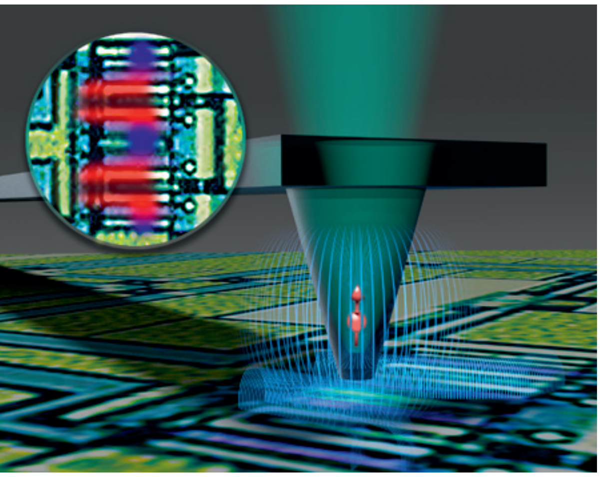
Microelectronics News

Fraunhofer MIKROELEKTRONIK

August 2019 75

Quantum sensors to measure extremely weak magnetic fields



Fraunhofer's lighthouse QMag project is developing quantum magnetometers for industry. Two technological approaches are being pursued to overcome the previous limits of magnetometry.
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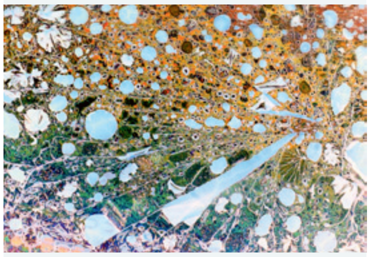

Hidden motifs. © Fraunhofer IISB
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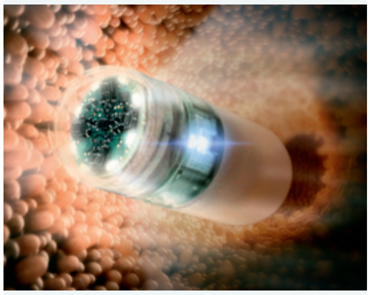

The new capsule technology can be used to diagnose the cause of symptoms such as gastrointestinal bleeding faster. © Fraunhofer IZM
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From the institutes

A drive-in movie for the vehicle radar

Sensors in autonomous vehicles must be extremely reliable in order to not endanger road users. The new ATRIUM testing device from Fraunhofer FHR means that, in the future, complex road tests will largely take place in the lab.

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From the institutes

Early detection of Lyme disease thanks to optical microsensors

In the transnational PoC-BoSens project, a diagnostic system based on optical microsensors is being developed to detect Lyme disease at an early stage. Fraunhofer IZM is responsible for developing the microsensors which are vital to the project.

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Li-Fi meets augmented reality

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Franco-German meeting in Dresden to link the Digital Innovation Centers

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Tissue models with integrated sensor technology using the modular principle

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The last word …

… goes to Dr. Mohammad Hejjo Al Rifai from Fraunhofer ISIT

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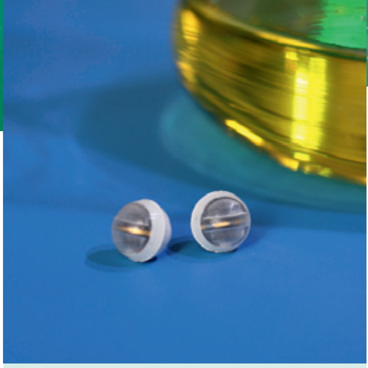
Content:

Events

Date	Event / WWW	Location	Group institutes involved
09/04 – 09/06	2019 International Conference on Simulation of Semiconductor Processes and Devices http://sispad2019.org/	Udine, Italy	IISB
09/10 – 09/13	HUSUM Wind https://husumwind.com	Husum, Germany	ISIT
09/10 – 09/13	IAA 2019 www.iaa.de/de/pkw	Frankfurt / M. Germany	FHR
09/12 – 09/13	FMD Innovation Days www.forschungsfabrik-mikroelektronik.de/IDays2019	Frankfurt (Oder), Germany	FMD
09/13	Machine Learning Forum www.iis.fraunhofer.de/de/muv/2019/machine-learning-forum.html	Nürnberg, Germany	IIS
09/13 – 09/17	IBC 2019 https://show.ibc.org/	Amsterdam, Netherlands	HHI
09/16 – 09/17	Industry of Things World www.industryofthingsworld.com	Berlin, Germany	FOKUS
09/16 – 09/20	ION GNSS+ www.ion.org/gnss/exhibits.cfm	Miami, Florida	IIS
09/17 – 09/19	AutoSens https://auto-sens.com/autosens-brussels	Brussels, Belgium	IMS
09/22	ECOC 2019 www.ecoc2019.org/	Dublin, Ireland	HHI
09/24	Workshop: Polymer Ageing & Microelectronic Package Reliability www.izm.fraunhofer.de/de/news_events/schulungen-und-workshops/ws_13.html	Berlin, Germany	IZM
09/25 – 09/26	Automotive LIDAR 2019 www.automotivelidar.com	Detroit, Michigan	IPMS
09/25 – 09/26	Hot & Cold Rolling Day www.rolling-day.com/	Memphis, Tennessee	IZFP
09/25 – 09/27	European MEMS Sensors Summit www.semi.org/eu/connect/events/mems-imaging-sensors-summit	Grenoble, France	IPMS
09/29 – 10/04	European Microwave Week 2019 www.eumweek.com	Paris, France	Group Institutes and FMD
10/16 – 10/17	ELIV 2019 - ELectronics In Vehicles 2019 www.vdi-wissensforum.de/eliv/	Bonn, Germany	FHR, IMWS, IZM,
10/16 – 10/23	K 2019 www.k-online.de/	Düsseldorf, Germany	FHR



Sens-o-Spheres have a diameter of only 8 mm. © Fraunhofer ENAS

Reliable localization in a bioreactor

Fraunhofer ENAS is developing a new localization method based on magnetic fields. The inductive system allows reliable localization even in non-homogeneous and opaque substances. A first application is planned for localizing Sens-o-Spheres in bioreactors.

Sens-o-Spheres were developed by the Fraunhofer Institute for Electronic Nano Systems ENAS in cooperation with TU Dresden and four industrial partners. The battery-operated, freely movable measuring probes are used for continuous monitoring of bioreactors. The measurements are transmitted wirelessly to a base station and evaluated there. Up to now, the spheres have been equipped with temperature sensors; in the future, they will also measure pH values and dissolved oxygen levels.

Measuring procedure

Inductive localization is particularly suitable for the use in bioreactors, where conventional locating technologies such as ultrasound or cameras have high error rates. An externally generated magnetic field induces electrical voltage on the charging coils of the Sens-o-Spheres. There, magnetic fields are generated, which are detected by locating coils. A neural network uses the signal strength to determine the position of the spheres. Equipped with a filter, the AI can take parasitic influences as well as the physical movements taking place in the reactor into account, thus producing reliable and accurate results.

Potential applications

In the future, inductive localization could also be used with RFID technologies, e.g., for centimeter-precise locating of labeled luggage in aircraft containers. In combination with other methods, high-precision localization applications in the areas of logistics, production and distribution are feasible.

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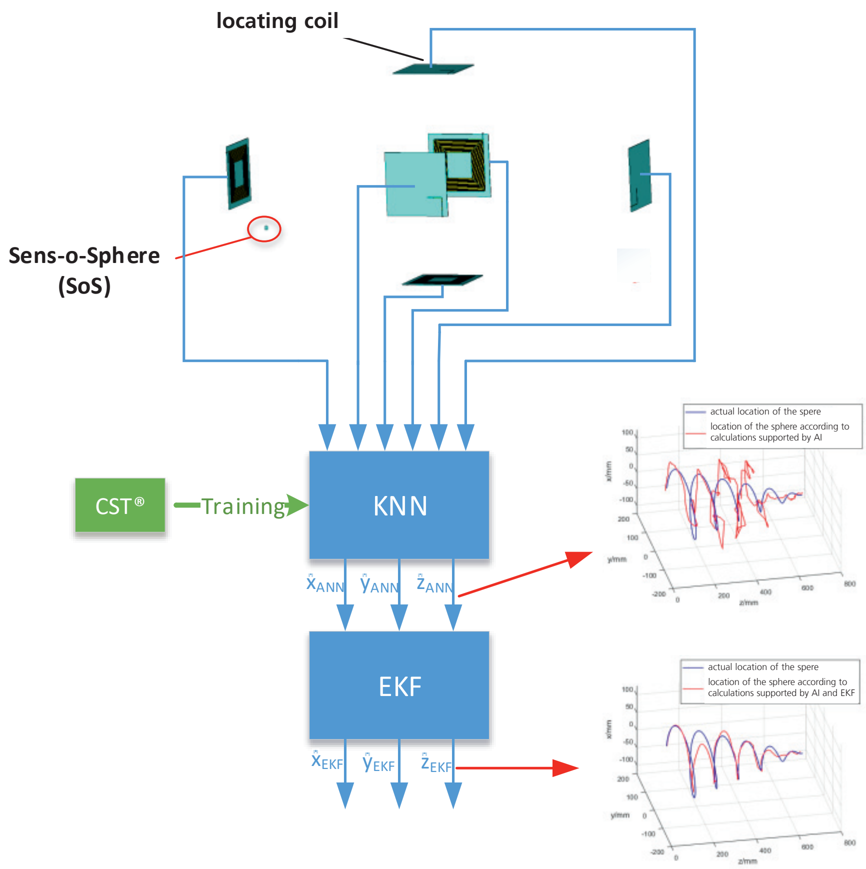


Schematic of inductive localization of the Sens-o-Spheres. © Fraunhofer ENAS

Quantum sensors to measure extremely weak magnetic fields

As part of Fraunhofer's QMag lighthouse project, quantum magnetometers for imaging very weak magnetic fields are being developed and evaluated for use, among other things, in the analysis of microelectronic and nanoelectronic circuits.

The sensor systems to be developed in the QMag lighthouse project make use of the quantized magnetic moments of individual electrons in order to use them as the smallest possible scanning magnets for the representation of magnetic field distributions with extremely high sensitivity and spatial resolution. The choice of single electron systems and the high integration of sensor components make the quantum magnetometers useful for industrial applications.

Technical challenges

The magnetic sensors currently available are only suitable for industrial use to a limited extent: in order to achieve good spatial resolution and sensitivity, the sensors must be cooled using liquid helium – this results in high operating costs and a high degree of technical complexity.

Within the scope of QMag, innovative quantum sensors suitable for industrial applications are being developed that can measure magnetic fields at room temperature with high precision and on a very small scale. The Fraunhofer Institute for Applied Solid State Physics IAF and its project partners are pursuing two technological approaches.

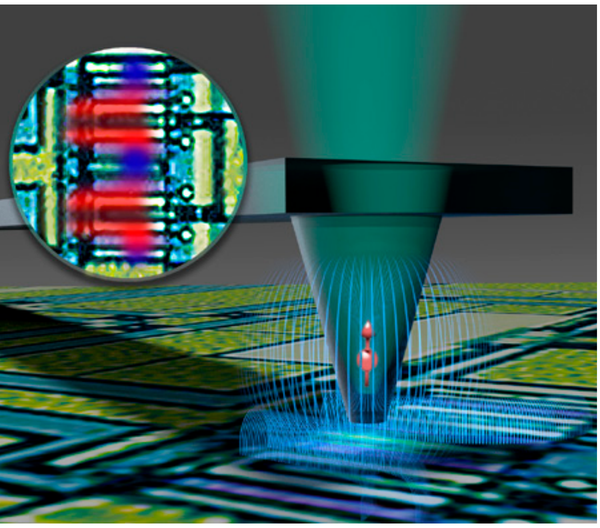
Measurement with nitrogen vacancy centers in diamond

With the scanning probe quantum magnetometer, an atomic defect is introduced into the nanoscale tip of a diamond crystal in a controlled manner. In this defect, a single electron is trapped. The magnetic moment of this electron is aligned and used as the smallest possible tactile magnet. This system allows the measurement of magnetic fields with highest spatial resolution even at room temperature. This makes it possible, for example, to visualize current distributions in nanoelectronic circuits.

Measurement with alkali atoms

In optically pumped magnetometers (OPMs), the magnetic moments of the outer electrons of gaseous alkali atoms are aligned. Their movement patterns then provide information about the strength of the magnetic field to be measured. At room temperature, OPMs also detect weak fields with strengths of only a few femtoteslas. This corresponds approximately to the magnetic field of human brain waves. This quantum magnetometer is suitable, among other things, for non-destructive detection of microscopic defects in material testing and for production monitoring.

In QMag, six Fraunhofer institutes are working together with two universities. The project is being funded by the Fraunhofer-Gesellschaft and the state of Baden-Württemberg equally over a period of five years.



Schematic representation of a scanning probe quantum magnetometer with a diamond crystal in whose tip the magnetic moment of a single electron was aligned as a scanning magnet. © Fraunhofer IAF

The QMag lighthouse project started in April 2019 and runs until 2024. © Fraunhofer IAF / Dmitriy Rybin Shutterstock

About QMag

The core team of QMag:
- Fraunhofer Institute for Applied Solid State Physics IAF (coordination)
- Fraunhofer Institute for Physical Measurement Techniques IPM
- Fraunhofer Institute for Mechanics of Materials IWM

Also involved:
- Fraunhofer Institute for Microengineering and Microsystems IMM
- Fraunhofer Institute for Integrated Systems and Device Technology IISB
- Fraunhofer Centre for Applied Photonics CAP

Experts from the following universities are involved:
- University of Stuttgart
- University of Colorado Boulder

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Prof. Oliver Ambacher.
© University of Freiburg, Klaus Polkowski

"Unlocking the innovation potential of quantum sensors for industrial products"

Quantum magnetometry is intended to enable novel applications in the failure analysis of micro- and nanoelectronic circuits. Fraunhofer Microelectronics spoke with QMag project coordinator Prof. Oliver Ambacher about the challenges and opportunities of the project.

Prof. Ambacher, what would you like to achieve within the framework of the QMag project?

Our goal is to develop quantum magnetometers with which we can image tiny magnetic fields with unprecedented spatial resolution and sensitivity. We want to attain this with two complementary quantum sensor systems that both use a single electron as a "tactile magnet": for the first quantum magnetometer, we capture an electron by means of an atomic defect found in diamond, for the second we use an alkali atom with a single electron in its outer shell.

The quantized magnetic moment of a localized electron in a diamond crystal is ideally suited for the realization of a scanning probe quantum magnetometer. A sensor system of this kind enables contact-free measurement of current distributions in microelectronic and nanoelectronic circuits.

Due to the magnetic interaction of a metallic material to be measured with the outer electron of the alkali atom, the sensitivity can be further increased with the aid of a second sensor system. In this flagship project, we will also demonstrate quantum sensors based on optically pumped magnetometers and evaluate them for industrial applications in materials testing and process analysis.

What are the application perspectives of the two technological approaches?

A scanning probe quantum magnetometer can measure magnetic fields with the highest spatial resolution at room temperature without contact or destruction. That means that it can be used to determine the manufacturing tolerances of magnetic data storage devices or to detect magnetite in the sense of orientation of bacteria. Due to their extremely high sensitivity, optically pumped magnetometers are particularly well suited for medical analyses, materials characterization, or production monitoring.

What are your tasks as project coordinator?

Since almost every institute will contribute its own technical and technological expertise to the research and development of the two quantum sensors, I make every effort to ensure that the participating researchers, technical experts, and administrative staff are regularly and intensively coordinated. This ensures close and efficient cooperation between the six participating Fraunhofer institutes and the two associated universities. I would also like to ensure that our project is accompanied by creative public relations and customer-oriented marketing.

How do the partners contribute to the success of the project?

Fraunhofer IPM and Fraunhofer IWM, for example, contribute their extensive expertise in optical metrology and the simulation of atomic defects. The University of Stuttgart and the University of Colorado Boulder contribute their great experimental experience in the characterization of quantum sensors based on diamond and alkali atoms. Each of the challenging milestones can only be achieved in a team. The flagship project is being borne by many smart and interesting people with a shared vision: unlocking the innovation potential of quantum sensors for industrial products.

Prof. Ambacher, thank you very much for the interview!

The interview was conducted by Marco Krämer.

About Oliver Ambacher:
Oliver Ambacher received the titles of Diplom-Physiker and Doctor of Natural Sciences at the LMU and TU Munich in 1989 and 1993 with distinction. As a scientific assistant at the Technical University of Munich, he began researching low-dimensional electron systems in GaN-based heterostructures and quantum wells in 1993. After being appointed to lead assistant professor in 2001, one year later he was appointed Professor of Nanotechnology at the TU Ilmenau. In 2002, he was appointed Director of the Institute for Solid State Electronics and in 2004 Director of the Center for Micro- and Nanotechnologies at the TU Ilmenau. Since October 2007, Oliver Ambacher has been a professor at the University of Freiburg and Director of the Fraunhofer Institute for Applied Solid State Physics IAF.

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A drive-in movie for the vehicle radar

The sensors in autonomous vehicles must be extremely reliable in order to not endanger road users. In the past, these sensors were subjected to arduous road tests. The new ATRIUM testing device from Fraunhofer FHR means that, in the future, these tests will largely take place in the lab.

The car of tomorrow will drive itself. But even if there are already driving assistants that support humans, completely autonomous vehicles are not yet ready for series production. Questions of responsibility play an important role in the development process. To date, vehicle manufacturers have relied on road tests and comparative studies covering several million kilometers to test the reliability of sensors. If errors are detected, changes must be made and new road tests carried out.

Moving road tests to the lab

Laboratory tests reduce this complexity considerably. This type of laboratory test already exists for radar sensors: radar target sensors record the radar beams emitted by the vehicle radar and send an artificial echo back to the car. However, the radar target sensors currently available are not capable of adequately imaging natural environments. They produce a very reduced image with a single-digit number of reflections.

ATRIUM technology significantly more powerful

The Fraunhofer Institute for High Frequency Physics and Radar Techniques FHR has now developed the more powerful radar target sensor ATRIUM (Automobile Test Environment for Radar In-the-loop Investigations and Measurements). Thanks to the optimized structure of the transmission channels, it can generate up to 300 reflections and thus simulate a far more realistic scene. "In the future, we will be able to run highly complex tests that will significantly reduce the time required for road testing," summarizes Dr.-Ing. Thomas Dallmann, head of the Aachen research group at Fraunhofer FHR.

The ATRIUM radar target sensor was presented at the Automotive Testing Expo in Stuttgart in May.

Single-channel version of the ATRIUM radar target simulator. © Fraunhofer FHR

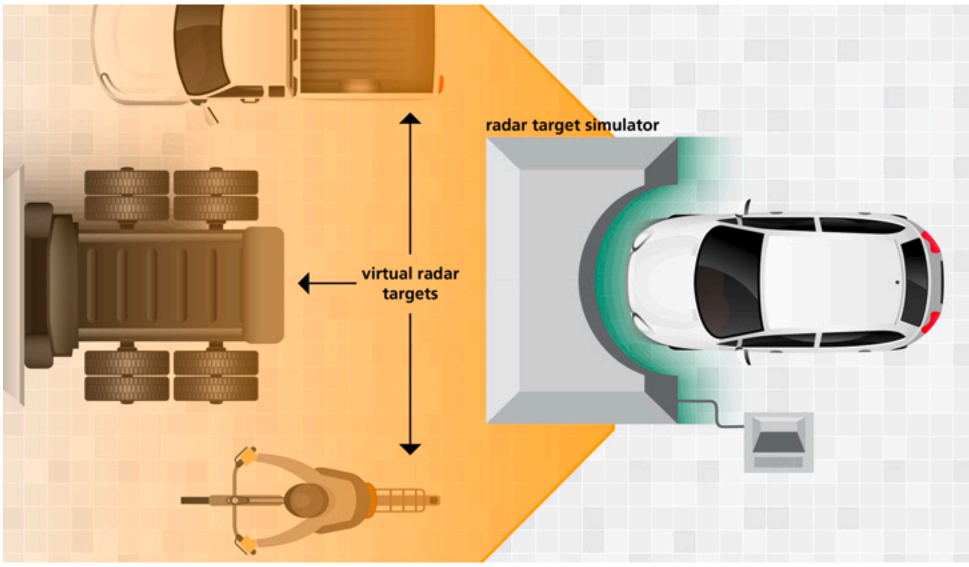

Illustration of the ATRIUM radar target simulator. © Fraunhofer FHR

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© R2D – Road to Digital Production

Digitization of production processes

As part of the R2D - Road to Digital Production project, Fraunhofer IIS, its SCS Center for Applied Research, and industrial partners are developing a system for digital recording and control of industrial production processes. This is intended to improve the cooperation between humans and technology in individualized production with a batch size of 1 and thus increase efficiency and quality.

The Cyber-Physical Production System (CPPS) replaces the linear assembly line with modular production cells. After each work step, the workpiece is automatically transported by driverless vehicles to the next production cell. What is known as a smart production tag accompanies the product through the entire manufacturing process and recognizes, controls, and logs the individual steps independently. Smart apps and eye tracking programs round off the project result at the human/machine interface.

From the essentials to the finished system

The Fraunhofer Institute for Integrated Circuits IIS has been entrusted with the production and realization of smart production tags and is developing the software components for status acquisition, control, and interaction with the production environment. The Center for Applied Research on Supply Chain Services, which is part of the institute, is responsible for the process capturing and evaluation methodology. The Center is also developing software components for initializing the smart production tags at the start of production and for visualizing internal CPPS communication.

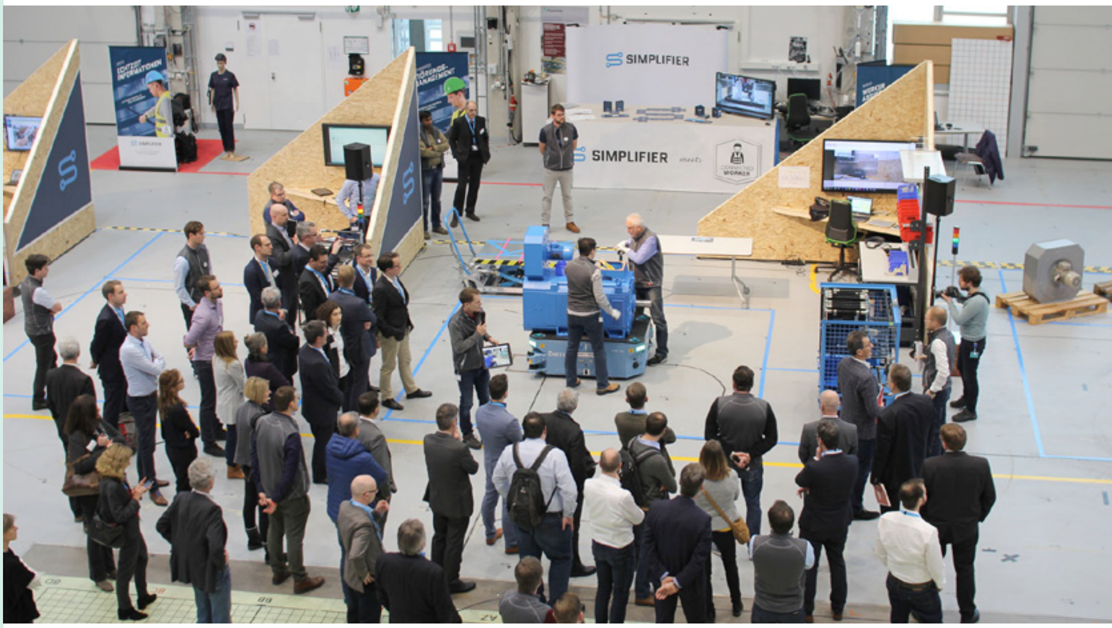
Live demonstration in Nürnberg

As part of the project’s closing event, a 1,500 m² proof-of-concept demonstrator of the CPPS was presented at the L.I.N.K Test and Application Center of Fraunhofer IIS. The specialist audience was given the opportunity to see the system's functionality for itself in an industrial environment by watching the production process for large electric motors. The plant handover of the project results and possible follow-up projects are currently already being considered. The live demonstration was planned and accompanied by Fraunhofer SCS. You can find more impressions of the event at s.fhg.de/R2D-Downloadbereich.

You can view the project trailer here:

About R2D:
R2D is being funded by the Bavarian Ministry of Economic Affairs as part of the Bayern Digital initiative. The following partners are involved:
- Fraunhofer Institute for Integrated Circuits IIS
- Fraunhofer Center for Applied Research on Supply Chain Services SCS
- Siemens AG
- Simplifier AG
- KINEXON Industries GmbH

For more information, see: www.road2digitalproduction.com



The assembly of an electric motor is used to show the specialist audience the production process of the future. © Fraunhofer SCS

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New savings potential thanks to intelligent energy systems

The SEEDs research project developed a way of reducing peak loads without interfering with processing or production.
© MEV Verlag

Intensive operating of process and production equipment causes high load peaks in energy consumption and associated costs. Until now, reducing these costs has required intervention in existing operations and processing. Fraunhofer IISB's innovative electrical energy system offers an alternative method of reducing peak loads.

As part of the energy research project SEEDs, scientists at the Fraunhofer Institute for Integrated Systems and Device Technology IISB developed a battery system with a storage capacity of 60 kWh and integrated it into the institute's own DC grid in Erlangen. Without interfering with existing work processes, peak loads were successfully reduced by approximately 10% with the aid of intelligent algorithms.

Functionality and scope of services

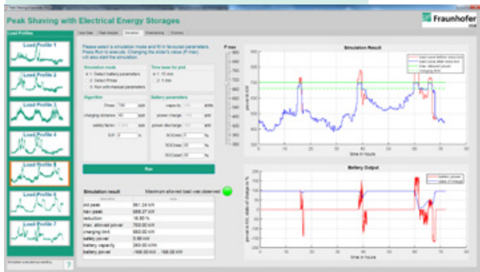
The scientists developed an algorithm for the optimal use of the stationary battery storage. This algorithm determines the battery power required to reduce the load from the external grid and also reacts flexibly to changing electricity prices.
The MATLAB application, also developed with a graphical user interface, ensures user-friendly application and serves to design and economically evaluate peak load reduction. In addition, individual extensions with additional components, such as a cogeneration plant with heat storage, can be included in the algorithm.

First successful practical tests

The practical results at Fraunhofer IISB show a very good overlap with simulations carried out previously, and in principle, are transferable to other consumers. The integration of electrical battery storage for peak load reduction was thus successfully tested in the institute's own infrastructure. In addition, a solution for an industrial customer has already been developed together with a commercial battery storage provider.

Outlook

The Fraunhofer IISB algorithms can be used not only to design battery systems according to demand and be optimally used for peak load reduction. Individual extensions with additional components can also be included, e.g., a combined cogeneration plant with heat storage. Yet another consideration is to make infrastructure systems more flexible for the provision of heat and cold by means of thermal storage and to integrate them into peak load reduction applications. The work is always focused on transferability to other energy systems for the broadest possible application of peak load reduction measures.



Validated software algorithms of the MATLAB app calculate the optimum parameters for reducing peak loads and demonstrate the energy saving potential. © Fraunhofer IISB

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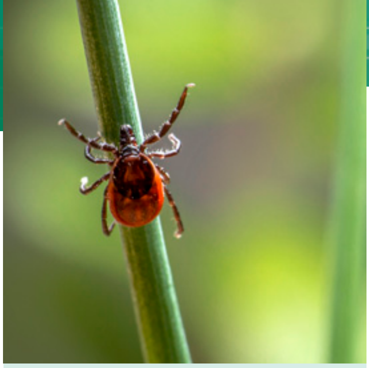
Intelligent energy storage achieves success in peak load reduction.
© Fraunhofer IISB



The Ixodes tick transmits Lyme disease, which might be diagnosed and treated earlier thanks to Fraunhofer research. © Diarect AG

Early detection of Lyme disease thanks to optical microresonators

Lyme disease (also known as Lyme borreliosis) is the most common tick-borne infection in Germany. Only if the infection is diagnosed and treated in time, the patient will be spared additional complications. However, current diagnostic methods do not reliably detect Lyme disease at an early stage.

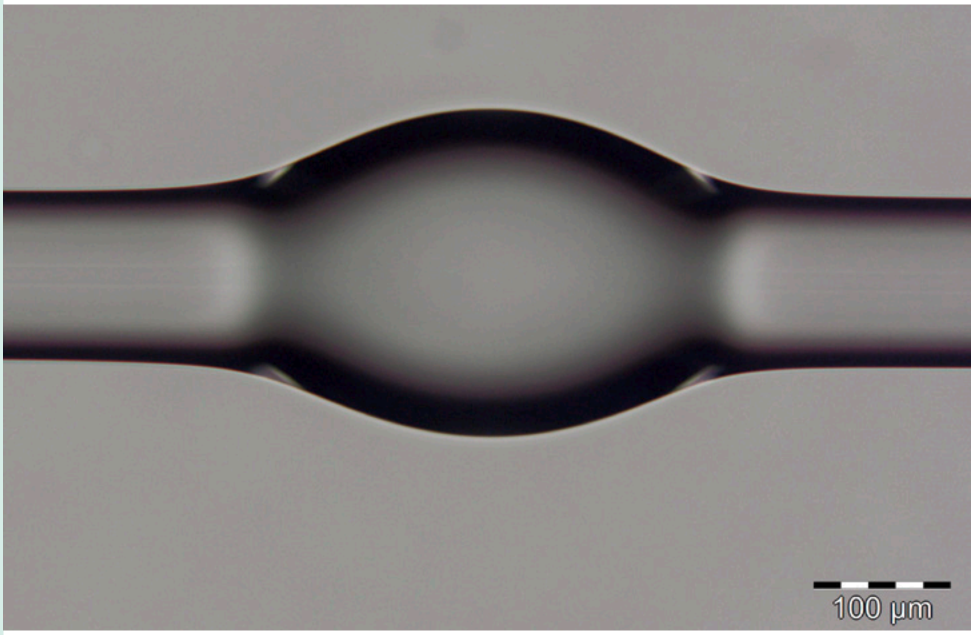
In the transnational PoC-BoSens project coordinated by Fraunhofer Institute for Reliability and Microintegration IZM, a portable, highly sensitive diagnostic system based on optical microresonators is being developed that can early detect Lyme disease infection in a short time. The sensor works by simultaneously detecting several Lyme-related biomarkers that occur in the human body in the case of infection.

As a world first, the research project combines a micro-fluidic system with bottle microresonators. These sensing structures are highly sensitive, easy to integrate, and have an ultra-compact size. Project coordinator Dr. Alethea Vanessa Zamora Gómez of the Fraunhofer IZM says, "The technological backbone of the project is our use of bottle microresonators as biosensors. They are an excellent choice for a multi-channel detection of our target biomarkers."

The project brings together an international consortium of researchers and industrial partners with competences in photonics, microfluidics, biochemistry, electronics, and biomedicine. The German contingent consists of partners from Fraunhofer IZM, Diarect AG, Scienion AG, MDX Devices GmbH, and IfU Diagnostics Systems GmbH.

The German Federal Ministry of Education and Research (BMBF) is funding PoC-BoSens within the framework of the transnational funding initiative Photonics Based Sensing ERA-NET Cofund (PhotonicSensing).
The project runs from April 2018 to March 2021. The project volume is approximately 2.4 million euros.

Image of a structured glass bottle microresonator, the building block technology core of PoC-BoSens. © Fraunhofer IZM



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Hidden motifs

Microscopic imaging is an indispensable part of scientific work. Often, it produces remarkable pictures that provide a surprising insight into a world normally hidden. Some images also have an impressive aesthetic effect. Things that work well in the laboratory can also be of good use in a photo studio. Specially staged under light microscopes and macro lenses, even inconspicuous technical objects show their most beautiful sides. According to the principle of pars pro toto – one part stands for the whole – even larger thematic complexes can be communicated with the right unusual detail shots.

Fotos: © Fraunhofer IISB

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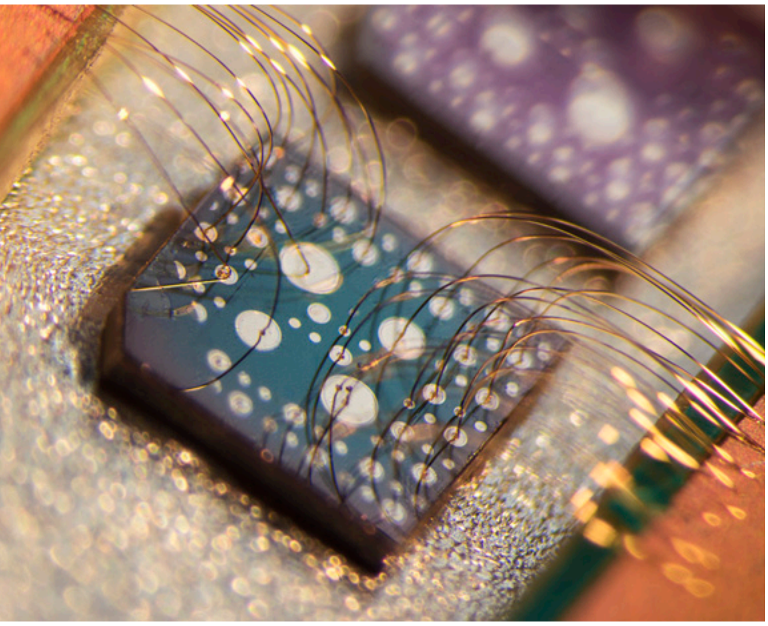
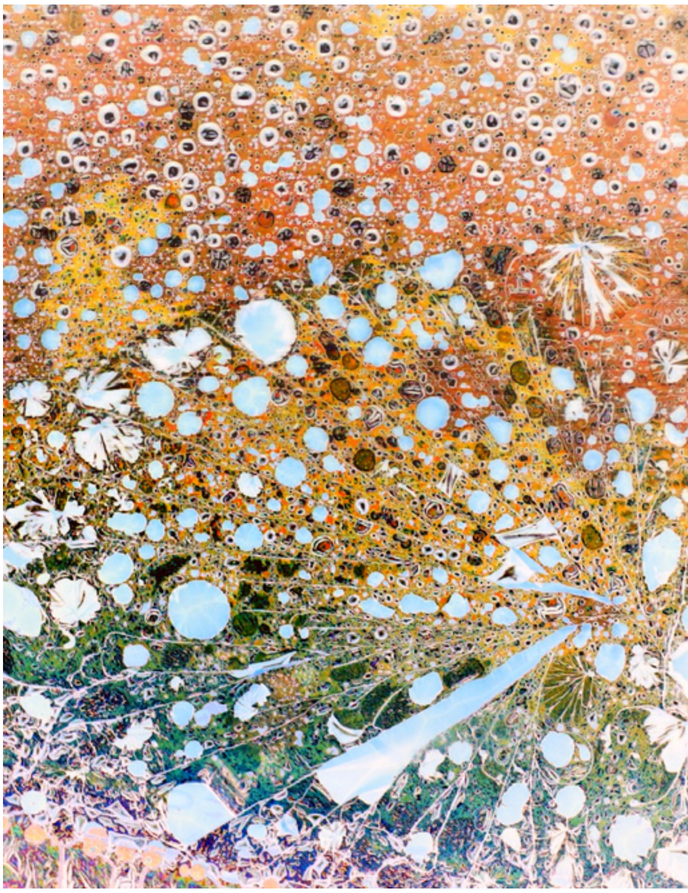
Cracks in a plasma-etched glass substrate for microfluidics application

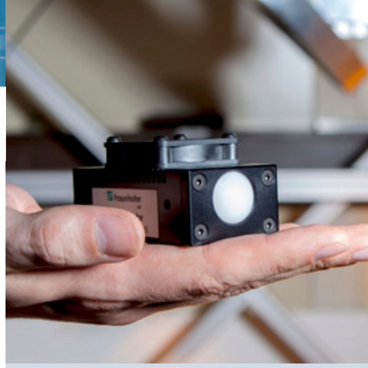


Ball bonding with gold wires of a first prototype of a diamond Schottky barrier diode.

Thermally stressed passivation layer on silicon.



Precipitates and dendrites in an insulation gap of a direct copper-bonded substrate.



The compact W-Band radar is capable of precisely measuring distance and speed, even if the objects are difficult to detect or are even obscured. © Fraunhofer IAF

Industrial automation with radar sensors

Within several projects, Fraunhofer IAF is developing compact and high-resolution radar solutions for industrial applications.

Sensor systems can be used to automate production and logistical processes. The radar sensors of Fraunhofer IAF operate within the frequency range of millimeter waves, which can penetrate plastics, cardboard, wood, and textiles, but also dust, smoke, and mist. Compared with optical sensors, they are therefore impervious to poor visibility conditions. Unlike X-ray based systems, radar sensors are harmless to health.

Fraunhofer IAF presented a radar system which checks the content and completeness of packaged goods at this year's Hannover Messe trade fair. Radar sensors from Fraunhofer IAF are also deployed in the following projects:

RoKoRa: A radar system monitors workspaces in human-robot collaboration and adjusts the speed and direction of movement of the robots. This increases the safety and efficiency of the processes.
RAD-Energy: Radar sensors control strip sizes and process variables of hot rolling mills in the metal industry. This saves resources and energy.
InFaRo: Radar technology detects even the smallest material defects in rotor blades for wind turbines as early as during the production stage. This aids quality assurance and lowers production and operating costs.

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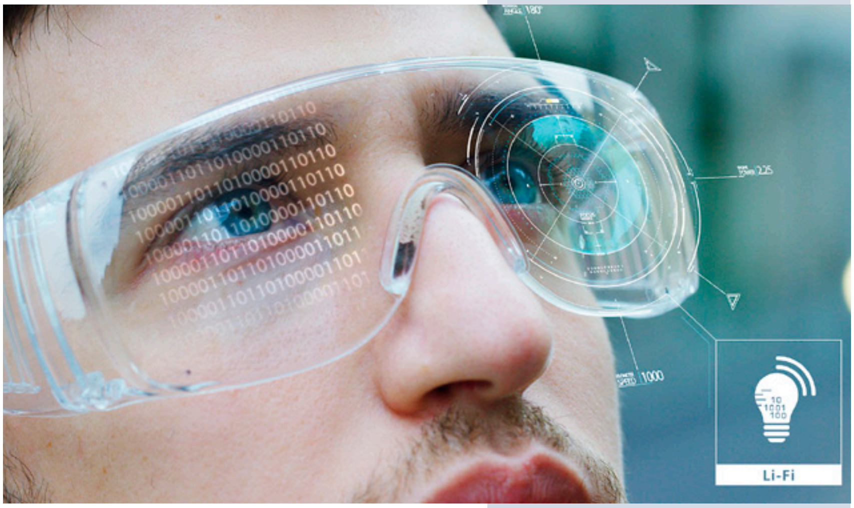
Li-Fi meets augmented reality

Optical communication using visible or infrared light – Li-Fi (Light Fidelity) – is currently being advanced at Fraunhofer IPMS and prepared for applications in the field of augmented reality, among others. The advantages of optical data transmission come into play above all when cables and connectors cause interference or wireless radio networks such as Wi-Fi or Bluetooth reach their limits in terms of bandwidth or real-time capability.

This is the case, for example, with data glasses or augmented reality (AR) glasses. In addition to the perception of the real environment, augmented reality glasses provide the user supplemental information superimposed on their field of view. Such glasses are used in areas like warehousing and logistics, assembly and product development, and medical technology. Depending on the application, large amounts of data need to be transferred and interactive content resulting directly from a user's actions must be available within a certain period of time. Because cables restrict movement and users of mobile applications typically need to have their arms free, wireless data transfer techniques are the preference for installation in AR glasses. The usual standards such as Wi-Fi and Bluetooth are, however, limited in bandwidth and not designed for real-time transmission – unlike Li-Fi.

As long as there is a clear visual axis between the transmitting and receiving modules, optical data transmission can be used wherever connectors, cables, sliding contacts, and radio networks need to be replaced.

Li-Fi can be used to transmit augmented reality applications wirelessly and in real time. © Shuttershock / Fraunhofer IPMS



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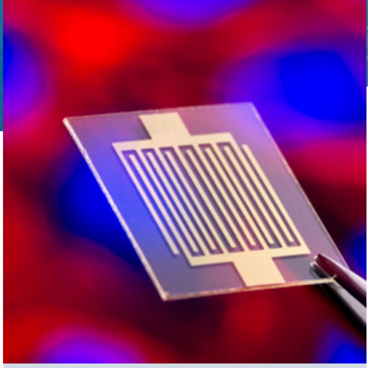

Interdigital electrodes for impedance-based monitoring of animal cells (example of an electrode layout). © Fraunhofer EMFT / Bernd Müller

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Tissue models with integrated sensor technology using the modular principle

As part of the TissueSense project, Fraunhofer EMFT is optimizing 3D tissue models for pharmacological research by integrating sensors.

Laboratory-grown tissue is increasingly being used in drug development and in the assessment of biological, chemical, or physical hazards. These models are used to test the reaction of the cells to various external stimuli. However, two-dimensional cell layers only reflect reality to a limited extent, whereas three-dimensional models can only be quantitatively investigated by subsequent degradation of the material.

With the TissueSense concept, tailor-made 3D tissue models can be created using the modular principle: First, 2D cell monolayers are cultivated individually on thin porous polymer substrates and then assembled in such a way that they interact with each other and exchange substances like a natural organism. Signal converters integrated into the polymer substrates allow non-invasive and real-time measurement of the chemical and physical parameters of each individual cell layer of the 3D tissue model. This enables an unprecedented depth of information, especially in the screening of substance libraries.

Faster small-intestine diagnostics thanks to a camera pill

A larger image section, sharper images, and more efficient image evaluation – this is the promise of an endoscopy capsule developed by Fraunhofer IZM for detailed examination of the small intestine.

In 2001, the human small intestine was examined for the first time with a capsule endoscopy: a patient swallowed a pill containing a tiny microcamera. Once inside the body, the camera took thousands of photos of the small intestine, which, with its winding six meters in length, had previously been inaccessible for an examination. Today, thanks to various capsule technologies, a method for imaging analysis of the small intestine has been established.

All capsule endoscopies have the same downside, however: the images are time-triggered, regardless of whether the capsule endoscope has moved or not. This produces redundant data that needs to be filtered out manually. Having the photography triggered by motion can reduce the amount of redundant data to a minimum by up to one-third.

Endotrace, a research project funded by the German Federal Ministry of Education and Research (BMBF) to the tune of €1.2 million, has produced a capsule technology that no longer takes redundant photos. The project partners have developed a simple-looking capsule the size of a hard candy, or sweet, but equipped with high-tech features: in addition to a total of five cameras, a tracer, and a computer memory the small pill also contains integrated batteries and LED lights. From a technical point of view, the pill is already ready for market, but it still requires approval.

But how does the camera know when to take a photo? The change in the intestinal villi sends a signal to the computer memory and the capsule takes a photo after a movement of 2-3 mm. Instead of several thousand images, the Endotrace capsule generates less than half the data for evaluation and ultimately leads to a faster medical diagnosis.

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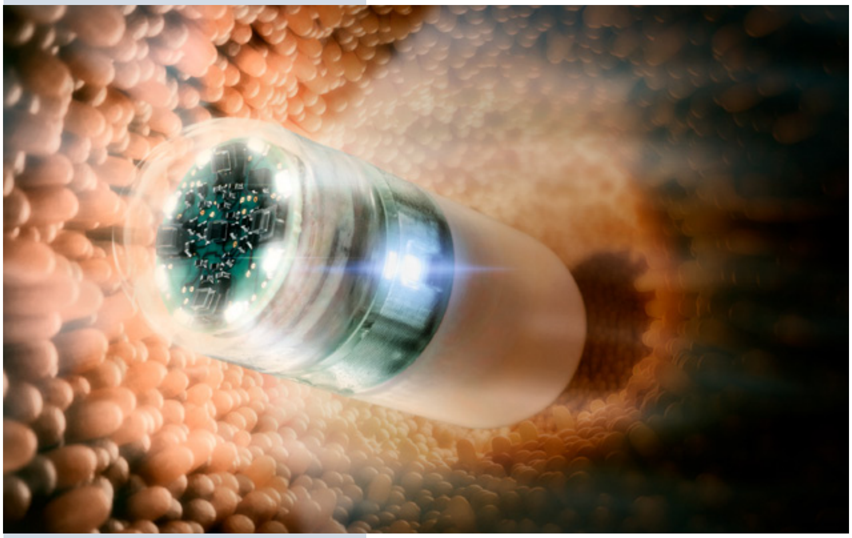

The new capsule technology can be used to diagnose the cause of symptoms such as gastrointestinal bleeding faster.
© Fraunhofer IZM / Volker Mai

Mobile transponder for the localization of tools in an industrial environment.
© Fraunhofer IZM / Volker Mai

Precise positioning brings clarity to the manufacturing process

Whether a screw connection will hold depends on a wide variety of factors. In a drilling machine, for example, the angle and torque of the screwdriver are decisive. This also applies to safety-relevant connections – in the automotive industry, for example. The NaLoSysPro project, which was completed at the end of 2018 and in which Fraunhofer IZM was also involved, aimed to make manually produced screw connections safer.

NaLoSysPro (from the German abbreviation for "near-field localization of systems in production lines") helps to determine the exact position of the screwdriving tool at a manual workstation. The position data determined is stored in a database with parameters relevant to the screw connection, for example the torque. Each assembly step then has a complete data set that can be used to evaluate screwdriving processes and track any deviations from the process. This is made possible by four permanently installed radar stations and a mobile transponder on the screwdriving tool. The transponder transmits signals to the fixed units and these, in turn, use algorithms to calculate the transponder's position. The miniaturized transponder was developed within the NaLoSysPro consortium and built by Fraunhofer IZM. For example, bumping technology for single chips was used during development at the institute. This is a rare niche technology that can be particularly useful in research and development projects where whole silicon wafers are too expensive or unavailable. Furthermore, experience in the field of transponder technology and antenna integration for radar applications was both gained and applied.

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Franco-German meeting in Dresden to link the Digital Innovation Hubs

A French delegation of representatives of research and technology, led by Yannick Neuder, Vice-President of the Auvergne-Rhône-Alpes region with responsibility for universities, research, innovation, and European funding, visited Dresden, the capital of the state of Saxony, in March. The purpose of the trip was to discuss with representatives of the state government of Saxony and of the regional microelectronics community how to intensify the existing cooperation and increase the funding opportunities. The common goal is to link the corresponding regional Digital Innovation Hubs "Minismart" (Auvergne-Rhône-Alpes) and "Smart SystemsHub – enabling IoT" (Saxony) better.

Oliver Schenk, Saxony's Minister of State for Federal and European Affairs and Head of the State Chancellery, and Prof. Hubert Lakner, Executive Director of Fraunhofer IPMS in Dresden representing the Function Integration for Micro-/Nanoelectronics Performance Center, welcomed the French guests. The visit, which began in the Saxon State Chancellery, also included tours of microelectronics production sites in Dresden and vicinity. Together with the two government representatives, the managing director of Smart Systems Hub GmbH, Michael Kaiser, the head of the French research institute CEA-Leti, Dr. Emmanuel Sabonnadière, and Prof. Hubert Lakner signed a memorandum of understanding to promote links between the respective regional Digital Innovation Hubs. Measures were agreed on to improve cross-border research and development services for the microelectronics industry in France and Germany.

The memorandum of understanding supports the implementation of the Franco-German agreement between Fraunhofer and Leti to jointly strengthen key technologies in the field of microelectronics. The underlying cooperation agreement was already signed in June 2018 as part of the Sixth Franco-German Research Forum in Berlin.

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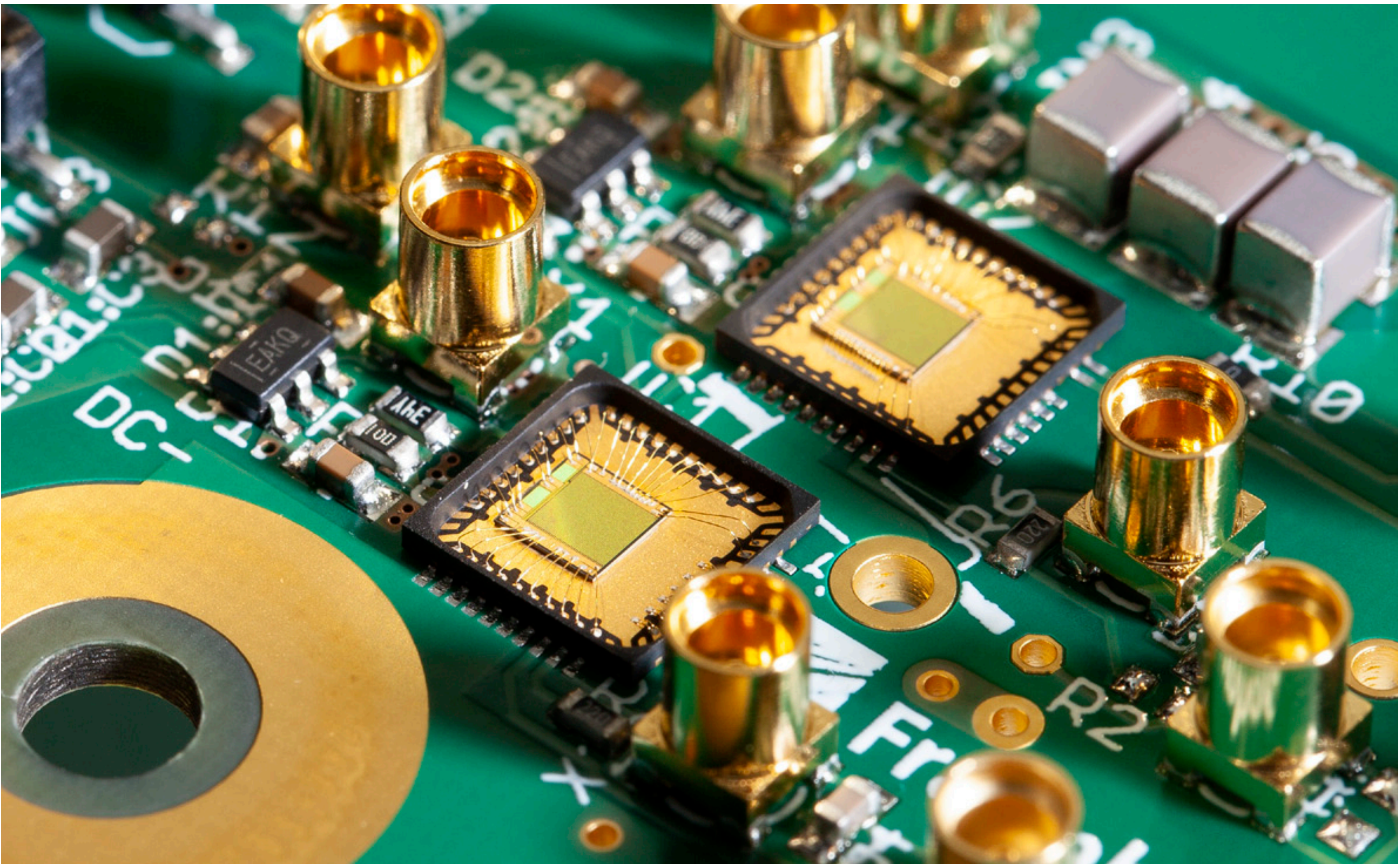
(From left to right:) Prof. Hubert Lakner, Chairman of the Fraunhofer Group for Microelectronics and Executive Director of Fraunhofer IPMS; Yannick Neuder, Vice-President of the Auvergne-Rhône-Alpes region with responsibility for universities, research, innovation, and European funding; Dr. Emmanuel Sabonnadière, Head of CEA-Leti; Michael Kaiser, Managing Director of Smart Systems Hub GmbH; and Oliver Schenk, Saxon Minister of State for Federal and European Affairs, at the signing of the memorandum of understanding in the Saxon Parliament.
© Fraunhofer Mikroelektronik



The photo shows integrated power circuits (GaN-on-Si power ICs) of the 600 V class, sized 3×3 mm². Scientists at Fraunhofer IAF monolithically integrated current and temperature sensors into the chips, as well as flyback diodes and a gate driver – thus adding a whole range of additional functionalities to the power transistors, all on a single chip. This setup allows many devices that previously had to be external to be combined into one chip to save space. When it comes to chargers for electromobility, the use of these kinds of circuits – with their high degree of efficiency and low space requirements – offers real benefits.
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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 ...

… today goes to Dr. Mohammad Hejjo Al Rifai from Fraunhofer ISIT

Dr. Al Rifai, what fascinates you most about microelectronics?

What fascinates me above all is working with the small structures and different materials through which we create products that change the world.

Which project are you currently working on?

I am currently working for the Research Fab Microelectronics Germany (FMD). This is a great challenge, as we are developing and processing new components together with other institutes. I find the exchange of experience between the institutes very important. It is a completely new form of cooperation at Fraunhofer.

Which topic being investigated by colleagues from another Fraunhofer institute do you find particularly exciting?

In the past, I have worked intensively on the development and optimization of silicon solar cells and solar modules. For this reason, I find the projects at the Fraunhofer Institute for Solar Energy Systems ISE in Freiburg particularly exciting.

What invention would you not like to do without in daily life?

I can barely imagine a life without a smartphone, Internet, or online portals – for example when it comes to shopping or booking a trip. All these things have made life much easier and more pleasant and I wouldn't want to do without them.

Let's look into the future. What would you like to have achieved in five or ten years' time?

I have been working at the Fraunhofer Institute for Silicon Technology ISIT since 2017 and I manage the institute's activities in the cleanroom. I enjoy my job very much and I am looking forward to the challenges that will arise. Here, we have many opportunities to develop new processes and technologies. I'm sure ten years from now I still won't be bored here.

If you could meet someone well known – from either the past or present – who would it be and why?

William Bradford Shockley. He changed the world lastingly by discovering the transistor effect.

What do you wish you had more time for?

I used to program regularly. I don't have time for that today. Sports like running and swimming also always seem to fall by the wayside.

What song belongs to the "soundtrack" of your life?

There's several, I'll name two: Johnny Cash's "You Are My Sunshine" and Bon Jovi's "It's My Life."

Last, but not least: Can you tell us what motto you live by?

The future depends on what you do today.

Dr. Mohammad Hejjo Al Rifai manages the activities in the cleanroom of Fraunhofer ISIT.
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Dr. Mohammad Hejjo Al Rifai.
© Fraunhofer ISIT, Itzehoe

About Dr. Mohammad Hejjo Al Rifai:
Dr. Mohammad Hejjo Al Rifai studied physics at the Faculty of Natural Sciences of Aleppo University (Syria) and graduated with a master's degree in 1991. He then worked there as a scientist for four years. Dr. Al Rifai came to Germany in 1995 and received his doctorate in materials science from the Technical Faculty of the Christian Albrecht University in Kiel. He dealt in particular with silicon semiconductor technology and the development of solar cells. He then worked as a postdoctoral fellow at the Max Planck Institute of Microstructure Physics in Halle. Since 2004, Dr. Al Rifai held executive positions with many companies including Infineon, Qimonda, Centrosolar, OSRAM, and Continental, before joining Fraunhofer ISIT in 2017.

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