Microelectronics News

Fraunhofer MIKROELEKTRONIK

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■ Title

A container full of energy

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It does seem quite cramped when you enter the 20-foot steel container at Fraunhofer IISB. Inside is hydrogen technology for the storage and release of electrical energy on a large scale. The Leistungszentrum Elektroniksysteme LZE is researching on a safe and clean energy supply for industrial firms and large building complexes based on this technology.

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The Fraunhofer Group for Microelectronics presented the latest developments at the MST Congress and at productronica.
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■ From the institutes

Intelligent energy supply for smart objects

Smart objects that communicate and interact on the Internet of Things must be self-sufficient in order to remain operational for as long as possible. As part of the EU's EnSO project, 39 partners from eight countries are working on new solutions for an intelligent energy supply.

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Looking into a basset horn

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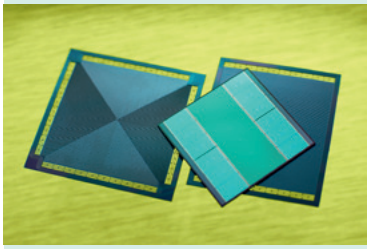

As part of the CarriCool project, Fraunhofer researchers have developed a new, effective cooling method.
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Highly automated driving in any weather

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Camera components for the most powerful X-ray laser

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Primetime Engineering Emmy Award for HEVC

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■ The last word …

… today goes to Dr. Eng. Stephan Guttowski from the FMD

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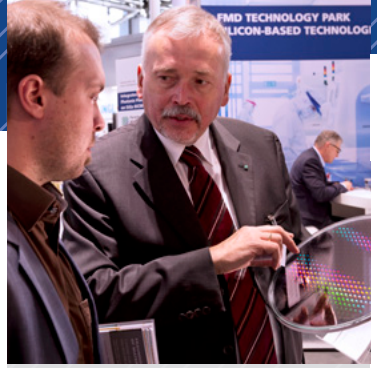
■ Content:

Events

Date	Event / WWW	Location	Group institutes involved
03/11 – 03/15	OFC – The Optical Networking and Communication Conference & Exhibition www.ofcconference.org	San Diego, USA	HHI, IPMS
03/12 – 03/14	GeMiC 2018 – German Microwave Conference www.gemic2018.de	Freiburg, Germany	IAF
03/13 – 03/15	LOPEC 2018 www.lopec.com	Munich, Germany	ENAS, IKTS, IZM
03/13 – 03/15	LogiMAT 2018 www.logimat-messe.de/en	Stuttgart, Germany	IIS / SCS, IPMS
03/14 – 03/16	SEMICON China 2018 www.semiconchina.org	Shanghai, China	ENAS
04/07 – 04/12	NAB show www.nabshow.com	Las Vegas, USA	HHI, IDMT, IIS
04/10 – 04/12	Hot & Cold Rolling Day www.rolling-day.com	Kolkata, India	IZFP
04/10 – 04/13	analytica 2018 www.analytica-media.de	Munich, Germany	EMFT, IAF, IPMS
04/11 – 04/12	Smart Systems Integration 2018 www.mesago.de/en/SSI/home.htm	Dresden, Germany	ENAS, IZM
04/18 – 04/19	12th ITG Conference www.hhi.fraunhofer.de/en/events/2018/12th-itg-conference-2018	Berlin, Germany	HHI
04/23 – 04/27	Hannover Messe www.hannovermesse.de/home	Hannover, Germany	Group institutes
04/24 – 04/27	Control www.control-messe.de/en	Stuttgart, Germany	IKTS, IZFP
04/25 – 04/26	7th CAM workshop www.cam-workshop.de	Halle (Saale), Germany	IMWS
05/14 – 05/15	Workshop: EMC in Power Electronics – Electro Magnetic Compatibility www.izm.fraunhofer.de/en/news_events/events/ws_4.html	Berlin, Germany	IZM
05/15 – 05/16	7th FOKUS Media Web Symposium www.fokus.fraunhofer.de/go/mws	Berlin, Germany	FOKUS



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Productronica 2017
The Fraunhofer joint stand was shared with twelve members of the Group for Microelectronics and participants in the Research Fab Microelectronics Germany: Fraunhofer EMFT | IAF | ENAS | FHR | IISB | IMS | IMWS | IPMS | ISIT | IZM | the Ferdinand-Braun-Institut, Leibniz-Institut für Höchstfrequenztechnik (FBH) | IHP GmbH – Innovations for High Performance Microelectronics – as well as the two Fraunhofer institutes ILT and IPT.

Forschungsfabrik Mikroelektronik
Deutschland

The Research Fab Microelectronics Germany at productronica 2017

With around 1200 exhibitors from 42 countries, productronica in Munich is the world's leading trade fair for the development and manufacture of electronics. From November 14th to 17th, twelve Fraunhofer institutes – together with their cooperation partners – presented their research and development results at the trade fair. What's more, attendees had the chance to experience the Research Fab Microelectronics Germany (FMD) and its newest research results live and in person.

The customer and press event "Industry meets FMD" on the second day of the trade fair offered a special opportunity to do just that. Prof. Hubert Lakner, chairman of the Fraunhofer Group for Microelectronics, and Prof. Bernd Tillack, Scientific Director of IHP GmbH – Innovations für High Performance Microelectronics, presented the new cooperation model for German microelectronics research. The four technology park managers – the central FMD contacts – also answered questions about the organization and the services offered by these new technology tools.

The Fraunhofer and Leibniz scientists used the joint stand to inform attendees about future-oriented topics. Fraunhofer IAF from Freiburg, for example, presented the first research results of the EU's TERRANOVA project. The TERRANOVA team will be working on the next cellular standard but one – 6G – until the end of 2019.

MikroSystemTechnik Congress 2017

From October 23rd to 25th, visitors at the MikroSystemTechnik Conference in Unterschleissheim near Munich were able to get to know six Fraunhofer institutes from the Group for Microelectronics as part of the technology exhibition. Fraunhofer EMFT, ENAS, IMS, IPMS, ISIT, and IZM used exhibits at a shared stand to introduce themselves for the first time as part of the cross-location technology pool Research Fab Microelectronics Germany, which was launched last year.

In numerous lectures and poster exhibits, our colleagues also reported on the potential offered by Fraunhofer research in the area of electronic and microsystems. Prof. Christoph Kutter, Institute Director at Fraunhofer EMFT, guided visitors through the three-day program. In 2019, the 8th MST Congress will take place in Berlin. That congress will be directed by Prof. Klaus-Dieter Lang, Institute Director of Fraunhofer IZM.

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A container full of energy

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Energy storage with LOHC technology

Chemical hydrides are one way of safely storing surplus energy – from local photovoltaic plants, for example – for longer periods and to make it available for energy-intensive systems.

The LZE pilot project "DC-Backbone mit Strom-Gas-Kopplung" (DC backbone with electricity-gas coupling) makes use of a liquid organic hydrogen carrier, called LOHC. This makes it possible to store large quantities of electrolytically generated hydrogen and to store it safely at the usual ambient pressure and temperature. In order to generate electricity from the hydrogen, a PEM fuel cell (PEM = proton exchange membrane) is used. The PEM technology means that the fuel cell is operational within a few minutes, which is important to smooth load peaks. The carrier is not consumed when storing and releasing the hydrogen, and it can potentially be used for several hundred cycles. The current prototype would be able to store enough energy to cover the power requirement of a small industrial company for several hours. Additional tank containers allow the quantity of stored energy to be increased by several magnitudes.

"Only interdisciplinary cooperation will ensure the success of our research project," explains deputy project manager Michael Steinberger. The necessary know-how for LOHC technology is supplied by the Institute of Chemical Reaction Engineering (CRT) at the Friedrich Alexander University of Erlangen-Nürnberg; the Fraunhofer Institute for Integrated Circuits IIS is providing support for the control technology.

Research questions and aims

The researchers intend to use the new facility to investigate various questions: how can an LOHC-based energy storage system be operated to store energy from fluctuating sources? How can systems of this kind be integrated into a single container in a compact manner? How can a facility of this nature be efficiently incorporated into industrial energy grids? With the right operating strategy, the LOHC system will make it possible to incorporate renewable energies in industrial energy systems on a large scale while also guaranteeing supply reliability.

LZE project staff discussing the compact operational structure of the innovative energy system.
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About the Leistungszentrum Elektroniksysteme (LZE):
The LZE is a joint initiative of the Fraunhofer-Gesellschaft, its institutes IIS and IISB, and Friedrich Alexander University of Erlangen-Nürnberg (FAU), together with other research institutions outside the university and associated partners from industry. The LZE is built on many years of intensive cooperation between the Fraunhofer institutes and the FAU as well as the unique concentration of research and industry in the electronics system segment at the Nürnberg-Erlangen-Fürth location. The pilot phase of the LZE was launched in January 2015 and is being funded by the Bavarian Ministry of Economic Affairs and Media, Energy and Technology.

The inside of the innovative container allows efficient power generation and production of hydrogen.
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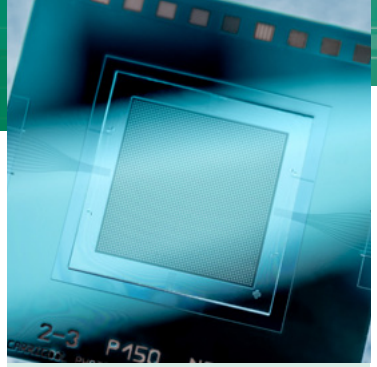


Precision flip chip bonds of silicon photonic IC on silicon interposer using solder-assisted self-alignment with mechanical stops.
© Fraunhofer IZM / Volker Mai

Higher processor performance with microchannel coolers

As part of the CarriCool project, Fraunhofer researchers have developed a new, effective cooling method. By integrating microchannels into the silicon interposer it is now possible to cool high-performance processors from the underside as well. Moreover, the scientists have integrated passive components for voltage regulators, photonic ICs, and optical waveguides into the interposer.

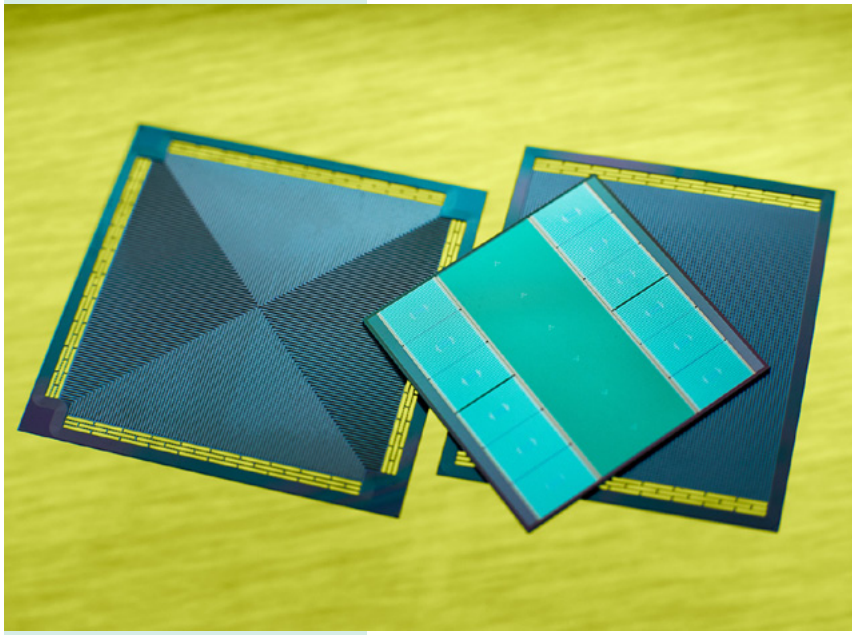
When processors get too hot, they reduce their clock rate and operating voltage. In order to protect the CPU and motherboard from heat damage, the processors either reduce their computing speed or even shut themselves off entirely. Effective cooling is thus an important factor in computing power. Up until now, cooling elements have been used to avoid overheating of the processors. At the same time, fans are used to cool the heat-sensitive components from above. A research team from the Fraunhofer Institute for Reliability and Microintegration IZM, in Berlin and Dresden, has now found a way to cool microchips from the top as well as from below using a liquid-based cooling system. The development was made as part of the CarriCool project under the aegis of IBM. For this purpose, microchannel structures with hermetically sealed vias are installed in the silicon interposer, which is located between the processor and the printed circuit board. The coolant is then pumped through the microchannels, channeling off the heat from the processor. This cooling system is considerably more effective than conventional solutions and demonstrably improves processor power.

Cooling near the computer core

The particular challenge was not only to integrate the small channels into the interposer, but also to hermetically seal them and thus to separate them from the electrical paths. The solution of the scientists: the interposer is made of two silicon plates. The horizontally extending cooling channels as well as the vertically extending channels for the electrical lines are incorporated in a complementary manner. In order to prevent contact between the water and the electrical vias, each individual contact is specially sealed. Up to now, the cooling structures have not been very close to the computer core itself. The closer you get to the heat source, the more effective the cooling. In high-performance computing in particular, the data rates are continuously increasing and this issue is becoming more important.

Additional optoelectronics for low-loss data transmission

As if the cooling system were not enough, the Fraunhofer researchers additionally integrated voltage regulators for the power supply as well as optoelectronic components for data transmission into the interposer. While the voltage regulator supplies the processor with the appropriate operating voltage, the optoelectronics converts electrical signals from the processor into light signals. As a result, even large amounts of data can be transmitted with low loss and high signal quality – in contrast to copper lines in which the data losses increase with growing data rate.



The integration of microchannels into the silicon interposer allows for the first time to cool a processor also from the bottom and thereby increase the computing power. © Fraunhofer IZM

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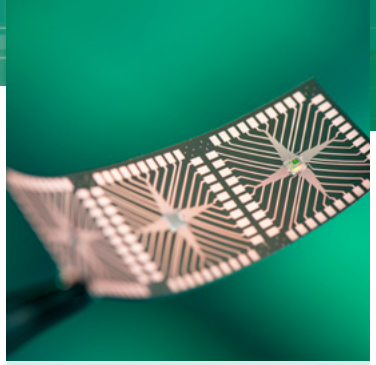
Intelligent energy supply for smart objects



25 µm thin microcontroller chip in a flexible film package.
© Fraunhofer EMFT

It is forecast that there will be up to 24 billion networked things around the world by 2020. Over a third of these will be "smart" everyday objects that will communicate and interact within the Internet of Things. One sticking point is the energy supply: smart objects need to be self-sufficient in order to be able to work for as long a period as possible. As part of the EU's EnSO project, 39 partners from eight countries are working on new solutions for an intelligent energy supply.

The aim of EnSO ("Energy for Smart Objects") is to develop AMES, or autonomous micro-energy sources. AMES combine various elements such as energy harvesting, energy management, and micro-energy storage in order, ideally, to allow them to operate for a lifetime. As part of the project, researchers at the Fraunhofer Research Institution for Microsystems and Solid State Technologies EMFT and the Fraunhofer Institute for Integrated Circuits IIS are developing concepts and technologies to manufacture, integrate, and embed electronic microchips in autonomous energy supply units.

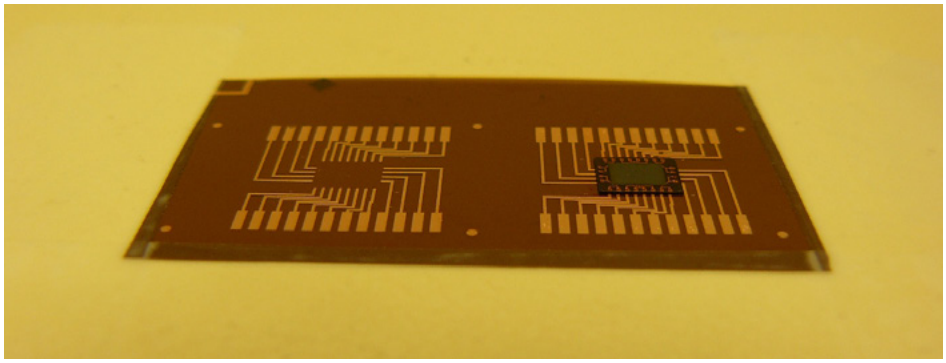
Thin, flat, and flexible

The construction height of the compact packages is intended to be considerably less than 1 mm. Furthermore, the packages are intended to be mechanically deformable in order to allow them to fit into different-shaped environments. To this end, the experts plan to embed a very thin and flexible microchip into an ultra-flat foil housing. Different technology concepts are going to be tested for the contacts: in addition to flip-chip approaches where the chip is placed face down on a wiring foil and is contacted and embedded, new technologies will also be used where the chip is placed face up on a foil and embedded using, say, a casting compound. The electrical contacts and the wiring level with the outward connections will then be added using conventional thin-film lithography processes. While the first demonstrator of an ultra-thin film package in EnSO will be based on flip-chip technology, the next generation will make use of film packages with microchips in a face-up configuration.

New chips for energy harvesting

The project is also producing various microchips for the realization of self-powered energy harvesting systems. A high-efficiency voltage converter with an extremely low start-up voltage allows thermoelectric generators to be used with even the smallest temperature differences. Another energy management ASIC combines charging and monitoring circuits for micro-batteries and super capacitors as well as a wide range of energy management functions that allow operation of conventional wireless sensor systems with energy sources from the environment. In order to significantly increase the bandwidth and thus the area of application of energy harvesting systems of this nature, the research team is also developing electronic circuits to adjust the resonance frequency of vibration harvesting systems.

The project is being funded by the ECSEL initiative within Horizon 2020, the EU framework program for research and innovation, and the German Federal Ministry of Education and Research (BMBF).



Chip package on system film.
© Fraunhofer EMFT

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CT makes the inner workings of the outwardly unassuming box trumpet visible. © Fraunhofer EZRT

Looking into a basset horn

As part of the MUSICES project, 3D computed tomography (CT) is being used to X-ray historical musical instruments from the collection at the Germanisches Nationalmuseum in Nürnberg. For the first time, they are drawing up a guideline for producing optimum images and measurement results. The results will be published on the Internet.

Looking inside a violin, fortepiano, basset horn, or similar instruments provides us with a solid foundation for determining the condition of an instrument – for restorers, conservators, musicians, museum educators, and instrument makers these images are thus invaluable. Currently, however, there are no measuring standards as to the best way to examine historical musical instruments using 3D computed tomography. To fill this gap is precisely the aim of the research project MUSICES: researchers at the Fraunhofer Development Center for X-ray Technology EZRT – a division of the Fraunhofer Institute for Integrated Circuits IIS – are, in tandem with the Germanisches Nationalmuseum in Nürnberg and the chair for X-ray microscopy at the University of Würzburg, developing guidelines that museums around the world can use to digitize various classes of instruments with comparable image quality.

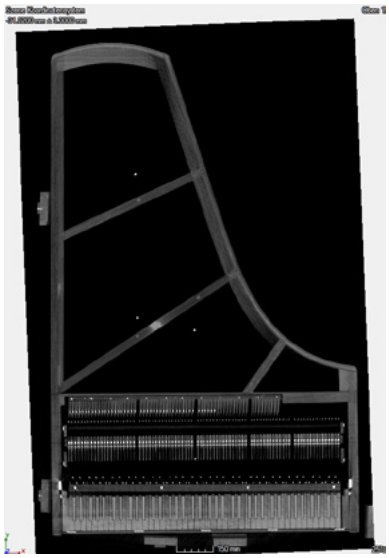
Complex interaction

This is no trivial matter: a large number of parameters such as the radiation dose, exposure time, measurement distance, measurement duration, composition of the CT system, and algorithms for calculating the 3D data records must all be taken into account. During the examination, the objects are positioned on a rotary table between the X-ray source and the detector. A specially developed bracket fixes the instrument tightly in position. The X-rays penetrate the rotating object; depending on material thickness and density, different radiation doses are required. The scan can be a time-intensive matter – X-raying a violin in full, for example, with a resolution of less than 50 µm can take up to 20 hours. The CT system creates thousands of individual images that, when put together, create a three-dimensional picture.

Virtual museum online

The digital images will contribute to a type of virtual online museum, making these valuable instruments accessible to everybody. Most of these highly sensitive original pieces are stored in underground vaults – the Germanisches Nationalmuseum alone has an inventory of over 2500 old instruments.

More than 100 instruments from previous centuries have already been digitized by the team, from the box trumpet to the mouth organ and the square piano. The virtual museum will include all the CT data, but also a detailed documentation of the measuring procedure, including all its steps. In the medium term, the experiences and lessons learned from the project can be transferred to other cultural assets such as e.g. scientific instruments like telescopes.



X-ray image showing the inner workings of a fortepiano. © Fraunhofer EZRT

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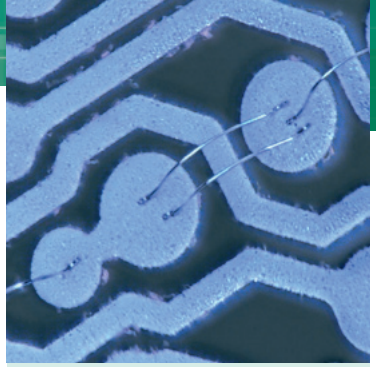
Thick aluminum for packaging



Oblique light microscope image of structured Al with four 18 µm wire bonds. © Fraunhofer ENAS

The Fraunhofer Institute for Electronic Nano Systems ENAS, in cooperation with several partners, has developed a process for the deposition of thick aluminum layers (Al layers) on circuit boards, silicon, and ceramic substrates. Electrochemical deposition from ionic Al allows the manufacture of layer thicknesses of over 1 µm. These layers can be used as a conducting path and as a bond pad for wire-bond contacts.

Why aluminum?

Over the last few years, aluminum (Al) as a material for electric wires has been replaced by copper (Cu) in many areas of everyday life. The electrical and heat conductivity of Al is lower than that of Cu, but Al's ratio of density to conductivity is better. With Al, you need a 40 % thicker layer in order to be able to conduct the same quantity of electricity as with Cu, but the Al layer is 50 % lighter.

One additional advantage is Al's wire-bonding capability. This saves not only Cu, but also the typical nickel-gold or nickel-palladium-gold finishing metallizations. Al also maintains a stable price and offers better physical and machining properties. The aim is to reduce the use of copper and subsequent finishing metallizations in order to conserve valuable raw materials and to make circuit boards lighter.

Requirements of the process

The circuit board industry is dominated by medium-sized companies that need a smooth process. Galvanization, as a robust and established coating technology, is indispensable for circuit boards. That is why the Al coating also needs to be formed using a galvanic process. Aqueous solutions are unsuitable for Al deposition as Al has a more negative reduction potential than water and thus water decomposition would occur earlier. The idea for the procedure is based on the recognition that ionic liquids offer a way to deposit Al. The process has been described frequently in the literature over the last 20–25 years, but an application has yet to be found.

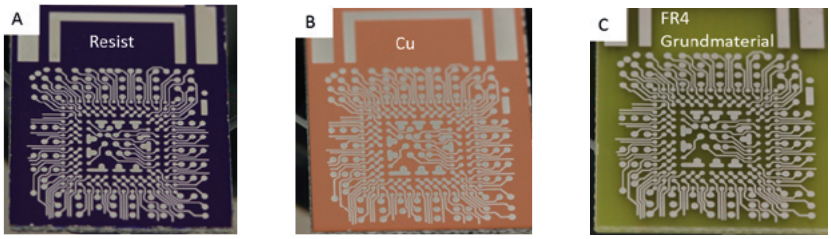
Process sequence and characterization

For the manufacture of conductor paths, a Cu-clad standard circuit board with a structured photoresist is used to begin with. In the open structures, Al is galvanically deposited on the Cu seed layer. The photoresist is then removed and the Cu is etched. Detached Al structures are left behind. The layer thicknesses are around 25 µm.

Wire bonding is easily possible with both thin and thick wires with the Al layers.

Outlook

The deposition processes must now move to a higher level. We need to move away from samples that are only 2 × 5 cm² to realistic sizes such as a credit-card format of approximately 5 × 8,5 cm². In order to really remove Cu from circuit boards, Al cladding will be required. To make this a reality, further-processing methods need to be worked out. Vias of up to 200 µm in diameter have been demonstrated to be possible, but only with a Cu starting layer. This layer also needs to be replaced, e.g. with graphite or electrically conductive polymers. The next steps will then be to develop appropriate packaging in order to attain an Al circuit board flexibility comparable to existing Cu circuit boards.



Processing sequence for manufacturing thick aluminum structures. © Fraunhofer ENAS

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A ball with hidden features. A very robust housing protects the sensors against the high pressure in the compressed silage.
© Fraunhofer IZM

Autonomous sensor nodes: live from inside the silo

Good silage is truly the basis for efficient biogas production. Thanks to autonomous sensor nodes from Fraunhofer IZM, it is now possible to monitor data from directly inside a silo and thus to keep an eye on the ensilage process.

Ensilage is a tried-and-tested method of using fermentation to make substrates (usually corn) durable for biogas plants. The crushed plant material is placed in the silo and compressed; the silo is then sealed airtight in order to prevent the spread of anaerobic microorganisms such as bacteria, yeasts, or fungi. Lactobacilli, on the other hand, are very happy in this environment and turn into acids (most lactic acid) due to the presence of sugar. The better the ensilage process, the more efficiently biogas can be produced.

Detecting disturbance variables early

Previously, there have not been any suitable methods to monitor the entire process from starting up the silo to removing the finished silage. Researchers at the Fraunhofer Institute for Reliability and Microintegration IZM have developed a seamless monitoring system together with the Julius Kühn Institute (JKI) and Esys GmbH. Autonomous sensor nodes make it possible, for the first time, to collect measurements directly inside the silo and to use this method to monitor critical parameters such as silage density when the silo is started up. Disturbance variables during the ensilage process and after removal can be detected early, before the quality of the silage is affected. The team used pretests to determine suitable sensors for measuring pH value, temperature, and density as well as designing a low-energy signal processing system and developing an extremely robust housing that can both withstand the high pressures inside the compressed silage and hermetically seal the outward sensors from the sensitive electronics. Project staff from the JKI developed a model silo for the sensor calibration.

Connection to established harvest management software

The communication concept includes a wireless connection between the sensor nodes and an Internet bridge equipped with a cellular network connection that forwards the data to a web server with a database. This system is being developed by Esys GmbH. The results can be called up using a web API. An Android app for mobile use offers geographic online representation of the measurements. The use of a software standard that is common in harvest data management also ensures that the sensor data can later be integrated into established agricultural software solutions and thus put into practical use straight away. After the first successful sensor tests, a practical test within the real operation of an ensilage cycle is imminent.

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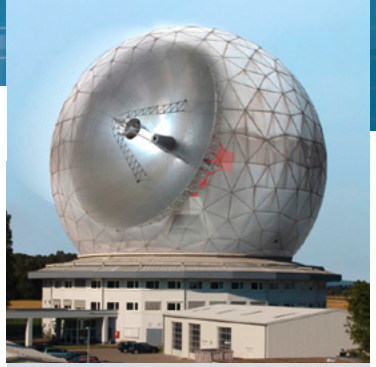
Sensor system for monitoring of the ensilage process in biogas production. © Countrypixel



Fraunhofer FHR's space observation radar TIRA. © Fraunhofer FHR

Fighting against dangerous space debris

Fraunhofer FHR has developed new methods to precisely determine the inherent rotation of damaged satellites – which will help support future de-orbiting missions, i.e., deliberately destructive re-entries of defective satellites into the atmosphere.

It is important to be able to control damaged satellites as, if they are uncontrolled, they present a hazard to all space travel. Since April 2012, one of the largest space vehicles – the European environmental satellite ENVISAT – has been orbiting the earth, unable to maneuver. ESA is therefore currently looking for solutions to move ENVISAT into a lower orbit and to allow it to burn up in the earth's atmosphere in a controlled manner. This de-orbiting mission will only be successful if the satellite's inherent rotation can be correctly determined beforehand.

The research team at Fraunhofer FHR will support future de-orbiting missions by the space observation radar TIRA. The raw radar data concerning ENVISAT and recorded by TIRA will be processed and evaluated using the unique methods developed at Fraunhofer FHR. This will allow the orientation and inherent rotation of space objects to be analyzed, a durable forecast to be made thereof, and potential external damage to satellites to be investigated efficiently.

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Supply chain analytics

The digitalization of industrial processes is presenting today's companies with significant and diverse challenges. In addition to technical issues – such as data collection, data transmission, data storage, and data analysis – strategies and organization need to be re-aligned. With Supply-Chain-Analytics, Fraunhofer SCS helps companies to get new insights from their data and to apply this knowledge to the development of data-driven business processes.

Methods and objectives

- **Descriptive analytics** processes historical or real-time data within a supply chain in order to track material movements and events, for example, or to determine key figures.

- **Predictive analytics** evaluates current processes and events within a supply chain using models that have been derived from historical data. This allows prediction of critical situations such as transport delays or customer demands for capacity planning.

- **Prescriptive analytics** provides actions and measures for the future planning and control of a supply chain (e.g. MRP parameters, storage locations). Models based on historical data – often combined with mathematical optimization are needed for prescriptive analytics.

SCS library for analytics use cases

The starting point for an analytics project is identifying and selecting relevant use cases to support logistical business processes. To support this selection process, Fraunhofer SCS has developed a library for analytics use cases. The library is based on a comprehensive study within scientific databases and specialist trade journals as well as the development of a classification scheme.

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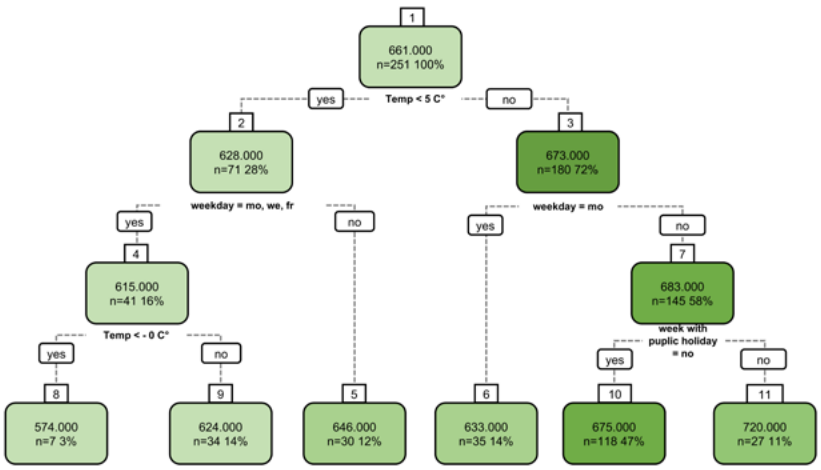

Decision trees can be used to predict transport volumes. © Fraunhofer SCS

Virtual testing of the RobustSENSE software. © Fraunhofer FOKUS

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Highly automated driving in any weather

For humans, the weather on the road can often present a great challenge. Reliable perception of the road situation at all times is just as critical for highly automated vehicles, too. In the European project RobustSENSE, researchers from Fraunhofer FOKUS along with 14 partners from industry and science have developed a software platform that can be used by vehicles to generate a reliable view of the road situation in all weathers.

In order to build up a picture of the situation, the vehicle accesses highly accurate HD maps, combined data from the vehicle's own sensors such as cameras, lasers, or radar and further information like weather data. That is why RobustSENSE includes a software platform that combines and analyzes data from various sources. The platform can recognize obstacles on the road even if visibility is impaired by strong sunlight or heavy precipitation.

The vehicle's evasive maneuvers are then adapted individually to the weather and road conditions.

The system has already proved itself in the virtual simulation environment VSimRTI from Fraunhofer FOKUS. Practical tests in cities and on the freeway have been ongoing since fall.

Environmentally friendly anti-fouling paint for ships

Algae, barnacles, and mussels are like stowaways in shipping. These often attach themselves to the hull of anchored ships; they increase flow resistance and they damage the material. Biofouling, as it is known, can significantly increase fuel consumption, which in turn results in higher costs and pollutant emissions. Fraunhofer IMWS, together with the Helmholtz Centre for Environmental Research UFZ and three partners from industry, have developed a special paint that is intended to remedy this problem. The innovative paint comprises several layers through which a weak direct current of 0.1 mA is conducted. The outermost layer of paint alternately acts as the anode and the cathode, meaning that oxygen and then hydrogen form on it. The resulting pH stress around the ship makes the hull unattractive for water organisms. Biofouling processes can thus be prevented in a completely environmentally friendly way.

So far, the anti-fouling paint has been successfully tested in a long-term trial using test rods and in an initial ship trial. The next step is to transfer the paint to an industrial scale. To this end, a modern test rig will be set up in the Baltic Sea. An exhibit of this anti-fouling technology has been available for viewing since November at the exhibition grounds of the Heidelberg Zoo.

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Test rods in the test aquarium: the new anti-fouling paint prevents organism coverage when a direct current is applied.
© Fraunhofer IMWS

Characterization of the reliability of integrated circuits (ICs).
© Fraunhofer IIS/EAS, Katharina Knaut

Modular toolkit for More-than-Moore electronics

In order to make microelectronics even more intelligent, manufacturers rely on integrating an increasing number of functions into chips of decreasing size. When it comes to these "More-than-Moore" technologies, no single site exists yet in Europe where customers can find everything necessary for the production of small series.

This is where the European project ADMONT – which also includes Fraunhofer IIS/EAS as a member – comes in. The objective is, by 2019, to create pilot lines for these technologies in and around Dresden, making them available to companies from various industries for their product development work. According to the modular design principle, they should be able to use either individual modules or entire manufacturing chains.

Researchers at Fraunhofer IIS/EAS are responsible for guaranteeing the quality of the microchips that are produced. At the midpoint of the project, they have already developed the initial models for simulations that realistically represent the components' future behavior. The work is intended to assist the integrated-circuit designers in coming up with systems that function robustly and reliably for long periods. After that, the models are to be refined further and supplemented with additional ones. This will allow the pilot lines to be used for customers with particularly individual requirements in the future.

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Artificial sphincter system with microfluid actuators

Incontinence is among the most common ailments – approximately 8 million people suffer from it in Germany alone. Together with DUALIS MedTech GmbH, Fraunhofer EMFT is working on a new artificial sphincter technology, which allows a combination of diagnostics and therapy (theranostics). As with passive systems, the sphincter function is realized by opening and compressing the urethra using a fluid-filled cuff. In contrast to traditional methods, the quantity of hydraulic fluid in the cuff – and thus the closure function – is not controlled manually, but by the interaction of active microelectronic components: a micropump is responsible for emptying, a microvalve for filling the cuff. Both components are currently being developed at Fraunhofer EMFT. The actuators meet essential requirements such as high flow rates, fast reactivity, small size, and low energy consumption. The new developments must be both corrosion-resistant and MRI-capable.

The pressure control algorithm ensures that the pressure is automatically readjusted when the threshold values in the cuff and/or reservoir are exceeded – for example, at unforeseen stresses such as coughing or laughing – so that continence is ensured at all times. Using a programmer, the attending physician can adjust the tissue-defying normal pressure at any time, wirelessly without surgery. The patient can also manually adjust the cuff pressure with a remote control (for example, by means of predetermined modes such as sports or night mode).

The development is supported by the Bavarian Research Foundation. Fraunhofer EMFT presented the current development level of the sphincter system at this year's Compamed trade fair.

Stainless steel micropump from Fraunhofer EMFT.
© Fraunhofer EMFT / Bernd Müller

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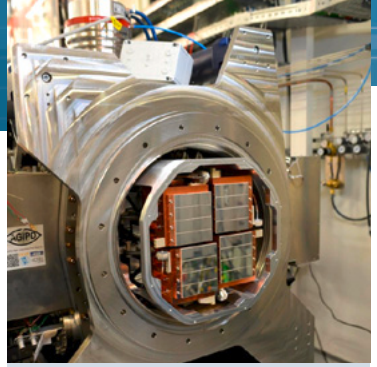

SPB camera on the XFEL with modules built at Fraunhofer IZM. © A. Allahgholi – CFEL

Camera components for the most powerful X-ray laser

What is the structure of the Alzheimer's protein? What happens in the body when cancer cells develop? Searching for the answers to questions like this leads researchers deep into the nano-cosmos. With the European XFEL, the world's most powerful X-ray, entirely new possibilities are opening up for science. On September 1st, the device – which is more than 3 km long – was officially approved for research. It took an international team – including scientists from Fraunhofer IZM – eight years to develop the new technology.

The European XFEL will allow research groups to decode the three-dimensional structure of biomolecules and to analyze synthetic materials. The X-ray laser takes snapshots of the molecules by producing extremely bright and ultra-short light flashes – up to 27,000 times a second – 200 times more than other X-ray lasers. Strung together the images produce entire films, which can be used to research biochemical and chemical processes. As part of their participation in the European XFEL consortium, Fraunhofer IZM took on manufacturing of the modules for the SPB camera whose uses include the analysis of biomolecules. The Berlin-based research team deposited micrometer-sized solder balls to silicon wafers and then bonded 16 electronic read-out chips onto each of the 11 × 3 cm² X-ray-sensitive silicon sensor chips. This makes them the largest detector modules that have ever been assembled at the institute. The Fraunhofer researchers have already completed 20 camera modules for the European XFEL. The radiation produced by the X-ray laser, however, places a considerable stress on the modules. That is why the researchers are working on assembling up to 100 units.

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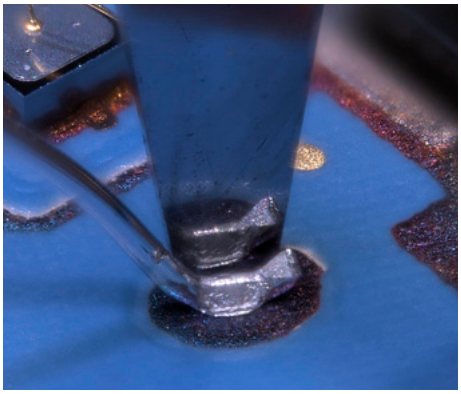
New evaluation criteria for heavy-wire bond contacts

For components in the micrometer range, engineers are placing their trust in new materials – particularly in the case of wire bond contacts that can be found in chips, electronic components and electrical connections, where they connect circuitry.

Heavy-wire bond technology is used for contacting power semiconductors in the areas of alternative energy generation and the electrification of vehicles. New types of aluminum wire materials and heavy copper wires with an aluminum coating are being used more and more: they are corrosion-resistant, ultra-high strength, and more heat-resistant, and they have a service life that is up to ten times longer.

To check the quality of the connection, mechanical tests such as pull and shear tests are carried out. The initial development and refinement of wire materials and changes to the mechanical properties exert additional effects on the test results. The interpretation of the test results and the evaluation criteria previously applied for classifying the bond quality need to be adapted. Within the current research project, entitled "Correlation of shear test results and reliability of fine-crystalline aluminum-based heavy-wire bond contacts", Fraunhofer IMWS and Fraunhofer IZM are developing a fundamental knowledge base regarding the microstructure property relationships of the bond contacts. This is a requirement for the definition of generally applicable assessment and evaluation guidelines.



Shear chisel positioned behind an aluminum heavy-wire contact. The shear test is the standard method for inspecting the bond quality of heavy-wire contacts. © XYZtec

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The project is being funded by Germany's Federal Ministry of Education and Research (BMBF). The project executing organization is the German Federation of Industrial Research Associations (AiF).

LTE and the compression standard HEVC mean that long loading times for mobile video viewing are a thing of the past. © Fraunhofer HHI

Primetime Engineering Emmy Award for HEVC

From left to right: Prof. Dr. Thomas Wiegand (Executive Director at Fraunhofer HHI), Benjamin Bross, and Dr. Detlev Marpe with their Emmy. © Fraunhofer HHI

Fraunhofer HHI is excited to have received a very special prize from California. On October 25th, the Berlin-based institute, together with its partners from the Joint Collaborative Team for Video Coding (JCTVC), was presented with the Primetime Emmy Award in Hollywood. The prize was awarded for the development of the High Efficiency Video Coding (HEVC) standard. HEVC allows efficient transmission of videos in Ultra High Definition (UHD).

This standard has become the primary transmission format for 10-bit UHD videos and it supports the relevant high dynamic ranges and extended color spaces. The new standard is used for almost all UHD television transmission channels, including antenna, satellite, cable, fiberglass, and cable-free television. To this end, HEVC is supported by almost all UHD TV-capable devices, including television sets, tablets, and cellular phones. HEVC balances a high level of compression, HDR processability, low complexity and power consumption, and is thus suitable for a very wide range of applications.

The Primetime Emmy Engineering Award is presented for ideas, solutions, and applications within the area of engineering. The jury's criterion is that existing processes be enhanced or that the processes significantly improve television transmission, recording, or reception.

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Ultrasound sensors make forage harvesters more reliable

During harvest season, some harvesting machinery is in use round the clock. To avoid expensive interruptions and guarantee a high level of productivity, researchers at Fraunhofer IZFP have developed a quality assurance system for forage harvesters. The semi-automatic high-performance testing technology LinScanDuo 2.0 uses ultrasound technology to test weld seams on blade holders, which are particularly subject to wear and tear. At 1200 rpm and more than 300 metric tons of harvested crop per hour, the cutting cylinders or cutterheads with their weld-on blade holders are exposed to enormous mechanical loads.

The LinScanDuo 2.0 is based on scanning phased-array electronics. Together with the software designed for the inspection system, the quality of 100 percent of the weld seams on each cutterhead can be automatically inspected, analyzed, and documented comprehensively in digital format. The advantages of phased-array technology include a very high testing rate with simultaneous, complete capture of the test volume and the flexible adaptation of the testing system to the blade holders without time-consuming adjustments. The scanning process of both weld seams is cycled electronically, eliminating the need for the sensor/test head or the test object to move. Inspecting the weld seam quality, a process that used to take about four hours per cutterhead, now takes less than 20 minutes.

The testing system is already being used successfully at the Zweibrücken plant of John Deere, the U.S.-based world market leader in agricultural technology.

Weld seam testing on the blade holder of a John Deere forage harvester using LinScanDuo 2.0. © Fraunhofer IZFP / Uwe Bellhäuser

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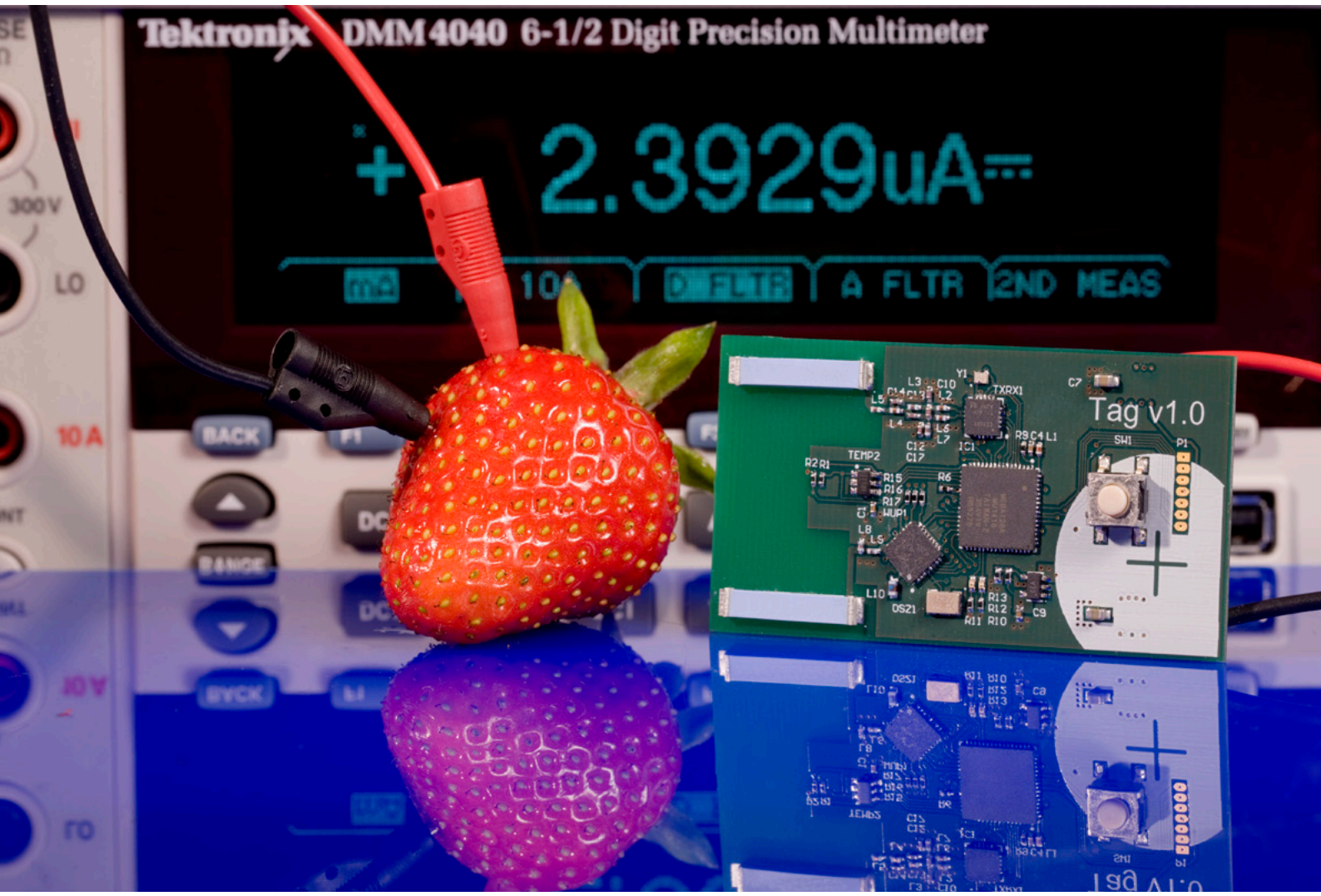

A radio receiver that requires so little energy that it can be powered by a "strawberry battery" – our photo shows the wakeup receiver developed by Fraunhofer IIS. The receiver uses so little power that it only requires one thousandth the electricity of an LED. The technology is used, for example, in wireless sensor networks or in building automation, but also for locating moving objects within buildings. © Fraunhofer IIS / Kurt Fuchs

Editorial notes

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The Fraunhofer Group for Microelectronics, founded in 1996, combines the expertise of 18 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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..... today goes to Dr. Eng. Stephan Guttowski from the FMD

Dr. Eng. Stephan Guttowski.
© Fraunhofer IZM / MIKA-fotografie Berlin

About Stephan Guttowski:
Dr. Eng. Stephan Guttowski studied electrical engineering at TU Berlin, focusing on measuring and automation technology, and then went on to do a doctorate in electromechanical compatibility. He then did a post-doc at the Massachusetts Institute of Technology (M.I.T.) in Cambridge. After returning to Germany, Guttowski first worked in the electric drive research lab at DaimlerChrysler AG and, in 2001, moved to the Fraunhofer Institute for Reliability and Microintegration IZM. Here, he was initially chairman of the Advanced System Development group before taking over the System Design & Integration department. Since June 2017, Guttowski has been technology park manager in the FMD and, within this role, works towards cross-institute cooperation.

Dr. Guttowski, the Research Fab Microelectronics Germany FMD has now existed for some months. What experience have you been able to garner so far?

I have become more familiar with the diversity within the Fraunhofer-Gesellschaft. I wasn't all that aware of it and it really impressed me. I have also learned how much Fraunhofer know-how is to be found in our daily lives – e.g. in white LEDs. These were invented by the Fraunhofer Institute for Applied Solid State Physics IAF (and, simultaneously, by the Japanese firm Nichia).

You are the technology park manager for heterointegration in the FMD. What does the term refer to?

Heterointegration refers to technologies that allow us to merge different components in a single product. The individual components differ in various properties such as size and material and each needs to be handled in a certain way. It's therefore important to find ways to use these different components in one product.

What are your duties in connection with this position?

First of all, I visit the ten institutes that are part of my technology park. I use our setup workshops to gain a better overview of the technologies on offer and also to get to know my colleagues. Together, in the second step, we define the interfaces between the individual process steps. The third step is developing a joint offering from all ten institutes for our project partners in industry and science.

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

My aim is to develop a complete heterointegration offering that is fully coordinated and ready for the future.

Which of the projects being worked on by your colleagues in other Fraunhofer institutes interests you in particular?

I have seen some amazing technologies at every institute. Some examples include the projectors from the Fraunhofer Institute for Silicon Technology ISIT in Itzehoe. Our colleagues there have been developing and manufacturing silicon micromirrors that can be used to deflect a laser beam very quickly. For the projectors, a mirror plate with a diameter of around 1 mm is suspended on two axes by means of springs that are only a few micrometers wide. This can be moved back and forth up to 70,000 times per second to deflect a laser beam both horizontally and vertically. Actuating a red, a green, and a blue laser source synchronously with the mirror movement makes it possible to project high-definition images. Projectors like this can be used as head-up displays in automobiles, for example. This development combines so many technical challenges – it's just crazy!

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

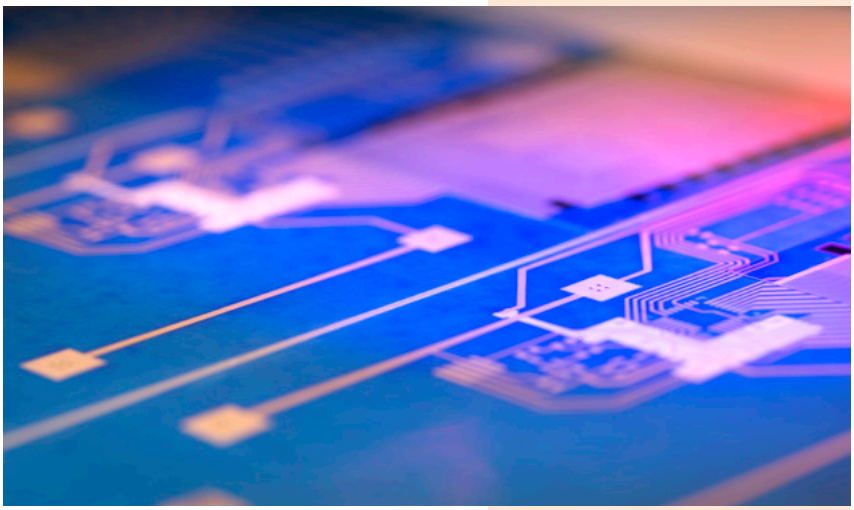
As an amateur yachtsman, I very much appreciate the GPS system – it makes navigating on the open seas much safer.

What do you wish you had more time for?

I wish I had more time to read – the stack of books at home is growing all the time.

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

Behind every person is an exciting story, and it's particularly nice when you get to hear it.



The focus of heterointegration is on merging all devices and components within a system to form a functioning unit.
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