UV Optoelectronics
Competence in Device Design & Technology

The FBH develops ultraviolet (UV) optoelectronic devices, including light emitting diodes (LEDs) in the UV-B and UV-C spectral range, solar-blind photodetectors (PDs) for the UV-C as well as diode lasers emitting in the violet and UV. The device performance is customized for applications such as light sources for UV curing, phototherapy, plant growth lighting, fluorescence spectroscopy, medical diagnostics, sensing, as well as for monitoring systems.

FBH technical experts specializing in various fields collaborate closely to develop custom high-performance UV optoelectronic devices:

- Electrical, optical, and thermal simulation of devices
- Epitaxial growth of group-III nitride layers and material analytics
- UV-LED, PD, and laser diode chip processing technology
- Optoelectronic characterization of devices
- Lifetime measurements and degradation analysis
- Design and fabrication of UV modules and systems

Products & Services

The FBH conducts research and development on UV LEDs, photodetectors, and diode lasers based on (Ga,Al,In)N targeting customized wavelengths in the UV, high brilliance, high power, high conversion efficiency, and devices with tailored spatial emission characteristics. In accordance with the mission of the institute, the activities at FBH cover fundamental experimental studies of the semiconductor materials system as well as the development and fabrication of optoelectronic devices. This also includes transfer of fabrication technologies to industrial partners.

The FBH has long-term experience in collaboration on development projects with partners from universities, research institutes and industry, and uses an integrated management system (ISO 9001 and 14001, OHSAS 18001).

Ultraviolet light emitting diodes and modules

The epitaxial structures are grown on 2” c-plane sapphire substrates. All stages of device processing are performed at the FBH, and the final UV LEDs are available as fully processed wafers, bare chips, chips mounted in ceramic packages and on TO headers, and in turnkey modules ready-to-use in applications. The following types of devices can be fabricated:

- **Bottom-emitting LEDs** with emission through the sapphire substrate in the wavelength range 280 to 320 nm and 230 to 250 nm
- **LED modules** utilizing FBH or commercially available UV LEDs, customized for the use in medical and biological environments, e.g., for water disinfection and plant growth lighting

Ultraviolet photodetectors

The epitaxial structures are grown on 2”, 3” and 4” sapphire substrates. All fabrication stages are performed at the FBH, and the UV PDs developed are available as fully processed wafers and bare chips. The following types of AlGaN metal-semiconductor-metal (MSM) photodetectors (PDs) are fabricated:

- **Solar-blind PDs** with maximum response in the UV-C range, e.g., 254 nm
- **PDs with narrow detection band**, for example for the disinfection band 240 to 280 nm
- **PDs switchable** between narrow-band and broad-band characteristics
Research on Future Products

Blue-violet and near-UV diode lasers

Diode lasers emitting in the violet wavelength range from 390 to 430 nm have been developed and are in the testing stage. The laser structures are grown on 2”, c-plane GaN substrates. Fabrication processes for the following types of lasers are available:

- **Broad area lasers (BA)** with stripe widths up to 40 µm for pulsed operation
- **Ridge waveguide lasers (RW)** with ridge widths down to 1.5 µm for cw operation
- **DFB lasers (DFB)** with 10th order surface Bragg gratings for pulsed operation

All stages of the fabrication process are performed at the FBH. The diode lasers developed are hence available as fully processed wafers, bare chips with customized facet coating, and chips mounted on current spreaders and heat sinks. Current research focuses on the qualification of the devices as customer products. Further developments include:

- Laser types with tapered structures
- Diode lasers in the UV-C range

Technology

GaN-based layers structures are epitaxially grown on 2”, 3” and 4” sapphire and 2” GaN wafers in single or multiwafer metal organic vapor phase epitaxy (MOVPE) reactors. Material options include InN, GaN, and AlN as well as their ternary and quaternary alloys.

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 and electron beam lithography for µm and sub-µm structures. Highly sophisticated optoelectronic devices are developed and fabricated in a class ISO 5 cleanroom environment.

Laser, LED, and photodetector chips can be mounted on submounts and heat sinks. The performance of these devices is then comprehensively characterized in FBH’s test laboratories using state-of-the-art measurement equipment.
translating ideas into innovation

The Ferdinand-Braun-Institut, Leibniz-Institut fuer Hochstfrequenztechnik (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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