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GaN-based laser sources featuring a small linewidth

FBH is developing customized GaN-based narrow-linewidth laser sources tailored for quantum optical applications. These lasers are built upon ridge waveguide laser (RWL) technology, realized either as distributed feedback (DFB) or distributed Bragg reflector (DBR) laser diodes with high order surface Bragg gratings. These lasers deliver single-peak emission in cw mode, achieving a linewidth < 30 pm (resolution-limited) and a side-mode suppression ratio (SMSR) > 26 dB.

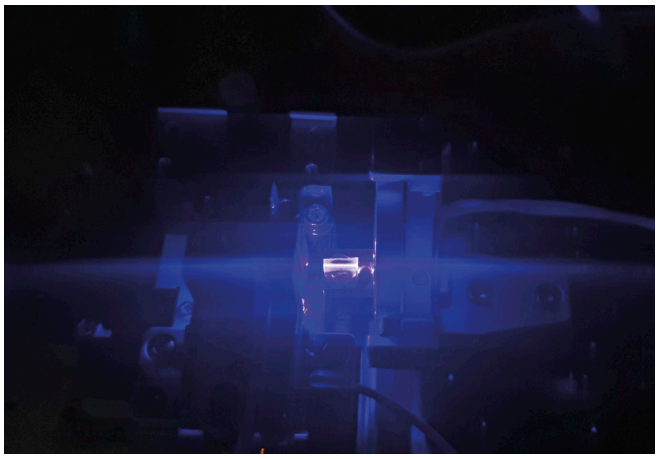
To achieve even smaller linewidths, external cavity diode laser (ECDL) setups are being investigated as laboratory setups. They have demonstrated linewidths < 20 pm (resolution limited) and an SMSR > 40 dB.

DFB laser diodes

- realized with high order surface Bragg gratings laterally coupled along a ridge waveguide
- single longitudinal mode operation at 405 nm with FWHM of 0.02 nm at emission peak and SMSR ≥ 26 dB
- mode-hop free operation up to 90 mW optical power

DBR laser diodes

- realized with high order surface Bragg grating as highly reflective resonator mirror
- periodic mode hops due to thermal detuning of gain and DBR section with increasing operation current
- single longitudinal mode operation at 405 nm with FWHM of 0.03 nm at emission peak and SMSR of 40 dB in the current ranges between two mode hops



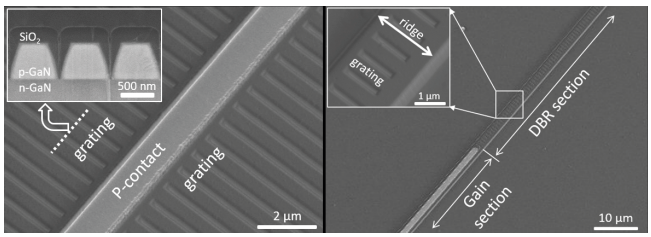
Beam path through volume holographic Bragg grating of an ECDL.

ECDL setup

- gain chip with highly reflective and anti-reflective facet coating as well as a volume holographic Bragg grating as wavelength-selective element
- single longitudinal mode operation at 420.3 nm with FWHM < 0.02 nm at emission peak and SMSR ≥ 40 dB
- advancing high-resolution linewidth measurements and modularization of laboratory setup to enable real-world quantum optical applications

Applications

- atomic spectroscopy
- atomic clocks in space



SEM images of DFB laser diode (left) and DBR laser diode (right).

Profile

The Ferdinand-Braun-Institut, Leibniz-Institut für Höchstfrequenztechnik (FBH) researches electronic and optical components, modules and systems based on compound semiconductors. In the field of III-V electronics, it manufactures high-frequency devices and circuits for communications, power electronics, and sensor technology. Moreover, FBH develops light sources from the visible to the UV spectral range: high-power diode lasers, UV light sources, and hybrid laser systems. Applications range from medical technology, materials processing and sensors to optical communications in space and integrated quantum technology. In close cooperation with industry, its research results lead to cutting-edge products.

The institute is a member of the Leibniz Association and part of Research Fab Microelectronics Germany (FMD).