UNIKASSEL VERSITÄT

Physikalisches Kolloquium

Thursday, 28.11.13, 17:15, HS 100
Reception with coffee & cookies 16:45

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High power ultrafast VECSELs and MIXSELs

Abstract

Optically pumped vertical external cavity surface emitting lasers (VECSELs) evolved to high-power laser sources offering excellent beam-quality, wavelength flexibility and low-noise properties in a compact and simple cavity [1]. Passively modelocked with a semiconductor saturable absorber mirror (SESAM), VECSELs demonstrated femtosecond pulses with multi-Watt average output powers at gigahertz repetition rates [2].

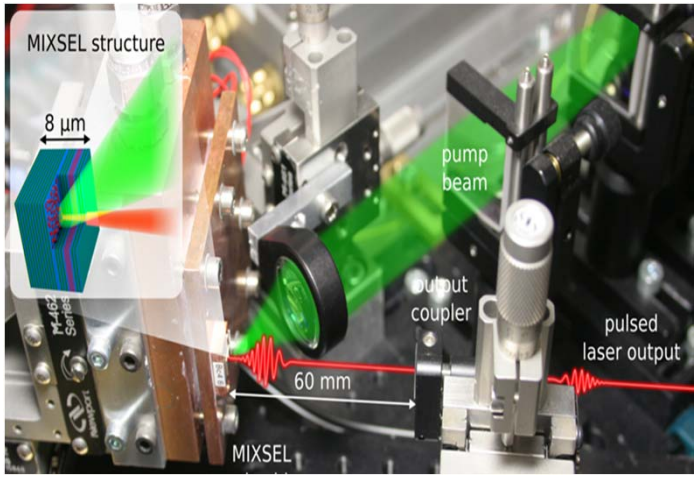
The modelocked integrated external-cavity surface emitting laser (MIXSEL) [3] combines the gain of the VECSEL with the saturable absorber of a semiconductor saturable absorber mirror (SESAM) in one single semiconductor wafer. This concept enables a higher level of integration to reduce complexity, packaging, and manufacturing cost, and allows for stable and self-starting passive modelocking in a simple straight cavity. With quantum-dot (QD) based saturable absorbers record-high watt-level average output power was demonstrated, however the pulse duration was limited to 17 ps [4]. Most recently we have been able to demonstrate the first femtosecond operation of a MIXSEL, generating 620-fs-pulses at a repetition rate of 4.8 GHz and 101 mW of output power.

Applications such as optical clocking and sampling benefit from sub-10-ps high-power lasers with repetition rates in the high gigahertz regime. A promising source is the MIXSEL with sub-10-ps pulse durations that can be scaled easily in repetition rate. At 5.1 GHz repetition rate an average output power of 1.05 W with a pulse duration of 2.4 ps was achieved most recently. Furthermore we scaled the repetition rate to 10 GHz (1.29 W average output power with a pulse duration of 3.9 ps), to 20.7 GHz (607 mW with 2.35 ps) and most recently even to 100 GHz by simply changing the cavity length accordingly.

Furthermore we can present most recent noise measurements of a free-running and actively stabilized MIXSEL generating picosecond pulses around 2-GHz repetition rate and more than 600 mW of average output power with 0.11% rms intensity noise. The free running rms timing-jitter was 127 fs (100 Hz to 10 MHz) and 70 fs (300 Hz to 10 MHz), which is the lowest timing-jitter of a free-running passively modelocked semiconductor laser to date. Actively stablized to a reference-source using a piezo-actuator an rms timing-jitter of 31 fs was obtained, representing the lowest value ever measured from a passively modelocked semiconductor laser between 100 Hz and 100 MHz.

References

[1] U. Keller, A. C. Tropper, Passively modelocked surface-emitting semiconductor lasers, Physics Reports 429, 67-120 (2006).
[2] M. Hoffmann et al., Femtosecond high-power quantum dot VECSEL, Optics Express 19, 8108 (2011).
[3] D. J. H. C. Maas et al., Vertical integration of ultrafast semiconductor lasers, Appl. Phys. B 88, 493 (2007).
[4] B. Rudin et al., Novel ultrafast semiconductor laser with 6.4 W average output power, Optics Express 18, 27582 (2010).



All of you interested in physics are cordially invited!

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