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Design, growth and characterization of Vertical-External-Cavity Surface-Emitting Laser for NIR

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This study focuses on the fabrication of two Vertical-External-Cavity Surface-Emitting Laser (VECSEL) chips. For the first one, InGaAs multiple quantum wells (MQWs) were chosen for the gain area to test or structure and have a reference. GaAsBi MQWs were used for the second. Incorporating bismuth into the GaAs lattice reduces its band gap, enabling longer wavelength emission with minimal Bi incorporation and improving bandgap temperature stability. This incorporation also increases the spin-orbit split-off energy of GaAsBi, reducing non-radiative Auger recombination. These properties make GaAsBi quantum structures promising for optoelectronic applications.

Unlike traditional Vertical-Cavity Surface-Emitting Lasers (VCSELs), which utilize a gain region encapsulated between two Distributed Bragg Reflectors (DBRs), in VECSELs an external coupler substitutes the top DBR allowing for optical pumping and granting cavity access. VECSELs can achieve much higher output power that is limited only by thermal management [1,2].

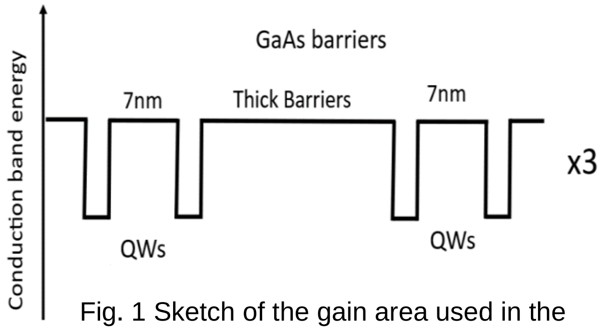

Fig. 1 Sketch of the gain area used in the VECSELs fabrication

The structures were grown using a Molecular Beam Epitaxy (MBE) system. A gain region featuring 12 QWs and alternating barrier thicknesses, was grown on top of a 30 periods AlAs/GaAs DBR. This design allowed to reduce the overall chip thickness improving the thermal management, the scheme of such structure is shown in Figure 1. Lasing was demonstrated from the VECSEL with an InGaAs/GaAs MQW gain area at 976 nm, emitting from a 500 μm diameter region. Using a similar double quantum well design, a VECSEL with a GaAsBi/GaAs MQW gain area was fabricated, achieving lasing at 1070 nm. Notably, this is the first reported instance of lasing from a GaAsBi-based VECSEL.

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