelengths has proven difficult for ICLs, partly originating in a still insufficient understanding of the internal device physics.

Here, we present our recent results on the impact of intersubband absorption in the valence band on the performance of ICLs. We use a numerical model employing the eight-band k·p method to calculate the wavelength-dependent intersubband absorption in the W-quantum well (QW) of the ICL active region. The calculated electronic band structure of an exemplary W-QW is shown in Figure 1. Here, we use a generalized momentum matrix element model, which can explain all contributions to the absorption in the W-QW, regardless of being interband or intersubband transitions.

We experimentally observe a clear performance dependence on the thickness and composition of the $Ga_{1-x}In_xSb$ hole- QW, reflecting in the characteristic temperature T_0 as well as the threshold current density J_{th}, which is supported by our model. By careful design of the active W-QW the intersubband absorption in the valence band can be tailored and even completely avoided, allowing us to enhance ICL performance outside of the sweet spot 3-4 µm region, paving the way towards higher cw operating temperatures and output powers.

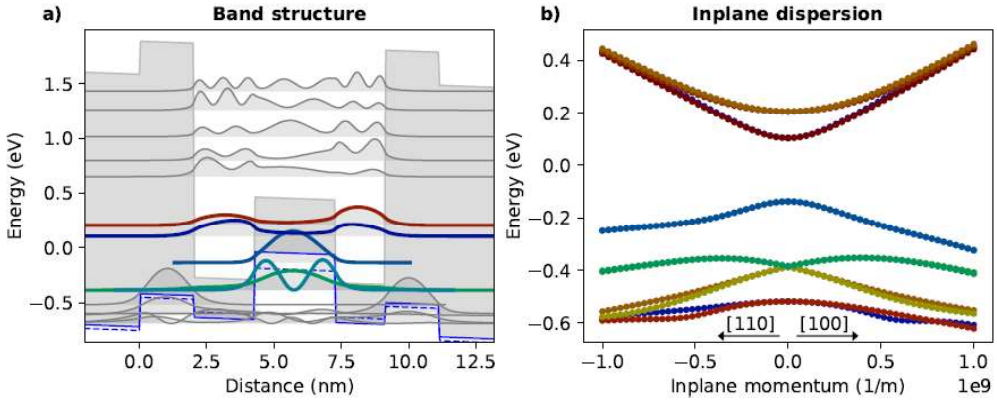

Figure 1. a) Calculated band structure at the Γ-point of an exemplary W-QW consisting of AlSb/ InAs/$Ga_{0.65}In_{0.35}Sb$/InAs/AlSb layers. b) Same band structure in dependence on wave vector k

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