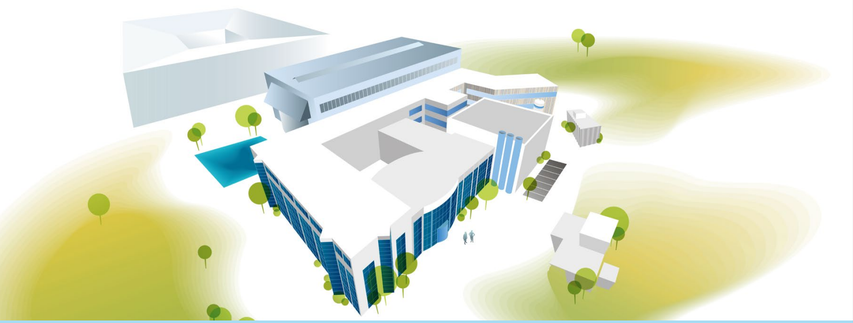

FRAUNHOFER IISB OFFERS INNOVATIVE POWER ELECTRONIC SOLUTIONS THAT ARE USED IN CONVERSION, SUPPLY, AND STORAGE OF ELECTRICAL ENERGY.

Fraunhofer IISB conducts applied research and development in the field of electronic systems for application in, e.g., electric mobility, aerospace, Industry 4.0, power grids or energy technology. In this connection, the institute uniquely covers the entire value chain from basic materials and semiconductor technologies to entire power electronic systems.

Being part of the Fraunhofer-Gesellschaft, the IISB does contract research for industry as well as public authorities. On that note it is the institute's main objective to provide excellent research to its industrial partners and to set technological benchmarks as one of the leading research institutions in electronic systems.

- Branches in Nuremberg and Freiberg
- Close cooperation with Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU), with its Chair of Electron Devices (LEB) and its Chair of Energy Electronics (LEE) being held by the directors of the IISB.
- Member of Leistungszentrum Elektroniksysteme (LZE) and Energie Campus Nürnberg (EnCN).

SEMICONDUCTORS AND POWER ELECTRONICS

With its two business areas, semiconductors and power electronics, the IISB provides innovation and solutions in various specialized fields. These services are supplemented by broad activities in test and reliability, simulation, characterization, and metrology.

In addition to silicon technology, the IISB has a strong focus on wide-bandgap semiconductors, especially silicon carbide (SiC). For SiC, the institute offers a complete technology backbone, including materials science, devices, modules, and their integration in highly efficient power electronic systems.

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FRAUNHOFER INSTITUTE FOR INTEGRATED SYSTEMS AND DEVICE TECHNOLOGY IISB

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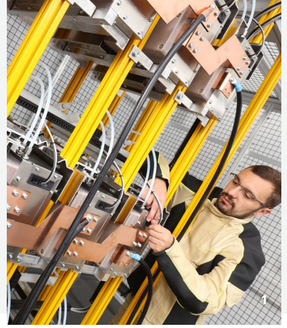
POWER ELECTRONIC SYSTEMS AND TECHNOLOGIES

POWER ELECTRONIC SYSTEMS AND TECHNOLOGIES



INTELLIGENT ENERGY SYSTEMS

- Power electronics for stationary grid applications, data analytics
- Highly reliable HVDC transmission components
- Multi-level converters for MVDC and high-power drives
- LVDC microgrids
- Mobile and stationary battery systems, BMS
- Increasing efficiency, availability, and economics

ENERGY TECHNOLOGIES

- Efficient energy production, storage, use, and supply
- Coupling of electrical and non-electrical energy
- Power electronic interfaces, grid connection
- Gas-to-power coupling, non-electrical storages
- Energy monitoring, peak load shift
- Intelligent local energy systems

VEHICLE POWER ELECTRONICS

- Extremely compact, robust power electronic systems
- High-efficiency AC/DC and DC/DC converters
- Integration of latest SiC and GaN technologies
- Advanced mechatronic system integration
- High-frequency power converter and EMC development
- For electric vehicles, motor sports, and aerospace

PACKAGING & RELIABILITY

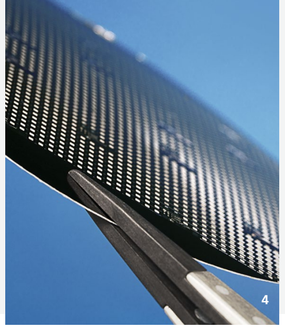
- New concepts and materials for packaging
- High-performance joining technologies, sintering
- Thermal, electrical, and mechanical characterization
- Lifetime characterization, statistical analysis
- Analysis of failure mechanisms
- Lifetime modeling

MATERIALS

- Bulk crystal growth and epitaxy
- Defect engineering
- Correlation of material and device properties
- Silicon, compound semiconductors (SiC, GaN, AlN)
- Micro, power, optoelectronics, photovoltaics
- Equipment, material, device manufacturers, suppliers

TECHNOLOGY & MANUFACTURING

- Si and SiC technology lines, large cleanroom facilities
- π-Fab for prototype device fabrication
- Custom-tailored SiC services, metrology
- Contamination and manufacturing control
- Data-driven production optimization, APC, equipment
- Particle and thin-film systems, nanopatterning



DEVICES

- Customer-specific active and passive electron devices
- Using silicon and silicon carbide processing technology
- For application in power electronics, microelectronics
- Sensor devices
- Novel device concepts and cost-efficient processes
- Ultra-thin and large-area applications

MODELING AND ARTIFICIAL INTELLIGENCE

- Development of physical models and software, AI-assisted simulation
- Computational lithography and optics
- Topography and doping process simulation
- Simulation of equipment and crystal growth processes
- Optimization of equipment, processes, and devices
- Multi-physics simulation, esp. for power electronics

1 *Grid simulator test setup with a three phase modular multilevel converter using 1.2 kV IGBT modules.*
© Kurt Fuchs / Fraunhofer IISB

2 *Air-cooled silicon carbide inverter for automotive and aircraft application.*

3 *Horizontal hot-wall reactor for silicon carbide (SiC) homoepitaxy on SiC substrates.*
© Kurt Fuchs / Fraunhofer IISB

4 *Vertical power electronic devices on a 4H-SiC wafer after thinning down to 100 µm thickness and backside metallization.*

5 *Industry-compatible cleanroom environment comprising a continuous silicon CMOS and silicon carbide process line.*
© Kurt Fuchs / Fraunhofer IISB

OUTSTANDING FACILITIES AND EQUIPMENT

The IISB is equipped with high-class laboratories, such as a test center for electric cars and an application center for DC grid technology. While the IISB institute building itself serves as a research and demonstration platform for advanced energy technologies to be used in industrial production environments, linking electrical energy and non-electrical forms of energy by providing the necessary interfaces. Furthermore, the institute runs 1500 m² of cleanroom area for semiconductor technology on silicon and silicon carbide together with University of Erlangen-Nuremberg.

ELECTRIC VEHICLE TEST CENTER

Vehicles with an electrical power train put completely new demands on test systems. The vehicle test center at IISB is dedicated to electric vehicles and allows for the testing and characterization of all components of an electrical power train, as well as complete electric vehicles. The test center includes test beds for electric drives, traction batteries, system reliability, and electro-magnetic compatibility (EMC). Overall electric vehicle testing is possible in an air-conditioned dynamometer, including fully automized road and driving cycle simulations. All labs of the test center include a powerful highly dynamic DC source (150 kW, 0 ... 800 V, 4Q), and a coolant conditioning system (-40 °C to +115 °C) for the operation of the system-under-test (SUT).

ΠT-FAB – ELECTRON DEVICE PROTOTYPE FABRICATION

In particular to meet the requirements of our external and internal customers better, the service sector is set up in a separate organizational unit called π-Fab. π-Fab is intended for the fabrication of custom-tailored prototype electron devices, mainly for power electronic application, and it is ISO 9001:2015 certificated for this.

For this purpose, IISB and the Chair of Electron Devices of the University of Erlangen-Nuremberg operate joint clean room facilities of 1500 m² (primarily class 10) with CMOS-compatible equipment. This allows the implementation of important process steps on silicon wafers with diameters of up to 200 mm and on SiC wafers with diameters of up to 200 mm. An industrial CMOS process transferred to IISB and constantly adapted for research and development purposes is used as a reference and as the basis for developing advanced process technologies. The main activities focus on the fields of Si power semiconductors, passives, and silicon carbide electronics.

IISB has increased its commitment especially to SiC by implementing new equipment and processes to meet special and additional requirements for SiC power device processing. Most of the FMD (Forschungsfabrik Mikroelektronik Deutschland – "Research Fab Microelectronics Germany") investments of the Technology and Manufacturing department are dedicated to the change in wafer size on SiC to 200 mm.