HL 14: Nanophotonics - Devices II (Focused Session with DS)

Time: Monday 14:00–17:45 Location: H2

Topical Talk HL 14.1 Mon 14:00 H2

High performance lasers realised by advanced nanofabrication technologies — •Johann Peter Reithmaier — Institute of Nanostructure Technologies and Analytics, Kassel, Germany

With advanced nanofabrication techniques beyond conventional semiconductor fabrication technologies, one has access to more independent parameters for the optimization of the device performance or the fabrication process itself. Two major nanostructure technologies will be addressed in this talk. One is based on self-organized growth of quantum dot materials with new formation techniques and structure designs, which are used for the realization of temperature stable high power lasers. Recent device results, e.g. based on tunnel-injection structures, and the realization of coolerless pump modules will be discussed. The second technique is based on nanolithography and high aspect ratio dry-etching, which allows the fabrication of surface defined gratings for high-speed multi-section DFB and DBR lasers. Recent results of such devices fabricated with this low-cost nanoimprint compatible fabrication technology will be presented. The work was mainly performed in the frame of two European projects (Brighter, DeLight).

Topical Talk HL 14.2 Mon 14:30 H2

High-brightness edge-emitting semiconductor lasers based on concepts of photonic band crystal and titled wave lasers — •Vladimir Kalosha, Thorsten Kettler, Kristian Posilovic, Daniel Seidlitz, Vitaly Shchukin, Nikolay Ledentsov, and Dieter Bimberg — Institute for Solid-State Physics, Technical University Berlin, Berlin, Germany

We will report on current status of the design, fabrication and performance of edge-emitting waveguide lasers and their arrays which are based on concepts of photonic band crystal (PBC) lasers and tilted wave lasers (TWL). Such lasers provide high radiation power and low beam divergence and present potentially a new elementary basis for high-brightness laser systems. Following to PBC concept, the laser is formed by multiple quasi-periodic AlGaAs layers and varying height and width of multiple stripes. As compared to typical lasers, they are characterized by an extremely large mode area and provide discrimination of high-order modes. Experimentally we have obtained a brightness of 8.7×10^7 W/cm^2/sr in pulsed regime and vertical and lateral beam quality factor $M^2 < 2$ for large range of the pump current in pulsed and cw regimes at 980 nm. Maximum power of 3.5, 10.5 and 27 W was achieved for one, three-and nine-stripe lasers, scalable with the number of stripes. Following to the TWL concept, the laser is formed by coupled narrow and broad waveguides and give rise in ultra-narrow tilted beam from the broad waveguide at proper phase-matching. Experiments have demonstrated far-field divergence of TWLs well below 1° and improved wavelength stability in wide pumping ranges.

Topical Talk HL 14.3 Mon 15:00 H2

Semiconductor optical amplifiers (SOA) for linear and nonlinear applications — •Wolfgang Freude[1], René Bonk[1], Thomas Vallaitis[1], Andrej Marculescu[1], Amita Kapoor[2], Christian Meuer[3], Dieter Bimberg[3], Romain Brenot[4], François Lelarge[4], Guang-hua Duan[4], and Juerg Leuthold[1] — [1]Inst. of Photonics and Quantum Electronics, Karlsruhe Institute of Technology, Germany — [2]On leave from Shaheed Rajguru College of Appl. Sciences for Women, Delhi, India — [3]Inst. of Solid State Physics, TU Berlin, Germany — [4]Alcatel-Thalès III-V Lab, Palaiseau, France

SOA characteristics for two selected applications are discussed, namely linear in-line amplification in gigabit passive optical networks (GPON), and fast nonlinear all-optical signal processing. As linear amplifiers, SOA feature moderate cost, low energy needs, 10 ... 25 dB gain in a bandwidth of 60 ... 120 nm, and a peak-gain range of 1.25 ... 1.60 μm.

In all-optical fast signal processing, SOA serve as regenerative wavelength converters, as nonlinear elements for four-wave mixing, and as switches. The respective application areas are determined by the SOA parameters gain, saturation power, recovery time, α-factor and noise figure.

Quantum-dot (QD) SOA are known for pattern-free amplification and fast cross-gain modulation. We demonstrate that QD SOA are also well suited as linear in-line amplifiers because of their large saturation power, wide dynamic range, large burst mode tolerance and small cross-phase modulation (XPM) due to a low α-factor. On the other hand, bulk SOA can be engineered for low saturation power and large α-factor, which enables nonlinear signal processing via XPM.

Topical Talk HL 14.4 Mon 15:30 H2

Controlling light on the Nanoscale — •Nikolay Zheludev — University of Southampton, UK

We overview recent results on ultrafast active plasmonics, nanoscale phase change photonics, nonlinear and switchable metamaterials and tuneable free-electron light source on a chip.

15 min Coffee Break

Topical Talk HL 14.5 Mon 16:15 H2

New developments of high power LEDs and challenges in lighting applications — •Christian Fricke — Neophos Development Pte. Ltd, Jocherstr.7, 85221 Dachau

Improvement of PowerLED structures is still at a tremendous improvement rate per year. Epitaxy, chip design, phosphor efficiency and package design see large improvements - The brightness of LED devices increased by a factor of 4 over the last 4 years and will certainly continue over the next years. Light quality and device cost for LEDs that are to be marketed for home and office lighting are key to successfully replace conventional lighting by LED solutions. Only when standardized modular systems are available to the market consumers will switch at an accelerated rate. Key performance indicators will be presented as well as an outlook to individual tunable light sources fitting to existing home / office installations.

Topical Talk HL 14.6 Mon 16:45 H2

High speed VCSELs for short reach DATACOM applications — •Alex Mutig[1], James Lott[2], Sergey Blokhin[1], Gerrit Fiol[1], Alexey Nadtochiy[1], Vitaly Shchukin[3], Nikolai Ledentsov[2], and Dieter Bimberg[1] — [1]Institut für Festkörperphysik und Zentrum für Nanophotonik, Technische Universität Berlin, Hardenbergstrasse 36, 10623 Berlin, Federal Republic of Germany — [2]VI Systems GmbH, Hardenbergstrasse 7, 10623 Berlin, Federal Republic of Germany — [3]PBC Laser GmbH, Hardenbergstrasse 36, 10623 Berlin, Federal Republic of Germany

Around the year 2001 VCSELs emerged as the key component for up to 10 Gbit/s, aggregated high speed local-area and storage-area network data communication systems and soon thereafter for optical cable links for computer and consumer applications as well. The rapid increase in serial transmission speed and the limitations of copper wire-based links at bit rates >10 Gbit/s and distances >1 m greatly expanded the possible application areas of fiber-optic interconnects. Here we present our work on oxide-confined VCSELs operating at bit rates up to 40 Gbit/s and at low current densities of ∼10 kA/cm^2, sufficient for reliable operation. The small signal modulation bandwidths and resonant frequencies up to ∼22 GHz are measured, and the relaxation resonance frequency, damping factor, and electrical parasitic cut-off frequency are evaluated. According to our results with further improvement in the device design to reduce parasitics optical modulation bandwidths exceeding 30 GHz can be realized, leading toward reliable VCSEL serial operation at rates up to 50 Gbit/s.

Topical Talk HL 14.7 Mon 17:15 H2

Long-Wavelength Vertical-Cavity Surface-Emitting Lasers with a High-Contrast Grating — •Werner Hofmann — Technische Universität Berlin

Long-wavelength Vertical-Cavity Surface-Emitting Lasers (VCSELs) based on a subwavelength high-contrast gratings (HCGs) as output mirrors have been realized for the first time. By design, these devices are highly polarization stable, single-mode at large apertures and solve the VCSEL-mirror problem at long wavelengths in an elegant way. The device is grown on an InP substrate, incorporating a BTJ for a low electrical and optical losses and avoiding p-material. A hybrid reflector is used as bottom-mirror and the light is coupled out via the HCG reflector. With cost effective mass-fabrication in mind, the top HCG reflector consists of amorphous silicon on isolator. The single-mode laser emission is tailored to be around 1320 nm wavelength targeting applications in high-speed optical data transmission, especially for passive optical networks. The device is manufactured in a low parasitics,

high-speed design, good for bandwidths well above 10 GHz. We report single-mode emission for devices with apertures as large as 11 μm operating continuous wave with output-powers in excess of 0.4 mW. Pulsed operation with output powers up to 4 mW at room temperature is demonstrated as well. This is the first electrically pumped VCSEL structure realized in this wavelength regime utilizing an HCG mirror.