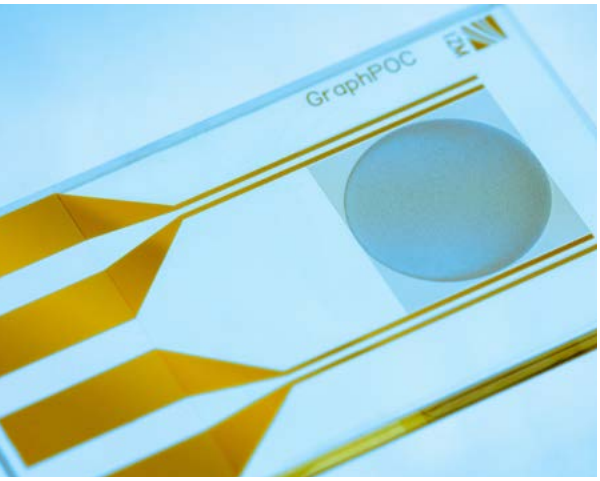
Microelectronics News

Fraunhofer MIKROELEKTRONIK

November 2020 80

■ #WeKnowHow

Certainty in just 15 minutes – graphene oxide based rapid test for infection detection



Researchers at Fraunhofer IZM and its project partners are developing a handy sensor platform based on graphene oxide. This enables the detection of acute infections such as sepsis or antibodies against the corona virus within minutes. »» page 3

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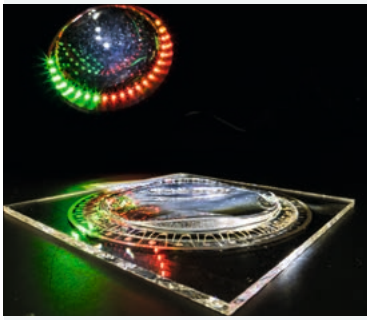

Mass production of individualized products: Methods for that are being debeloped by six Fraunhofer Institutes in the lighthouse project "Go Beyond 4.0". © Fraunhofer IOF » page 7

The ultrasensitive electronic patch XPatch analyzes body sweat in real time. © Fraunhofer IZM / Volker Mai » page 6

■ Research Fab Microelectronics Germany

Machine-Close-up: Worldwide unique measurement system

At the FMD member institute Leibniz FBH, a measurement system with customized broadband microwave down converters by Keysight Technologies has been brought into operation. Thus, all key components for a novel 5G Multiple Input Multiple Output (MIMO) system are available at the institute.

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GESTRA: The near-earth orbit always "in sight"

In order to monitor the near-Earth orbit, a phased array radar with high beam agility is required. In Autumn 2020, researchers from Fraunhofer FHR officially handed over the semi-mobile space surveillance radar GESTRA to the German Aerospace Center (DLR).

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Events

Upcoming Digital Events

Date	Topic	Institute	Information on programme and registration
11/09 – 11/11	Safetronic 2020	IKS	www.hanser-tagungen.de/en/safetronic
11/09 – 11/12	electronica 2020	IPMS	www.electronica.de
11/16 – 11/19	COMPAMED 2020	ENAS, IMS	www.compamed-tradefair.com
11/24 – 11/26	sps – smart production solutions	IMS, IPMS	sps.mesago.com/nuernberg/en.html
11/26 – 11/27	Reliability of Electronic Systems	IZM	www.izm.fraunhofer.de/en/news_events/trainings-and-workshops/ws_12.html
12/01 – 12/04	Wind Energy Hamburg 2020	ISIT	www.windenergyhamburg.com/en/
12/08 – 12/10	Medical Wearables	IPMS	www.medwearablesconference.com/agenda.html

Scheduled On-site Event

Date	Topic	Institute	Information on programme and registration
01/10/2021– 01/15/2021	European Microwave Week 2020	FHR, IAF; Leibniz IHP, FBH	www.eumweek.com/

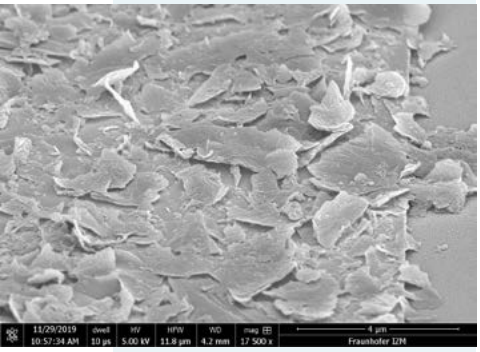
Webinars available at any time

On our website, you will find an overview of tech webinars and online events of the institutes of the Fraunhofer Group for Microelectronics. This will be updated continuously. You will also find an overview of webinars whose recorded content is freely available.

Fraunhofer researchers are developing biosensors based on graphene oxide that make it possible to detect bacterial and viral infections in just 15 minutes.
© Fraunhofer IZM / Volker Mai

Certainty in just 15 minutes – graphene oxide based rapid test for infection detection

Researchers at Fraunhofer IZM and its project partners are developing a handy sensor platform based on graphene oxide. This enables the detection of acute infections such as sepsis or antibodies against the corona virus within minutes.



The flake structure of the graphene oxide results in a larger measuring surface and thus a better sensitivity.
© Fraunhofer IZM

The COVID 19 pandemic in particular shows how important it is to detect infections quickly and accurately so that infection chains can be interrupted and the pandemic can be controlled. Diagnoses for the determination of viral or bacterial infections, are currently based on symptoms. However, these are prone to errors. Although blood tests provide certainty, they are only carried out in laboratories when prescribed by the family practitioner. Until the results of the analysis arrive, unnecessary antibiotics may be prescribed or chains of infection may not be interrupted quickly enough.

One drop of blood is enough for the diagnosis

Since April 2018, researchers at the Fraunhofer Institute for Reliability and Microintegration IZM have been working on a graphene oxide-based sensor platform in the Graph-POC project, which is intended to solve precisely these challenges in the diagnosis of infections. Only one drop of blood or saliva is needed to perform an exact analysis. The drop is placed on the sensor surface and within a few minutes a result, conveyed via electrical signals, appears – at the family doctor's office on site. Lengthy laboratory tests of the blood are thus replaced by a quick test that provides certainty within only 15 minutes.

If the infection has already been passed, the test can be designed for antibody detection. In order to be able to detect previous infections with the SARS-CoV-2 virus and to demonstrate infection paths, the research currently focuses on this application. During an infection, the human body forms certain molecules or proteins, so-called biomarkers. In order to recognize these, capture molecules are coupled on the sensor surface of the graphene oxide-based platform. Whether an infection is present is then determined by means of differential measurement in relation to the concentration of the biomarkers.

3D structure enlarges measuring surface

The special feature of the sensor platform is the material used: graphene oxide is an electrically conductive and biocompatible material that allows for particularly reliable detection. In microelectronics, it has so far only been used in its original 2D form. However, researchers at Fraunhofer IZM are now applying it in a 3D structure in the form of flakes. This three-dimensional form increases the measuring surface and also the sensitivity of the measurements. The 3D arrangement of the graphene oxide flakes and the resulting sensitivity also opens up further applications, for example in the detection of harmful gases such as carbon monoxide or acetone. In order to scale the manufacturing process for mass production, the graphene oxide flake coating is to pass through at wafer level so that hundreds of chips can be processed at once.

Antibody detection after coronavirus infection next year

Until the rapid tests are ready for use, the graphene oxide-based sensors must be embedded in a plastic carrier and the reliability of the system tested. The project will run until spring 2021, but the verification of the sensor with relation to corona application is expected to take about another year. The project partners involved are the Charité, Aptarion Biotech AG, the Technical University of Berlin, MicroDiscovery GmbH and alpha-board GmbH. The project is funded by the German Federal Ministry of Education and Research (BMBF).

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Energy-saving semiconductor chips

Silicon chips are the nerve cells of Artificial Intelligence: their surface contains millions of tiny components that transmit important information and signals to increasingly smart devices. These semiconductor chips are built into smartphones, for example, and are becoming increasingly powerful and smaller. Energy efficiency is of particular importance for chip architecture. It is crucial for realizing Artificial Intelligence applications in the future in a resource- and environmentally friendly manner.

Within the IPCEI project "EMMA", Fraunhofer IPMS's Center Nanoelectronic Technologies develops innovative materials, processes and components for the energy saving technology FDX together with the Dresden chip manufacturer Globalfoundries. This chip manufacturing technology is particularly in demand in the growth markets "Internet of Things" and "Automotive".

The EMMA project, which will run until the end of 2021, also focuses on sustainability in the research area: it includes a doctoral program to qualify young scientists. This ensures the long-term promotion and safeguarding of expertise and thus the competitiveness of the region.

Fraunhofer IPMS is supported by the German Federal Ministry of Education and Research (BMBF) within the framework of the funding for the Research Fab Microelectronics Germany (FMD).

The EMMA project develops innovative processes for the energy-saving FDX technology. © Fraunhofer IPMS

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Machine-Close-up: Worldwide unique measurement system for 5G MIMO and space applications

At the FMD member institute Leibniz FBH, a measurement system with customized broadband microwave down converters by Keysight Technologies has been brought into operation. Thus, all key components for a novel 5G Multiple Input Multiple Output (MIMO) system are available at the institute. With this system, even complex cross modulation, as it occurs in components of modern beam shaping applications in telecommunications and space, can be measured.

The commissioning of the supplied broadband downconverter unit is an important milestone in the construction of this unique measurement system. The wide bandwidth, the large number of ports and the ability to perform vector calibrated MIMO measurements are among the greatest strengths of this system. The investment was funded by the German Federal Ministry of Education and Research (BMBF) within the framework of the Research Fab Microelectronics Germany (FMD).

This 5G MIMO measurement system offers unique measuring possibilities not only to Leibniz FBH and its customers, but also to the partner institutes that have joined forces in FMD. "This system represents exactly what FMD is all about, ensuring that microelectronic research in Germany has access to state-of-the-art equipment," explains Dr. Andreas Grimm, FMD Technology Park Manager. "Equipment like this is fundamental to be able to play a role in the development of the future challenging applications, thus supporting the German and European microelectronic industry to stay competitive."

Keysight representatives during their visit at FBH in early March. © Leibniz FBH / P. Immerz

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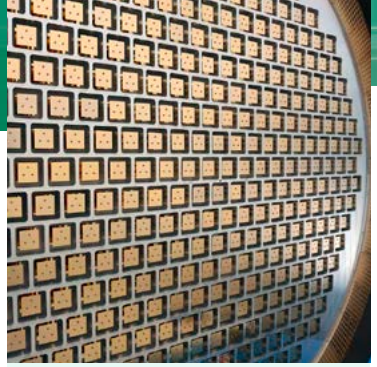

Phased array antenna of the GESTRA transmitter and receiver. © Fraunhofer FHR / Philipp Wolter

GESTRA: The near-earth orbit always “in sight”

In order to monitor the near-Earth orbit and to know which objects are moving there, a phased array radar with high beam agility is required. Fraunhofer FHR has built such a system on behalf of the German Federal Ministry of Economics and Technology: In Autumn 2020, the researchers officially handed over the semi-mobile space surveillance radar GESTRA to the German Aerospace Center (DLR).

Phased array radar for monitoring the low earth orbit

What is buzzing where in the low earth orbit (LEO)? In the LEO, satellites that transmit important information to us follow their orbits. However, space debris poses a danger to the satellites. In order to be able to warn satellite operators in time if a piece of scrap metal threatens to come dangerously close to a satellite, the American space surveillance system creates a global catalog – the US SSN Catalog. In this catalog, most of the larger flying objects in LEO are listed. Germany is also currently using the American data, but would like to free itself from this dependence with its own resources. However, this requires two different radar systems: One that tracks and images individual space objects – this is done by the space observation system TIRA at the Fraunhofer Institute for High Frequency Physics and Radar Technology FHR. And another one that performs the monitoring function, i.e. tracks down the various objects in a large section of space. This can only be done by a phased array radar with a high range and beam orientation, which has not been available on the German side so far.

Core competence: Fast Space Surveillance

The German Federal Ministry of Economics and Energy (BMWi) therefore commissioned Fraunhofer FHR to set up such a phased array radar: From the conception and design phase to the operational system. The design envisages a quasi-monostatic system consisting of separate transmitter and receiver systems. The phased-array antennas are each mounted on a 3-axis positioner: this allows the monitoring area to be first set mechanically and then scanned electronically within milliseconds. The radar beams are used to create a kind of fence, similar to a windshield wiper: any object large enough to pass through the fence is detected. The unique feature of GESTRA is that it is semi-mobile, i.e. it can be set up at any location.

Autumn 2020: Handover to DLR

By, the GESTRA system has been completed. In July 2020, GESTRA was shipped to Schmidtenhöhe near Koblenz in Southwestern Germany connected to the local infrastructure. This was followed by system verifications for the German Aerospace Center (DLR). And the series acceptance tests of the components from Fraunhofer FHR, in particular the electronics in the transmitting and receiving antennas. In September 2020, GESTRA was officially handed over to the DLR. With the new radar system, the Space Operations Center will produce a German catalog. If an object from this catalog is then to be examined more closely, the researchers of Fraunhofer FHR will track and image it with the help of TIRA.

GESTRA arrived at its destination near Koblenz in July 2020. © Fraunhofer FHR / Jens Fiege

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Sensory patches measure biochemical parameters during sports

Together with partners from industry and research, Fraunhofer IZM has developed a flexible sensor system for the analysis of body sweat that helps athletes to improve their fitness.

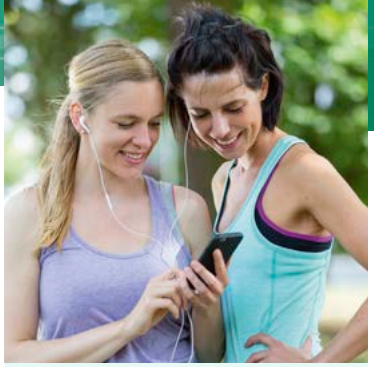
The aim of the international "XPatch" project is to provide competitive athletes with a system for monitoring their cardiovascular system to the second in the form of a sensory patch that is suitable for everyday use. This enables them to see directly what individual sports units and exercises are doing and to further optimize their training.

Integration

The small health monitor contains antennas and integrated circuits for wireless radio communication with a Bluetooth-capable terminal device, a flexible micro-battery for self-sufficient energy supply, analog electronics, sensor chips and power management. In order to integrate all this into the targeted total thickness of significantly less than 1 mm and at the same time ensure flexibility, packaging and integration technologies from the Fraunhofer Institute for Reliability and Microintegration IZM are used. Biocompatibility is ensured by using skin-like materials such as polyurethane and silicone. The electronics are embedded in them and thus protected from external influences and direct skin contact. Only the biochemical sensor chips lie directly on the skin. Sweat is absorbed by a tiny piece of fabric. The measured data can be transferred directly to mobile devices via Bluetooth interface and can be viewed there in real time. The energy-saving Bluetooth low-energy transmission standard is used.

Practical tests and outlook

Following successful technical validation, the first prototypes have been tested since the end of August 2020. The knowledge gained in the project on flexible substrate technology and the integration of electronic components can potentially be used by medical technology companies as well as component and material manufacturers to develop or improve their own products. Such projects are planned within the next five years.



Thanks to XPatch, it will soon be possible to do more than just listen to music on a smartphone while doing sports – via the integrated Bluetooth interface, the measured vital parameters can be viewed in real time. © MEV Verlag

Involved partners:
The following partners are involved in the international consortium alongside Fraunhofer IZM:
- OLT (Germany)
- R-DAS (Slovakia)
- VU Amsterdam (Netherlands)
- Xsensio (Switzerland)

The ultrasensitive electronic patch XPatch analyzes body sweat in real time – a helpful support especially for competitive athletes.
© Fraunhofer IZM / Volker Mai

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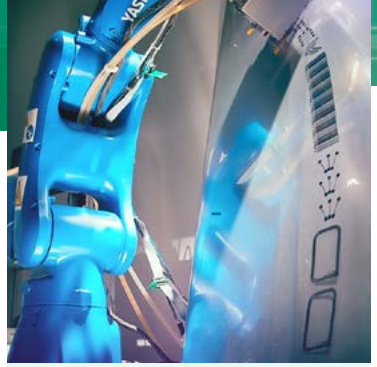


Robot-assisted inkjet printing on 3D surfaces at Fraunhofer ENAS. © Biermann & Jung

Mass production of individualized products

Under the direction of the Fraunhofer ENAS, six Fraunhofer Institutes are developing mass production methods for individualized products.

The individualization of products such as cars is in line with the trend: Volkswagen, for example, produces only about one or two identical Golf models each year. So far, however, such individualizations are hardly compatible with the low-cost methods of mass production. The Fraunhofer lighthouse project "Go Beyond 4.0" addresses this problem.

Laser and printing processes expand possibilities

The researchers rely on a combination of digital printing and laser processing methods. Special inks with properties such as conductivity or insulation are used to produce single- or multi-layer systems. Even sensors can be realized in this way.
A laser beam then follows the exact lines of the printer – and can thus, for example, cure previously printed photopolymers or sinter nanoparticle inks. The spatial resolution reaches smallest line widths of down to approx. 50 µm.

First application scenarios

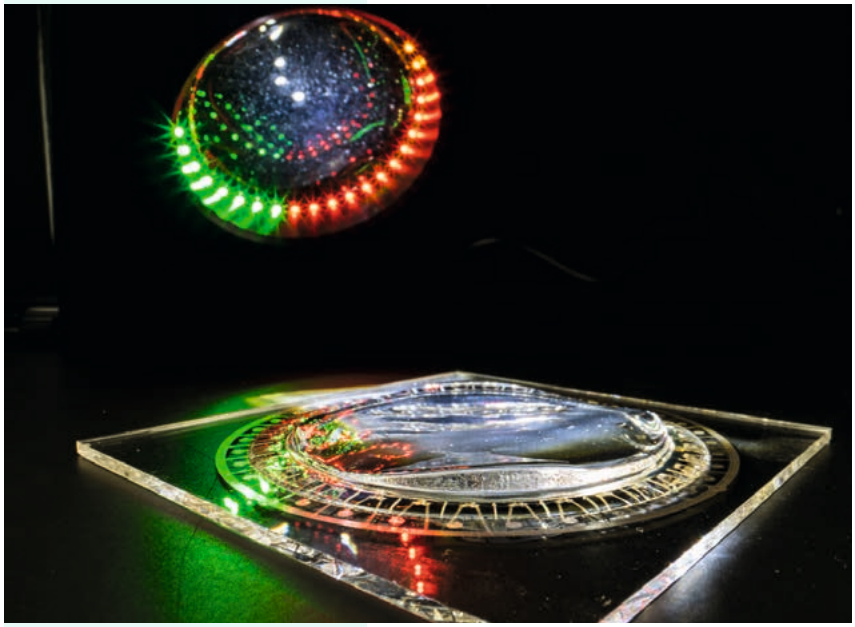
Under the principle of the greatest possible product and production reliability, the team has already realized demonstrators for three important future markets:

Automotive industry: Digital printing is used to integrate signal-transmitting cables into body parts such as doors, thus partially replacing heavy copper cables.

Aircraft construction: Individual wires and sensors are digitally printed onto the fiberglass or carbon mats. Afterwards, they are impregnated with a synthetic resin and integrated directly into the lightweight component. In a first step, temperature, capacitive and impact sensors as well as UHF antennas and LEDs were integrated into the wing elements of a commercial aircraft.

Optics: With this technology, it is now possible to produce freely shaped optics that combine the properties of three lenses in one element instead of one lens. Light-emitting diodes and thus signal functions can also be integrated into these free-form optics. This also opens up new application possibilities: Free-form optics could project information from the car onto the road, for example a stop sign, before the real one is visible. The car could obtain the necessary information from the Internet or from the network environment.

With Go-Beyond-4.0 technology, the work pieces are processed "in-line" in the manufacturing environment. There is no need to remove them from the production line for individualization, they can remain in the line. On a laboratory scale this already works and the adaptation to cycle speeds of real production lines is already ongoing. The technologies will be continuously developed further in order to be able to also serve other markets in the future.



The technology can be used, for example, to produce intelligent lighting fixtures by means of customized light distribution. © Fraunhofer IOF

About the project:
Participating in "Go Beyond 4.0" are the Fraunhofer Institutes for
- Electronic Nano Systems ENAS (Management)
- Manufacturing Technology and Advanced Materials IFAM
- Laser Technology ILT
- Applied Optics and Precision Engineering IOF
- Silicate Research ISC
- Machine Tools and Forming Technology IWU

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Fraunhofer IAF optimizes 5G standard

Fraunhofer IAF is involved in the optimization of 5th generation mobile communication (5G).

While the infrastructure for the 5G standard is still under construction, research is already underway to optimize it in the "ARIADNE" project (Artificial Intelligence Aided D-band Network for 5G Long Term Evolution). 5G is characterized by high frequencies and thus high transmission rates, which enable almost latency-free data transfer. However, the necessary line of sight between transmitter and receiver is not always guaranteed, especially in urban areas. The so-called cancelling effect, in which a reflected copy overlays the actual signal, can lead to connection interference. Such scenarios should be easier to handle with the "Beyond 5G" technology of the ARIADNE project. The aim is to develop energy-efficient and reliable mobile communications in the high-frequency D-band (130 – 174.8 GHz).

Main research topics

ARIADNE is dedicated to three major research areas:

Development of hardware components: Fraunhofer IAF contributes its expertise in the field of high-frequency electronics to this research area. Together with its partners, it develops new radio modules with highest spectral efficiency that exploit frequency diversity and provide a control interface for optimization in the network. The new 20 nm InGaAs HEMT technology will be used on silicon for the first time.

Research of metasurfaces: In order to avoid network interference in non-line of sight connections, ARIADNE is researching the optimization of radio communication by metasurfaces. Metasurfaces are adjustable reflectors for radio waves and are intended to counteract network control problems in urban areas by reflecting radio waves and thus ensuring propagation outside the line of sight. Metasurfaces are already used in lower frequency ranges, but will be adapted to the D-band within the framework of ARIADNE. The metasurfaces are controlled by a central network controller.

AI-based adaptation of network control: In order to provide a constant and reliable radio connection in all weather conditions, methods of machine learning and Artificial Intelligence (AI) are to be used for network management. Machine learning will provide a sound data analysis, on the basis of which an AI-based network control system will be able to detect and prevent problems at an early stage.

Demonstrators illustrate research results

Two demonstrators will have been built when the project is completed at the end of 2022: The first demonstrator should achieve a reliable connection over 100 m with a data rate of 100 Gbit/s in any weather condition. The second demonstrator is intended as a proof of concept in the laboratory to show how a metasurface can improve the propagation condition of radio transmissions.

Besides Fraunhofer IAF, ten other partners from five European countries are involved in ARIADNE. The project is funded by the European Union within the framework of the "Horizon 2020" program.

ARIADNE – Artificial Intelligence for "Beyond 5G".
© Fraunhofer IAF

The ARIADNE project develops technologies for improved reliability of 5G specifically in urban areas.
© MEV Verlag

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ARIADNE

Researchers at Fraunhofer IIS / EZRT have developed a technology that enables the synchronous, high-resolution generation of an optical and an X-ray image (see photo at the bottom of the page).
© Fraunhofer IIS

"High-speed X-ray": New technology records dynamic processes

The Development Center X-ray Technology EZRT of the Fraunhofer IIS has developed a technology for the simultaneous recording of internal and external structures in dynamic processes.

The investigation of structures that are subject to unique dynamic changes – e.g. in failure and deformation analyses, flow and mixing processes in fluids or functional tests for airbags – is an important step in many product development and optimization processes. To record the processes that are otherwise too fast for the human eye, imaging methods with high temporal resolution recording more than 1000 images per second are applied. Until now, however, it has been necessary to decide whether to use high-speed cameras to observe the outer structures or X-ray technology to observe the inner structures. In addition, temporally high-resolution X-ray imaging is so far only possible under highly specialized laboratory conditions.

Technology allows more precise analyses

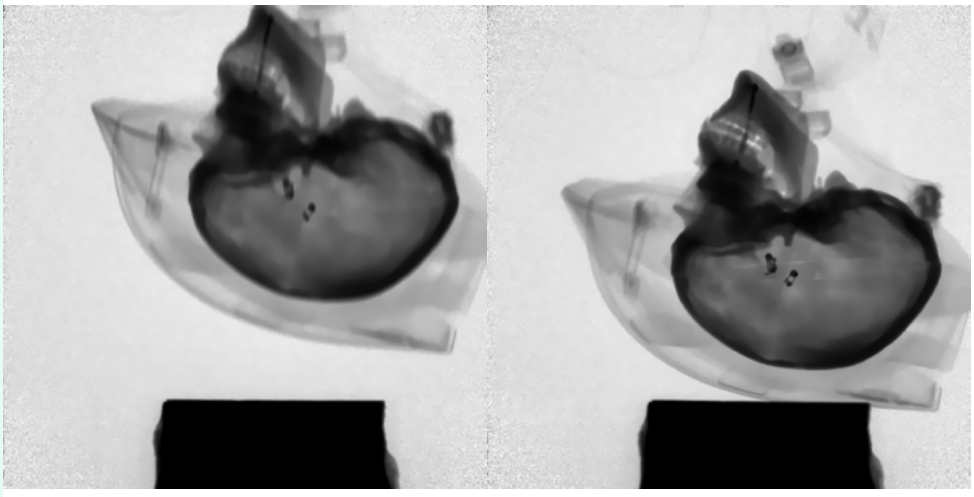
With its new technology solution, the Development Center X-ray Technology EZRT makes it possible to record both structures in parallel. This enables precise nominal-actual value comparisons and offers the potential to optimize product quality, especially in the pre-development phase of new products.

Development of optimized X-ray detectors

With a detector area of 40 × 40 cm², the measurement setup of the demonstrator covers an image section of 30 × 30 cm². In principle, however, the technology can be scaled to almost any size. The system has already proven its potential in various experiments and has e.g. been tested on various helmets in a cooperation with the sporting goods manufacturer Uvex Sports.

You can watch the videos of this experiment here:

Crash test of a bicycle helmet with an artificial skull. The impact can be followed in slow motion by means of X-ray technology. There are about 11 ms between the two images. © Fraunhofer IIS



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Robust converters for renewable energy plants

In the "power4re" project (Reliable converters for renewable energy supply), researchers are working on increasing the reliability and robustness of converters for wind power and photovoltaic plants.

Converters are a key technology for the energy transition. They make it possible to feed the electricity generated by wind power and photovoltaic plants into the electricity grid. However, they are exposed to harsh environmental and operating conditions – and thus among the most failure-prone system components. Failures are accompanied by high losses. Therefore, more durable converters have great economic potential.

The aim of the power4re project is to use field data and damage analyses to investigate application-specific weak points and failure mechanisms. In this way, a concept for more reliable and robust converters and a procedure for testing the components will be developed. The findings can also be transferred to other applications, such as rail transport, aviation or electromobility. The Fraunhofer Institutes IISB, IMWS, ISE, IWES and IZM as well as partners from industry are involved in power4re.

IGBT module of a wind turbine converter. © Fraunhofer IWES

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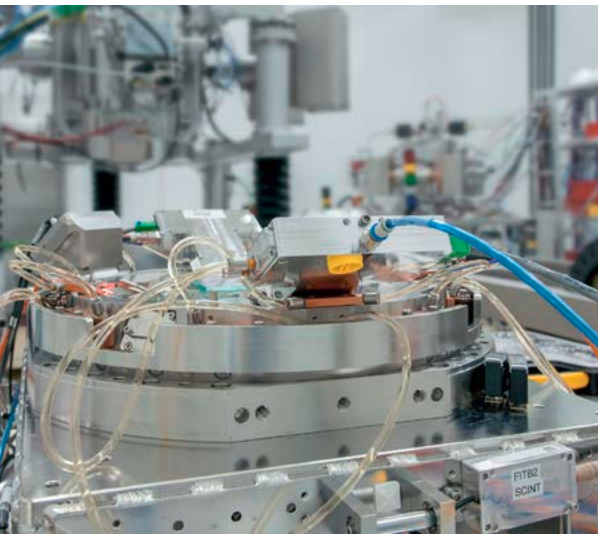
Leading edge equipment for 5 nm technology

The continuing rapid development in the semiconductor industry also places special demands on the processes for structure transfer to silicon wafers – lithography. The state of the art in the most advanced semiconductor companies is currently the realization of a structure width below 10 nm. This is to be further reduced to increase packing density, energy efficiency and the switching speed of the components. Considerations of economic efficiency also promote this trend.

Fraunhofer ISIT and the company IMS Nanofabrication GmbH have been developing innovative processes for several years, with which silicon wafers can be processed using complex microsystems technology. The final product of this processing is the core of the multi-beam mask writer developed by IMS Nanofabrication. It supports the implementation of an electron multi-beam writing process, which enables the production of masks of highest resolution. By processing at Fraunhofer ISIT, a microchip developed by IMS Nanofabrication allows 262,000 individually addressable electron beams to be switched on and off and thus used for mask structuring. For each of these electron beams, an opening with a shielded gold control electrode is realized on this microchip at the institute. Fraunhofer ISIT uses highly developed microsystem techniques for the necessary processes for structuring.

As a result of this successful cooperation, the next milestone in semiconductor manufacturing technology will be reached: the production of leading-edge 5 nm chips. These have been in production at leading semiconductor manufacturers since the first half of 2020, using the IMS multi-beam mask writer to produce masks for EUV lithography (with 13.5 nm light wavelength) on silicon wafers.



Test equipment. © IMS Nanofabrication

The project partner:
The Viennese company IMS Nanofabrication GmbH manufactures the mask writers. The production equipment is used for mask production. The Multi-Beam Mask Writing Technology (MBMW) is unique worldwide and a key to the production of nanoelectronic devices.

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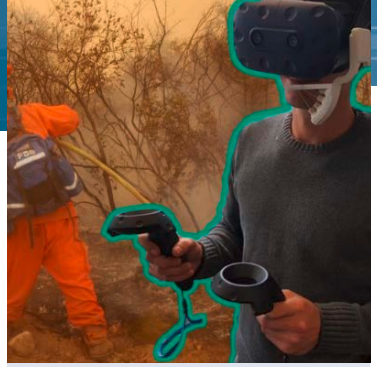

Use of the virtual reality system for training purposes.
© Frauhofer EMFT / US Dept. of Agriculture

Realistic VR training for emergency staff

Fraunhofer EMFT and the Universität der Bundeswehr in Munich are developing a virtual reality system (VR) with olfactory components for the training of emergency and rescue staff.

Emergency and rescue staff are subject to particular pressure and must act quickly and with focus even under stress and danger. This makes it all the more important to prepare for the job as realistically as possible. Therefore, in the project "StressScent", applications for scent dosage and vital parameter sensor technology are integrated into a VR headset.

Fraunhofer EMFT is developing the necessary microdosing technology in the form of the smallest micropumps in the world to date, measuring 3.5 × 3.5 × 0.6 mm³. An array of these piezoelectrically driven silicon micropumps and several reservoirs for aromatic substances enables changing scent scenarios with every breath cycle.

In parallel, vital parameters such as respiratory cycle, pulse, heart rate variability and skin conductivity are recorded to determine the stress level. In particular, respiratory data are also taken into account in the dosage of fragrances, thus enabling individual adaptive gameplay.

The current main application of the StressScent system is a simulation of the Universität der Bundeswehr, which is intended to prepare emergency medical care staff for deployment in public and military sector.

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Direct current for production halls

The Fraunhofer Institutes IISB and IPA are involved in the design and testing of an intelligent DC power supply system for production plants.

Alternating current (AC) is the standard for electrical power transmission and distribution – but direct current (DC) grids have great potential in terms of energy efficiency, reliability and flexibility, especially in industrial environments. A paradigm shift can also be expected in the context of the energy transition, because modern systems for power generation and storage, such as photovoltaic systems and electrochemical storage, only supply direct current.

The aim of the joint project "DC-INDUSTRIE 2" is to link all electrical systems in a factory via an intelligent DC grid. The predecessor project DC-INDUSTRIE already demonstrated the feasibility of a decentralized energy flow control of a DC supply network in the factory. Efficiency increases of between five and ten percent were achieved. Now the task is to transfer the proven concept for a machine network to a production hall and achieve even higher efficiency increases. This will also make it possible to reduce CO_2 emissions and respond flexibly to the introduction of climate-neutral technologies.

Fraunhofer IISB is responsible for the implementation of DC converters and protective equipment, inspecting the network for small-signal/large-signal stability of the grid and local management of interconnected transformer systems. Initial tests in test halls and real factory facilities are already underway.

Power electronic converters and stationary battery storage system at Fraunhofer IISB.
© Fraunhofer IISB / Bernd Müller

About the project:
DC-INDUSTRIE 2 is funded by the German Federal Ministry of Economics and Energy (BMWi). Further information on the project and the partners involved (in German) can be found at: dc-industrie.zvei.org

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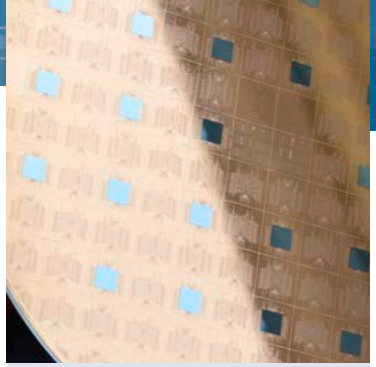
Manufacturing technologies for 3 nm semiconductor technology

New manufacturing technologies must be developed for the next generation of highly integrated microelectronics. To this end, the European "PIN3S" project is working on processes for the production of ICs with lead spacing of only 3 nm.

These integrated circuits come close to the limits of what is physically possible. They will significantly exceed the performance of today's circuits and thus enable applications with particularly high computing power. In autonomous driving, machine learning or in large data centers, they can contribute to leaps in development. In order to reliably produce such structures for high-performance computer chips, innovations are needed in all aspects of manufacturing and the associated measurement technology.

In PIN3S, such novel technologies are brought together and evaluated for the first time in a pilot production line. An additional focus is the further development of the infrastructure for the defect-free production of highly precise masks for wafer production, which serve as templates for the structures to be manufactured.

Fraunhofer IIS / EAS will develop a sensor module for measurement data capturing for wafer exposure with extreme ultraviolet lithography (EUVL).



The aim of the PIN3S project is the defect-free production of highly precise masks for wafer production. © Fraunhofer IIS / EAS

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New video codec

Fraunhofer HHI was involved in the development of the new video codec H.266/VVC (Versatile Video Coding). Due to significantly improved compression, VVC requires 50% lower data rates than its predecessor codec H.265/HEVC while maintaining the same perceived picture quality. This enables more efficient transmission and storage of all video formats from SD to 8K and thus streaming applications with much lower bandwidth.

The standard was developed specifically with a focus on ultra-high resolution video content (4K and 8K) and also supports special applications such as high dynamic range and omnidirectional 360-degree video. Mobile video applications, where data capacity is usually limited, also benefit from the reduction of the required data rates. Overall, VVC improves the accessibility of video formats in general and at the same time expands the range of possible applications.

VVC-compatible chips are currently under development. Fraunhofer HHI has already published suitable software for both encoder and decoder.

The new video codec H.266/VVC (Versatile Video Coding) improves the storage and streaming of video files. © VVC

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At Fraunhofer IIS, Christian Menden works at the Center for Applied Research on Supply Chain Services on the development of an AI strategy.
© Fraunhofer IIS / Paul Pulkert

How AI increases efficiency in logistics

How does AI increase efficiency in logistics? Christian Menden, head of the Analytics department, and his colleagues from the Fraunhofer Center for Applied Research on Supply Chain Services at Fraunhofer IIS are investigating this question. In the exchange forum of "open sessions", ideas are exchanged weekly, whether on current customer projects or new research projects. "People support each other and thus make faster progress. Every employee can actively initiate projects," says Menden. "We identify future research topics and opportunities for cooperation with a wide range of partners from industry." Finding the right algorithm for every problem is the big challenge for him. As in the "PRODAB" project, for example, which aims to make logistics processes more efficient. Here, data for specific logistics processes is systematically collected using data analytics applications and mapped using Bayesian networks. Compared to the frequently used neural networks, for Menden this theorem from classical statistics is an ideal AI method, as it leads to considerably more efficiency. "If data is not available in sufficient quantity, it is instead possible to integrate expert knowledge into Bayesian networks. The software can then make recommendations for targeted process improvement or for the optimal allocation of resources".

The complete portrait can be found here:

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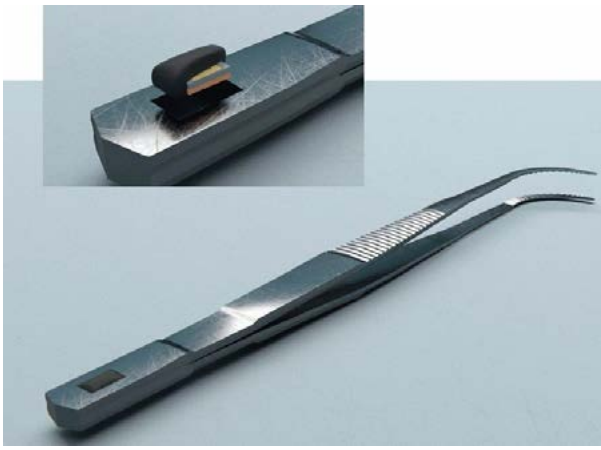
New RFID technology for metallic environments

Fraunhofer IMS has developed a new RFID technology for the use in and on metal.

RFID (Radio-Frequency Identification) technology is established in numerous areas of application, from theft protection to monitoring of company sizes. Depending on the application, the frequency standards of low, high or ultra high frequency are used.

However, the application in metallic environments or on metallic surfaces is problematic. These can lead to standing waves or will impact the performance of the RFID transponder (tag). In addition, many use cases are subject to size restrictions in order not to endanger the usability of RFID-tagged tools, for example.

Fraunhofer IMS addresses these challenges with RFID technologies in the super-high frequency (SHF) range. The researchers are supported by the Fraunhofer FHR and other partners. The RFID-in/on-Metal technology improves the performance in metallic environments or on metallic surfaces and also enables the tags to be further reduced in size. In order to establish an SHF standard in the market, the Fraunhofer IMS also develop communication protocols for this frequency range.



With RFID-in/on-Metal technology, RFID tags can also be integrated into surgical instruments.
© Fraunhofer IMS

Therefore the technology solution of Fraunhofer IMS contains a complete RFID system from reader to tag. It can be adapted to individual requirements and environments. The technology is already used for the management of tools and surgical instruments, i.e. their unique identification, tracking and life cycle management.

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Production of custom-made silicon crystals at Fraunhofer IISB for degradation studies within the ZORRO project. The picture shows Dr. Matthias Trempa, ZORRO project coordinator.
© Kurt Fuchs / Fraunhofer IISB

Solar cells without loss of efficiency

Together with partners from industry and research, Fraunhofer IISB is developing ways to limit the degradation of solar cells.

The use of solar energy through photovoltaic systems is an integral part of today's energy supply. Crystalline silicon technologies have a 95 % share of the global photovoltaic market. Current PERC solar cells (Passivated Emitter and Rear Contact) achieve cell efficiencies of over 22 % for monocrystalline and around 20 % for multicrystalline silicon base material. However, this efficiency can gradually decrease by several percentage points.

This is due to various degradation processes, most notably the LeTID (Light and elevated Temperature Induced Degradation) phenomenon. The aim of the joint project "ZORRO", coordinated by Fraunhofer IISB, is to identify these degradation phenomena and to develop a well-founded zero degradation concept for the industrial production of PERC solar modules. As a possible factor, the occurence of impurities during the production of the wafer material as well as during the processing of the solar cells are investigated.

Fraunhofer IISB contributes its expertise in crystal growth for the production of voluntarily contaminated base material to the research project.

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Thin glass – multifunctional substrate

With the increasing processing of ever higher data rates, the quality of signal transmission must also improve. While optical signal transmission currently dominates for long transmission distances, a large part of signal transmission at circuit board level is still electrical.

This is where electro-optical circuit boards (EOCBs) come in. A promising material for such circuit boards is thin glass. For this purpose, optical waveguides are generated in the glass and electrical layers are applied to both sides of the glass.

Fraunhofer IZM has developed a process that integrates low-attenuation (< 0.06 dB/cm) single-mode waveguides into large-format (440 mm × 330 mm) thin glass boards. The requirements of the display industry have also greatly improved the mechanical properties of the glass substrates, which benefits the production of glass EOCBs. In the future, flexible EOCBs will also be realized with these glass materials.

Researchers at Fraunhofer IZM are currently working on connector concepts. These should enable broadband coupling with low coupling losses between the printed circuit boards and fibers as well as between the printed circuit boards and the optical chips located on them. In addition, the scientists are opening up the research fields of sensor technology in connection with microfluidic structuring of glass and photonic quantum technology. The latter calls for more compact and cost-effective system integration technologies, for which novel approaches are being developed. The combination of low-cost PCB technology, optical functionalization of thin glass and expertise in microsystems technology opens up innovative and design-oriented approaches.

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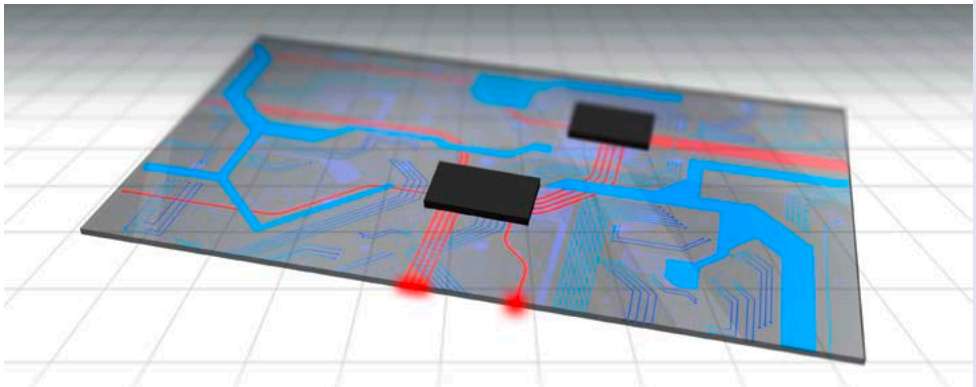
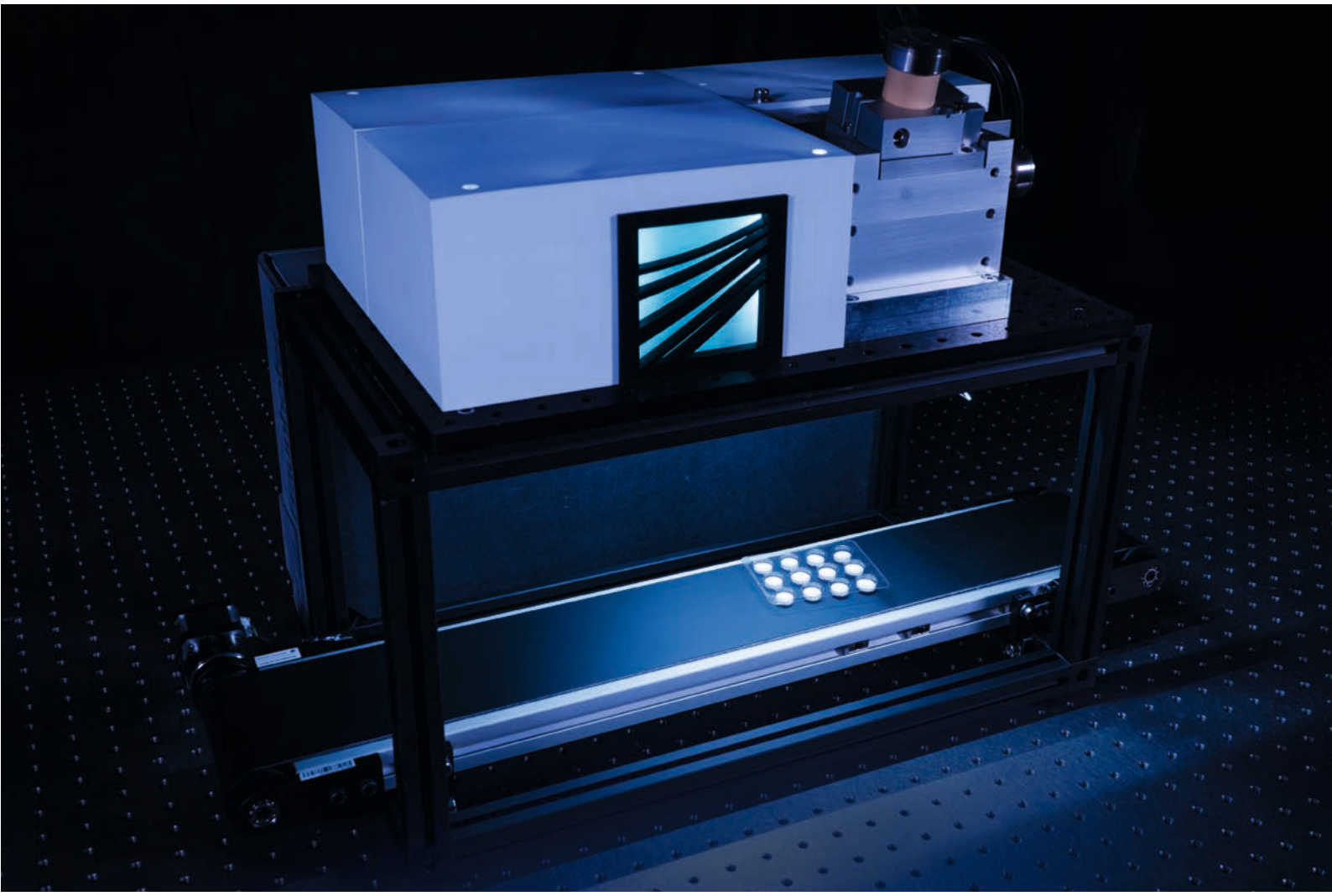


Schematic diagram of an electro-optical printed circuit board (EOCB) made of thin glass.
© Fraunhofer IZM



The photo shows a demonstrator from Fraunhofer IAF for real-time analysis of tablet ingredients. The system is based on back-scatter spectroscopy with a fast tunable quantum cascade laser. In addition, it is equipped with machine vision so that tablets are automatically recognized and scanned as they pass by. This allows inline analysis to be easily implemented. © Fraunhofer IAF

Editorial notes

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

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... goes to Anne Loos from Fraunhofer IIS / EAS

Anne Loos © Fraunhofer IIS / EAS

Mrs. Loos, in mid-September 2020 the Consortium Project "Artificial Intelligence: Understand – Apply – Benefit" began. In a few words, what can people imagine?

At the beginning of the year, we published an AI study that looked at fields of action and general potential of AI in Saxony. Building on this, we now want to go deeper into the topic of AI with companies of different sizes, from different industries and with individual challenges. The aim is to find the individually optimal way to use Artificial Intelligence for each partner.

What are the advantages for the companies?

In the project, we work together with the knowledge service provider KEX AG to offer various added values for the establishment of AI in the participating companies. This includes an individual AI maturity assessment by experts – from an economic, technical and organizational point of view. In addition, competence development, for example in a 5-day AI intensive course, plays an important role. But we will also implement prototypes of selected use cases, derive concrete solutions and next steps for the companies and develop roadmaps.

What long-term goals do you expect from the project?

Our overall goal is to enable companies to understand how they can use AI to gain competitive advantages. The goal is to inspire even more companies in Saxony and beyond to use AI than before. For some, the wide range of applications opens up completely new possibilities for accelerating their product and process development. For others, it helps them to position themselves with business partners and customers as innovative companies.

In your opinion, how will AI develop in the coming years?

AI is nothing new, but in my opinion it will continue to establish itself in the economy in the coming years. AI will not be a panacea in the future, but will remain one of several possible approaches to solve a problem. Nevertheless, the methods are becoming an increasingly exciting tool for companies to differentiate themselves even more from their competitors. For the microelectronics location Saxony, for example, I see the development of AI hardware as a promising topic and an opportunity to secure the outstanding position of the Free State of Saxony in the future as well.

Which project by colleagues from other Fraunhofer Institutes do you find particularly exciting?

There are always many interesting activities at Fraunhofer. Against the background of the currently omnipresent topic of corona, some institutes have really creative and clever project ideas. For me, this includes not only the Corona Warning App, whose development was also accompanied by Fraunhofer. I am particularly interested in projects that are dedicated to the topic of resilience – for example of supply chains, business processes or systems. By the way, this is also an area that we are working on at Fraunhofer IIS / EAS. For me, this is an important point, not only to master these and other crises, but also to grow from them.

If you were allowed to meet a famous person – alive or dead: Who would it be and why?

I recently read the biography of Michelle Obama and was deeply impressed by her personality and the competence she radiates in so many areas. She is definitely someone I would like to meet personally.

The Consortium Project "Artificial Intelligence: Understand – Apply – Benefit" makes it its business to develop an individual way of using Artificial Intelligence for each partner.
© Fraunhofer IIS / EAS

About Anne Loos

Anne Loos studied economics at the Technical University of Dresden and obtained her Master of Business Administration at the Technical University of Chemnitz. Afterwards she gained professional experience in project management, among others at PricewaterhouseCoopers AG and futureSAX, the innovation platform of the Free State of Saxony. Since 2016, she has been working for the Dresden-based EAS division of Fraunhofer IIS in the area of marketing and business development, where she has been in charge of business development since last year. In this context, she is, among other things, the first point of contact for customer projects on Artificial Intelligence.

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