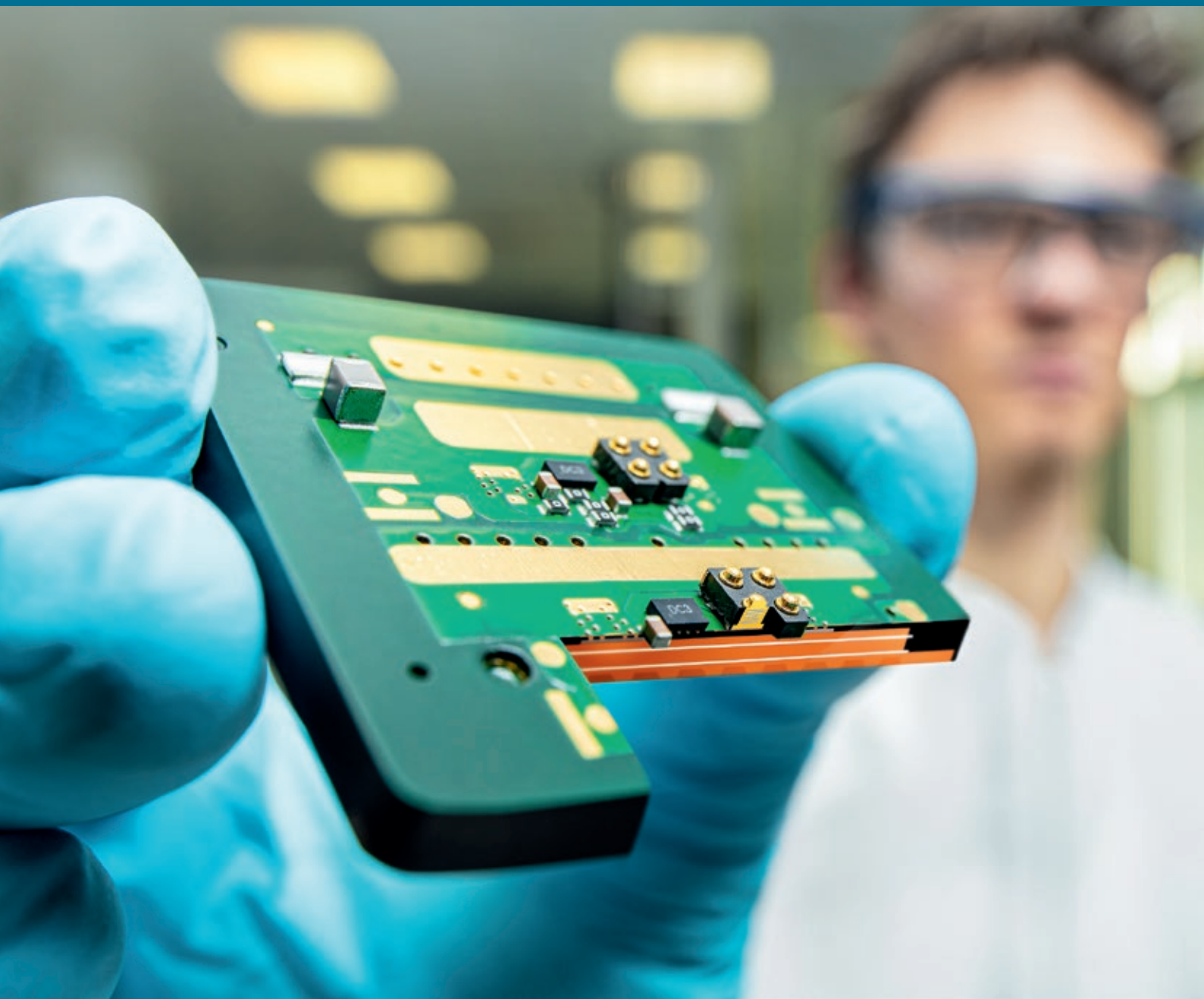




Fraunhofer
IZM

FRAUNHOFER INSTITUTE FOR RELIABILITY AND MICROINTEGRATION IZM

ELECTRONIC PACKAGING & SYSTEM INTEGRATION



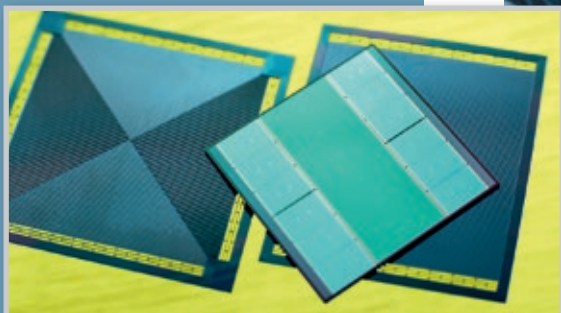
ELECTRONICS AT THE LIMIT

INDUSTRIAL ELECTRONICS



Mobile transponder for locating tools in an industrial environment

ICT



Micro fluidic interposer test chip with RF-evaluation

AUTOMOTIVE



Radar sensor module for autonomous driving



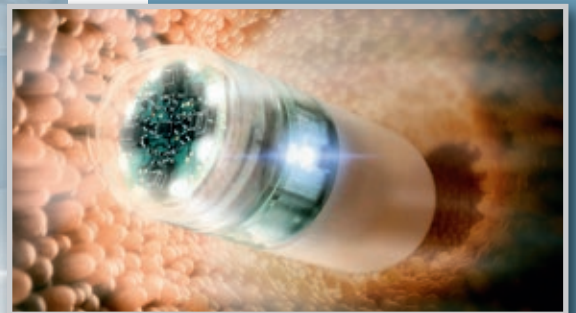
Intelligent electronic systems – available everywhere and to everyone! In order to make this possible, components need to have exceptional properties. Depending on the application, they need to function reliably at high temperatures, be extremely miniaturized and moldable to individual build spaces or even flexible. The Fraunhofer Institute for Reliability and Microintegration IZM helps companies around the world deve-

lop and assemble robust and reliable electronics to the very cutting edge and then integrate them into the required application.

To this end Fraunhofer IZM develops adapted system integration technologies on wafer-, chip- and board level. Our research continues to improve reliability and helps customers confidently predict a product's lifetime.

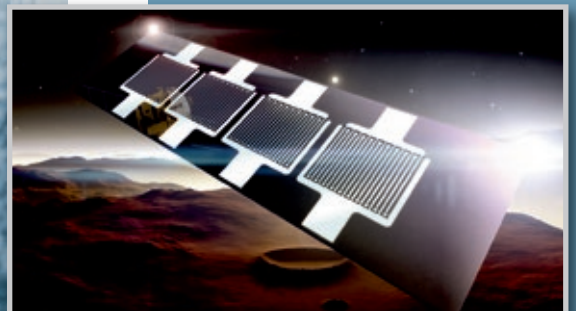


MEDICAL ENGINEERING



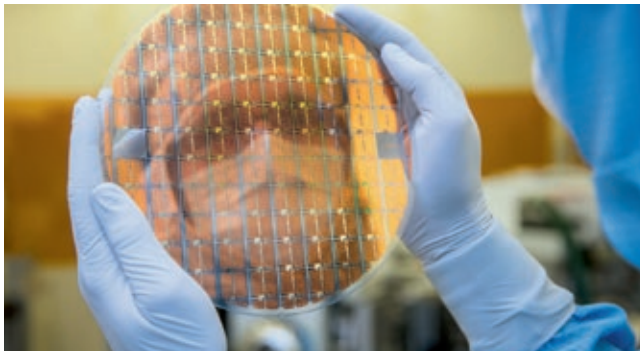
Endoscopy capsule for faster examination of the small intestine

SEMICONDUCTORS



Humidity sensor in ppm-range for aerospace research

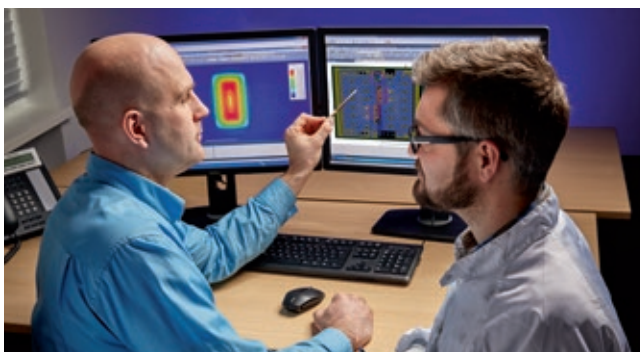
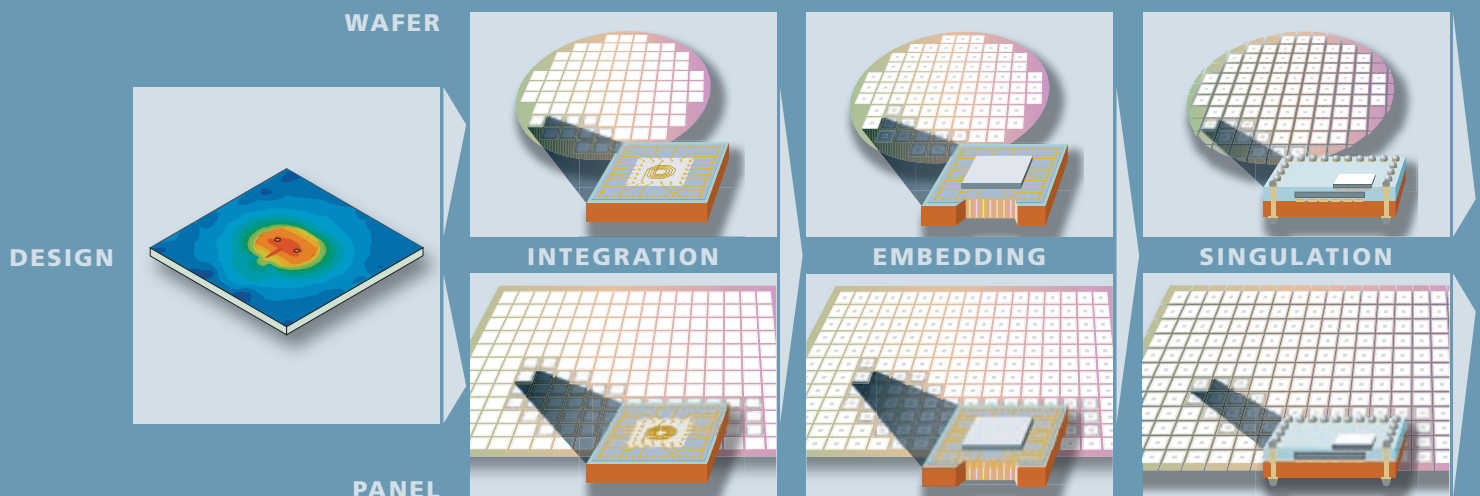
WAFER, SYSTEM AND EVERYTHING IN BETWEEN



Wafer-level manufacturing of glass interposers based on silicon technology

Integration at wafer level

The highest integration densities possible in heterogeneous assemblies are achieved using wafer-level integration. All processing steps are carried out at wafer level after the actual front-end processes have been completed. The packages we develop have lateral widths almost identical to the chip dimensions. We also include active and passive components on the wafer in interlayers and even higher integration densities are achieved with 3D integration using through-silicon vias (TSV).



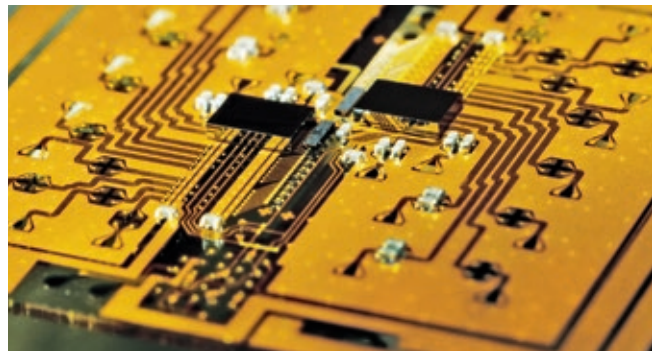
Design optimized for high frequencies of up to 40 GHz

System design

Due to the use in harsh environments, the application of new sensor principles and increasing frequencies and data rates, packaging technologies need to evolve and be more specifically characterized and optimized with regard to their electrical, thermal and thermo-mechanical properties. Fraunhofer IZM's strength lies in the combination of excellent technology development, sophisticated electrical design and electrical, thermal and thermo-mechanical modeling, simulation and analysis methods.

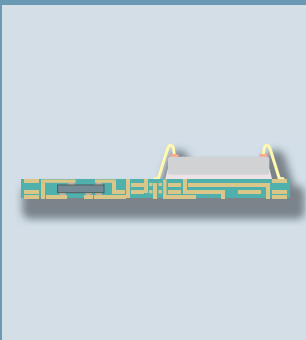
Integration at substrate level

Fraunhofer IZM's substrate integration line combines state-of-the-art assembly equipment with a complete large-format PCB production and is one of a kind worldwide. Besides precision assembly, embedding technologies and highly reliable encapsulation processes we develop cutting-edge panel-level packaging technologies, which in turn provide a start-to-finish manufacturing opportunity for system-in-packages, modules and miniaturized systems on large formats. Fraunhofer IZM also offers the manufacturing of prototypes, small series and the process transfer into industry.



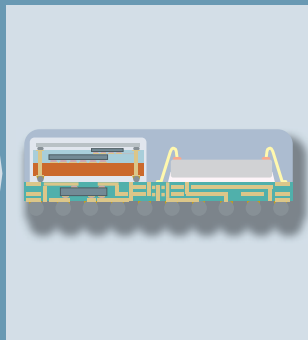
4-channel midboard optical transceiver based on glass interposer, flip-chip assembly of electro-optical components

EMBEDDING



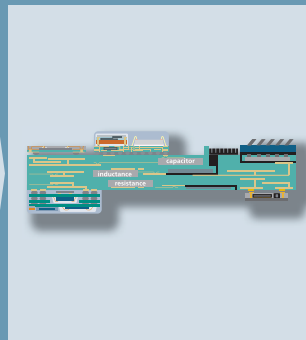
REDISTRIBUTION

THRU SUBSTRATE VIA



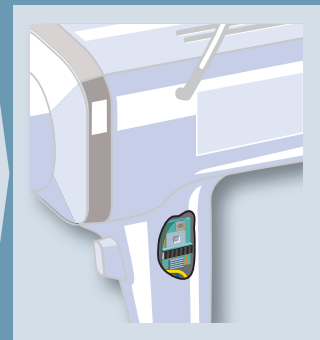
ENCAPSULATION

BALLING / STACKING



QUALIFICATION AND TESTING

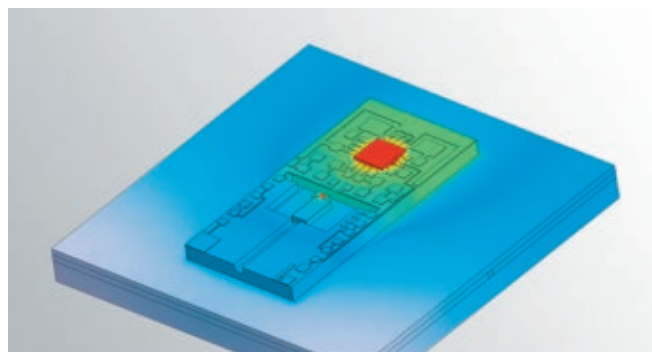
RELIABILITY



PRODUCT INTEGRATION

Materials, reliability and sustainable development

Reliability and environmental compatibility are an increasingly important factor in the development of electronic assemblies and systems. Fraunhofer IZM combines reliability analyses of electronic assemblies and their environmental impact with the development of new technologies. We conduct analyses of the materials right through to the system as a whole using material behavior and mechanical reliability models. Apart from simulation processes, we employ laser-optical, X-ray and material tests individually or in combination.



Thermal simulation to determine the optimum placement of components and cooler

CORE COMPETENCIES

WAFER LEVEL SYSTEM INTEGRATION

The Wafer Level System Integration department focuses on the development of advanced packaging, system integration technology and client-specific solutions for microelectronic products within the overall context of smart systems. The department's technological emphasis includes 3D integration, wafer-level packaging, fine-pitch bumping, hermetic MEMS and sensor packaging, high-density assembly, sensor development and integration, and hybrid photonic integration.

The services available to industrial customers include process development, materials evaluation and qualification, prototyping, low volume manufacturing as well as process transfer. The production lines in Berlin and Dresden (up to 300mm wafer size) are set up for production- and industry-compatible development and processing (ISO 9001 certified management system).

Services

- Wafer bumping (ECD: Cu, Ni, Au, AuSn, CuSn, SnAG, In)
- Thin-film redistribution (CU-RDL) on active IC wafers
- Through-silicon vias (Cu-TSV)
- TSV silicon interposer with Cu-multi layer high-density redistribution layer
- Passive device integration (R, L, C)
- BEOL metallization
- Pre-assembly and wafer thinning
- Temporary wafer bonding and de-bonding
- Die-to-wafer and wafer-to-wafer bonding
- 3D stack formation
- Dicing by grinding (DBG)
- Application-specific 3D WL-SiP, CSP, TCI prototyping and small batch production
- Thin-film technology training and courses

WAFER LEVEL PACKAGING AND TSV-LINE



Photoresist / Polymer process

WAFER SIZES UP TO 300 mm



Sputtering



Wafer bonding (perm. or temp.)



TSV etching

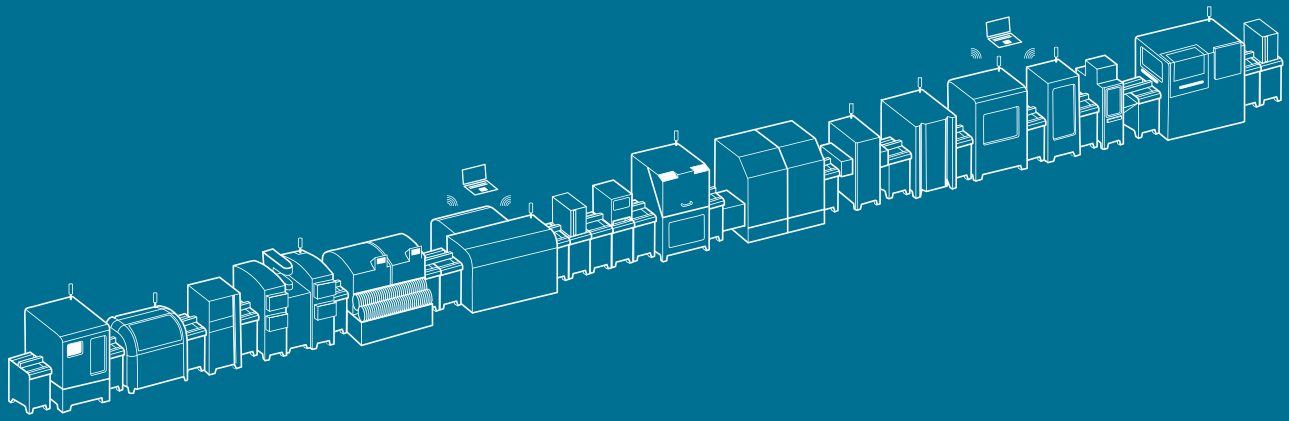


Electroplating



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SYSTEM INTEGRATION & INTERCONNECTION TECHNOLOGIES

The range of services provided by the System Integration and Interconnection Technologies (SIIT) department, with its roughly 170 employees, spans from consultation and process development right through to technical system solutions. Developing processes and materials for interconnection technologies on board, module and package levels and the integration of electrical, optical and power-electronic components and systems are at the forefront of the department's research.

We assist companies with application-oriented pre-competitive research, as well as the development of prototypes and small volume production. Our services include application advice, technology transfer and further qualification of personnel through practical training.

Services

- SMD, CSP, BGA, POP and bare die precision assembly
- Flip-chip techniques (soldering, sintering, adhesive joining, thermo-compression and thermosonic welding)
- Die attach (soldering, sintering and adhesive joining)
- Wire and ribbon bonding (ball/wedge, wedge/wedge, heavy wire and ribbon)
- Optical: fiber optics and sensors, electro-optical circuit boards, photonic assembly, plasmonics
- Conformable electronics
- Power electronics: Electrical/electromagnetic/thermal/ thermomechanical design
- Power cycling of power modules

PANEL LEVEL EMBEDDING LINE



Molding



Sputtering

COST-OPTIMIZED SYSTEM-IN- PACKAGES



Assembly



Imaging



Electroplating

UP TO
610 × 456 mm²/
24" × 18"

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CORE COMPETENCIES

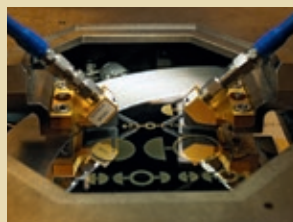
RF & SMART SENSOR SYSTEMS

Creating advanced systems for communication, radar and sensor applications, founded on Fraunhofer IZM's technology know-how. Development and optimization of methods and tools for the design of technologically sophisticated miniaturized electronic systems. Providing power supply solutions through energy harvesting, energy conversion concepts, energy management for autonomous systems and energy-optimized programming. Extensive range of equipment for measurement and characterization of RF materials, assemblies and components (up to 220 GHz), as well as for assembly and measurement of autonomous sensor nodes and for manufacturing of micro batteries.

Services

- RF-design and RF-characterization of materials, packages and components
- RF-system integration and module design with regard to signal and power integrity
- Design and realization of autonomous, wireless sensor systems
- Development of micro batteries, power supply and management for autonomous systems
- Tools for optimized design of micro systems and server-client software architecture

RF SYSTEMS



RF characterization

SYSTEM DESIGN



EMC assessment



Waste water sensor

WIRELESS SENSORS



Test & validation



Micro battery line

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ENVIRONMENTAL AND RELIABILITY ENGINEERING

The service spectrum of the Environmental and Reliability Engineering department not only encompasses both the investigation and the minimization of environmental impact with regard to development and reliability aspects, but also the eco-design of products and development of green technologies in electronics. In addition, we offer accelerated lifetime testing for complex load operations, special testing methods for monitoring the aging process and can support you in the material-related analysis, characterization and simulation in the micro and nano range. The department is also able to offer the development of lifetime modeling for materials, components and systems, thermal management, condition monitoring for electronics and reliability management.

Services

- Reliability optimization using multi-physics simulation (thermal, mechanical, fluidic)
- Materials characterization
- Structure and failure analysis
- Combined load testing (humidity, vibration, temperature, mechanical, electrical, etc.)
- Strategies for the sustainable development of electronics
- Ecodesign of products and assistance with the applicable legal regulations
- Lifetime-oriented design, recycling and condition monitoring of electronic systems

RELIABILITY QUALIFICATION

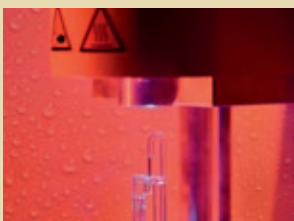


Electronics condition monitoring

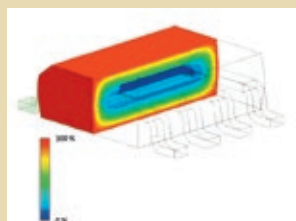


Thermal and reliability analyses

SUSTAINABILITY



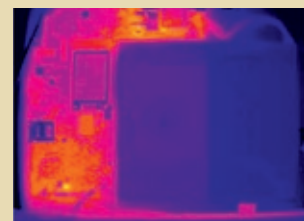
Micro material characterization



Package simulation



Disassembly & eco design

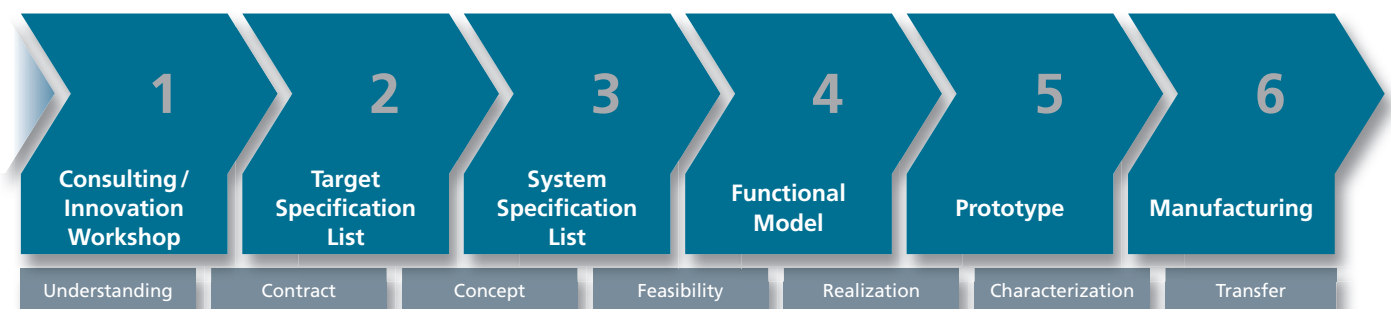


Test & optimization

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COOPERATION

WORKING TOGETHER WITH FRAUNHOFER IZM



Fraunhofer IZM's research results are highly relevant to industries such as the automotive industry, medical engineering, industrial electronics and even lighting and textiles. Semiconductor manufacturers and suppliers of related materials, machines and equipment, but also small companies and start-ups can choose the approach that best suits their needs – from easily accessible standard technologies through to high-end disruptive innovation. As partners, our customers profit from the advantages of contract research, by selecting between exclusive release of a product innovation, improving a workflow or qualifying and certifying a process.

Contract research

Often a successful cooperation project begins with a preliminary consultation phase that is usually free-of-charge. Fraunhofer only begins billing for its research and develop-

ment services once the parameters of the cooperation have been defined. Customers retain ownership of the material project outcomes developed within their contract, as well as the applicable usage rights to the produced inventions, property rights and the know-how.

Project funding

Some development challenges require pre-competitive research. In these cases, teaming up with companies and research institutes and public funding support is more effective than operating solo. The institute cooperates closely with numerous universities, including the Technische Universität Berlin and the Berlin University of Applied Sciences (HTW), to ensure that the preparation for future cooperation with industry is optimal.

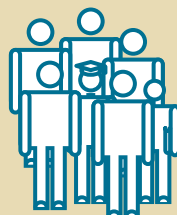
Fraunhofer IZM in facts & figures



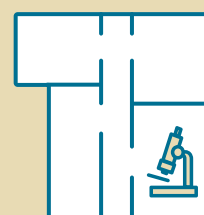
Turnover \approx 36 Mio €



Industry projects \approx 40 %

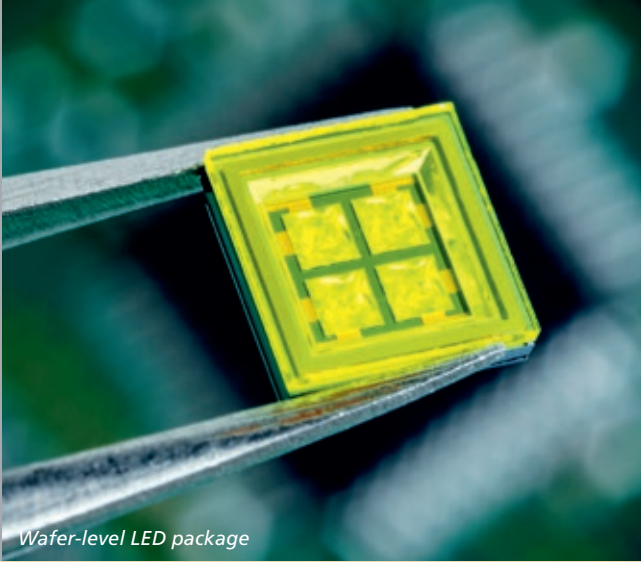


\approx 430



Labs & cleanrooms $>$ 8,000 m²





Wafer-level LED package



Cross section of a power chip-scale package with embedded SiC power MOSFETs

BENEFIT FROM OUR NETWORKS !

Fraunhofer-Gesellschaft

The Fraunhofer-Gesellschaft is the leading organization for applied research in Europe. Its research activities are conducted by 72 institutes and research units at locations throughout Germany. The Fraunhofer-Gesellschaft employs a staff of more than 26,000, who work with an annual research budget totaling 2.6 billion euros. Of this sum, over 2 billion euros is generated through contract research. Around 70 percent of the Fraunhofer-Gesellschaft's contract research revenue is derived from contracts with industry and from publicly financed research projects. International collaborations with excellent research partners and innovative companies around the world ensure direct access to regions of the greatest importance to present and future scientific progress and economic development.

Fraunhofer Group for Microelectronics

The Fraunhofer Group for Microelectronics, founded in 1996, is the leading European R & D service provider for smart systems. It combines the long-term experience and expertise of currently 16 Fraunhofer institutes with a total of more than 3,000 employees and a combined budget of roughly 480 million euros, of which industry accounts for around 48 percent. The core competences are in the following areas: design for smart systems, semiconductor-based technologies, power electronics and system technologies for energy supply, sensors and sensor systems, system integration technologies, RF and communication technologies, as well as quality and reliability.

Research Fab Microelectronics Germany

Since April 2017, eleven institutes within the Fraunhofer Group for Microelectronics (among them Fraunhofer IZM) and two Leibniz-institutes (FBH and IHP) with more than 2,000 scientists have been working together in the Research Fab Microelectronics Germany (FMD). The cooperation is already the world's largest cross-location pool for microelectronics with a variety of competencies and facilities that is unique in the world. FMD bridges the gap between basic research and customer-specific product development and brings together the technological skills of Fraunhofer and Leibniz in a common technology pool. For the modernization and extension of their equipment the 13 research facilities receive around 350 million euros from the Federal Ministry of Education and Research.

Centers of Excellence

Goal of the Center of Excellence »Functional Integration of Micro-/Nanoelectronics« is above all to support SMEs in Saxony with sensor and actuator technology, measurement technology, and mechanical engineering and construction by rapidly transferring research results into innovative products. The Fraunhofer Institutes ENAS, IIS, IPMS, and IZM, as well as the TU Dresden and Chemnitz and the HTW are also members.

The »Berlin Center for Digital Transformation« is a cooperation between the four Berlin Fraunhofer institutes FOKUS, HHI, IPK und IZM. Its work focuses on technologies and solutions that advance increasing digitalization and networking in all areas of life.

Start-A-Factory

Bringing startups and small and medium-sized companies quickly from the first idea to professional prototypes: This is what Start-A-Factory offers, with the help of state-of-the-art systems and embedded in the network of scientists at Fraunhofer IZM and partners. The development team remains fully involved and retains 100 % intellectual property.



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MINDS FOR
SMART
ELECTRONICS

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Cover: Embedded power electronics module



**Forschungsfabrik
Mikroelektronik**
Deutschland

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Döring (p. 8, top center), Janine Escher (p. 4, bottom, p. 7, bottom left, p. 9, middle left), Volker Mai (cover, all
technological images p. 2 and 3, p. 4 top, p. 6 bottom left, right and center, p. 7 middle left, p. 8 bottom left,
p. 9 top, p. 11 left, right), Bernd Müller (p. 7 bottom right).
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