HL 7: Semiconductor Lasers

Time: Monday 15:00–15:45 Location: H14

HL 7.1 Mon 15:00 H14

Development and Analysis of a VECSEL based on InGaAs Quantum Dots for Emissions in the Telecom O-Band — •Justus Unfried, Philipp Noack, Rebecca Rühle, Michael Jetter, and Peter Michler — Institut für Halbleiteroptik und funktionelle Grenzflächen (IHFG), Center for Integrated Quantum Science and Technology (IQST) and SCoPE, University of Stuttgart, Allmandring 3, 70569 Stuttgart, Germany

The advancement of sophisticated laser technologies for high-resolution spectroscopy and sensing applications has stimulated interest in versatile, high-performance light sources. Vertical External-Cavity Surface-Emitting Lasers (VECSELs) based on InGaAs quantum dots (QDs) are promising for emissions in the telecommunications O-band and offer broad wavelength tunability, high output power, and excellent beam quality. This study focuses on optimizing QD layers through metal-organic vapor-phase epitaxy (MOVPE), utilizing the Stranski-Krastanov growth mode, followed by laser performance characterization. To enhance QD density and emission characteristics, the gallium precursor was substituted with TEGa, exhibiting a higher decomposition rate at lower growth temperatures. The indium supply was modified, and the duration of the arsine interruption following QD deposition was examined to increase density and reduce large In-clusters. Subsequently, 12 of these high-density QD layers are deposited on a distributed Bragg reflector (DBR) structure, completing the VECSEL. This laser development is accompanied by structural and performance characterizations.

HL 7.2 Mon 15:15 H14

Comparison between a 675nm and 532nm pumped 4x3 InGaAsP QW VECSEL emitting at around 760nm in a V-Shaped resonator — •Rebecca Rühle[1], Maxim Leyzner[2], Marwan Abdou Ahmed[2], Thomas Graf[2], Michael Jetter[1], and Peter Michler[1] — [1]Institut für Halbleiteroptik und Funktionelle Grenzflächen, Center for Integrated Quantum Science and Technology (IQST) and SCoPE, Universität Stuttgart, Allmandring 3, 70569 Stuttgart, Germany — [2]Institut für Strahlwerkzeuge, Universität Stuttgart, Pfaffenwaldring 43, 70569 Stuttgart, Germany

The quantum defect between the emission and the pump wavelengths has a substantial impact on the performance of a vertical external-cavity surface-emitting lasers (VECSEL). An increase in the wavelength of the pump laser should result in an improvement in thermal behavior and the laser performance. One disadvantage is that the pump absorption is reduced, given that the pump energy is typically below the barrier bandgap. In our previous studies, the GaInP barrier of our InGaAsP VECSEL structure was modified to absorb pump light at a wavelength of 675nm. Power measurements were conducted with a 675nm pump laser and a 532nm pump laser, employing the aforementioned adapted structure. By varying the reflectivity of the outcoupling mirror in the V-shaped resonator, we gain further insight into the absorption characteristics within the active region of the VECSEL. Due to the specifications of the laser source, the pump spot size was approximately 310μmx230μm, resulting in a multimode emission from the VECSEL rather than single mode for both pumplasers.

HL 7.3 Mon 15:30 H14

Quantum optical validation of high-β lasing in monolayer-based self-assembled photonic-defect nanocavities — •Aris Koulas-Simos[1], Chirag Palekar[1], Kartik Gaur[1], Imad Limame[1], Bárbara Rosa[1], Cun-Zheng Ning[2], and Stephan Reitzenstein[1] — [1]Institut für Festkörperphysik, Technische Universität Berlin, 10623 Berlin, Germany — [2]College of Integrated Circuits and Optoelectronic Chips, Shenzhen Technology Univesity, Shenzhen 518118, China

Nanolasers based on transition metal dichalcogenides have garnered substantial research interest for innovative photonic applications. This study presents the fabrication of multiple self-assembled photonic defect nanocavities within a single, fully encapsulated WSe_2 monolayer integrated into a dielectric distributed Bragg reflector (DBR) structure. Spontaneously formed bubbles during the encapsulation process lead to the generation of photonic-defect nanocavities in the DBR. These structures achieve strong optical lateral confinement and exhibit size-dependent optical characteristics, as confirmed by μPL-measurements in both the real and k-space and numerical cavity simulations. Optical power-dependent investigations conducted at cryogenic temperatures reveal lasing behavior, evidenced by a distinct kink in the input-output curve, accompanied by slight linewidth narrowing and a lineshape transition in two specific devices. Finally, photon-autocorrelation measurements performed on one of these devices provide unequivocal confirmation of a lasing transition [1].

[1] A. Koulas-Simos et al., Laser & Photonics Rev., 2400271 (2024).