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Recent advances in high-performance 2.X µm VECSEL

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The (AlGaIn) (AsSb) semiconductor materials system has been shown to be ideally suited to realize Vertical External Cavity Surface Emitting Lasers (VECSELs) for the 2-3 µm wavelength range. For 2 µm emitting VECSELs with a ternary GaInSb quantum well active region, employing a linear planar-concave resonator geometry, a maximum continuous wave (cw) output power of 4.2 W at 20 °C heat sink temperature (6 W at 0 °C) has been achieved when using standard fiber-coupled 980 nm diode lasers for barrier-pumping. For a 2 µm emitting VECSEL structure optimized for barrier-pumping at 1.5 µm, an increased maximum cw output power of 7.0 W at 20 °C (10 W at -10 °C) has been achieved due to the reduced quantum-deficit, with a corresponding differential power efficiency of 30% at 20 °C.

The resonator versatility of VECSELs also allows the insertion of additional optical elements into the cavity for wavelength selection and linewidth control as well as for achieving pulsed mode operation. Employing a V-shaped folded cavity, single-mode operation has been achieved with a linewidth <100 kHz and 1 W optical output power at 2.05 µm in free-running operation, and just 20 kHz linewidth when actively stabilizing the laser cavity. Inserting an intra-cavity Brewster-angled birefringent polarizer prism in combination with a Pockels cell, electro-optically cavity-dumped operation of a 2 µm emitting VECSEL has been demonstrated with a pulse full width at half maximum of 3 ns, a pulse peak power of 30 W, and repetition rates adjustable between 87 kHz and 1 MHz.

Biography

Joachim Wagner is currently deputy director and head of the Department “Optoelectronic Modules” at the Fraunhofer-Institute for Applied Solid State Physics (IAF), Freiburg, Germany. He is also Professor at the Institute of Physics of the University of Freiburg and an associated member of the Materials Research Center Freiburg (FMF). His current research interests include III/V-semiconductor heterostructures and their application in optoelectronic devices both for the infrared and the visible/UV spectral range. He is author or coauthor of more than 400 scientific publications including several review papers and book chapters.

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