Leibniz
Ferdinand
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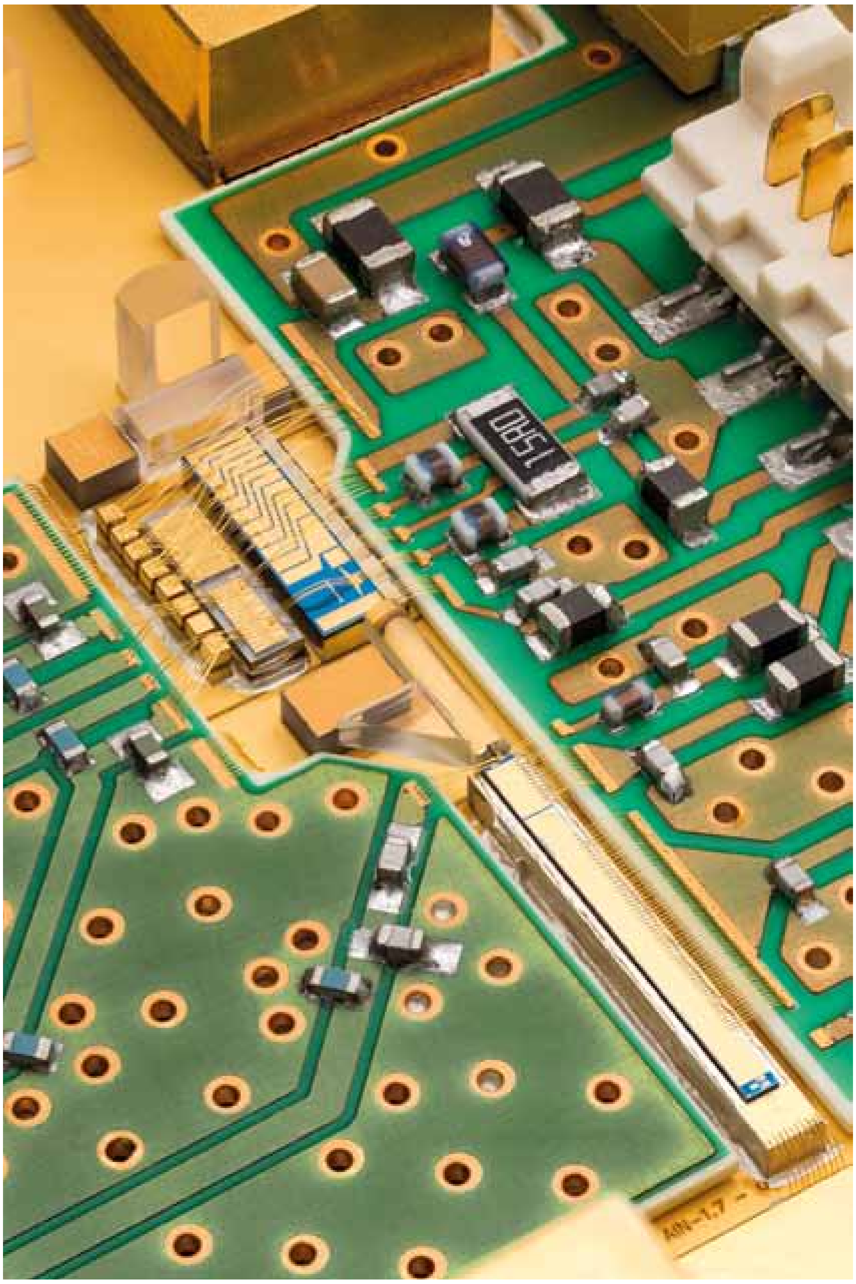
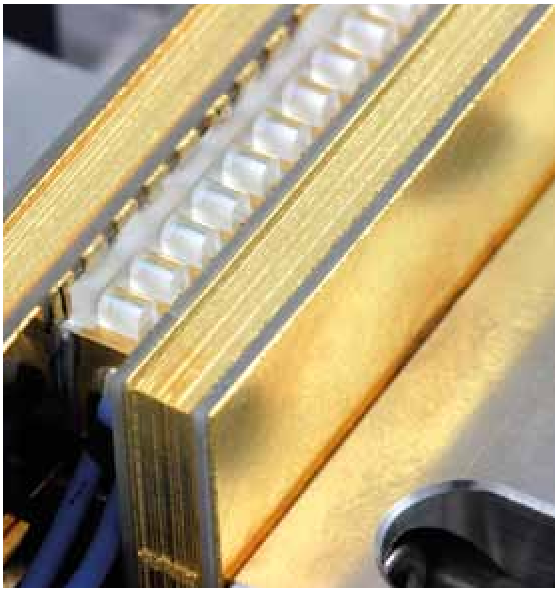
Institut





Compact Diode Laser Modules

Leading Technology in Semiconductor Lasers

The FBH is a center of competence for compound semiconductors comprising the full value chain – from device design to epitaxy, process and mounting technology. As a one-stop agency, the institute offers complete solutions and know-how starting with the key components, the laser chips, through to sophisticated ready-to-ship modules. FBH's hybrid diode lasers are compact, highly brilliant light sources which are preferred for use in materials processing, measurement technology, medical diagnostics and treatment, sensor and quantum sensor technology, display technology, and entertainment systems. High-power diode laser with outstanding brightness, efficiency, and reliability are the main objectives of FBH's optoelectronic research. The institute achieves cutting-edge results through continuously improving technology and by innovation in design. For example, hybrid integrated devices, such as master oscillator power amplifiers, allow the combination of narrow spectral linewidth, nearly diffraction limited beam quality, and high optical output power.

Products & Services

The FBH conducts research on diode lasers targeting the highest possible brightness as well as maximum conversion efficiency. Building on this technology, the institute develops tailor-made diode lasers and laser modules according to the highly specific requirements of its customers in research and industry. The FBH has long-term experience of commercial delivery and collaboration on development projects with industrial partners and uses an integrated management system (ISO 9001 and 14001, OHSAS 18001).

Hybrid Diode Laser Sources for the Most Demanding Applications

The FBH offers a wide variety of cutting-edge modules making full use of its unique know-how in diode laser technology. Developments include CW and high-power short-pulse (ps...ns range) laser sources that combine FBH laser technology with FBH customized electronic circuitry, using GaN transistors to realize compact and efficient short-pulse high-current drivers and switches.

for display technology and entertainment

- **RG(G)B sources** up to 1 W with $M^2 < 3$ at 460 nm, 488 nm, 532 nm, 561 nm, 590 nm (frequency conversion) 638 nm, 647 nm (direct application)

for ophtalmology and fluorescence spectroscopy

- **yellow lasers** with up to 2 W CW at 561 nm or 574 nm using frequency conversion (via nonlinear crystals)

- **ps lasers** with watt-level output power at 561 nm and 589 nm

for laser metrology and space applications

- **high-power modules for pump applications in space** 808 nm for pumping Nd:YAG lasers for atmospheric sensing applications

- **laser modules for coherent optical communications** < 100 kHz linewidth, up to 1 W optical power at 1064 nm

- **narrow and ultra-narrow linewidth laser modules for laser metrology** at 767 nm, 780 nm, 1064 nm, up to 1 W, MHz to kHz linewidth (10 µs, free running), frequency noise PSD as small as 10 Hz^2/Hz for f > 10 kHz

- **photonic integrated circuits** application-customized integration of AlGaAs phase modulators and MZIs at 780 nm and 1064 nm, and of SiO_2 waveguides and high-Q micro-resonators

for sensing applications

- **background-free visible laser sources with blue, green, and yellow emission** up to 100 mW available by combining FBH's DFB and DBR diode lasers with second harmonic generation (SHG), enabling wavelength-stabilized narrow line emission with side-mode suppression ratio > 60 dB. These compact light sources are ideally suited for integration into handheld sensors for Raman and fluorescence spectroscopic applications

- **single-chip dual-wavelength diode lasers for Shifted Excitation Raman Difference Spectroscopy (SERDS)** optical powers up to 200 mW, alternating wavelength operation with a spectral spacing of 10 cm^{-1}, devices demonstrated and applied at 671 nm and 785 nm. These diode lasers are implemented into miniaturized handheld probes for in situ Raman and SERDS applications

- **compact deep UV lasers for resonance Raman spectroscopy** 225 nm diode laser system using a GaN ECDL and single-pass SHG

for LiDAR and materials processing

- **pulse laser source up to 100 W** with 4 – 10 ns pulses for automotive LiDAR

Application-ready modules that integrate high-performance master oscillators and power amplifiers:

- **gated amplifiers for pulse widths of 1 – 20 ns** < 5 MHz linewidth using narrow linewidth CW master oscillators, peak power up to 10 W

- **Q-switched diode lasers for pulse widths around 100 ps with high repetition rate** multi-section DBR laser diodes and modules, peak power up to 50 W with repetition rates up to 10 MHz

- **mode-locked diode laser master oscillator for pulse widths around 10 ps** peak power > 0.5 W at 4 GHz repetition rate (oscillator only), peak power > 30 W at repetition rates up to 10 MHz using pulse picker and tapered amplifier

- **high-power QCW modules for pump applications** high energy pulses at 940 nm (6 kW peak power at 20 % duty cycle) from fiber (1.9 mm 0.22 NA) for disk laser pumping

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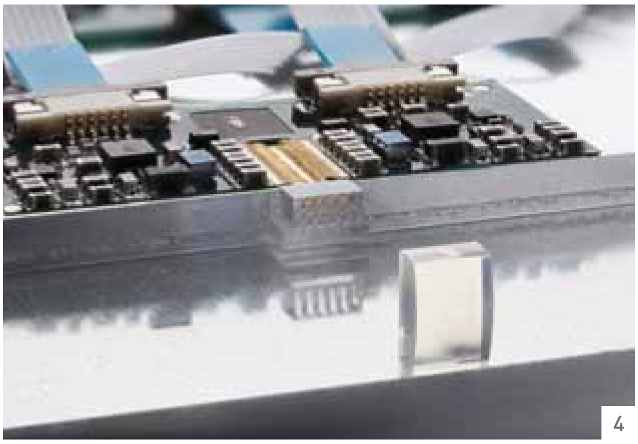

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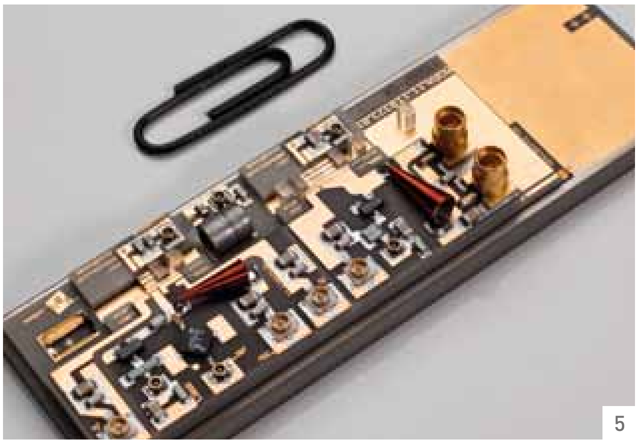

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1 High-precision mounting – integration of optical and electro-optical components into a space-compatible, Doppler-free spectroscopy module
2 Handheld probe with implemented dual-wavelength diode laser for mobile Raman and SERDS spectroscopy
3 Compact diode laser module for biophotonics and medicine
4 High current ns laser driver with integrated ridge-waveguide laser diode for LiDAR applications
5 Space-compatible micro-integrated MOPA for high-precision spectroscopy
6 Custom pump modules for advanced solid-state lasers used in materials processing

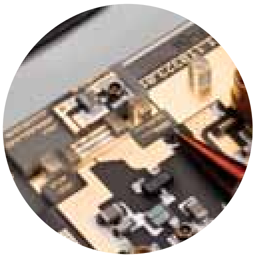
Technology

AlInGaAsP-based layer structures for highly sophisticated optoelectronic devices are grown on 2", 3", and 4" wafers in multiwafer MOVPE reactors. Single and multiple GaInP, GaAsP, and InGaAs quantum wells are grown as active regions for use in semiconductor lasers at wavelengths between 630 nm and 1180 nm.

The FBH runs a highly flexible and industry-compatible process line for compound semiconductor devices on 2", 3", and 4" wafers. It includes an i-line wafer stepper, as well as holographic and e-beam exposure for sub-micron structures.

High-performance automated die bonding and assembly tools are used for mounting laser chips on submounts and for assembly of laser modules. Micro-optic components are fixed in place using an adhesive technology which is qualified for space applications and enables stable attachment with sub-micron precision.

The performance of these high-brightness, high-power, narrow linewidth laser diodes is comprehensively characterized in FBH's test laboratories by using state-of-the-art measurement technology.

translating ideas into innovation

The Ferdinand-Braun-Institut, Leibniz-Institut fuer Hoechstfrequenztechnik (FBH) researches electronic and optical components, modules and systems based on compound semiconductors. These devices are key enablers that address the needs of today's society in fields like communications, energy, health, and mobility. Specifically, FBH develops light sources from the visible to the ultra-violet spectral range: high-power diode lasers with excellent beam quality, UV light sources, and hybrid laser modules. Applications range from medical technology, high-precision metrology and sensors to optical communications in space. In the field of microwaves, FBH develops high-efficiency multi-functional power amplifiers and millimeter-wave frontends targeting energy-efficient mobile communications, industrial sensing and imaging, as well as car safety systems. In addition, the institute fabricates laser drivers and compact atmospheric microwave plasma sources operating with economic low-voltage drivers for use in a variety of applications.

The FBH is an internationally recognized competence center for III-V compound semiconductors. It operates industry-compatible and flexible cleanroom laboratories with vapor phase epitaxy units and a III-V semiconductor process line. The work relies on comprehensive materials and process analysis equipment, a state-of-the-art device measurement environment, and excellent tools for simulation and CAD.

In close cooperation with industry, its research results lead to cutting-edge products. To ensure Germany's technological competence in microwave and optoelectronic research, FBH works in strategic partnerships with industry. The institute also successfully turns innovative product ideas into spin-off companies.

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