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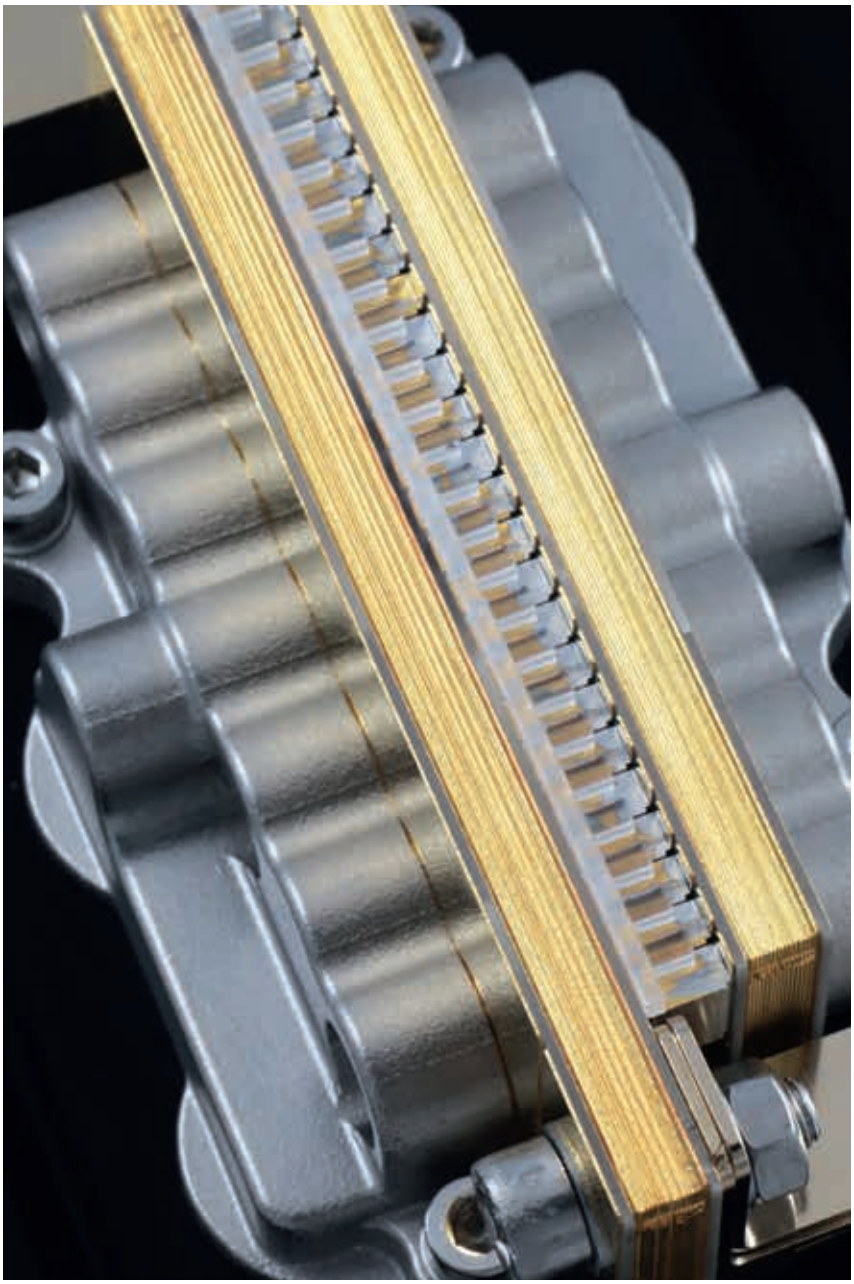
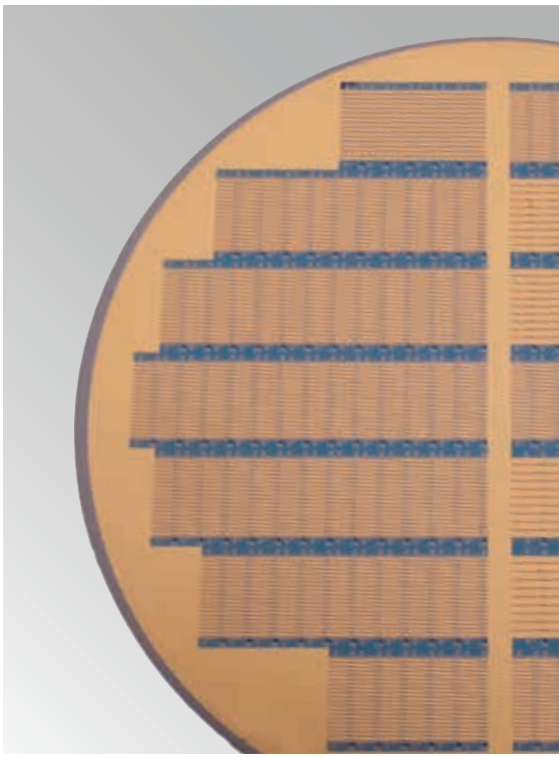
Institut





Laser Diodes & Amplifier

Leading Technology in Semiconductor Lasers (620 – 1180 nm)

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-use modules.

FBH's laser diodes are highly brilliant light sources which are preferred for use in material processing, measurement, medical diagnostic, and sensing applications as well as for use as pump sources for ultra-high peak power solid-state laser 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. Recent examples include very efficient kilowatt-scale high-power diode laser sources for direct use and for pumping solid-state laser systems. Such sources span applications from continous wave (CW) direct-diode additive manufacturing tools to pulsed pumps for mid-infrared solid-state lasers, from CW pumps for industrial material processing tools to pulsed pumps for high energy laser facilities.

Products & Services

Research & Development

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 devices according to the highly specific requirements of its customers in research and industry, such as

- highly reliable and highly efficient power laser diodes for material processing and medical applications
- laser diodes for highest output power in the kW range, as pump modules for large-scale solid-state laser research facilities e.g. for studies into laser-induced fusion
- multi-emitter chips with tailored properties for sensing and high-precision measurement systems

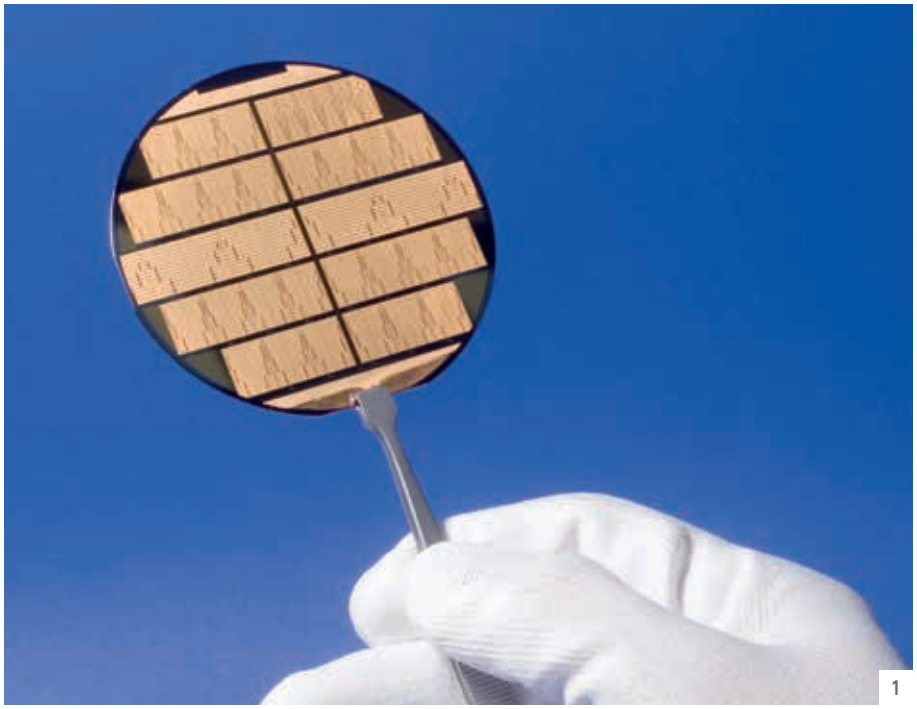
The FBH has long-term experience of commercial delivery and collaboration on development projects with industrial partners and uses an integrated management system (based on ISO 9001, 14001, and 45001).

Diode Lasers for the Highest Demands

The FBH offers a wide variety of cutting-edge devices to meet specific requirements in various applications. These are based on FBH's long-term research program and leverage its unique know-how in diode laser technology.The wavelength range covered extends from 620 to 1180 nm.

High power and efficiency

- **broad area (BA) lasers**
  - with CW powers of up to 25 W from a 100 µm stripe and 70 W from a 1000 µm stripe
  - with high CW lateral brightness, delivering 18 W in a 3.5 W/mm-mrad beam
  - up to 200 W with 81 MW/cm^{2}sr (10 ns, 10 kHz) from DFB-BA lasers



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1 processed 3" laser diode wafer
2 1 kW QCW diode laser bar
3 350 W red-emitting laser bar
4 sensor chip containing 24 single mode emitters
5 SEM image of an apodized grating for efficient, high yield monolithic wavelength stabilization
6 Compact kilowatt CW direct diode module for application in efficient additive manufacturing

- **laser bars**
  – with 1900 W QCW output power (typ. 0.2...1 ms 10 Hz) at 25 °C and 2.2 kW at -70 °C
  – with 800 W CW output power
  – with DBR-based monolithic wavelength stabilization for 800 W QCW output in a < 1 nm spectrum
- **laser stacks**
  – single stacks delivering up to 3 kW in a symmetric 70 mm-mm-mrad beam, from 100 µs pulses to CW operation
  – stacks integrated into custom application-ready modules, for direct or pump use, with free-space beam delivery or integrated fiber coupling

High brightness

- **ridge waveguide (RW) lasers**
  > 1 W with > 60% efficiency in fundamental mode and a peak power > 4 W
- **narrow linewidth tapered lasers**
  with integrated Bragg reflector, > 5 W in a nearly diffraction-limited beam, spectral width below 50 pm
- **distributed feedback (DFB) and distributed Bragg reflector (DBR) RW lasers**
  up to 500 mW output power in fundamental mode, spectral width down to 100 kHz
- **mode-locked lasers**
  pulse width down to 3 ps, repetition rates from < 1 GHz (external cavity) up to 12 GHz
- **tilted RW and tapered amplifiers**
  1 W; respectively up to 5 W

Customized chips

- **RW DBR laser arrays**
  up to 24 individually addressable emitters with independently adjustable wavelengths and small spectral widths
- **gain switched RW lasers**
  pulse widths from several 100 ps to several ns, > 5 W peak power in fundamental mode
- **single-emitter dual-wavelength RW DBR lasers**
  up to 200 mW, wavelength spacing > 0.3 nm, adjustable

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, InGaAsP, AlInGaAs and InGaAs quantum wells are grown as active regions for use in semiconductor lasers at wavelengths between 620 and 1180 nm.

The FBH runs a highly flexible and industry-compatible full wafer process line for compound semiconductor devices. It includes an i-line wafer stepper as well as e-beam exposure for sub-micron periodic 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 laser diodes is comprehensively characterized in FBH's test laboratories by using state-of-the-art measurement equipment.


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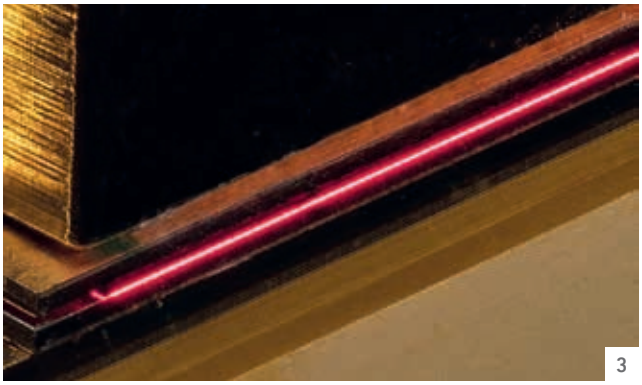
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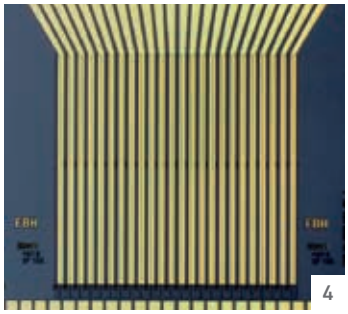
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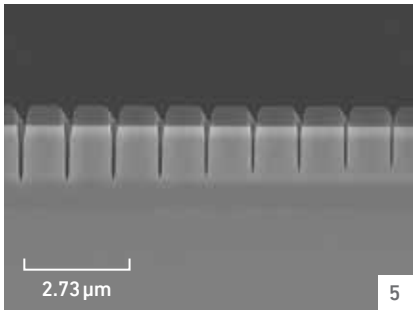

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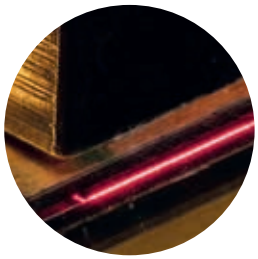
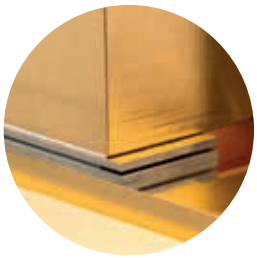
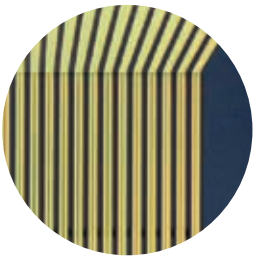
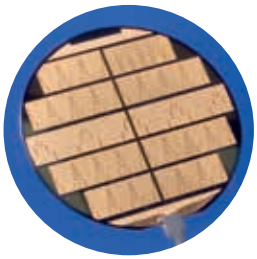

translating ideas into innovation

The Ferdinand-Braun-Institut, Leibniz-Institut für Höchstfrequenztechnik (FBH) is an application-oriented research institute in the fields of high-frequency electronics, photonics, and quantum physics. It researches and realizes 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 infrared 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 and integrated quantum technology. 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 energy-efficient low-voltage drivers for use in a variety of applications.

The FBH is a center of competence for III-V compound semiconductors covering the full range of capabilities, from design through fabrication to device characterization. Within Research Fab Microelectronics Germany (Forschungsfabrik Mikroelektronik Deutschland – FMD), FBH joins forces with 12 other German research institutes, thus offering the complete micro and nanoelectronics value chain as a one-stop shop.

In close cooperation and strategic partnerships with industry, FBH's research results lead to cutting-edge products. The institute also successfully turns innovative product ideas into spin-off companies. With its Prototype Engineering Lab, the institute strengthens its cooperation with customers in industry by turning excellent research results into market-oriented products, processes, and services. The institute thereby offers its international customer base complete solutions and know-how–from design to ready-to-use modules and prototypes.

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