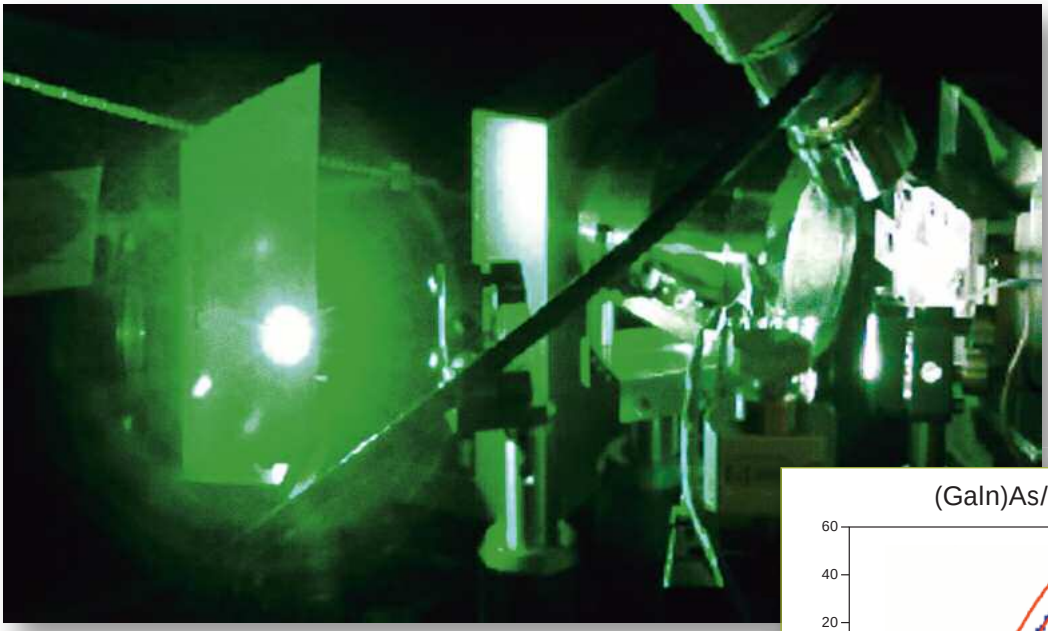
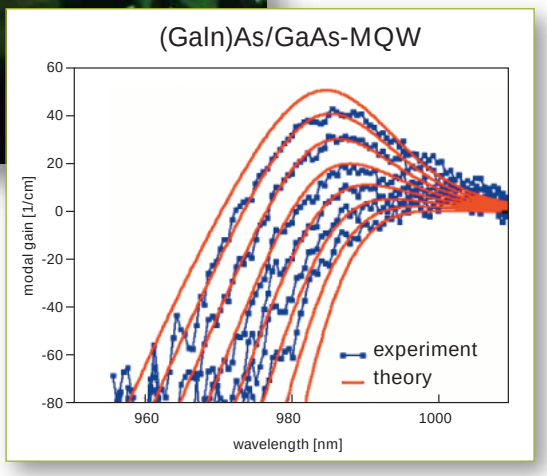
Philipps Universität Marburg

VECSEL

Vertical external cavity surface emitting laser





From design and epitaxial realization to full microscopic modelling

Advantages

- High power levels (scalability)
- Excellent beam quality
- New frequencies by intracavity second harmonic generation

Applications

- Projection systems
- Pump source for fiber lasers
- Your R&D needs and projects

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VECSEL or also Optical pumped semiconductor disk lasers ...

... with an external cavity allow for high output power scaled by the pump beam. Because of the optical pumping the active region can be extended to larger number of QWs, which leads to higher gain, see figure 1 and 2. Output powers of tens of watts can be achieved, if the disk laser is mounted to an effective heat sink. Particularly the external cavity enables the adjustment of non linear optics for second harmonic generation, e.g. infrared light is converted into visible laser light. Therefore, laser devices with high output power and circular beam profile can be realised also in the visible spectral range for various novel applications, e.g. "laser TV", mini-projectors, head-up displays etc.

The dedicated realization of VECSEL device structures requires a thorough knowledge of the physical properties as well as the epitaxial realization of these complex semiconductor devices. Thus, the research groups at Philipps-University have adopted an iterative approach from full microscopic design and theoretical modelling (Prof. Dr. S.W. Koch) to epitaxial realization and detailed experimental characterization. Applying this approch VECSEL layer structures for emission wavelengths at 980 nm, 1040 nm, 1178 nm and 1260 nm have successfully been realized also in cooperation with the University of Arizona (Tucson) and industrial partners.

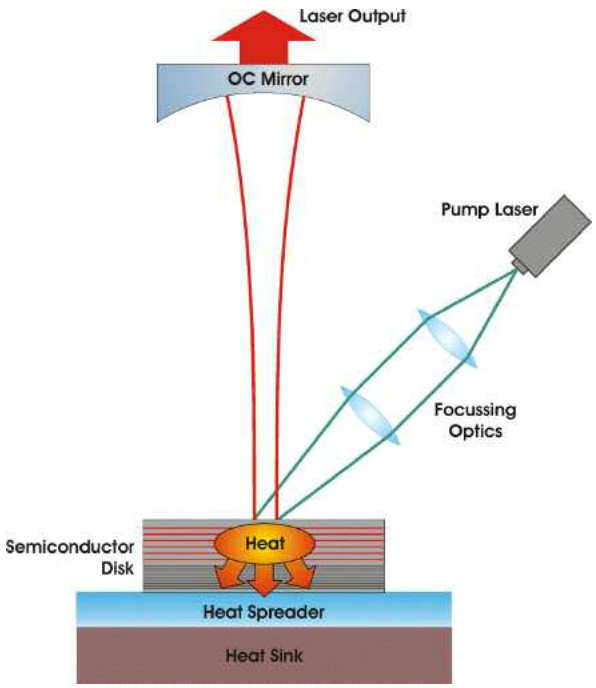

Figure 1: Principle setup of a VECSEL. The semiconductor disk laser is mounted to a heat sink in order to guarantee an effective heat removal. A non linear optic adjusted into the external cavity allows for second harmonic generation.

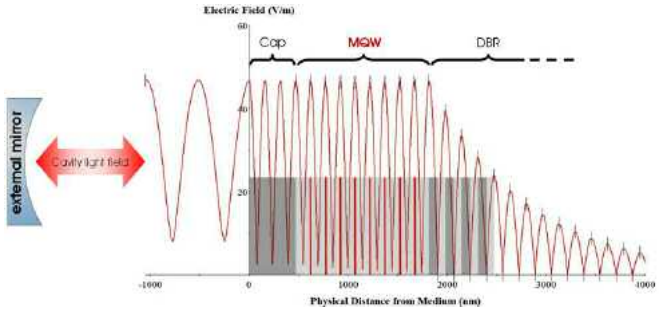

Figure 2: Spreading of the electric light field in a VECSEL. For an accurate thickness of the cap layer and the MQW structure the incident light field couples into the semiconductor disk without any intensity losses. Each QW is adjusted to a maximum of the electric field indicated by the red line, in order to obtain high gain.

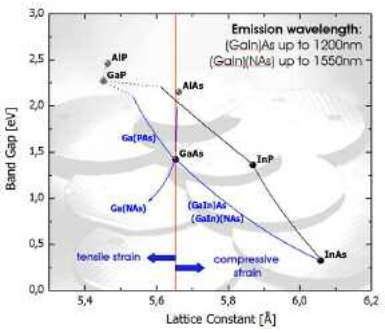

Figure 3: Energy gap versus the lattice constant of different III-V semiconductors.

Selected publications:

"Closed loop design of a semiconductor laser", J. Hader et al., Opt. Lett. 31, 3300 (2006)
"Tunable VECSEL", L. Fan et al., Appl. Phys. Lett. 88, 021105 (2006)
"High-power VECSEL", P. Brick et al., CLEO-PR (2005)
"VECSEL as fiber pump laser", L. Fan et al., IEEE Phot. Techn. Lett., 17, 1764 (2005)
"0.7 W cw green VECSEL", S. Lutgen, et al., CLEO US (2004)