



Fraunhofer

IAF

**FRAUNHOFER INSTITUTE FOR
APPLIED SOLID STATE PHYSICS IAF**

SPOT ON – FRAUNHOFER IAF



THE INSTITUTE

Fraunhofer IAF is one of the leading research institutions worldwide in the area of III-V semiconductors and diamond. We develop electronic and optoelectronic devices based on modern semiconductor materials.

IAF's research and development work covers the entire value chain – from materials research through design, technology and circuits to modules and systems.

Location	Freiburg
Founding Year	1957
Staff	265
Budgets	33.0 Mio. €
Investments	8.2 Mio. €

RESEARCH

»Spot on«: This year, the »International Year of Light«, we want to put the spotlight on the Institute's highlights:

Millimeter-wave cameras for viewing through dust and smoke

Infrared detectors for the detection of CO₂

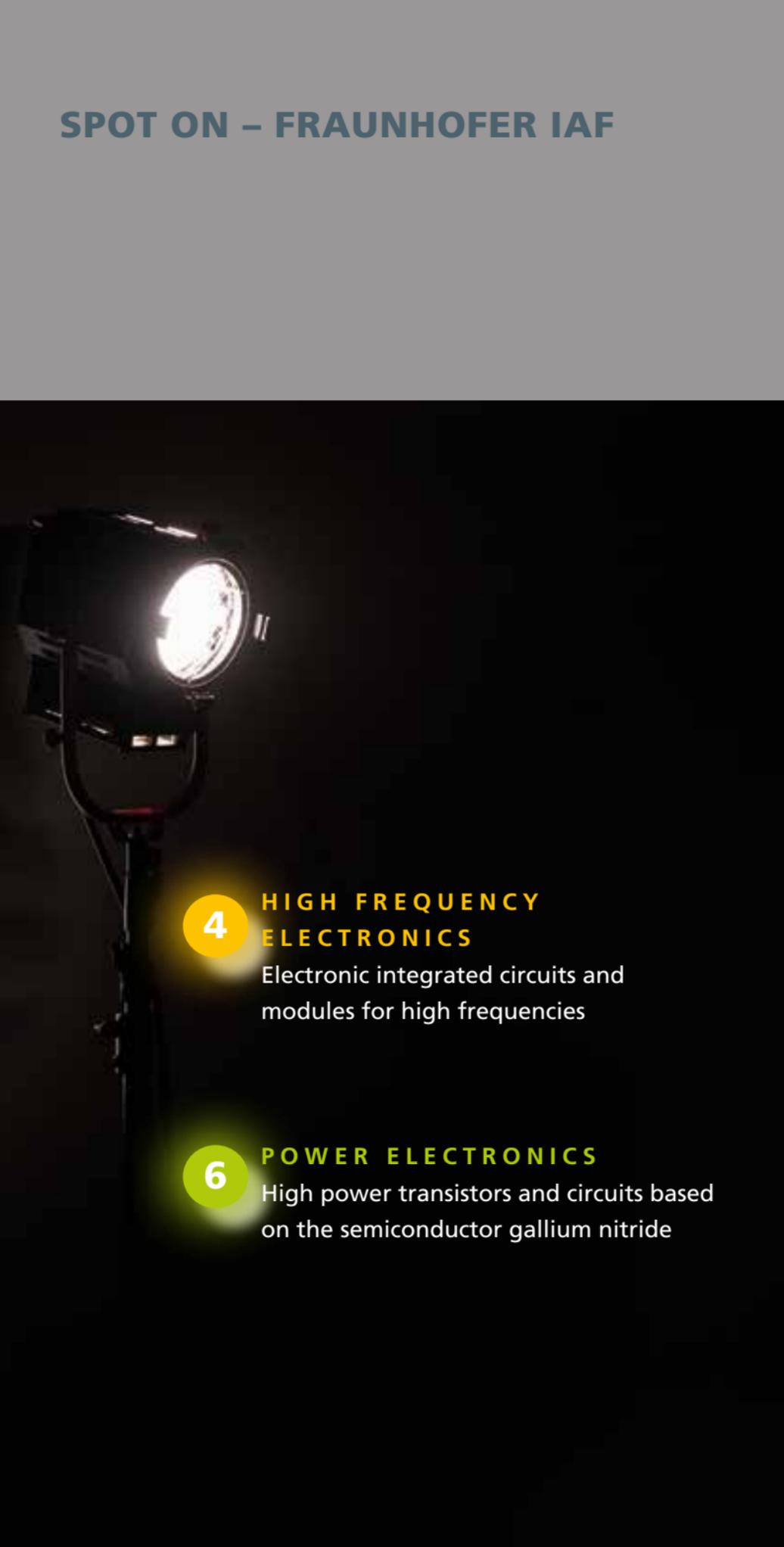
High-frequency power electronics for fast voltage converters

Semiconductor lasers for the detection of hazardous substances

Diamond lenses for high performance lasers

We would be happy to develop your next innovative product with you.

SPOT ON – FRAUNHOFER IAF



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HIGH FREQUENCY ELECTRONICS

Electronic integrated circuits and modules for high frequencies

Increasing amounts of data need to be transmitted within a very short time – be it in applications for communication, sensors or space technologies. Tomorrow's solutions place high demands on electronic devices: they need to be fast and energy-efficient but also small in size.

In the business unit »High Frequency Electronics«, we develop a wide range of high performance integrated circuits for frequencies over 600 GHz based on III-V compound semiconductors. Moreover, we create monolithic integrated microwave and millimeter-wave circuits by means of metamorphous high electron mobility transistor technology on GaAs substrate. Together with our project partners from research and industry we manufacture complete systems for sensors and communication technology.

Within the next few years, we will further increase the functionality of the circuits – up to complete systems on a single chip.

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High frequency electronics for high efficiency and high bandwidth applications

■ **Communication**

- Transmitters and receivers for efficient data transmission at up to 100 Gbit/s
- Low-noise and efficient power amplifiers for mobile communication stations

■ **Safety and security**

- Millimeter-wave camera for imaging at 100 GHz
- Millimeter-wave radar systems for distance and velocity measurements

■ **Space technology**

- Low-noise amplifier circuits for receivers of weather satellites

■ **Quality control**

- Contactless material testing with millimeter-waves

POWER ELECTRONICS

High power transistors and circuits based on the semiconductor gallium nitride

Increasingly efficient systems to produce, distribute and use electrical energy are necessary to cover the increasing worldwide energy needs.

The business unit »Power Electronics« develops high performance transistors and monolithic integrated circuits on the basis of the compound semiconductor gallium nitride (GaN). The semiconductor material can realize more powerful and more efficient electronics than silicon. Using modern high electron mobility transistors, we realize power electronics for operating frequencies between 10 kHz and 100 GHz.

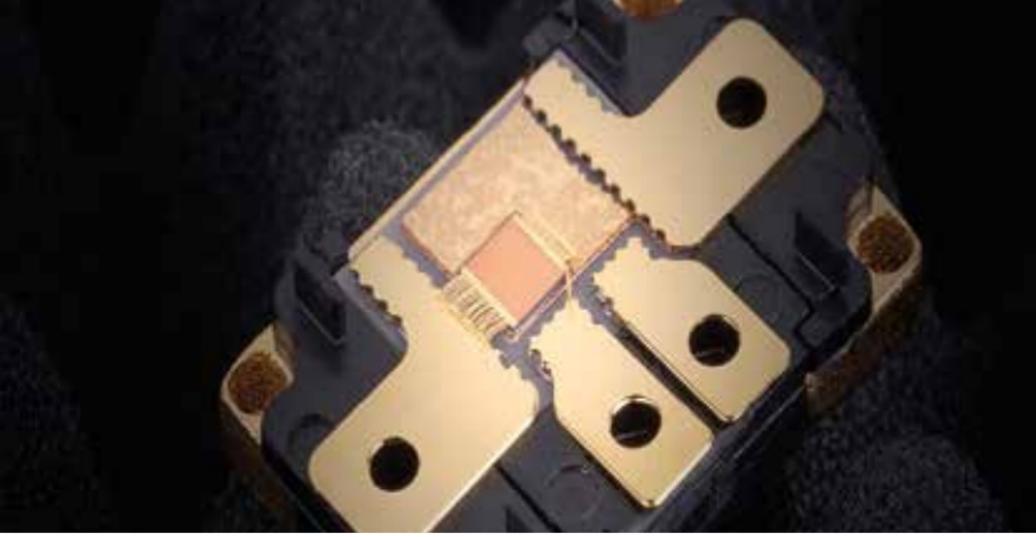
GaN devices can save energy in a wide array of applications. They can give new drive to the market of electric and hybrid vehicles in the form of efficient voltage converters and increase the efficiency of photovoltaic systems or household appliances.

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High frequency power electronics for high speed data connections and efficient energy conversion

■ Communication

- Gallium-nitride-based directional radio amplifiers for high-speed connections in the mobile network
- Mobile data links for gigabit data rates

■ Energy

- Energy-efficient voltage converters with switching frequencies of 10 kHz up to 1 MHz

■ Space technology

- High-resolution, weather-independent radar systems for earth observation
- Transmitters and receivers for satellite communication

■ Meteorology

- High-frequency power sources for weather observation

PHOTODETECTORS

Detectors with high spatial resolution in the infrared and UV spectral range

Imaging systems for wavelength regions not visible to the human eye have a tremendous impact on security and safety systems. They are also key enablers for industrial process control, environmental imaging as well as medical diagnostics.

Our business unit »Photodetectors« focuses on the development of detectors with high spatial resolution and the ability to detect infrared radiation in different wavelength ranges simultaneously – our high-resolution dual-color infrared cameras are unique world-wide. A large part of our research addresses bi-spectral thermal imaging systems for infrared detectors within the two transparent atmospheric windows in the mid-wavelength infrared ($\lambda = 3 - 5 \mu\text{m}$) and the long-wavelength infrared ($\lambda = 8 - 12 \mu\text{m}$).

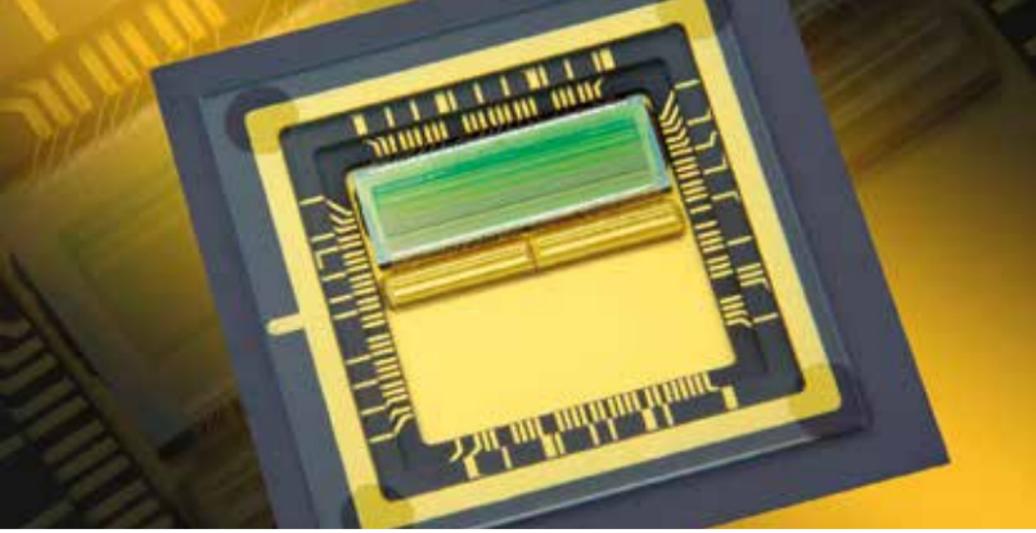
Short-wave infrared detectors ($\lambda = 1.4 - 3 \mu\text{m}$) with high sensitivity are developed for the replacement of night vision goggles and for active imaging systems such as gated viewing cameras.

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Detectors for material analysis, process control and the detection of carbon dioxide

■ Safety and security

- Bispectral warning sensors for the protection of aircraft
- Indium gallium arsenide chips with 640 x 512 pixels in a 15- μm -pixel pitch for high-resolution infrared cameras
- Avalanche photo detectors in the short-wave infrared range for three-dimensional scene analysis

■ Quality control

- Highly sensitive infrared detectors for non-destructive material analysis
- Radiation-resistant UV detectors for process control

SEMICONDUCTOR LASERS

Infrared semiconductor lasers, emitter systems and LED modules

Semiconductor lasers and light-emitting diodes (LEDs) as compact and robust light sources enable the direct conversion of electrical energy into light. This enables innovative solutions for lighting systems, spectroscopy and sensing.

The main tasks of the business unit »Semiconductor Lasers« are the development of infrared semiconductor lasers and emitter systems covering the 2 – 11 μm spectral range as well as the realization of LED modules for the visible and UV spectral range. Furthermore, the light sources will be equipped with additional functionalities such as wavelength tunability or the generation of ultra short optical pulses.

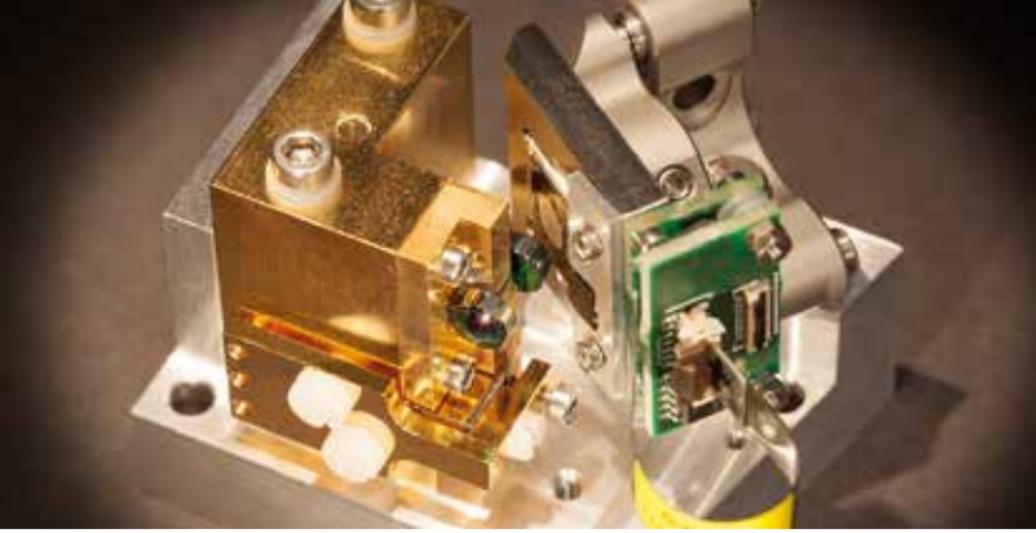
We optimize components and systems for a wide range of laser applications, including medical diagnostics, process analysis and control, as well as safety and security, but also for lighting systems with LEDs.

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Lasers for the detection of hazardous substances and LEDs for energy-efficient lighting

■ Safety and security

- Imaging infrared laser systems for the detection of residues of explosives on e. g. baggage items
- Quantum cascade lasers for the continuous, on-site monitoring of contaminants in drinking water

■ Process analysis

- Broadband tunable and compact quantum cascade lasers for spectroscopy
- Laser-based measuring systems for the decoding or control of chemical processes

■ Medical engineering

- Infrared lasers for non-invasive breath gas analytics

■ Energy

- Energy-efficient LED lamps based on gallium nitride with light intensities above 2000 lm

SEMICONDUCTOR SENSORS

Micromechanics and sensors based on III-V semiconductors, graphene and diamond

Using tiny sensors to detect hazardous materials or to monitor industrial processes – micro- and nano-sensors find applications in many areas of daily life.

In the business unit »Semiconductor Sensors«, we develop a variety of different sensors, using modern materials which possess extraordinary physical properties, like diamond, graphene and III-V compound semiconductors. The spectrum of our research ranges from UV to IR lenses, gas detectors, electro- and biochemical sensors, high-energy radiation and particle detectors, heat spreaders, single photon sources to micro- and nanoelectromechanical systems.

Our components can be used in a wide range of applications, e. g. in the identification of diseases and toxins as well as in material processing and power electronics.

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Robust components for applications under extreme conditions

■ Material processing

- Diamond lenses for high-energy laser systems

■ Energy

- Graphene for transparent, conductive contacts
- Diamond-based resonators for high-frequency applications
- Power transistors on diamond heat spreaders
- Supercaps from diamond-nanowires, diamond-silicon nano-wires and from graphene flakes

■ Environment and Health

- Actinoid and ozone sensors
- Diamond-based electrochemical sensors
- Magnetometry sensors and nano-size tips

■ Space technology

- Radiation-hard, ultra-light diamond-based bipolar transistors for satellite communication

SERVICES

We offer services for the analysis of materials, components and circuits:



Optical Analysis

- Spectroscopic ellipsometry
- Fluorescence microscopy
- Infrared spectroscopy
- Photoluminescence
- Optical profilometry
- White light interferometry



Structural Analysis

- Scanning electron microscopy including focused ion beam preparation
- Electron diffraction
- Scanning probe microscopy
- Secondary ion mass spectrometry
- X-ray diffraction
- Energy dispersive X-ray analysis



Electrical characterization

- Dark and photoconductivity
- Capacity and Hall effect measurements
- Eddy current measurements
- High voltage measurements up to 2000 V
- High frequency measurements up to 1000 GHz
- Life time measurements



Mechanical Characterisation

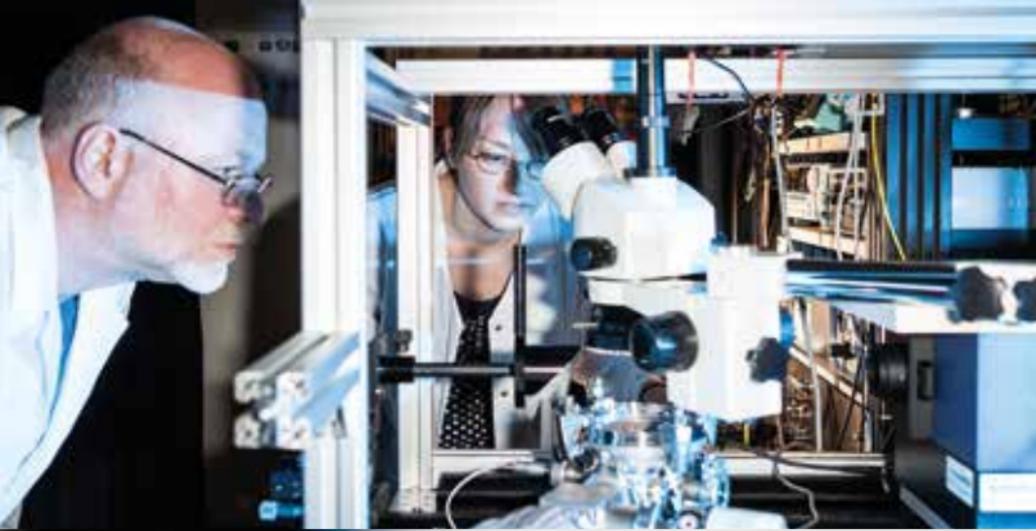
- Young's modulus
- Vibrometry
- Tactile profilometry
- Atomic force microscopy

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DESIGN WITH US THE NEXT GENERATION OF SEMI- CONDUCTOR TECHNOLOGY

We offer you an attractive working environment in a high-tech institute, excellent development opportunities and a research environment with close links to industry. Get to know the Fraunhofer-Gesellschaft as one of the most popular employers in Germany.

We are looking for staff in

- Science
- Technical Services
- Administration

We also offer

- PhD positions
- Bachelor and Master positions
- Student Assistantships
- Vocational Training

Please find our current open positions at:

www.iaf.fraunhofer.de/career.html

FAIRS AND CONFERENCES 2015

42nd Freiburg Infrared Colloquium,
Freiburg, 03. – 04.03.2015

Laser world of Photonics, Munich, 22. – 25.06.2015

Compound Semiconductor Week, Santa Barbara, CA,
USA, 28.06. – 02.07.2015

Freiburger Wissenschaftsmarkt, Freiburg, 10. – 11.07.2015

11th International Conference on Nitride Semiconductors,
Beijing, China, 30.08. – 04.09.2015

European Microwave Week, Paris, France, 06. – 11.09.2015

Future Security, Berlin, 15. – 17.09.2015

Semicon Europa, Dresden, 06. – 08.10.2015

3rd International Symposium on Development of
CBRN-Defence Capabilities, Berlin, 19. – 21.10.2015

Mikrosystemtechnik-Kongress, Karlsruhe,
26. – 28.10.2015

6th International Symposium on Growth
of III-Nitrides, Hamamatsu, Japan,
08. – 13.11.2015

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Achim Käflein (p. 1, 2, 13, 16)

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