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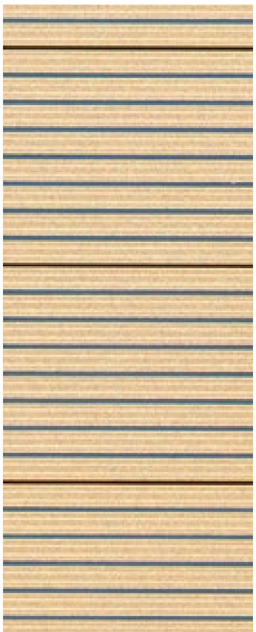

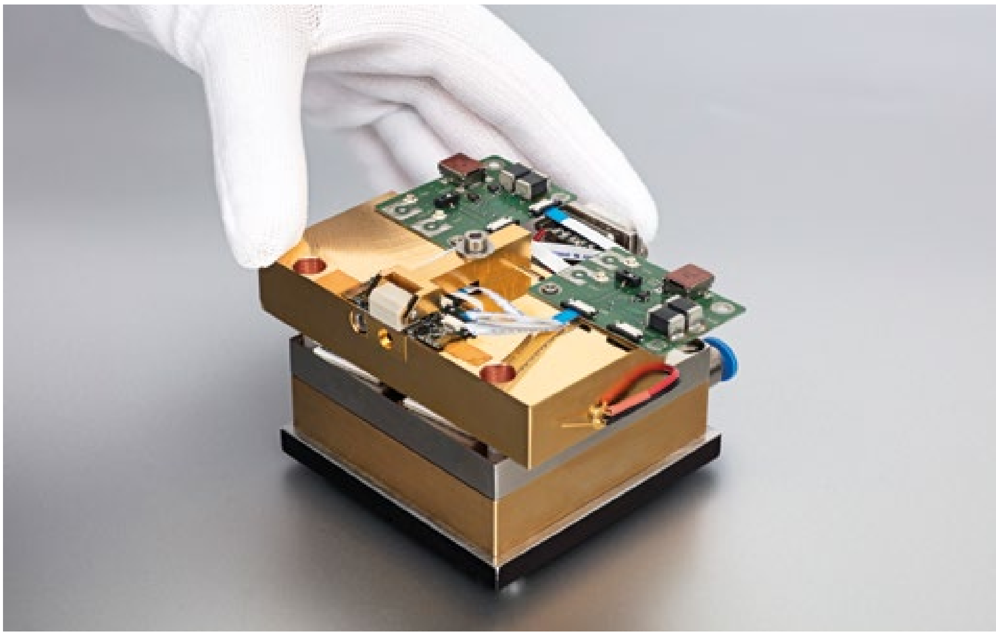

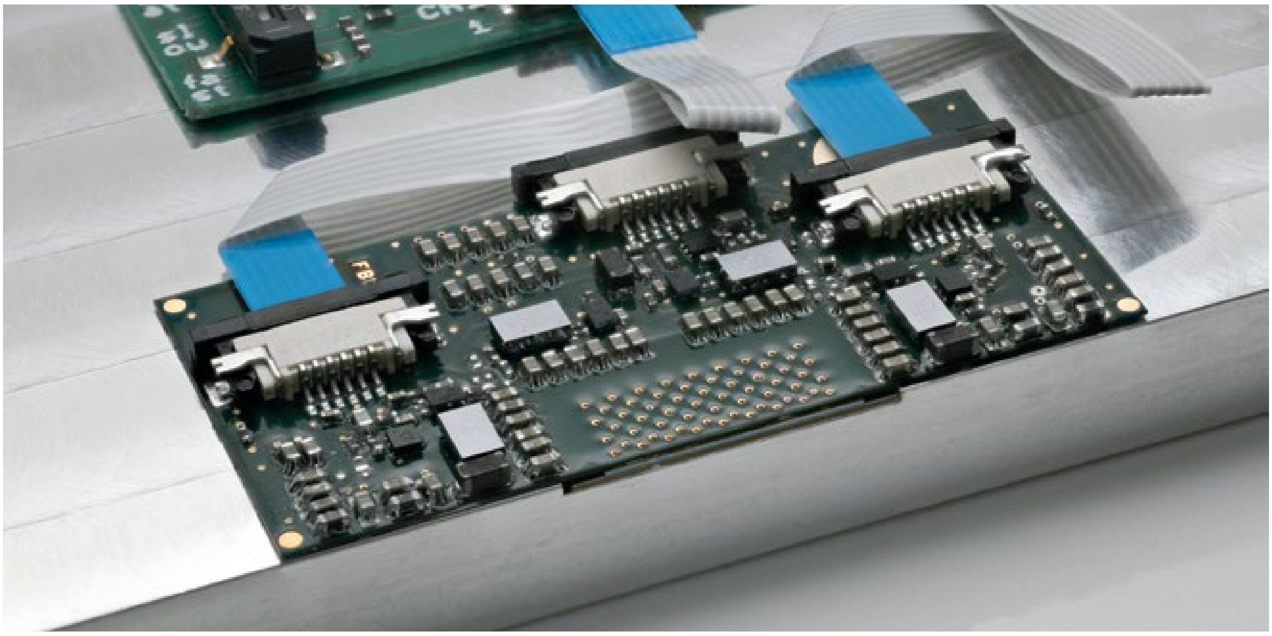

High-Power Pulse Laser Sources for LiDAR Applications

Leading Technology in Semiconductor Laser Modules

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 and the complete electronic circuits, through to sophisticated prototypes and ready-to-use modules.

FBH's laser diode modules are highly brilliant light sources which are preferred for use in materials processing, measurement, medical diagnostics, and sensing applications, as well as for use in LiDAR applications.

Products & Services

Research & Development

The FBH develops novel, compact laser beam sources delivering highly precise pulses in the pico- and nanosecond range. These sources use a tailored design for pulse generation from the diode laser technology as well as optimized RF components from microwave electronics as electronic driver. Both are core competencies of the FBH. The laser sources and systems can be flexibly adapted to the respective application, thus leading to customized solutions for different LiDAR applications, e.g., for autonomous driving, 3D object detection, and laser scanning (air-/ spaceborne).

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, 14001, and 45001).

Light sources for pulse applications

For customized applications, a broad variety of FBH laser diodes can be combined with fast switching laser drivers and offered as complete pulsed laser sources. The FBH laser diode portfolio comprises high power and high brilliant diodes with single or multi-mode operation as single emitters or laser bars – offered also with on-chip wavelength stabilization. Special distributed Bragg reflector (DBR) broad area (BA) laser diodes are available for LiDAR applications.

Customized laser drivers for nanosecond short pulse generation

The maximum range of a LiDAR system depends on the available optical pulse power, the range resolution is determined by the pulse width. Typical scenarios demand for power levels exceeding 100 W at pulse widths from 2 to 10 ns. To generate such short and powerful laser pulses, pulse drivers with a peak current of some 100 A, high efficiency and high repetition rates are needed.

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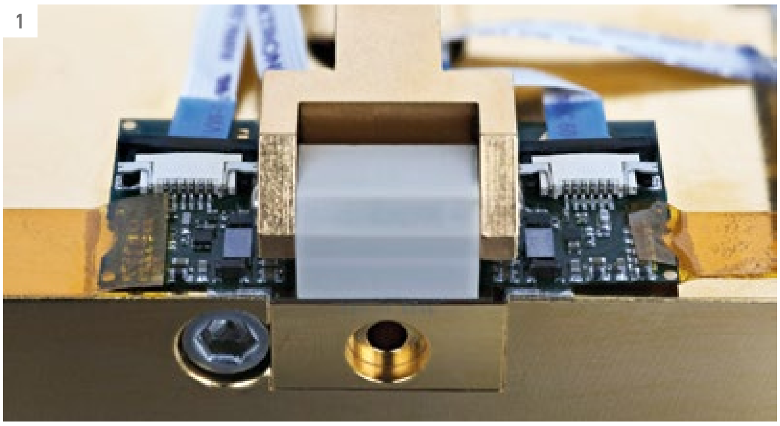

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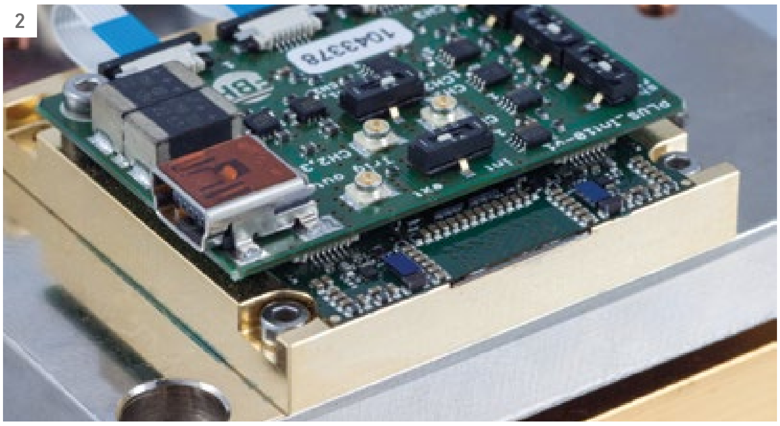

1 The 800 A LiDAR test setup allows fast diode laser characterization with ns pulses by patented chip mounting.

2 600 W LiDAR module: high-pulse current laser driver with integrated DBR 48-emitter bar.

3 Pulsed laser source for automotive LiDAR applications. The emission of its three emitters is optically combined into one spot (cooperation with FISBA Photonics).

The unique challenge is providing the high-speed high-current switching circuit as well as handling the parasitic inductances due to the assembly of the laser diode and the driver board. FBH drivers use GaN devices in the final stage. For different LiDAR applications, electronic circuits providing pulse widths from 2 to 10 ns for single, three, eight and forty-eight emitter bars are developed with maximum pulse currents of 100 A, 270 A, and 980 A at 25 °C (see table). A patent is pending.

DBR-BA laser diodes and bars for LiDAR applications in the 905 nm wavelength range

For automotive LiDAR systems, wavelength-stabilized broad area laser diodes have been developed as single and 3-emitter devices for power levels up to 40 W and 100 W, respectively. These devices are designed for operation temperatures in the full range between -35 °C and 85 °C. Owing to their good beam quality, they can be used in scanning applications (i.e. with MEMS); the emission of 3-emitter devices can be easily combined by Beamtwisters®. Integrated DBR gratings ensure a spectral width below 0.5 nm. The wavelength shift with temperature is as low as 0.06 nm/K. Higher power levels up to 600 W are available from 10 mm wide laser bars, providing repetition rates between 10 kHz and 150 kHz. Long-term operation of 3-emitter devices at a pulse power of 80 W (pulse width 10 ns, repetition frequency 10 kHz) shows no performance degradation after 1.1 x 10^{12} pulses.

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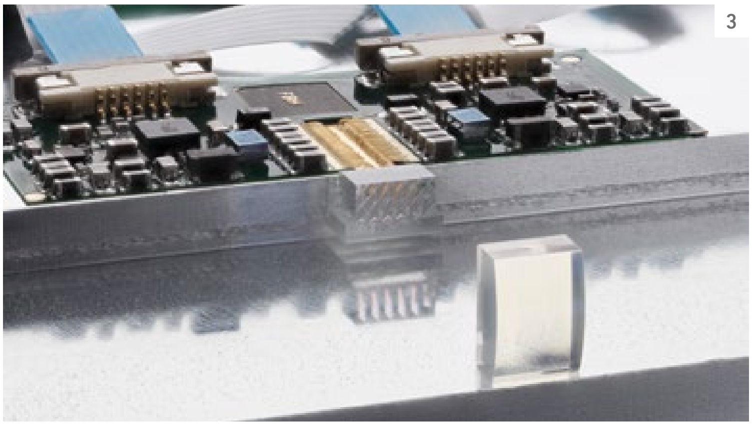

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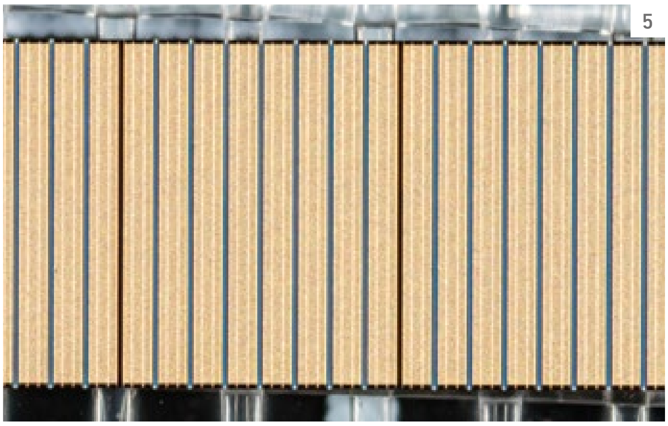

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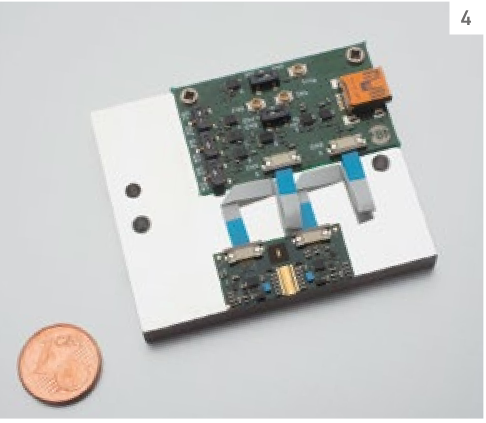

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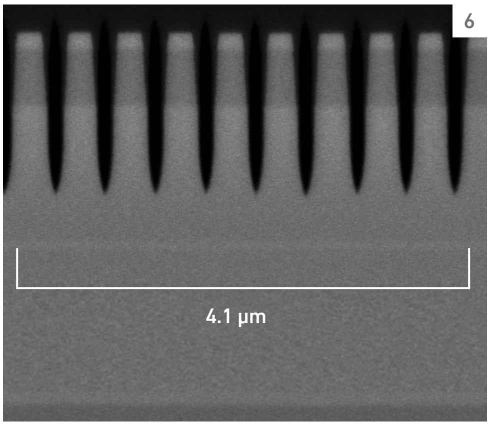


4 HF electronic circuit for single emitter laser and 3-emitter bar.

5 DBR laser bar with 48 emitters for pulse powers up to 600 W. For lower power levels, bars can be cleaved into 8-emitter chips.

6 The wavelength of laser diodes for automotive LiDAR is stabilized by integrating distributed Bragg reflectors (DBR). The SEM picture shows a dry etched surface grating defined by electron beam lithography.

Pulse operation parameters of wavelength-stabilized DBR-BA laser diodes with wavelengths around 905 nm, measured at 25 °C

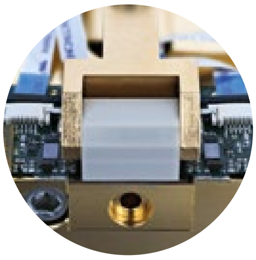
	1 emitter		3 emitter (beams combinable)		8 emitter (bar)		48 emitter (bar)	
repetition frequency / kHz	10		10		10		10	
pulse width / ns	5		5		2	5	2	5
temperature / °C	25	85	25	85	25		25	
max. pulse current / A	110	110	190	190	170	410	600	900
max. peak power / W	40	35	100	85	120	180	400	600
pulse energy / nJ	200	175	500	425	240	900	800	3000
wavelength / nm	905	909	905	909	905		905	

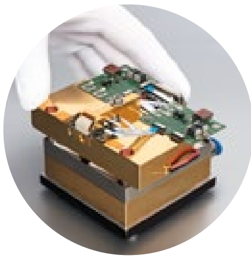
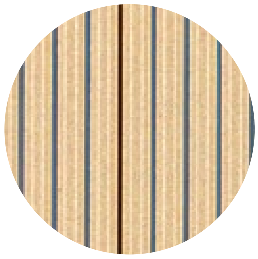
Laser Technology

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 1150 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 holographic and e-beam exposure for sub-micron periodic structures. Cutting-edge laser chips for optoelectronic devices are developed and fabricated in the ISO 5 cleanroom environment.

Laser chips are mounted on submounts and laser modules in high-performance assembly and packaging facilities. The performance of these high-brightness high-power laser diodes and bars is comprehensively characterized in FBH's test laboratories by using state-of-the-art measurement equipment.



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 energy-efficient low-voltage drivers for use in a variety of applications.

The FBH is an internationally recognized center of competence 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, 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 offers its international customer base complete solutions and know-how as a one-stop agency - from design to ready-to-use modules and prototypes. Overall, working in strategic partnerships with industry, FBH ensures Germany's technological excellence in microwave and optoelectronic research.

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