Microelectronics News

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Introducing the "Research Fab Microelectronics Germany"

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Institutes in the Fraunhofer-Gesellschaft and two Leibniz institutes are bundling their expertise. What they want to achieve is to strengthen and build on the technology locations of Germany and Europe for microelectronics and nanoelectronics. Our photograph shows Prof. Hubert Lakner, chairman of the Fraunhofer Group for Microelectronics with his Leibniz colleagues Prof. Günther Tränkle (l) and Prof. Bernd Tillack (r).
»» page 4

■ From the institutes

A monitoring system that can hear production errors

In industrial production, the testing of machines and products by means of acoustic signals still takes a niche role. Researchers at Fraunhofer IDMT have developed a cognitive system that can hear erroneous sounds more objectively than human hearing. The technology was proved in initial practical tests, in which it detected up to 99 percent of the errors.

»» page 6

■ From the institutes

Micro-energy harvester for self-sustaining, integrated chip systems

Fraunhofer IPMS is starting the two-year CONSIVA research project focusing on the development of micro-energy harvesters for self-sustaining, integrated chip systems. The use of novel piezoelectric materials in vibration-based harvesters can drastically reduce their size and significantly prolong operation time.

»» page 11

■ Short news

Nondestructive cable monitoring in nuclear power plants

»» page 12

■ Short news

Keeping an eye on all the tools

»» page 13

■ Short news

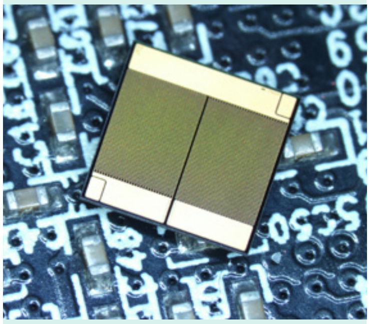
New measuring method to regulate quick-curing processes

»» page 14

■ The last word …

… goes to Prof. Nina Kloster from the Fraunhofer-inHaus-Center

»» page 16



Efficient and compact voltage converters are setting new standards for electromobility. © Fraunhofer IAF
» page 3

Because tomorrow, today will be yesterday.
© Christian Klant / Fraunhofer IISB
» page 8 / 9

■ Content:

Events

Date	Event / WWW	Location	Group institutes involved
08/28 – 08/31	International Symposium on Wireless Communication Systems ISWCS www.iswcs2017.org	Bologna, Italy	FOKUS
09/04 – 09/07	European-American Workshop on Reliability of NDE www.nde-reliability.de	Potsdam, Germany	IZFP
09/07 – 09/09	International Conference on Simulation of Semiconductor Processes and Devices SISPAD www.sites.google.com/site/sispad2017	Kamakura, Japan	IISB
09/10 – 09/13	23rd Soft Magnetic Materials Conference SMM http://smm.us.es	Sevilla, Spain	IZFP
09/12 – 09/14	The Battery Show www.thebatteryshow.com	Michigan, USA	ISIT
09/13 – 09/15	ISPA 2017 | International Symposium on Piezocomposite Applications www.ikts.fraunhofer.de/en/communication/events/ispa_2017.html	Dresden, Germany	IKTS
09/14 – 09/19	IBC 2017 https://show.ibc.org	Amsterdam, Netherlands	Group Institutes
09/17 – 09/21	European Conference on Optical Communication ECOC www.ecoc2017.org	Gothenburg, Sweden	HHI
09/25 – 09/29	ION GNSS+ www.ion.org/gnss/index.cfm	Portland, USA	IIS
09/25 – 09/29	OpTecBB Summer School Photonic Integration www.optecbb.de/lang/en/home.php	Berlin / Fraunkfurt (Oder), Germany	HHI, IZM
09/26 – 09/28	Future Security www.future-security.org/en.html	Nuremberg, Germany	Group Institutes
10/01 – 10/05	Euro PM2017 www.europm2017.com	Milan, Italy	IKTS
10/01 – 10/06	Gettering and Defect Engineering in Semiconductor Technology GADEST www.gadest2017.com	Georgia, USA	IISB
10/04 – 10/06	MEMS Sensing & Network System www.mems-sensing-network.com/en/index.html	Chiba, Japan	ENAS
10/08 – 10/13	European Microwave Week www.eumweek.com	Nuremberg, Germany	FHR, IAF
10/10 – 10/12	it-sa 2017 www.it-sa.de/en	Nuremberg, Germany	AISEC
10/15 – 10/18	Global Wireless Summit (GWS) www.gwsummit2017.org	Cape Town, South Africa	FOKUS

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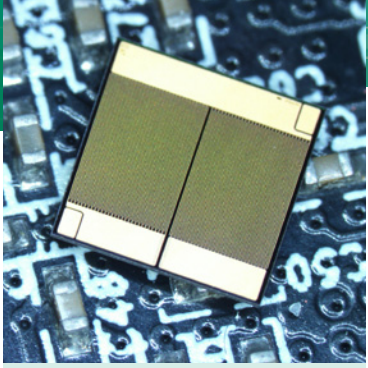

Monolithically integrated half-bridge circuit from Fraunhofer IAF.
© Fraunhofer IAF

Efficient and compact voltage converters are setting new standards for electro-mobility

By 2020, it is intended that there be a million electric vehicles on Germany's roads. In order to fulfill this target set by the federal government, the possibilities offered by e-mobility must be improved. With the development of an innovative half-bridge circuit, Fraunhofer IAF has been able to take an important step in this direction.

Half-bridge circuits are the core of many voltage converters. These converters are the link between voltage supply and consumers – and they are becoming more widespread due to the increase in the number of electrical devices. The energy transition and e-mobility are also increasing the demand for reliable and, above all, efficient and compact voltage converters of all kinds.

Technical innovations for half-bridge circuits

The half-bridge circuit developed by the Fraunhofer Institute for Applied Solid State Physics IAF is designed for the 600-volt class, which is a standard for various devices ranging from tablets and washing machines to the electric car. This circuit was the first time that several high voltage components could be combined monolithically on a single chip. This allows for particularly small and powerful voltage converters. In tests, it was possible to increase the switching frequency to up to 3 MHz at 400 V input voltage, which is about ten times the frequency of conventional circuits. This also considerably reduces the effort required for packaging. "This is very important in areas such as e-mobility, where many converters which are as efficient as possible have to be fitted in very little space," says Richard Reiner, research associate at Fraunhofer IAF in the Power Electronics business unit.

The basic material, the semiconductor gallium nitride (GaN), is cost-effective to manufacture and offers excellent performance figures compared to the competing power semiconductor silicon carbide. The GaN technology used has already proved itself with powerful transistors, diodes, and monolithically integrated GaN circuits.

Potential uses in e-mobility

Based on the new half-bridge circuit, the smallest and most efficient on-board chargers possible are now to be developed. These will allow electric cars to be even lighter and more economical in the future – which is exactly what automobile manufacturers and users are looking for. The compact design also improves the electrical switching characteristics by, for example, reducing line impedances. Integrating additional sensors, such as thermal monitoring systems, also allows optimized operation.

"This innovative approach brings a new level of power density, efficiency, robustness, functionality, and reliability to e-mobility," explains Dr. Patrick Waltereit, deputy head of the Power Electronics business unit at Fraunhofer IAF.

Fraunhofer IAF last publicly demonstrated its monolithically integrated half-bridge circuit at PCIM Europe in May.

E-mobility is causing an increased demand for efficient and compact voltage converters.
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Introducing the "Research Fab Microelectronics Germany"

Handing over the grant approvals on April 6, 2017, Federal Research Minister Prof. Johanna Wanka dropped the starter's flag for the Research Fab Microelectronics Germany. In this research fab, institutes within the Fraunhofer-Gesellschaft and the Leibniz Association pool their expertise in order to strengthen and build on the technology locations of Germany and Europe for microelectronics and nanoelectronics.

German microelectronics research is moving closer together – the Federal Ministry of Education and Research is investing 350 million euros in infrastructure expansion

As part of the new technology pool known as the Research Fab Microelectronics Germany, for the first time, eleven institutes in the Fraunhofer Group for Microelectronics and two Leibniz institutes (FBH and IHP) are bundling their expertise in order to reach and expand on a new quality in research, development, and (pilot) manufacture of semiconductor-based microsystems and nanosystems. Consistent pooling of joint know-how will make it possible to offer customers from heavy industry, small and medium enterprises, and universities the entire value-creation chain for microelectronics and nanoelectronics from a single supplier. "A year and a half ago, the Fraunhofer Group for Microelectronics presented a strategy for long-term renewal of microelectronics infrastructure. With the two Leibniz institutes on board, this strategy has now been developed into an overall concept to provide Germany's microelectronic research facilities that work closely with industry with the equipment they need," says Prof. Hubert Lakner, chairman of the Fraunhofer Group for Microelectronics. The Federal Ministry of Education and Research (BMBF) supports the necessary investment to the tune of around 350 million euros over the next 3.5 years.

Four technology domains for electronic system development

The Research Fab Microelectronics Germany is organized into four "technology parks." Having a knowledge edge in these future-relevant domains of technology is a basic requirement for enabling Europe and Germany to secure their position among international competition.

- Technology park 1: The latest "Silicon-based Technologies" for sensor technology, actuation systems, and information processing technology
- Technology park 2: "Compound Semiconductors" with modern materials for power-saving and communications technology
- Technology park 3: "Heterointegration" – the latest combinations of silicon and other semiconductors; for example for the Internet of Things
- Technology park 4: "Design, Test and Reliability" for design and design methods, quality, and safety and security

Taking advantage of successful developments

One example of the type of cooperation in question is the joint development of monolithically integrated spatial light modulators between the Fraunhofer Institute for Photonic Microsystems IPMS in Dresden and the Fraunhofer Institute for Microelectronic Circuits and Systems IMS in Duisburg. Spatial light modulators are made up of an arrangement of micromirrors on a semiconductor chip, the number of which currently varies from between a few hundred up to several million mirrors per chip, depending

The institutes involved in the Research Fab Microelectronics Germany are:
Fraunhofer Research Institution for Microsystems and Solid State Technologies EMFT in Munich • Fraunhofer Institute for Electronic Nanosystems ENAS in Chemnitz • Fraunhofer Institute for High Frequency Physics and Radar Techniques FHR in Wachtberg • Fraunhofer Institute for Telecommunications, Heinrich Hertz Institute, HHI in Berlin • Fraunhofer Institute for Applied Solid State Physics IAF in Freiburg • Fraunhofer Institute for Integrated Circuits IIS in Erlangen, Dresden and Ilmenau • Fraunhofer Institute for Integrated Systems and Device Technology IISB in Erlangen • Fraunhofer Institute for Microelectronic Circuits and Systems IMS in Duisburg • Fraunhofer Institute for Photonic Microsystems IPMS in Dresden • Fraunhofer Institute for Silicon Technology ISIT in Itzehoe • Fraunhofer Institute for Reliability and Microintegration IZM in Berlin and Moritzburg • Ferdinand-Braun-Institut, Leibniz-Institut für Höchstfrequenztechnik (FBH) in Berlin • Leibniz Institute for Innovations for High Performance Microelectronics (IHP) in Frankfurt/Oder

Federal Research Minister Prof. Johanna Wanka hands over the grant approval to Prof. Hubert Lakner, chairman of the Fraunhofer Group for Microelectronics.
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The BMBF-funded Research Fab Microelectronics Germany is a measure to accompany the Important Project of Common European Interest (IPCEI) applied for jointly by Germany, France, Italy, and the United Kingdom. © Fraunhofer IPMS

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on the application. The individual mirrors, which vary in size depending on the application, can be tipped or lowered individually. This allows the creation of a planar pattern that can be used, for example, to project defined structures. High-resolution adjustable-mirror arrays with up to 2.2 million individual mirrors are used by customers as highly dynamic programmable masks for optical micro-lithography in the UV range. Other fields of application can be found within mask inspection and measuring technology for the semiconductor industry, in microscopy, and in laser inscription, laser marking, and laser material processing. One important technological aspect in the development of the individual mirrors is to be found in the monolithic integration of the micromirrors as what is known as a back-end-of-line module in a CMOS process used for the direct actuation of the micromirrors.

This product, which is being manufactured within the Research Fab Microelectronics Germany in a small series as part of an industrial cooperation, uses the potential offered by two clean rooms. For the manufacture of the CMOS backplane on 200 mm wafers – i.e. the carrier wafers with control electronics – the front-end-of-line CMOS process developed by Fraunhofer IMS in Duisburg is used. The micromirrors themselves are set up at Fraunhofer IPMS in Dresden with the micromirror process directly on the carrier wafers in the back-end-of-line. Only thanks to this combined use of both pilot lines could the technology be transferred from the original 150 mm technology from Fraunhofer IPMS to 200 mm silicon substrates.

To a successful cooperation: as part of the kick-off event, chairman of the Fraunhofer Group for Microelectronics Prof. Hubert Lakner exchanged the contracts of cooperation with his Leibniz colleagues Prof. Günther Tränkle and Prof. Bernd Tillack.
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Technology park managers – internal coordinators. Program managers – customer contacts

Even with the jointly organized operation of the Research Fab Microelectronics, the existing locations of the institutes will be retained. New models of cooperation are required. The expansion of the research institutions spread across Germany and joint operations are coordinated and organized in the Berlin business office. The overarching cooperation of the four technology parks will take place in close consultation between the program managers and the technology park managers.

The technology park managers will look after the technology parks from a content, coordination, and strategic point of view. They are the central contacts for cross-location coordination of the design and process chains, as well as measuring and testing technology. They will work very closely with their contacts at the individual locations. The program managers act as an interface with the application. They will look after the application topics of the Research Fab Microelectronics Germany while also being the central contacts for customers.

New perspectives, particularly for small and medium enterprises

The establishment of the Research Fab Microelectronics Germany will be a unique offering available to the German and European semiconductor and electronics industry. The cooperation of 13 research institutes and around 2000 scientists is, right from the beginning of the project, already the world's largest pool for technologies and intellectual property rights within the area of smart systems. Whether working on the development of intelligent sensor nodes, cyberphysical systems, and hardware-oriented solutions for Industry 4.0 or compound semiconductor-based devices and circuits for power electronics or communication technology – the researchers will be able to consult with one another quickly and efficiently from the first draft to the finished system. The close interlinking and coherent public face mean that the Research Fab Microelectronics Germany can offer SMEs a more comprehensive and simpler way of accessing the next generation of technology.

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A monitoring system that can hear production errors

In industrial production, the testing of machines and products by means of acoustic signals still takes a niche role. Researchers at Fraunhofer IDMT have developed a cognitive system that can hear erroneous sounds more objectively than human hearing. The technology was proved in initial practical tests, in which it detected up to 99 percent of the errors.

In industrial production, it is crucial that the machines work and that the product does not have any defects. The production process is therefore continuously monitored by humans, but also by more and more sensors, cameras, software and hardware. In most cases, machine-based automated testing relies on visual or physical criteria. Only people also use their ears naturally: if something sounds unusual, a person switches the machine off for safety. The problem, however, is that everyone perceives noises somewhat differently.

More objective than human hearing

Researchers at the Fraunhofer Institute for Digital Media Technology IDMT would now like to integrate the intelligence of listening into the industrial condition control of machines and automated test systems for products. In developing cognitive systems that use acoustic signals to detect errors exactly, they are combining intelligent acoustic measuring technology and signal analysis, machine learning, as well as data-safe, flexible data storage. Once they have been fed with many data records and trained, cognitive systems can hear more objectively than a human can.

Assigning sounds unequivocally

The scientists identify possible sources of noises and analyze their causes, create a noise model of the environment, and focus their microphones there. From the total signal, the system calculates out background sounds. This is then repeatedly compared with laboratory-pure reference noise. With the help of artificial neural networks, the scientists are gradually developing algorithms that are able to detect noises occurring from errors. The cleaner the acoustic signal is, the better the cognitive system recognizes deviations. The technology is so sensitive that it also displays nuances in error intensity and manages complex tasks. In modern car seats, for example, a large number of individual motors are installed, which the driver can use to adjust his or her seat individually. The design of the motors is not the same, their noises are different, and they are installed in different places. The system devised by the Ilmenau-based researchers has dealt with this challenge with aplomb: in a pilot project with an automotive supplier, it was able to perfectly detect all of the error sources the system was trained for.

Flexible, secure data storage in the cloud

The Fraunhofer researchers are able to ensure the data security of the collected acoustic signals through user authorizations as well as rights and identity management. One example is the decoupling of real and virtual identities in order not to violate user rights when evaluating the data by different persons. Machines and test systems are usually installed in the production line. The researchers store their acoustic data records in a secure cloud.

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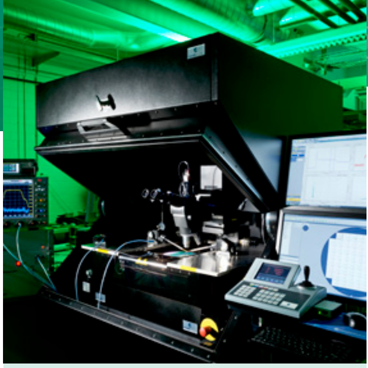
The Fraunhofer IDMT offers procedures for the end-of-line inspection of car parts, such as motors for seats, for the sake of automated quality analysis by means of airborne sound measurement. © Fraunhofer IDMT



CC-TLP test system for high-current characterization of circuits within the time and current range relevant to ESD.
© Fraunhofer EMFT / Bernd Müller

ESD: New measuring technologies offer effective protection

Microelectronic devices and systems are getting smaller and more complex – this also presents ESD protection with new challenges. Many established test methods are reaching their limitations. Researchers at Fraunhofer EMFT have developed new solutions that provide more accurate and reproducible measurement results.

We have all experienced it: you touch a doorknob and suddenly get a shock because you just walked across a carpet. This is the fault of electrostatic discharges (ESD), which result from an imbalance in positive and negative charge between two objects. Around 3000 V are required before a human can feel a discharge of this type. Semiconductor modules are not quite as sturdy: as little as 30 V can result in damage or functional impairment to such devices. Often, only certain parameters are shifted, which can lead to higher power consumption, for example. This can, however, reduce the service life of a battery, rechargeable or otherwise.

The leeway involved is getting smaller and smaller

The continuing trend for miniaturization in microelectronics is another factor contributing to new challenges: the increasingly delicate structures of the devices also reduce the maximum permissible discharge voltage. Today's conventional test methods are hitting their limits more and more as they are often incapable of mapping reality.

With the oft-used CDM (Charged Device Model), where a device is charged and then discharged, difficult to control air discharges are, for example, often the result. This leads to fluctuating measurement results and low levels of reproducibility. For the narrow ESD tolerance range of miniaturized devices, however, absolutely exact measurements are indispensable. Researchers at the Fraunhofer Research Institution for Microsystems and Solid State Technologies EMFT have, in Capacitive Coupled Transmission Line Pulsing (CC-TLP), developed and patented a measurement technology that allows for CDM levels of load with much greater precision and reducibility. The device is first contacted, and then the pulse is triggered. An additional benefit of CC-TLP is that testing can already be carried out on wafers, meaning that weaknesses from an ESD point of view can be detected early.

Design-related disruptive effects play an important role

The demands placed on test methods at the system level are even more complex, as currents may arise within the system that cannot be predicted within the simulation model. The Munich-based experts have therefore come up with an expanded measuring process with an integrated current sensor. "In one case, this approach showed us that secondary discharge was occurring in an air gap between the base plate of the measuring station and a metal cap on the system housing. Our measurements demonstrated that there were very strong currents of around 600 A for a brief period," explains group leader Dr. Horst Gieser. Phenomena such as this, which are often design-related, occur relatively often and cannot be controlled. This makes it even more important to include these disruptive effects in the analyses in order to develop more effective protective concepts. In the case previously described, the researchers identified four sensitive lines and integrated resistors at the critical pins. This allowed all disruptive influences to be eliminated systematically, increasing the robustness of the system.

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Discharge during ESD loading of a flash drive.
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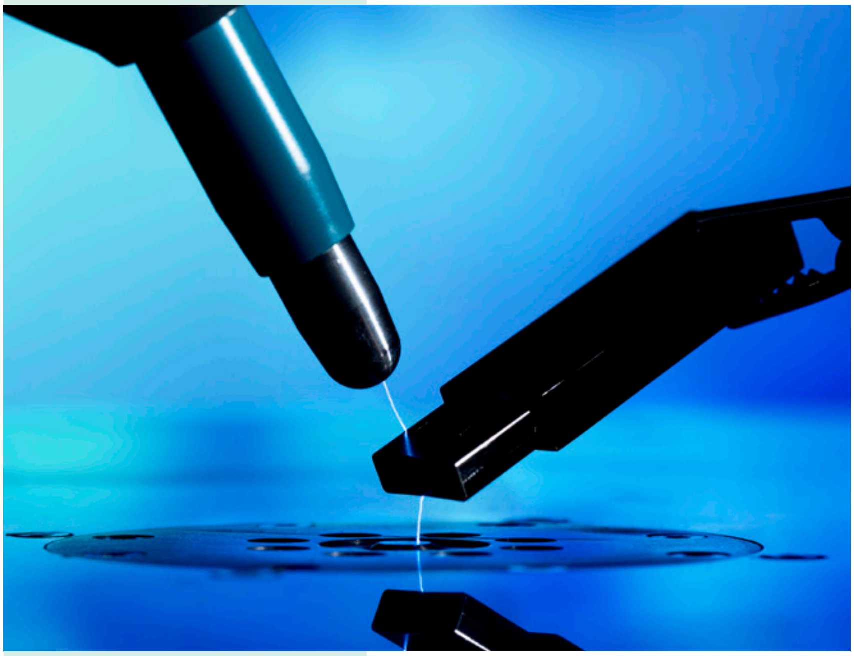

Because tomorrow, today will be yesterday – *photographic reflections about technical progress*

It is a creative principle among scientists and engineers that their work is to question the technological status quo each day anew. Existing technologies, say, are constantly becoming obsolete and being replaced with more modern successors, even when a lot seems to stay the same at the core.

After a workshop on "More Conscious Photography" with Berlin photographer Christian Klant and organized by the Fraunhofer PR-Network, the idea of photographing laboratory environments at Fraunhofer IISB using historical photography equipment was born. As an expert in the collodion wet plate photographic process invented in 1851, Christian Klant already had the right process in mind. While Klant sees his portraits and landscapes as photographic emotions, the guiding idea for the Fraunhofer IISB project was to build a bridge between old technology and its most modern counterpart.

Electric sports car IISB-ONE in the test center for electric vehicles at Fraunhofer IISB in Erlangen. © Christian Klant / Fraunhofer IISB

For example, high-tech subjects from the present can be visually thrown back to the beginnings of industrialization and a visually created past can make technical progress appear manifest and as an emotional experience. Put another way, the change in perspective, the temporal distance, the consideration of modernity from a consciously manufactured historical view offers eyewitnesses a look at the here and now from the point of view of an artificially anticipated future.

And that, consciously or unconsciously, is always a potential gain in knowledge.

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Looking inside materials the smart way

© Fraunhofer IZFP / Uwe Bellhäuser

Aircraft, trains, and power plants have to be inspected regularly. Detecting damage too late could pose safety risks, and time-consuming repair work results in expensive downtimes. Researchers at Fraunhofer IZFP are making complicated testing work easier with the sensor and inspection system 3D-SmartInspect.

The condition of safety-critical objects – turbines, generators or high-pressure containers, for example – have to be examined regularly. This has previously been performed manually. To this end, the inspectors check the entire surface using a sensor device – a task that requires a lengthy training process and a great deal of experience. But even then, inspectors may miss a spot.

Recording 100 percent of the data

Researchers at the Fraunhofer Institute for Nondestructive Testing IZFP have, in "3D-SmartInspect – Intelligence in Inspection and Quality Control", developed an inspection system that supports inspectors in their difficult task. The system shows at a glance which points have already been measured and what the result of the measurement was, and then generates a log that is available immediately in digital form. The inspectors can wear augmented reality (AR) glasses, though the system works with a tablet PC or a smartphone too. The employee can view the object to be examined – let's take the high-pressure container again – through the glasses. As the inspectors run the sensor over the object, the corresponding area on the glasses' display changes to green while the rest of the container retains its original color. This assures inspectors that they have examined every inch of the object. At the same time, the system constantly verifies that the sensor data has been recorded correctly. Once all data has been acquired, inspectors can see the results immediately. Areas with any kind of a defect – a cavity where it does not belong, or corrosion – appear red on the display. Inspectors can immediately indicate where the repair team needs to intervene, either by using chalk on the actual object or via digital means. Control center experts can also examine all the data as soon as it has been collected and can decide immediately how urgently the repair needs to be carried out.

AR system for manual or robot-supported testing of devices or large surfaces.
© Fraunhofer IZFP / Uwe Bellhäuser

Digital testing memory

Generating a test protocol will also be much simpler. Currently, inspectors have to laboriously document their work and then allocate the data to the object measured – a method prone to errors. With 3D-SmartInspect, data is automatically and clearly assigned to the object and writing a protocol is unnecessary. Digital approaches such as these offer enormous economic advantages because they significantly reduce – if not completely eliminate – downtimes. Another advantage is that the use of 3D-SmartInspect would, in the future, allow less experienced inspectors to carry out the complex measurements by themselves, and would also significantly reduce the training time required. The Saarbrücken-based researchers already presented an initial prototype of 3D-SmartInspect at this year's Hannover Messe trade fair.

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Power without a plug. Fraunhofer IPMS, as part of the CONSIVA research project, is developing small, long-lasting energy harvesters for self-sustaining microsystems.
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Micro-energy harvester for self-sustaining, integrated chip systems

Fraunhofer IPMS is starting the two-year CONSIVA research project focusing on the development of micro-energy harvesters for self-sustaining, integrated chip systems. The use of novel piezoelectric materials in vibration-based harvesters can drastically reduce their size and significantly prolong operation time. This paves the way for the use of previously unachievable medical implants and ever smaller wireless sensor systems.

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Many areas of life today already depend on the reliable, fully automated operation of miniaturized systems. For example, secure operation of sensor systems in industrial facilities is essential for timely fault analysis. In the future, the networking of complex devices, most of which have been previously powered via electrical lines or batteries, will play an even greater role. Because these concepts can only be used to a limited extent for site-independent networks or poorly accessible sensor positions, technology developments such as energy harvesting are urgently needed to provide an alternative energy supply.

Vibration-based harvesters – self-sustaining energy supply thanks to piezoelectric materials

Energy harvesters can supply self-sustaining microsystems by collecting small amounts of energy from sources such as ambient temperature, light irradiation, or vibration. Vibration-based harvesters, in particular, convert existing kinetic energy from the environment into electrical energy. Piezoelectric materials are especially suitable for the development of vibration-based harvesters by the direct mechanical-electrical conversion principle.

Micro-power plants: the energy harvesters from Fraunhofer IPMS can generate energy for difficult-to-access systems in a small space.
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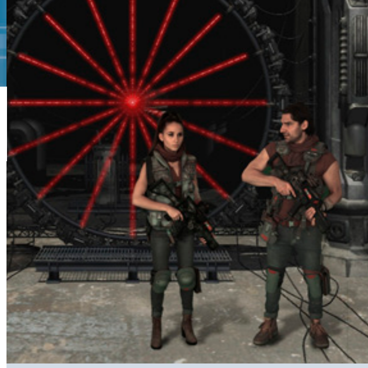
In the CONSIVA research project, the piezoelectric coefficient and the application potential of thin layers of hafnium dioxide will be evaluated at the Fraunhofer IPMS-Center Nanoelectronic Technologies (CNT) in Dresden. This material has ferroelectric and therefore piezoelectric properties and is qualified in microelectronics. Due to its high dielectric constant, it is already used in modern field-effect transistors.

In addition to the material development and the electromechanical characterization of active test structures, a harvester layout adapted to hafnium dioxide by means of simulations is to be conceptualized at the CNT. On the basis of these designs, Fraunhofer scientists want to illustrate new, concrete application scenarios for micro-energy harvesting. „Over the past few years, we have been able to gain extensive experience with the manufacturing, integration, and optimization of ferroelectric hafnium dioxide for the most up-to-date storage applications. We see great potential to successfully use these experiences, especially in the field of energy harvesting. Thanks to these novel piezoelectric materials, we can decisively advance the miniaturization of vibration-based harvesters," explains Dr. Wenke Weinreich, group leader at Fraunhofer IPMS-CNT.

Self-sustaining microsystems have potential in a wide range of applications

The main fields of application for self-sustaining microsystems are found in medical and wireless sensor technology. The findings from the implementation of micro-energy harvesting technology can also be transferred to other fields of application in the Internet of Things.

The project is funded by the Development Bank of Saxony.



When watching the VR test production Gateway to Infinity, viewers can immerse themselves in the science fiction environment on a faraway planet. © Fraunhofer HHI

Volumetric film: Become immersed in the stories

Fraunhofer HHI and UFA GmbH presented Germany's first test production for volumetric film at NAB in Las Vegas. The movie Gateway to Infinity, which is designed to allow viewers to walk right into it, uses the "3D Human Body Reconstruction (3DHBR)" technology.

This reconstruction method makes it possible to generate dynamic 3D models of people that appear natural, going far beyond the conventional animation of virtual characters. Recordings of gestures, facial expressions, and textures can be visualized in detail in the 3D models. In this first test shoot, facial expressions and moving clothing were reconstructed naturally and accurately. The person is then integrated into a virtual scene. Viewers with virtual reality glasses can therefore view these virtualized people at very close range and from various perspectives. Thus the viewer is immersed directly in the scene, experiencing the story close up and personally.

Fraunhofer HHI cooperated with UFA for the test production. This partnership is also aimed at developing a professional production process that makes it possible to quickly generate dynamic 3D models of high quality. The huge volumes of data for a volumetric film are recorded with a number of specially constructed cameras, posing new challenges for the exploitation chains in production. Fraunhofer HHI is currently planning to build a fully functional VR production studio for "3D Human Body Reconstruction (3DHBR)".

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Nondestructive cable monitoring in nuclear power plants

In a nuclear power plant (NPP) an average of 25,000 cables with a total length of 1,500 km are installed. These cables are partially exposed to harsh environmental conditions such as increased temperature or radiation: under these circumstances, the cable insulation deteriorates, with the risk of cracks and short circuits occurring as a result of premature embrittlement. Within the framework of a EURATOM project funded by the European Union, researchers at Fraunhofer IZFP are looking at how these aging effects can be detected in good time and in a nondestructive manner. The Saarbrücken-based Fraunhofer institute is part of a consortium of 13 partners from Germany, Finland, France, Italy, Poland, and the Czech Republic. Currently, the cables are replaced preventively on the basis of experience, but without reliable information on the actual condition. Thus, the actual condition can vary in a wide range.

Fraunhofer IZFP engineers are studying the advantages in terms of safety and efficiency that could be offered by nondestructive testing when investigating cable insulation. "TeaM Cables" focuses on a terahertz process further developed at Fraunhofer IZFP, which uses high-frequency electromagnetic waves. These examinations could be used to provide information that allows for revision scheduling and timely inspection of the cable insulation. Hence, brittle cables can be replaced promptly while sound cables can stay in operation for many years more. Fraunhofer IZFP is making a significant contribution to increased safety and cost savings – also in the context of nuclear decommissioning – while economy and competitiveness still increase.

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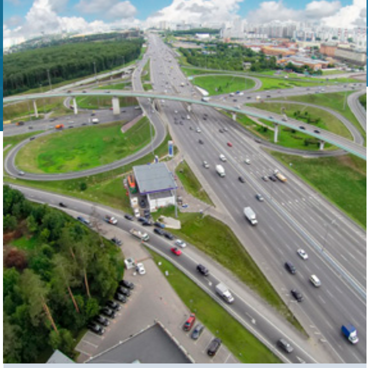

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TIMON offers road systems more

More safety, sustainability, flexibility, and efficiency in road traffic. The "TIMON" project (enhanced real TIme services for optimized multimodal MObility relying on cooperative Networks and open data) can make this idea a reality. TIMON is being executed by Fraunhofer ESK and partners from seven other European countries and is being funded as part of the EU's "Horizon 2020" program.

The aim of the project is to develop a hybrid communication system that bundles open transport data and information from infrastructure sensors and road users. The collected data is distributed strategically to vehicle drivers, pedestrians, and cyclists in the area affected. This "cooperative ecosystem" is intended to considerably reduce traffic jams, accident hazards, and environmental impact by using artificial intelligence to forecast traffic jams or calculate suitable routes, for example. An open web platform and a mobile application are used for collecting, harmonizing, and evaluating the data. The information is distributed via a hybrid communication system that uses different means of communication adaptively to call up information in real time and to allow it to be distributed over a wide geographic area. Available communication resources and partners are permanently monitored and evaluated. The necessary algorithms and software are being developed by Fraunhofer ESK.

The communication systems developed within the TIMON project are being tested using simulations and field tests in road traffic and on test tracks in order to find out what they can do and where their limits lie.

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Keeping an eye on all the tools

In modern production environments, most processes run automatically. To ensure that employees still have an overview of the tools in use and their current position, researchers at Fraunhofer IIS have developed a sensor-based tracking system. To this end, cost-effective inertial and magnetic field sensors are installed on the tool or in its housing. Bluetooth or Wi-Fi is used to forward the results to a central interface, where they are compared with preset parameters. If the values do not match, this can be displayed in the central office or via an LED on the device itself. Locating a tool relative to a workpiece within a given working area is initially performed without needing to set up a separate infrastructure. The locating system is very resistant to other sources of interference and is combined with radiolocation systems within the production environment in order to perform global positioning.

Fraunhofer IIS, together with the BMW Group, presented a project for developing and testing an intelligent screwdriver for assembly use at the Hannover Messe trade fair. A special attachment module directly connected to the IT system receives a job order, uses sensor data to check that the order has been fulfilled, and signals this fact. This allows production employees to always know whether the order has been completed correctly and in full. At the moment, preparation is under way for a test launch on BMW's production line in Regensburg. This could form the basis for possible expansions of the intelligent tool. In addition to networking, the innovative software from Fraunhofer IIS can also offer analysis of the screwing process, determination of tool movements, and position detection.

Additional fields of application for tool tracking could include monitoring, geofencing, and the documentation of work processes.

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Intelligent tools improve quality during assembly.
© BMW Group

The 5G mobile communications standard is a key technology for Industry 4.0. © iStock / hh5800

Industry 4.0 in real time

Transmit data at high speed, yet reliably: this is the demand that the 5G mobile communications standard must fulfill for use in industry, traffic, and medicine. In order to implement exactly that, a team at Fraunhofer HHI is currently working on solutions to make 5G more reliable.

When controlling traffic or helping in the performance of teleoperations, the data must be transmitted reliably and securely. But wireless transmission is currently more susceptible to interference than data transport via fiberglass cables. The data stream can be stabilized using optimized signal processing and selecting certain frequencies that make use of reflection within buildings, for example. "We have already proved in the laboratory that the desired 10 Gbit/s with a latency of 1 ms and top reliability are possible. In certain areas of application, we can already present solutions that are very close to the product," says Prof. Slawomir Stanczak, head of the Wireless Communications and Networks department at Fraunhofer HHI. Possible uses of 5G are waiting in areas including Industry 4.0. Robots, for example, can be controlled using ultra-fast wireless communication in the same way as if the human operator were standing right at the robot and controlling it via a joystick and buttons.

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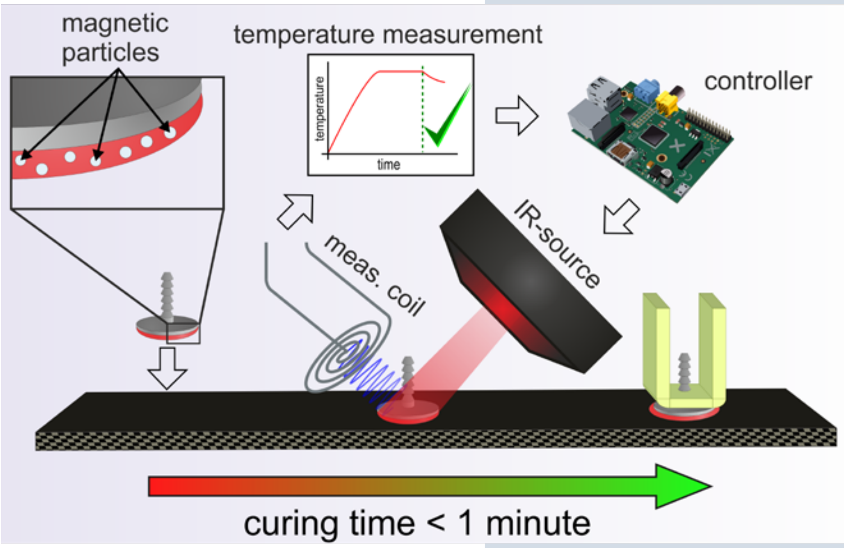
New measuring method to regulate quick-curing processes

Adhesive methods are playing a more and more important role in industrial joining technology. In order to optimize and accelerate the curing process for an adhesive bond, the location of the adhesive is heated up. The temperature of the layer must be known so that the thermal curing can be regulated efficiently. Otherwise, there is a risk that the adhesive will become too hot and will be damaged. The surface temperature of the adherends is often measured pyrometrically. Correction factors are used to determine the temperature of the adhesive layer. The factors must be recalculated metrologically for each new usage case, however. Alternatively, thermal elements can be embedded into the adhesive location to allow direct measurement, which leads to increased costs in series production.

The Advanced System Engineering department at Fraunhofer ENAS, in cooperation with Fraunhofer IFAM, has developed an inductive measuring method for flexible, direct, and contactless measurement. This method allows the temperature of the adhesive layer itself to be recorded. To this end, magnetic particles are added to the adhesive. Above their Curie temperature, these sensor particles have a very temperature-dependent permeability that can be used to record the temperature of the adhesive layer. The induced change in permeability results in a change in inductance within a measurement coil. Thus, if the temperature is above the sensor particles' Curie temperature, measuring the inductance means that the temperature of the adhesive layer can be determined.

By combining several sensor particles made of materials with different Curie temperatures, the measuring interval can be increased. In the current test set-up, two plastic adherends (made of e.g. GFRP or polyamide) can be glued together within 60 s. The samples offer adhesive strength comparable to that of samples cured using the conventional method (i.e. 30 min in a convection oven).

The test set-up developed by Fraunhofer ENAS and Fraunhofer IFAM for flexible, direct, and contactless measurement of adhesive layer temperatures. © Fraunhofer ENAS



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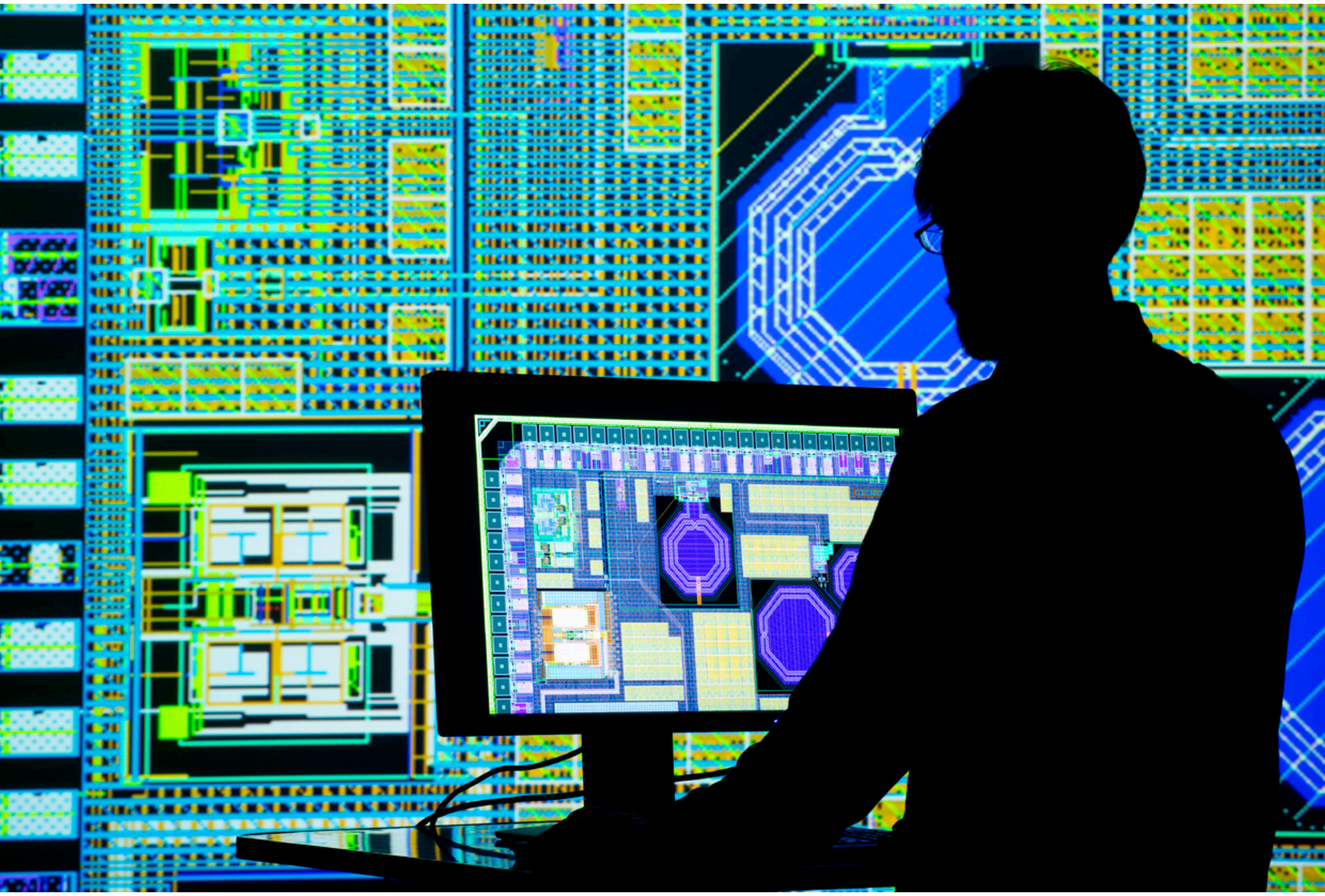

David Borggreve, doctoral candidate at Fraunhofer EMFT, stands in front of a very special map: it shows the complex devices and connections within a circuit – in this case the AMBER1 chip – as part of the European research project Things2Do. During the layout stage shown here the elements are arranged geometrically and examined to ensure that they obey all technological and electrical rules. After this last step in the design, the chip is sent to the foundry for manufacture. © Fraunhofer EMFT

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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The last word…

… comes from Prof. Nina Kloster from the Fraunhofer-inHaus-Center

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Prof. Kloster, what are you working on at the moment?

One example of my current activities is the work on the Group research project ILIGHTS. Within the consortium of partners, we are investigating the non-visual benefits of a newly developed LED lighting system within shift operation of the BMW assembly plant. Over the long term, we intend to improve the health and well-being of the employees. The 21-week study in the Munich plant is preceded by a pre-study at the Fraunhofer-inHaus-Center in which the planned methods, processes, and software and hardware components are tested for their practical feasibility and adapted as needed.

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

In general, I am very excited by developments and smart technologies that are concerned with sustainable treatment of our resources. The vertical greenery project being worked on by our colleagues from Fraunhofer UMSICHT in Oberhausen uses the positive properties of plants in order to promote such factors as air quality, microclimate, and noise protection within urban spaces by means of vertical greenery systems. The use of vertical grassed areas on buildings in order to optimize quality of life and work is, to my mind, a new stage in the future smart home. The research and development work in this field is extremely interesting.

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

For me, navigation devices and – in particular – Google Maps are a real help. This free map service accesses the location data of countless smartphone users and uses the masses of data to map the traffic situation amazingly accurately. Google Maps shows in real time the congested routes on all roads – including the smallest side streets – and calculates the fastest route with very good timing. I use the app almost every day and it has saved me many hours of traffic jams – and soothed my nerves many times – when driving around Cologne. In the future, Google also intends to use cellphone data to detect available parking spaces, which would be a real sensation in city centers.

What do you wish you had more time for?

I would like to have more time for conversations and exchange of ideas without a set framework or topics or a timetable – without focus, even. I also wish I had more time to attend events that are well outside my "world." Unfortunately, my hectic working life and routines tend to restrict the mind a little. I enjoy thinking back to the freedoms I had while studying. Today, such moments are considerably less frequent, but I am still always pleased if unplanned conversations, or ones I expected to be unimportant, throw up a new big idea.

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

I have just accepted the Chair in Health and Comfort in Buildings at Cologne University of Applied Sciences and, in the future, will conduct more intensive research into the health aspects of buildings. In the last few decades, topics such as increasing energy efficiency have dominated building technology, and health aspects have previously played a subordinate role. I can imagine, however, that health in the field of buildings will become a new and large field of the future, which I would like to help shape actively. As I will remain a Fraunhofer member, I can see good market opportunities for the Fraunhofer-Gesellschaft and, in particular, for the Fraunhofer-inHaus-Center. Perhaps, in the medium term, this topic will lead to Fraunhofer working groups in Cologne. I would be very pleased if it did.

What was the last book you read?

What If? In this book, author Randall Munroe answers the craziest questions in a scientific manner – it's wonderfully creative, entertaining, and extremely funny!

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

"Life begins at the end of your comfort zone." (Neale Donald Walsch), because "if you always do what you've always done, you'll always get what you've always got." (Henry Ford)

About Prof. Nina Kloster:
After studying at the University of Duisburg-Essen, Prof. Nina Kloster worked as a research associate at Fraunhofer UMSICHT. There, she managed groups such as the research group "Medicine, Technology, Design," which examined holistic products and concepts with the aim of increasing individual quality of life and tackling the challenges brought by demographic change. Innovative assistance systems and preventive products for the medical, sports, and healthcare sector have since been a focus of her work. In parallel to her activities at UMSICHT, Nina Kloster completed her doctorate on biofilm mechanics at the Johannes-Gutenberg-Universität medical school in Mainz. On January 1, 2016, Prof. Nina Kloster assumed management of the Fraunhofer-inHaus-Center in Duisburg and has since promoted the concept of the inHaus-Center functioning as a platform for joint research and development work, largely for the areas of energy efficiency and room and building systems, as well as for the development of future-oriented products and services for the health and care sector. On June 1, 2017, Ms. Kloster was appointed to the Chair of Health and Comfort in Buildings at Cologne University of Applied Sciences.

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