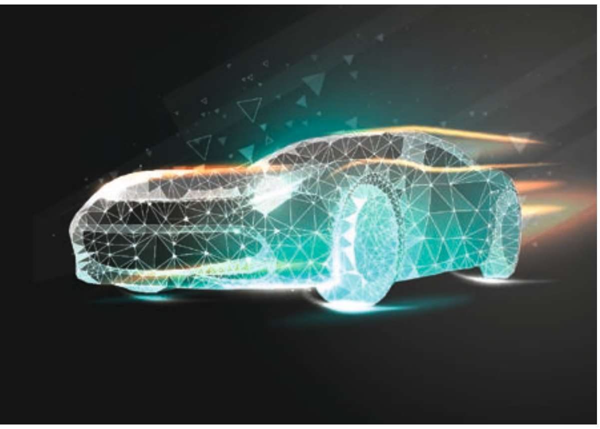
Microelectronics News

February 2020 77

Title

High-performance components for autonomous traffic



Self-driving cars are only one of the many mobility concepts of the future. They require environmental sensors such as camera, LiDAR, or radar systems to monitor the vehicle environment. Within the framework of the EU's Ocean12 research project, sustainable components for autonomous road and air vehicles are being developed. »» page 3

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Longer ranges for electric cars with silicon carbide assembly and connection techniques. © Fraunhofer IZM / Volker Mai

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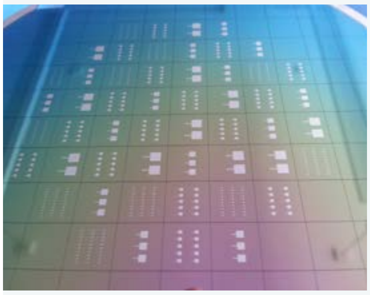

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… goes to Dr. Martin Schneider-Ramelow from Fraunhofer IZM

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Events

Date	Event / WWW	Location	Group institutes involved
02/24 – 02/27	Mobile Word Congress 2020 www.mwcbarcelona.com	Barcelona, Spain	Group institutes
02/25 – 02/27	Embedded World 2020 www.embedded-world.de	Nürnberg, Germany	IIS, IMS, IPMS
03/02 – 07/17	Leading Digital Transformation www.iisb.fraunhofer.de/en/press_media/events/lze_ldt.html	Bangalore, India / Erlangen, Germany	IIS, IISB
03/16 – 03/18	Munich Satellite Navigation Summit 2020 www.munich-satellite-navigation-summit.org	Munich, Germany	IIS
03/23 – 03/24	14th ITG Conference Broadband Coverage in Germany www.hhi.fraunhofer.de/en/events/2020/14th-itg-conference-broadband-coverage-in-germany.html	Berlin, Germany	HHI
03/31 – 04/03	Analytica 2020 www.analytica.de	Munich, Germany	IAF, IIS
04/21 – 04/23	NGMN Industry Conference & Exhibition 2020 https://ice2020.ngmn.org	Paris, France	IIS
04/27 – 05/01	IEEE International Radar Conference 2020 www.radar2020.org	Washington, D.C., USA	FHR
05/18 – 05/21	International Radar Symposium www.mrweek.org/irs/	Vilnius, Lithuania	FHR
06/08 – 06/12	20th WCNDT 2020 www.wcndt2020.com	Seoul, Korea	FHR
06/09 – 06/10	mtex+ 2020 www.mtex-plus.de	Chemnitz, Germany	ENAS
06/15 – 06/18	EuSAR 2020 www.eusar.de/de	Leipzig, Germany	FHR
08/31 – 09/03	ISWCS 2020 https://iswcs2020.org	Berlin, Germany	HHI

While every care is taken to ensure that this information is correct, no liability for omissions or inaccuracies is assumed.

Self-driving cars are part of a central mobility concept within the EU's Ocean12 project.
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High-performance components for autonomous traffic

Within the framework of the EU's Ocean12 research project, sustainable components for autonomous road and air vehicles are being developed.

Self-driving cars are one of the central mobility concepts of the future, but urban air traffic also has numerous autonomous applications such as air taxis or drones for the dispatch of time-critical goods and medicines. These require environmental sensors such as camera, LiDAR, or radar systems to monitor the vehicle environment. Equally important are microprocessors, which convert the recorded data into control commands such as to steer or to brake.

Promising technology

To ensure that these components operate as reliably and energy-efficiently as possible, Ocean12 researchers are using the manufacturing approach of FD-SOI (Fully Depleted Silicon On Insulator) technology. An additional wafer-thin insulation layer is inserted into the chip, which reduces what are known as leakage currents. This reduces power consumption by up to 90 % and also increases computing speed. Furthermore, this technology enables particularly compact sensor systems, as sensors with powerful integrated evaluation circuits can be integrated on an SoC (System on Chip).

European cooperation

A total of 27 European partners from industry and research are contributing their expertise in semiconductor technology, electronics, aerospace, and automotive engineering to the project – including the Fraunhofer Research Institution for Microsystems and Solid State Technologies EMFT, the Fraunhofer Institute for Integrated Circuits IIS, and the Fraunhofer Institute for Photonic Microsystems IPMS. The project runs until 2021 and is funded by the European Union, the German Federal Ministry of Education and Research (BMBF), and the Free State of Saxony, among others.

Further information on the project and the partners involved can be found at: www.elektronikforschung.de/projekte/ocean12

FD-SOI technology will facilitate autonomous flying, e.g., for the transport of time-critical goods using drones. © MEV Verlag

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Forschungsfabrik Mikroelektronik Deutschland

Embedded silicon carbide – the SiC Module project is researching new assembly and connection techniques. © Fraunhofer IZM / Volker Mai

Longer ranges for electric cars with silicon carbide

The performance of electric cars depends primarily on the power electronics installed. Semiconductors based on silicon carbide (SiC) play a special role in this context because SiC chips promise longer range, higher energy efficiency, less weight, and lower costs.

When installing electronics for electric cars, the factors of space, weight, and efficiency are the most important. SiC is not only highly efficient; it can also be installed in a particularly compact manner. This is a decisive advantage compared to conventional silicon semiconductors.

New assembly and connection technology

The key to SiC´s success lies in packaging. In the SiC Module project, researchers from the Fraunhofer Institute for Reliability and Microintegration IZM and seven other partners from industry and research are working together to develop a robust assembly and interconnection technology that enables the material to be used in large-scale industrial production. For this reason, the module that the researchers are developing is based on a classic printed circuit-board structure that is already established in industry.

With embedding technology towards series production

At the same time, the module incorporates the latest findings from research: the semiconductor is not contacted with a wire bond connection, but is embedded directly into the circuit via a galvanic copper contact. In this way, the cable length is shortened and power conduction is optimized. The research team also involves potential customers in the development process: in the first year of the project, a specification sheet was drawn up together with the project partners, in which the electrical, thermal, and performance-related requirements for the module and semiconductor were defined.

Lars Böttcher, group leader at Fraunhofer IZM and sub-project manager for the SiC project, explains: "We are going beyond general feasibility," because the project is intended to develop more than just a prototype. The goal is to bring both the new semiconductor material SiC and the embedding technology towards series production. The project is funded by Germany's Federal Ministry of Education and Research (BMBF) within the framework of the E-Mobility call with a project volume of €3.89 million and runs from January 2018 to December 2020.

Power electronics at the Research Fab Microelectronics Germany

Fraunhofer IZM and six other institutes are part of the Power Electronics Technology Platform of the Research Fab Microelectronics Germany (FMD). Here, the skills are bundled into individual components from the institutes. In this way, a product range covering the entire power electronics value chain – from devices and integration to developments at system level – is created. In an interview (see page 5), Dr. Andreas Grimm, platform manager for power electronics, talks about the need for energy-efficient components.

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Power electronics is the heart of e-mobility. Space, weight, and efficiency are decisive for the performance of e-cars. © MEV Verlag

Dr. Andreas Grimm is the contact person for the Power Electronics Technology Platform at FMD.
© Fraunhofer Mikroelektronik

"We must develop components that convert energy even more efficiently."

The Research Fab Microelectronics Germany (FMD) offers, in six technology platforms, a broad portfolio along the entire microelectronic value chain – from system design to test and reliability. One of these platforms is power electronics.

Dr. Grimm, you are the contact person for the Power Electronics Technology Platform – why is power electronics so important?

Power electronics is a key technology that makes our digital life possible. We now need energy in almost every situation in everyday life, and it has to be transformed in some way. Let's take the example of charging a mobile device: the voltage of the household supply must be converted accordingly to charge the battery of a mobile phone.

What are the current challenges in this area?

Energy efficiency is of great importance, and not only since the recent debates on climate protection and a sustainable life. Along the entire value chain – from generation and transmission to consumption – energy is transformed several times. However, energy is lost with every step. Only through efficient conversions can we reduce these losses and thus the overall energy consumption.

Can you give an example of this?

Let's take electric mobility: the range of an electric car is central to the acceptance of this new form of locomotion compared to conventional cars with combustion engines. Work is underway to increase the capacity of the batteries, but the energy in the batteries must also be used as efficiently as possible so that it suffices for as many kilometers as possible.

What is being done to increase the energy efficiency of the systems?

We must develop components that convert energy even more efficiently. To this end, our member institutes research and develop devices based on wide bandgap (WBG) semiconductors such as silicon carbide (SiC) and gallium nitride (GaN). Some of these are superior to the classic silicon (Si) in their physical properties. For example, the heat losses during energy conversion are significantly lower. They thus provide the basis for new and more efficient components.

"Power electronics is the heart of electromobility" – the SiC Module project (see page 4) is an example of this. What significance will power electronics have with the mobility revolution?

Let's take a look at the number of chips installed in a conventional car and, by comparison, in an electric car. According to the German Electrical and Electronic Manufacturers' Association (ZVEI), a conventional car has chips worth €340 installed. In an electric car, the chips installed have a value of €410. Autonomous driving results in an increase. ZVEI assumes that chips worth €910 are installed in an autonomous electric car. Of course, the majority of the chips are then responsible for driver assistance systems, but everything "on board" must be supplied with power. Therefore, the energy from the battery must be converted as efficiently as possible.

How does the FMD and its technology platform address the current problems in power electronics?

With the Power Electronics Technology Platform, my colleague Dr. Stephan Guttowski and I have created an instrument with which we are bundling FMD know-how across institutes. The excellent individual skills of our member institutes are combined to form a holistic offering. Together with our colleagues from the FMD member institutes, we can thus serve the entire value chain of power electronics. This makes us a central point of contact for cooperation and industry enquiries.

Further information on the Power Electronics Technology Platform is available at: www.forschungsfabrik-mikroelektronik.de/Power_Electronics.html

About Andreas Grimm:
Dr. Andreas Grimm has been Head of the Technology Park Compound Semiconductors at the Research Fab Microelectronics Germany (FMD) since 2018. Studied nanotechnology at the Leibniz University of Hannover. Subsequently, doctorate at the Hannover School for Nanotechnology with a research stay at the Indian Institute for Technology on the topic "Epitaxy of virtual germanium substrates for III-V semiconductors."

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Memristors for the computers of tomorrow

Together with the Helmholtz-Zentrum Dresden-Rossendorf, Fraunhofer ENAS develops memristors for state-of-the-art computer architectures.

6" wafer with structured rear electrodes for crossbar arrays in various sizes. © Fraunhofer ENAS

To increase the performance of computers, their circuits are becoming smaller and smaller. In perspective, this miniaturization will no longer be economically viable in conventional von Neumann computer architectures with spatially separated data processing and storage.

However, to achieve higher computing power, new types of components and architectures are needed that allow data processing and storage at the same location. Memristors (memory + resistor), as they are known, are of central importance. They enable energy-efficient machine learning, neuromorphic computing, and the encryption of data at the point of their origin.

First successes: memristors for CMOS hybrids

Within the ATTRACT project "Development of an overall technology for the modular integration of novel electronic components in microelectronic CMOS hybrids – BFO4ICT," the researchers have developed a BiFeO3 (BFO)-based membrane transistor for analog and digital data storage and processing. In the next step, they are researching technologies for wafer-level BFO production and the implementation thereof in conventional industrial processes. As a result, the technology availability and the technological know-how of Saxon and German industry with regard to memristor components can be massively expanded.

What's the advantage?

The resistance characteristics of BFO memristors can be set non-volatilely by a voltage or current write pulse and read out with a small voltage or current read pulse. When writing the BFO memristors, the barrier heights of the front electrode and the rear electrode are reconfigured, thus changing the diode properties of the BFO memristors in a non-volatile and analog manner.

Due to the inherent diode characteristics of BFO memristors, they can be arranged in crossbar array structures without additional selection transistors; this makes them particularly suitable for applications such as machine learning or neuromorphic computing.

Memristors enable previously unattained processing power, for example in neuromorphic computing. © MEV Verlag

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Matthias Steinmaßl with his luggage. © Fraunhofer-Gesellschaft

From Munich to Santiago de Chile

Matthias Steinmaßl from Fraunhofer EMFT has moved his workplace from Munich to the Chilean capital Santiago. In this interview, he reports on the mobility program CONNECT People and his time in the South American country.

You traveled to Chile with Fraunhofer's internal mobility program CONNECT People. What's the program like?

Imagine a doctoral student sitting in a laboratory on the outskirts of Santiago with a view of the Andes. After working on experiments with his team in the morning, he tries to run errands in the afternoon in the teeming city in order to get ahead with his experiments the next day. On the weekends, he is faced with the difficult decision of whether to reach for his hiking boots or (the dissertation needs to be finished at some point, after all) his laptop bag.

What opportunities does CONNECT People offer its participants?

CONNECT People creates opportunities for employees – whether they come from the technical, scientific, or administrative fields – to spend time abroad. The program aims to strengthen cooperation and synergies with Fraunhofer branches abroad. The stay abroad is organized as a business trip. There are also associated measures for personnel development.

What project are you working on locally?

Together with Fraunhofer IME in Aachen, we are researching a device for detecting virus-induced plant diseases for field use. In my luggage there were prototypes of biosensors (fully cleared by customs), which will be used in this device. At the Centro de Biotecnología de Sistemas – my current workplace – we are using these sensors for the first time to electronically evaluate the detection reactions. It is an exciting interdisciplinary project.

What intercultural differences can you identify in the work processes?

We are very similar in many things. When we discuss, we talk about basic principles, we speak plain language, and we structure our plans down to the last detail. What happens to these plans then is something we deal with in very different ways. I think I'll learn flexibility here. And the joy of work too, which is something that thrives on the relationships one cultivates at work. I think by always being strictly fixated on tasks I fulfill the classic German stereotype.

What challenges did you face in the preparation and planning?

How do I get everything settled by the departure date? I think my colleague in charge of dealing with customs hopes that this will be my last trip abroad.

In your blog you write about the rapid growth of emission-free energy in Chile. What lessons can countries with similar objectives draw from this?

In many regions of Chile, the energy supply must be regulated in a decentralized way with small power plants. Grid stability or base load coverage is no reason to preclude emission-free energy concepts there. Moreover, the country is not afraid to take responsibility for the necessary development of extremely weather-resistant photovoltaic or wind power plants.

In all honesty, what do you miss about home?

My wife and son. They are coming to visit me soon and I can hardly wait to see them again.

What happens after your stay?

First we will take a few days' vacation in Chile as a family, and then the most exciting project phase will begin. We have successfully completed the prueba de principio – the proof of principle – and are pouring the findings into the solid form of a demonstrator for field use.

Mr. Steinmaßl, thank you for this interview.

Matthias Steinmaßl was talking to Judith Siegel.

About Matthias Steinmaßl:
Matthias Steinmaßl, born in 1991 in Freilassing. Married, one child. Studied physics at the Technical University of Munich. Research associate at the Fraunhofer Research Institution for Microsystems and Solid State Technologies (EMFT) in Munich for the past two years; in the working group for chemical sensors of the department of silicon technologies. He is currently doing his doctorate at Bundeswehr University Munich on the subject of "DNA detection with biosensors" and hopes to achieve groundbreaking results at the Fraunhofer Research Center in Santiago de Chile together with his colleagues Derie Fuentes and Melissa Soto.

CONNECT People:
The aim is the internationalization of the Fraunhofer institutes through staff stays abroad and international networking. Stays for employees from all areas (technology, administration, science) are supported for 2 to 5.5 months. Fraunhofer employees can find all information on how to apply for CONNECT People on the intranet, as well as the Chilean blog.

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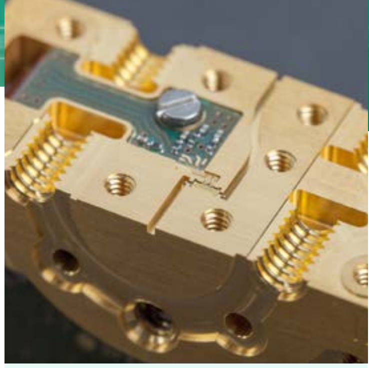

Detailed view of a low-noise 300 GHz receiver amplifier module developed by Fraunhofer IAF. © Fraunhofer IAF

Technologies for the sixth generation of mobile communications

Wireless data networks will have to enable ever higher transmission rates and shorter latency in the future. This requires network structures consisting of many small mobile radio cells. To connect these cells, high-performance transmission links at high frequencies up to the terahertz range are required.

Researchers from the Karlsruhe Institute of Technology (KIT) and the Fraunhofer Institute for Applied Solid State Physics IAF in Freiburg are working together on technologies to convert data signals from terahertz transmission to optical transmission. Fraunhofer IAF supports this work by developing very low-noise receiver circuits and high performance transmission amplifiers.

While the new 5G mobile phone standard is still being tested, researchers are already working on technologies for the next generation of wireless data transmission. 6G is intended to enable significantly higher transmission rates, shorter latency, greater device density, and the integration of artificial intelligence. On the road to the sixth generation of mobile communications, many challenges for the networking of many small mobile radio cells have to be overcome.

For example, the wireless networks of the future will consist of a large number of small mobile radio cells, within which high data volumes are transmitted quickly and energy-efficiently. To network these cells, radio links are needed that can transmit dozens or even hundreds of gigabits per second on a single channel. For this purpose, frequencies in the terahertz range, which lie in the electromagnetic spectrum between microwave and infrared radiation, are best suited. Another task is to seamlessly connect wireless transmission links with fiber-optic networks in order to combine the advantages of both technologies – high capacity and reliability with mobility and flexibility.

Use of ultrafast electro-optical modulators

Several groups of researchers have developed a promising approach to the conversion of data streams from terahertz transmission to optical transmission. The institutes involved are the KIT Institutes of Photonics and Quantum Electronics (IPQ), Microstructure Technology (IMT), and High Frequency Technology and Electronics (IHE) as well as Fraunhofer IAF. They use ultra-fast electro-optical modulators to convert a terahertz data signal directly into an optical signal, thereby coupling the receiver antenna directly to an optical fiber.

In their experiment, the scientists use a carrier frequency of about 0.29 THz and achieve a transmission rate of 50 Gbit/s. The modulator used is based on a plasmonic nanostructure and has a bandwidth of more than 0.36 THz. With its help, the technical complexity of future mobile radio base stations can be drastically reduced. Terahertz connections with enormously high data rates are thus made possible – several hundred Gbit/s are conceivable.

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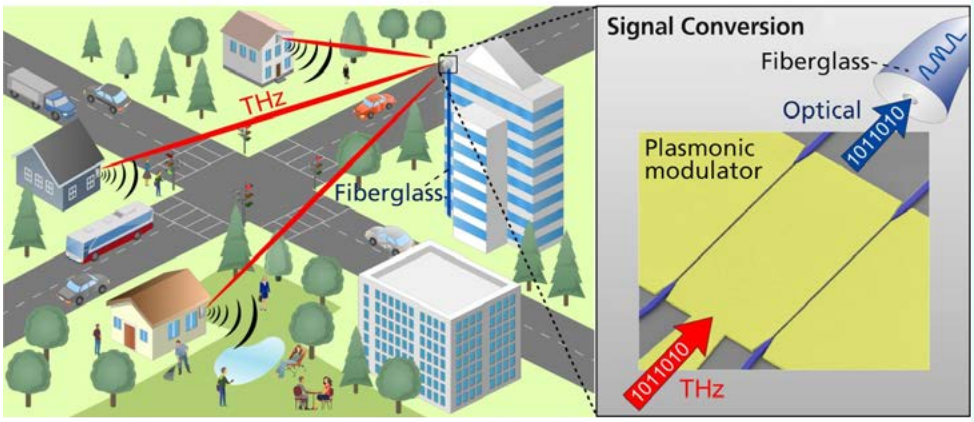
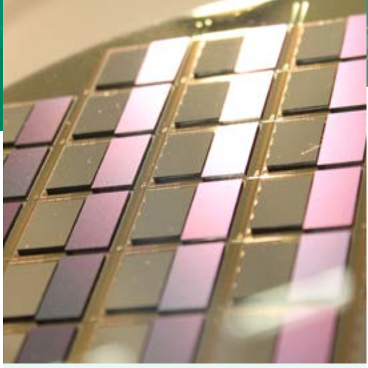


A large number of small radio cells are flexibly connected via powerful terahertz transmission links. At the receiver, the terahertz signals are converted into optical signals and transmitted via fiber-optic networks. © IPQ/KIT



3D module with TSV interposer and electronic components set up by means of FlipChip as preliminary stage for the chiplet technology.
© Fraunhofer IZM

System architectures straight from the construction kit

Fraunhofer IZM is paving the way for innovative system architectures based on chiplets.

As miniaturization progresses, Moore's Law will also reach its limits at some point: production in the 7 nm range is already underway and the jump to the 5 nm range is imminent. With conventional system architectures, the development costs of chips of this size are hardly economically viable. Further increases in performance will require a change to modular chip architectures, as Moore himself anticipated as early as 1965. One promising approach for a "construction kit system" such as this includes what are known as chiplets.

Chiplet technology

Chiplets are integrable individual components with which a wide variety of IPs can be combined in a modular fashion. This principle allows the use of already existing structures, so that only a few parts – e.g., those in the sub-7 nm range – have to be redesigned. This minimizes the development costs for new, more powerful chips and also increases their energy and space efficiency. This approach also allows analog or III-V components of an IC, combined with newly designed functions, to be assembled on a chip – an ideal basis for heterointegration.

Chiplets are already in use today and could soon become the new basic structure of technology development in the semiconductor industry.

Perspectives and challenges

The Fraunhofer Institute for Reliability and Microintegration IZM is developing both high-density 3D wiring systems on silicon and organic substrates and equipping technologies to further explore the possibilities of chip technology. Researchers at Fraunhofer IZM are also working on questions of reliability and the optimization of power loss, which are of central importance especially for applications such as autonomous driving.

Further information can be found in the RealIZM blog, where Dr. Michael Töpper explains the opportunities and challenges presented by chiplet technology.

High-density wiring carriers for chiplets require production techniques similar to those used in semiconductor manufacturing. © Fraunhofer IZM

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Electronic systems such as driver assistance or ABS are at the core of an automobile. © MEV Verlag

IP designs receive safety certificate

In modern cars, drivers are no longer alone. Complex electronic systems such as driver assistance or ABS support them and intervene in steering if necessary. In the development of electronic safety systems, IP cores – finished development units – are used to control the data processes. The IP designs, which function like circuit schematics, must meet high safety standards.

In order to guarantee the functionality, safety, and reliability of the systems, the ISO-26262 certification was established in 2011. It specifies the safety requirements for electronic systems to the special demands of the automotive sector, so that hardware failures can be prevented and brought under control. Fraunhofer IPMS has now had the CAN controller IP cores CAN FD and CAN 2.0B, developed in-house, certified according to this ISO standard for the ASIL B level. System engineers can now use IP cores with the confidence that they can be used in safety applications in compliance with ASIL A and ASIL B systems. The system can be flexibly implemented in individual ECUs or circuits (system-on-chip, FPGA) through the 32-bit controller interface (8-bit and 16-bit, as well as AMBA APB and AHB as options), fully synchronous description, and modern clock domain crossing.

This makes Fraunhofer IPMS the first institute worldwide to have developed a CAN 2.0b or CAN FD IP design certified according to this standard. The design was one of the first CAN IP cores on the market and has already been integrated into numerous ASIC and FPGA designs. More than 100 customers are already putting the IP design to successful use.

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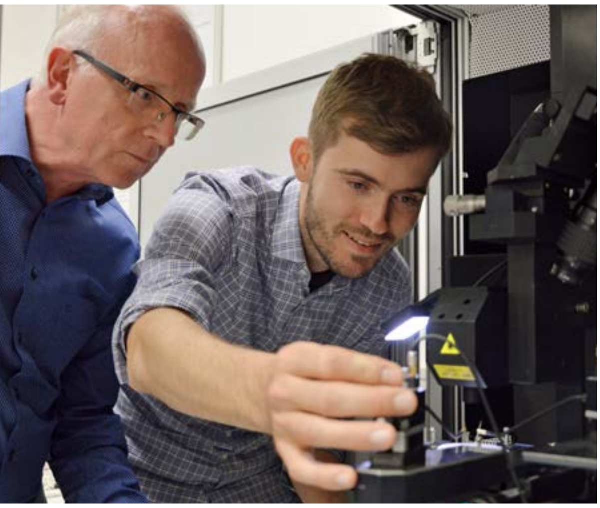
Newly discovered material property of AlScN

Simon Fichtner from Fraunhofer ISIT made a pioneering discovery at Christian-Albrechts-Universität zu Kiel (CAU) last year: he was the first to be able to prove the presence of ferroelectricity in a III-V semiconductor-based material.

Piezoelectric materials generate electric voltages when they are deformed and, vice versa, they change their shape when an electric voltage is applied to them. They are used to convert motion into electrical signals or electrical signals into motion and are used, for example, in MEMS loudspeakers, MEMS microphones, or MEMS print heads. During his investigations on piezoelectric aluminum scandium nitride (AlScN), Simon Fichtner discovered that the spatial electrical orientation of the crystals of the III-V compound semiconductor can be switched when an electrical voltage is applied. Contrary to expectations, the material is thus ferroelectric. By superimposing multiple layers of AlScN without intermediate insulation, microdrives, for example, can be generated. These special microdrives are significantly more powerful than conventional piezoelectric drives. But ferroelectricity in AlScN also promises to widen the application potential of the material from MEMS to microelectronics, for instance by advancing groundbreaking concepts in the context of nonvolatile memory and power electronics.

In a project funded by the German Federal Ministry of Education and Research (BMBF) to the tune of €2.3 million, researchers from CAU Kiel are now working together with Fraunhofer ISIT and Fraunhofer IAF to investigate the extent to which this substantial discovery can be made technically useful. The four-year project focuses on two types of components: a chip loudspeaker and an innovative power transistor. To accelerate the transfer of scientific results into disruptive applications, industrial partners are also involved.



Prof. Bernhard Wagner and Simon Fichtner from Fraunhofer ISIT measuring the semiconductor samples. © CAU / Julia Siekmann

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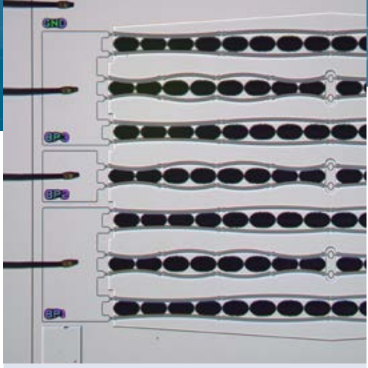

MEMS chip with micro-speaker devices on a carrier board for actuation. © Fraunhofer IPMS

Wireless headphones with MEMS speakers for the Internet of Voice

These digital assistants help users control devices with voice commands, translate speech into foreign languages, or make straightforward payments. Internet of Voice service can now be found everywhere, from cars and smartphones to living rooms. Hearables even allow the Internet of Voice to be implanted straight in your ear. Hearables are intelligent wireless headphones equipped with mini-speakers that can handle all Internet communication. To achieve this, however, the required hardware must be miniaturized to such an extent that it can be worn comfortably in the ear canal.

Fraunhofer IPMS has developed a new, power-efficient sound transducer principle for the miniaturization of the in-ear speaker found in hearables. This new principle no longer involves a conventional membrane. Instead, it was placed in the form of a multitude of flexible beams – similar to the strings of a harp – within the volume of a silicon chip. Inside the only 20 µm thin flexible beams, innovative electrostatic bending actuators, known as Nano-E-Drive actuators, are integrated; these are excited to oscillation by the audio signal voltage.

Based on the laboratory results, a first battery-powered demo system for in-ear playback was realized. This allowed sound pressures of more than 100 dB and promising linearities to be realized for the first time. A control system with amplifier is currently being developed, which should make the advantages in terms of energy efficiency and form factor easily accessible to end customers.

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Mobile nitrate laboratory for your own garden

Within the framework of the CitizenSensor project, Fraunhofer EMFT and FabLab Munich have developed a nitrate measuring kit for amateur gardeners.

A key factor in domestic horticulture is the nitrate in the soil: too low a concentration inhibits plant growth; too high a concentration pollutes the environment and the food grown. The measurement kit – based on electrochemical sensor technology and developed by Fraunhofer EMFT and FabLab Munich in a Co-Creation approach – enables nitrate measurements at a professional level even without expensive equipment and expertise.

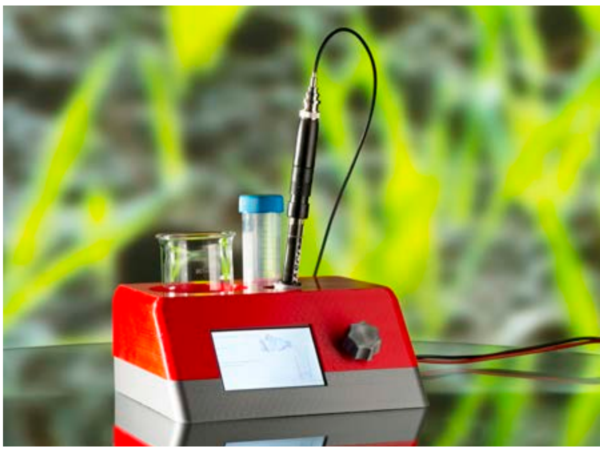
The system detects nitrate concentrations of up to 4 mg/L. For measurement, an electrode coated with an ion-selective membrane for nitrate is immersed in a solution together with an Ag/AgCl reference electrode, and the voltage between the electrodes is measured. Environmental parameters such as air pressure, temperature, and humidity are recorded by the device automatically.

Thanks to its low power consumption, the mobile laboratory is suitable for use in the field – in the truest sense of the word. Only a saline solution is required for calibration, which can be easily prepared using the integrated weighing scales. Web-based step-by-step instructions enable people without specialist knowledge to take the correct samples, document the measurement results, and automatically check them for plausibility.

The development team is currently testing its device for practical suitability together with urban gardening initiatives in Munich.

The project is being funded by Germany's Federal Ministry of Education and Research (BMBF) under funding code 01BF1711B.

The nitrate measuring device can also be operated by amateur gardeners without specialist knowledge. © Fraunhofer EMFT



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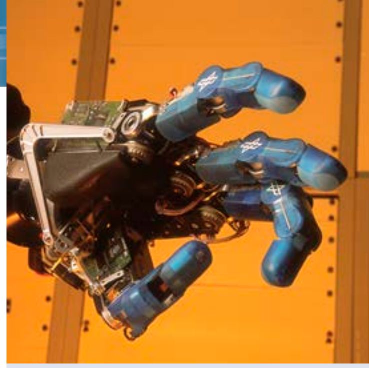

The research field of artificial intelligence aims to imitate human perception and human action by machines. © MEV Verlag

BMBF's Energy-efficient AI System competition

In order for artificial intelligence (AI) to create value and also to find its way into mobile and safety-critical applications, work must be done to improve energy efficiency. This is because the energy consumption required to run today's AI systems has so far been too high for many applications. The innovation competition Energy-efficient AI System organized by Germany's Federal Ministry of Education and Research (BMBF) aims to tackle this problem and supports universities and research institutions in developing solutions.

The winners of the pilot Energy-efficient AI System competition can look forward to follow-up projects in which they can further develop their ideas. With the ADELIA and LO3-ML projects, Fraunhofer IIS and Fraunhofer IPMS are also part of the competition.

ADELIA project:

Experts from Fraunhofer IIS and Fraunhofer IPMS have joined forces across institutes to compete in the competition category FDSOI Technology (22FDX) from GLOBALFOUNDRIES. Their activities are coordinated by Fraunhofer IIS. The proposed approach is based on an energy-efficient crossbar analog accelerator implementation. The potential applications range from energy-efficient ASICs for human-machine communication to disease prediction with medical wearables.

LO3-ML project:

The energy efficiency of the chip is set to be increased both through new technologies and through innovative computer architecture. To realize this, Friedrich-Alexander University Erlangen-Nürnberg (FAU) and Fraunhofer IIS are joining forces in a second project. The project will further expand collaboration between FAU and Fraunhofer IIS in the areas of analog and digital circuit technology and system design.

As an innovation driver in the field of textile-integrated smart sensors and algorithms, Fraunhofer IIS, together with industrial partners, will integrate the results of the projects into medical and non-medical applications.

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DRIVE-E 2019: the future of electric driving

The future belongs to alternative drive technologies: in September 2019, the DRIVE-E junior program provided students with an insight into the many facets of electric mobility for the tenth time. In addition, four young scientists were awarded one of this year's DRIVE-E study prizes by the German Federal Ministry of Education and Research (BMBF) and the Fraunhofer-Gesellschaft.

First prize in the category of Projects and Bachelor Theses went to Ronja Haas from the Justus Liebig University of Giessen. Her bachelor thesis dealt with the issue of dendrite growth and investigated the chemical processes within battery cells. In the category of Master's and Higher Degree Theses, first place was awarded to Julian Jakob Alexander Kreißl, also from the University of Giessen. He developed a promising approach to combat the growth of dendrites in metal/oxygen batteries.

DRIVE-E was initiated in 2009 by the BMBF and the Fraunhofer-Gesellschaft. Since then, more than 500 young talents have taken part in the junior program. The DRIVE-E host in 2019 was Fraunhofer IISB in Erlangen; the university partner was Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU). As part of a driving event on the Saturday, the participants got their own chance to experience the exhilaration of being at the wheel of different electric vehicles.

More information: www.drive-e.org

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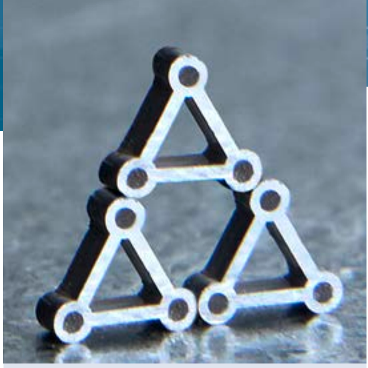

Silicon test structures manufactured using powder technology, each with three round micromagnets in each corner. The magnets have a diameter of 300 µm. © Fraunhofer ISIT

New method for manufacturing microstructures

Fraunhofer ISIT has developed a method for the manufacture of porous three-dimensional microstructures from bonded powder materials.

With this method, shrink-free and mechanically stable structures of various geometries and sizes from a few micrometers to one millimeter can be produced. The base materials are powders comprising particles only a few micrometers in size. The material of the particles can be chosen at will. An atomic layer deposition process on wafer level at temperatures between 100 °C and 300 °C solidifies the particles to form three-dimensional, porous structures. Modification of the particles' inner surface means that magnetic, optical, and sensory parameters can be individually adapted. This enables, for example, the manufacture of miniaturized permanent magnets made of NdFeB for batteryless sensors in Industry 4.0 applications, as well as sensors for monitoring power grids and adaptive lighting systems for car headlights or head-up displays.

The long-term goal is cost-effective automated production of special components for microelectromechanical systems (MEMS), which are used in safety and security, medical, and automotive technology, in the biosciences, or in consumer and communication electronics.

The state of Schleswig-Holstein is funding the research project to the tune of around €1.3 million.

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Joint Lab Data Analytics: creative solutions through new forms of cooperation

BHS Corrugated Maschinen- und Anlagenbau GmbH and the Fraunhofer Center for Applied Research on Supply Chain Services SCS have founded a so called Joint Lab Data Analytics. The common goal is to strengthen data analytics expertise by means of selected applications. The Joint Labs are an approach in which more creative solutions can be developed in less time through new forms of cooperation and infrastructure. To this end, scientists are working together with developers from companies in small interdisciplinary teams for a limited period of time on specific questions from industry. Practical cooperation between the teams is organized in an agile manner: depending on requirements, it's either virtual-digital or in direct exchange on site, for example in the newly developed co-working spaces at Fraunhofer SCS.

The three-year cooperation will pursue the goal of advancing the digital transformation and sustainably expanding the data analytics skills in the company. Compared to conventional collaboration formats, the Fraunhofer Center for Applied Research on Supply Chain Services SCS gains a more comprehensive insight into the company and can provide more in-depth scientific support.

In the run-up to the founding of the Joint Lab, a series of workshops took place in which data analytics use cases along the product life cycle at BHS Corrugated were collected, evaluated, and prioritized. The potential development was followed by detailing of the quick start ideas, planning of the lab activities, and creation of the lab concept.

Fraunhofer SCS is planning more Joint Labs with other interested companies.

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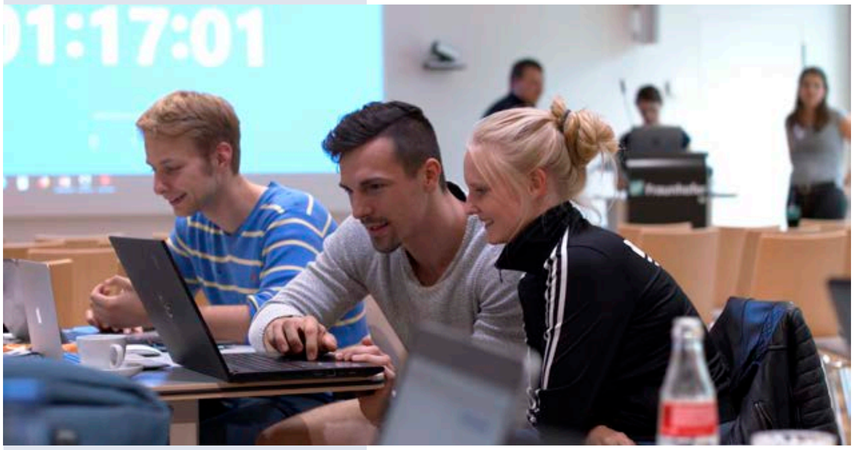
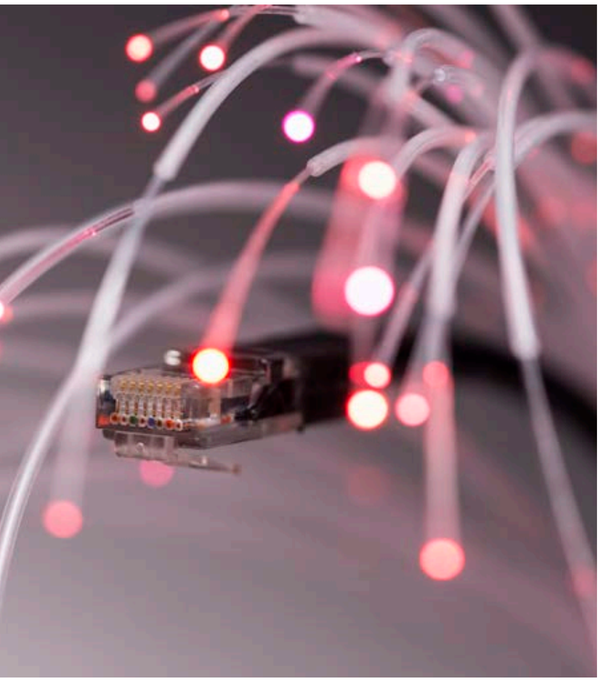


The Joint Lab was kicked off with a hackathon. Seven teams – five in Nürnberg, two in Mexico – had eight hours to work on a real-life problem from the mechanical engineering industry that was derived from a Joint Lab use case. The data analytics and optimization solutions developed are incorporated into the further analysis. © Fraunhofer IIS / Vedat Senturk

Future industrial communication

Network technologies are a central component of digitalization. The research initiative of the German Federal Ministry of Education and Research (BMBF), Industrial Communication of the Future, funds projects that promote the development of 5G using practice-oriented application examples. The project groups, including Fraunhofer IZM, are working on implementing communication systems for the tactile Internet – applications with minimum response times – based on 5G systems.



Projects funded by the BMBF are driving the development of 5G. © MEV Verlag

At the end of September 2019, the annual conference of the BMBF research initiative took place, at which the latest progress and some last questions regarding the 5G area were examined from both a research and a usage perspective.

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New Institute Director at Fraunhofer IIS

Prof. Alexander Martin is the new member of the management team at Fraunhofer IIS. © Fraunhofer IIS

Since November 1, 2019, Prof. Alexander Martin has been part of the three-member Fraunhofer IIS management team. The AI expert holds a chair for applied mathematics at FAU Erlangen-Nürnberg. Previously, he headed the analytics department at the Supply Chain Services division at Fraunhofer IIS.

Prof. Alexander Martin heads the ADA Lovelace Center for Analytics, Data and Applications. © dragonstock-fotolia.com

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Fraunhofer's first microelectronics blog

Fraunhofer IZM works in the vanguard of progress, identifying the latest trends and developing innovative microelectronics technologies. To share its knowledge, Fraunhofer has now launched its first microelectronics blog. RealIZM is an online communication platform that allows for an exchange of ideas on current research topics and provides insights into the development of microelectronics technologies. The blog is also a forum for scientific discussion for all electronics enthusiasts.

Read more about the latest technologies at RealIZM: www.blog.izm.fraunhofer.de

The REAL IZM blog – making ideas happen. © Fraunhofer IZM / Volker Mai

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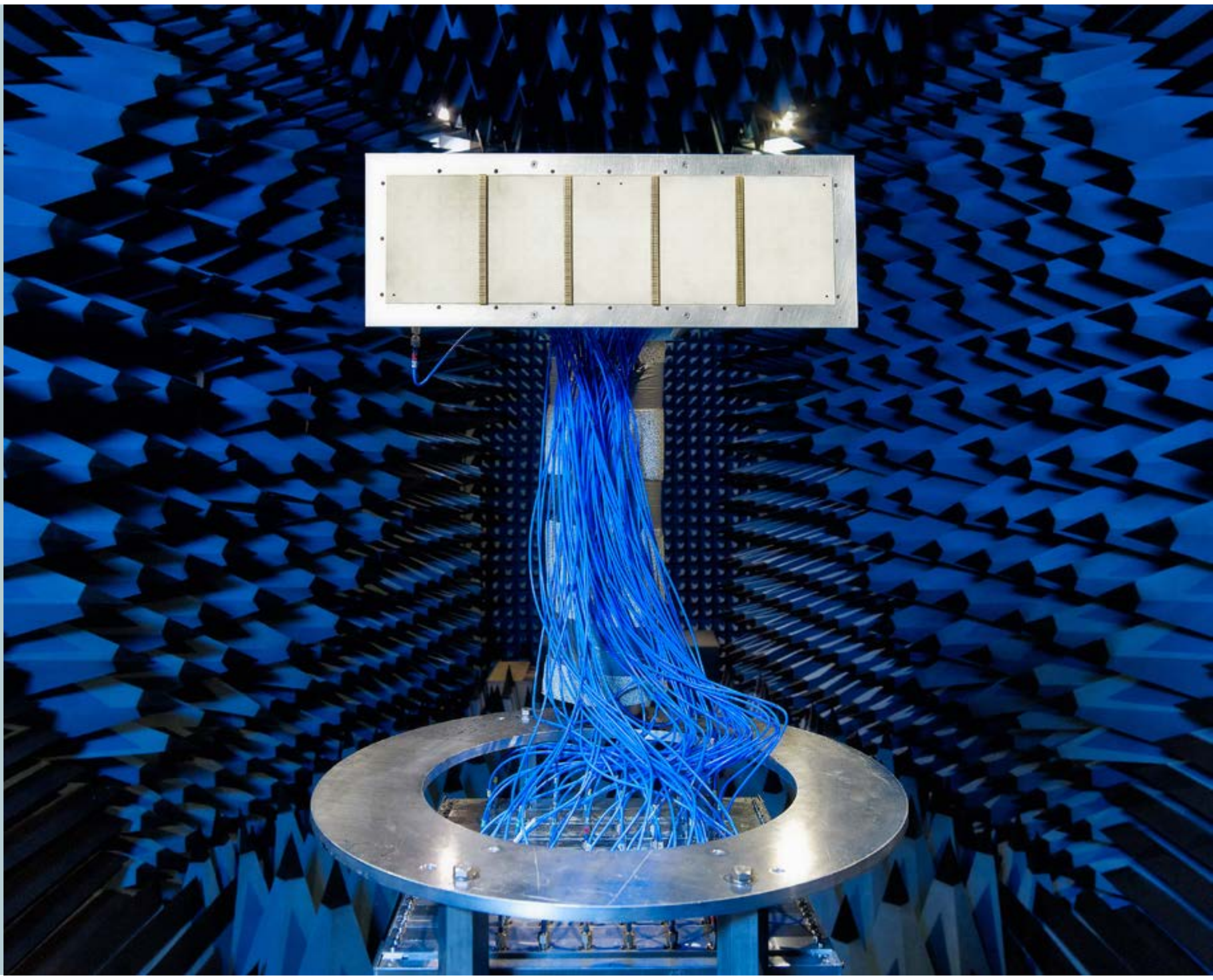

Our photo shows an antenna array for electronic beam scanning improved by the use of metamaterials during measurements in one of the antenna measurement chambers at Fraunhofer FHR. The metamaterial strips attached to the antenna aperture suppress parasitic surface waves, which are excited at large electronic scanning angles and can lead to blind spots and ambiguities. © Fraunhofer FHR / Bellhäuser

Editorial notes

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The Fraunhofer Group for Microelectronics, founded in 1996, combines the expertise of 16 Fraunhofer institutes, with a total of more than 3,000 employees. Its main focus is the preparation and coordination of interdisciplinary research projects, conducting studies and to assist in the process of identifying strategies.

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The last word …

Prof. Martin Schneider-Ramelow. © Fraunhofer IZM

… goes to Prof. Martin Schneider-Ramelow from Fraunhofer IZM

Prof. Schneider-Ramelow, your professional development began in materials research; you are now deputy director of Fraunhofer IZM. Looking back, how would you describe your beginnings?

As very instructive! In a way, I learned the microelectronics packaging trade from scratch. At the beginning I stood at the grinding plate in metallography and carried out REM examinations. Later I assumed responsibility for projects, first leading a group, then a branch office, and finally a department. Now that I have a say in the institute's strategy, it is sometimes very helpful to know of the needs and concerns at the grassroots level.

One focus of your activities is in the area of personnel coaching and advancement. What advice would you give to employees who want to advance their careers?

Have an inner compass! Anyone who starts at Fraunhofer should think about whether they want to move forward scientifically or hierarchically, or whether the job is more of a stepping stone into industry.

Which project from the Fraunhofer cosmos do you currently find most exciting?

As a researcher I regularly question existing limitations. This is why I consider the Research Fab Microelectronics Germany to be one of the most interesting initiatives, because this is the first time that a powerful collaboration for microelectronics in Germany has been forged across institutional boundaries. I am confident that we can take this idea forward at the European level.

You are author and co-author of 150 professional articles, professor at TU Berlin, and also deputy institute director at Fraunhofer IZM – you certainly have a lot to do. Do you have any advice on maintaining a good work-life balance?

If you don't make time for yourself, then you won't have any! I love to cook and have written down my best recipes in my own cookbook; my wife illustrated it. It's just like in the business world. With the right ingredients and the appropriate skill, small wonders can be conjured up. A good meal can bring even the most turbulent everyday life back into balance. And, if there's time, I love to visit the coast, especially the North Sea.

Let us imagine that a point in your life is about to be turned into a film. What point would you choose?

Even if research is often far from Hollywood, you may know that I have worked intensively on wire bonding methods. Not everyone finds that particularly exciting. But you wouldn't believe how exciting it can be to find the strongest wire bond connection and also to understand, at a scientific level, how and why. It's a bit like Cliffhanger. I think I would opt for my time as a young researcher when I was still experimenting a lot and basically setting the course for today.

If you could change one thing in the world, what would it be and why?
It must not be just a fashionable issue: I consider it to be our most important task, not only at Fraunhofer, to reduce CO_2 pollution and enable climate-neutral living worldwide! So that our grandchildren will also have a planet worth living on.

Prof. Schneider-Ramelow is happiest spending his downtime out by the sea. © Private collection

About Martin Schneider-Ramelow:
Born in the Emsland region in 1964. Married, one son. Studied materials science at TU Berlin and received his doctorate in the field of materials engineering with a thesis entitled "Inductive surface layer alloying of aluminum materials." Initially a research assistant at TU Berlin at the Institute for Metallurgy, Metallurgical Engineering, later at the Institute for Materials Engineering. At Fraunhofer IZM in Berlin since 1998; from 2008 a department head for almost eleven years. Since 2014 also honorary professor at TU Berlin and since 2017 professor of Materials of Hetero-System Integration. Vice President of the research field of Microperipheric Technologies and Fraunhofer IZM.

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