Microelectronics News

Fraunhofer MIKROELEKTRONIK

December 2020 **Anniversary Edition**

The Highlights and Successes from 20 Years of Fraunhofer Microelectronics Research

The Projects of the Former and Current Institutes of the Fraunhofer Group for Microelectronics

The 3,000 Scientists and their Outstanding and Rewarded Research Work

Dear Readers,

with this anniversary edition you keep 20 years of history in your hands: 20 years of Microelectronics News and thus also 20 years of highlights in research and development of the member institutes of the Fraunhofer Group for Microelectronics. In the past 80 issues we have reported on exciting projects, presented groundbreaking inventions which paved the way for our technological and social future of society, and we have managed to give a voice to those who are behind it.

While research activities are often forward-looking, we would like to address a small throwback this time: In October 2000 the first issue of Microelectronics News – with only four pages and for the time being only in German language – was published. From then on, regular news should follow. In the course of time the number of member institutes increased, but also the variety of topics and thus the page number of our magazine. From the very beginning, Dr. Joachim Pelka, until mid-2018 the managing director of the business office for the Fraunhofer Group for Microelectronics and the "father" of Microelectronics News, Christian Lüdemann, head of the Fraunhofer PR-Netzwerk, and until the end of 2018 editor-in-chief and their team made it possible by passion and a lot of heart and soul that you, our readers, can hold the latest developments from the microelectronics world every three months in your hands and since 2012 also in English. Even though the editorial team has meanwhile changed, one constant remains: the Microelectronics News.

It is particularly important to us, then as now, to strike a balance between scientifically demanding facts and their comprehensible mediation. Our magazine aims to explain microelectronic content in an exciting and entertaining way, to stimulate the discourse and to bring the scientists together among themselves, but also with external partners.

At this point, we would like to take the opportunity to thank Dr. Joachim Pelka, Christian Lüdemann, all the editors involved over the years, the researchers and PR employees of the Group institutes and our agency zappo Berlin for the support in the past 20 years of Microelectronics News. Finally, we would like to invite you to join us for a small time travel through the highlights of 20 years of Microelectronics News, and we hope you enjoy reading our anniversary edition.

Your editorial team

1996
Foundation of the Fraunhofer Group for Microelectronics

1996 – 2004
Prof. Herbert Reichl is founder and chairman of the Group

1996 – 2018
Dr. Joachim Pelka is the managing director of the business office

2005 – 2010
Prof. Heinz Gerhäuser is chairman of the Group

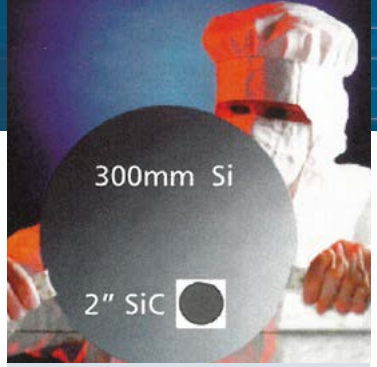
2011 – 2019
Prof. Hubert Lakner is chairman of the Group

2017
Foundation of the Research Fab Microelectronics Germany (FMD) – Fraunhofer Group for Microelectronics in cooperation with Leibnitz FBH and IHP

2017 – Mai 2020
Jörg Amelung is the managing director of the Research Fab

Since July 2018
Dr. Patrick Bressler is the managing director of the business office

Since 2020
Prof. Albert Heuberger is spokesman of the Group and chairman of the Research Fab



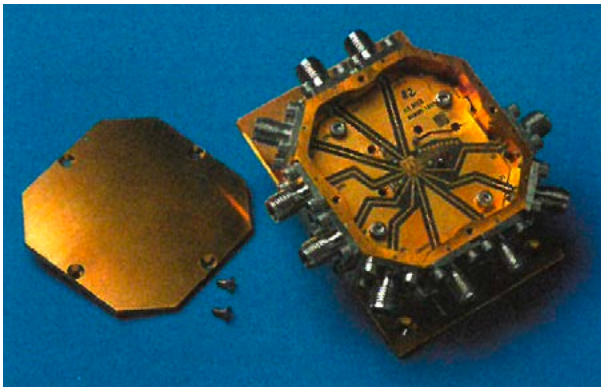
Both are comparable in price: State-of-the-art silicon and silicon carbide wafers. © Fraunhofer IIS-B (now Fraunhofer IISB)

HF power electronics SiC technology

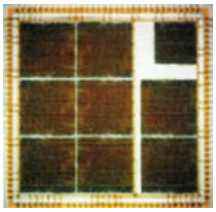
Telecommunications and thus wireless transmission technology is an exponentially growing market. New systems, such as UMTS or satellite broadcasting, made high demands on linearity and efficiency and required significantly improved high-frequency power amplifiers. Silicon Carbide (SiC) was used as a new semiconductor material for RF power transistors.

More communication through higher frequencies

Data transmission rates of 1 Tbit/s in optical long-distance connections: This should be possible in ten years by combining optics and electronics with the installed optical fibers. Bit rates of 40 Gbit/s are being developed worldwide in the year 2000.



4:1 multiplexer for optical data transmission at 40 Gbit/s. © Fraunhofer IAF



The crypto card of Fraunhofer IMS in Dresden (now Fraunhofer IPMS) offers data security in credit card format. © Fraunhofer IPMS

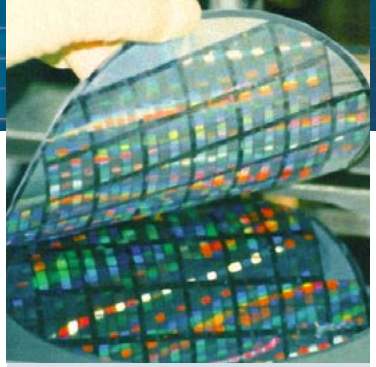
Cryptography ASICs

Modern data transmission technologies such as e-mail, radio transmission, chip cards of all kinds, data and computer networks place high demands on security and confidentiality in the transmission and storage of data. Cryptocoding is a technique already used in ancient times to protect messages from unauthorized access.

Fraunhofer researchers receive Future Prize: MP3 revolutionized the music industry

Three researchers from the Fraunhofer Institute for Integrated Circuits, Department of Applied Electronics, received the "German Future Prize". Their development: the MP3 audio coding process, which compresses music data to one twelfth. This enables music to be transmitted via the Internet and digital radio to be broadcasted in hi-fi quality via satellite. The prize endowed with 500,000 D-Mark, was awarded for outstanding achievements in science and technology.

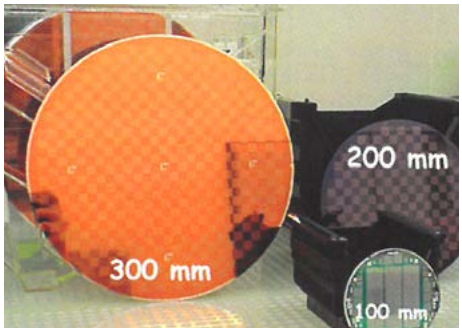
Former German Federal President Johannes Rau (2nd from right) presented the German Future Prize 2000 for the MP3 audio coding process to (from left) Harald Popp, Prof. Karlheinz Brandenburg and Dr. Bernhard Grill from Fraunhofer IIS. © Deutscher Zukunftspreis / Henning Scheffen



Thin and therefore flexible silicon enables the production of chips that can be used in mechanically specially stressful environments such as textiles. © Fraunhofer IZM

"SECAP" – International Packaging Consortium founded

With the aim of developing equipment and processes for wafer bumping and wafer-level packaging, a group of world-leading semiconductor device manufacturers founded the consortium "SECAP", together with Fraunhofer IZM.



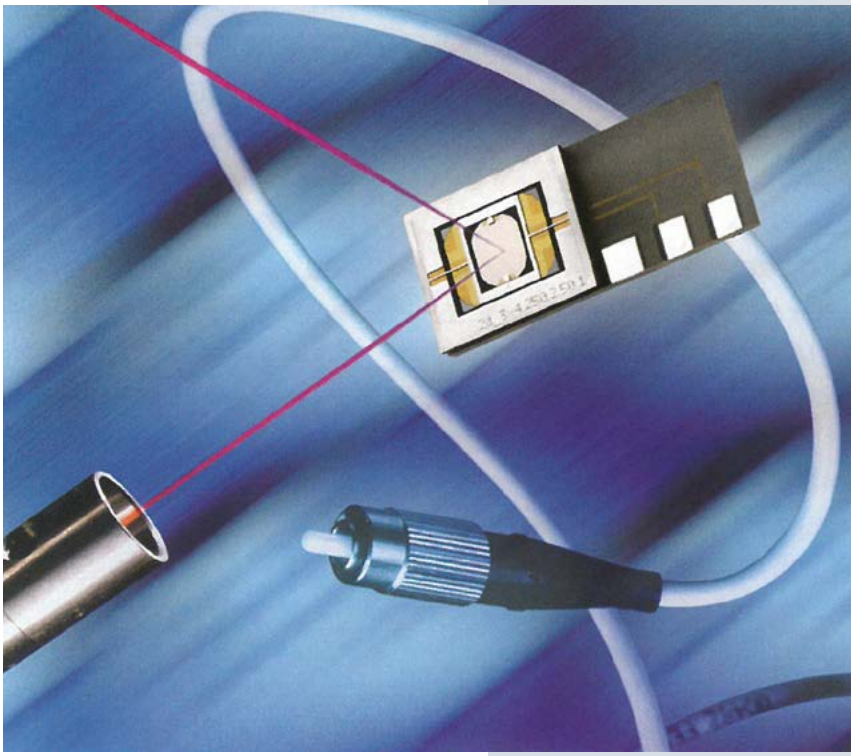
The first 300 mm wafer processes with 45 µm photo resist. © Fraunhofer IZM

"Chip in textile" – logistics in textile cleaning

In a project initiated by Fraunhofer IZM and the Thuringian textile research institute (Textilforschungsinstitut Thüringen-Vogtland e.V. (TITV), Greiz), concepts for the structural integration of RFID semiconductor chips in fabrics and textiles were developed.

Optical nodes in data networks

With new technologies such as fiber optic transmission, ever larger data packages are racing around the globe at ever increasing speeds. But the slow switching points have remained: Optical signals are converted into electrical signals, switched and then travel back on their journey as light waves in the next glass fiber. The data transfer is considerably accelerated when direct optical switching is performed in these switching centers. With its microsystem solutions for optical cross-connects, Fraunhofer ISIT now enables the rapid transmission of large amounts of data in the shortest possible time.



The two-axis cardan scanner can variably reflect a laser beam in x and y direction. If hundreds and thousands of such mechatronic tiny devices are combined to form optical cross-connects, they transmit data in fiber optic networks. © Fraunhofer ISIT

Fiber optic network with 1.2 Tbit/s for the internet of the future

At the Heinrich Hertz Institute in Berlin, the experiment on high-performance optical networks as a base for the Internet of the future has been successfully launched. In this experiment, various fiber optic networks were interconnected using the latest transmission and network technology. For the first time, data could be transmitted from Stuttgart to Berlin with 1.2 TBit/s on a standard fiber optic cable. Within the framework of the BMBF priority funding KomNet, the network components and transmission methods required for this were developed over the last three years.

Festive opening event at Fraunhofer HHI in Berlin. © Fraunhofer HHI

The measurement and test center in Munich. © Fraunhofer ESK (now Fraunhofer Institute for Cognitive Systems IKS)

Broadband Internet subscriber lines tested and optimized

In the measurement and test center of the Fraunhofer Institute for Communication Systems (ESK) in Munich, broadband Internet subscriber connections were tested and optimized. The growing demand for broadband Internet access led to the increasing use of xDSL (Digital Subscriber Line) technology.

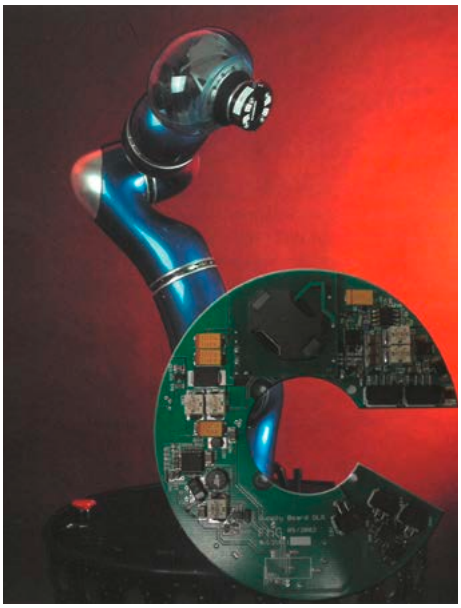
Acceptance and usability of communication technology

In the study "Microelectronics for innovative human-machine interfaces" of the Fraunhofer Group for Microelectronics, future communication systems were examined for acceptance and usability.

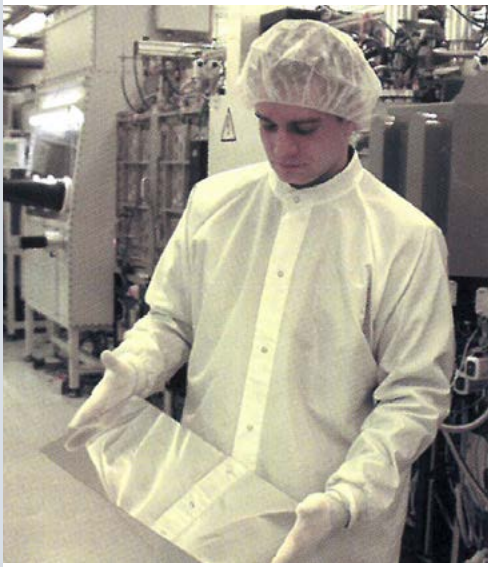
3D display with gaze and gesture recognition. Gesture recognition still placed very high demands on the hardware and software. That's why behind the 3D display above there is a high-performance workstation worth 250,000 euros. © Fraunhofer HHI

The new generation of lightweight robots

The Fraunhofer Institute for Integrated Circuits, Department of Component Technology (IIS-B) and the German Centre for Air and Space flight (DLR) worked closely together in a project for the development of a new generation of lightweight robots. The required power electronics were developed at Fraunhofer IIS-B and mechatronically integrated into a robot joint, which was developed by the DLR. The result was a flexible, intelligent and bus-controlled joint actuator.



The outstanding feature of lightweight robots is that instead of mechanically rigid and heavy construction elements, much lighter and therefore less rigid components are used. © Fraunhofer IIS-B (now Fraunhofer IISB)

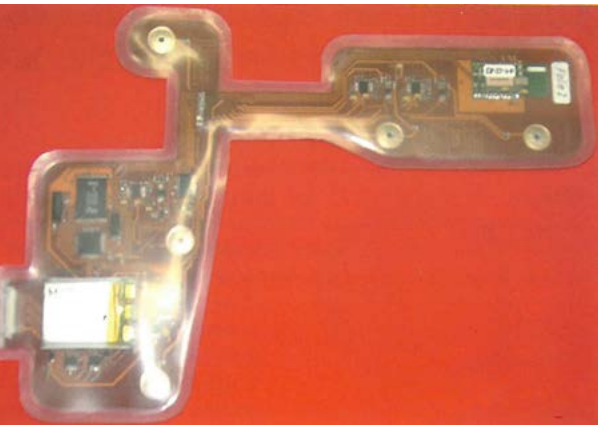


Substrates up to a size of 300 mm x 400 mm can be processed in the system. © Fraunhofer IPMS

World's first vertical inline production line for OLED displays went into operation

On December 16, 2002, the first inline production line for OLED displays was initiated. The event took place at Fraunhofer IMS in Dresden, which later became the Institute for Photonic Microsystems IPMS. Since 2014, work on organic semiconductors, which include flexible organic electronics, OLED-lighting and -Signage OLED-on-Silicon microdisplays and sensors continued at the Fraunhofer Institute for Organic Electronics, Electron Beam and Plasma Technology FEP.

Telemedicine – a new way to improve patient care



Fraunhofer IPMS focuses on the development of wireless medical sensors that can be integrated into a body area network. © Fraunhofer IPMS

Although telemedicine does neither replace the doctor nor trusting patient conversations – telemetric data transmission enables continuous provision of patient data, thus supporting the medical personnel in diagnosis and therapy decisions and saving the patient follow-up visits.

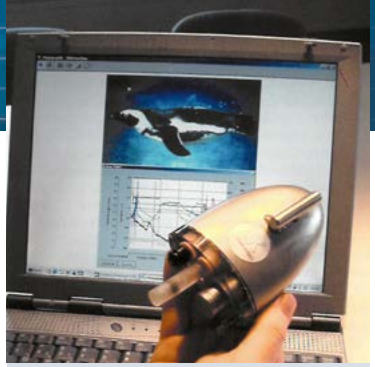
Science prize for high purity calcium fluoride crystals

On October 22, 2003, employees of Fraunhofer IISB were awarded the 50,000 Euro science prize of the "Stifterverband für die deutsche Wissenschaft". The prize was awarded by Dr. Oetker in front of about 1,000 participants to the Fraunhofer scientists for their successful growth of high-purity calcium fluoride crystals, which are used in the semiconductor industry for the production of microchips. Among the guests of honor was then German Chancellor Gerhard Schröder.

The winners of the Stifterverband Award, here without their colleagues from SCHOTT, gathered around a crystal cylinder: Alexander Molchanov, Dr. Jochen Friedrich, Oliver Gräbner, Gheorghe Ardelean and Prof. Georg Müller (from left). © Fraunhofer IISB

Marine mammals with mini-laboratory on travel

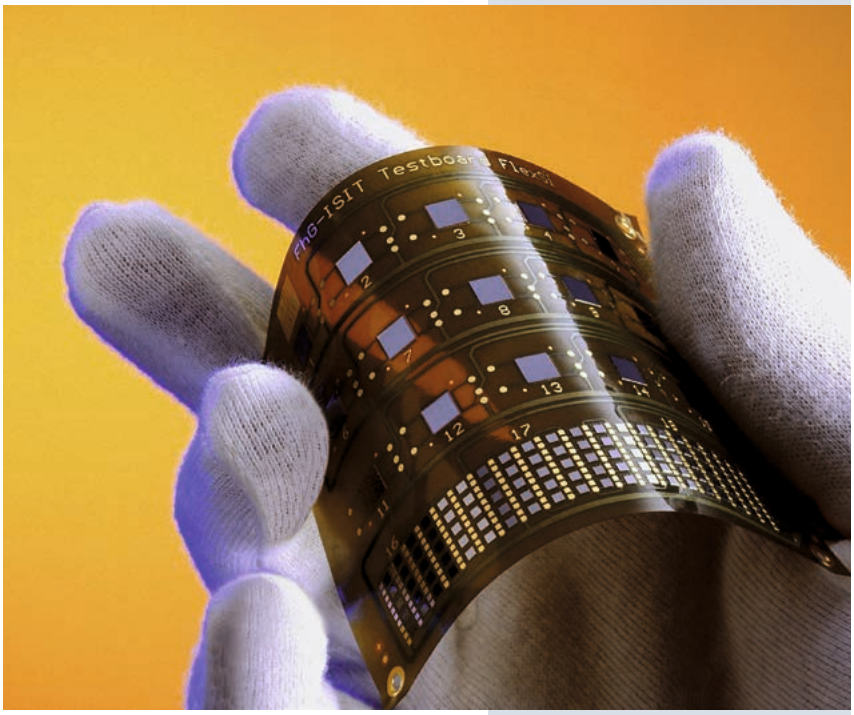
High-tech backpacks are now also available for whales. Researchers at Fraunhofer IZM in Berlin and the company Driesen + Kern in Bad Bramstedt have developed a miniature chemical laboratory to accompany marine mammals on their dives to determine the water quality in the depths of the ocean.



The miniaturized tachograph for marine life such as seals and penguins contained a variety of sensors for simultaneous measurement of data such as pressure, temperature, pH value and brightness. © Fraunhofer IZM

New method for processing thin silicon chips

Thin, flexible silicon chips are to be the future of the electronics industry. From the originally relatively stable silicon wafer to a fragile structure of significantly less than a tenth of a millimeter thickness: thin like paper and flexible like foil. Fraunhofer ISIT developed a method for processing thin silicon chips with a professional standard production equipment.



Thin silicon chips on flexible carrier. With such test boards, production equipment can be tested and optimized. © Fraunhofer ISIT

If all of Mozart's symphonies fit comfortably on one DVD in high quality, this is thanks to the DVD called "Bluray Disc" or "Blue Disc" with a capacity of up to 50 GB.
© Fraunhofer IAF / Osram

Bluray Disc replaces more than ten conventional DVDs

Listening to the "Flying Dutchman" without changing the CD, recording the film opus "Lawrence of Arabia" only on a Digital Versatile Disc (DVD) – the blue semiconductor laser, developed by Fraunhofer IAF and IMS together with the Osram company, made it possible by generating a light beam with a wavelength in the range of 410 nm.

A trained laboratory worker needs about a quarter of an hour to generate a blood count under the microscope.
© Fraunhofer IIS / Kurt Fuchs

Automatic blood counts

Draw blood and take it to the laboratory. Until now, the usual blood count examination had to be performed manually in case of abnormalities – after all, this was the case in 40 % of the patients. A computer-assisted blood cell analysis will now take over this task. With HemaCAM, researchers at Fraunhofer IIS in Erlangen have developed a technique to automate such analyses and increase the quality of the findings.

German Future Prize 2004

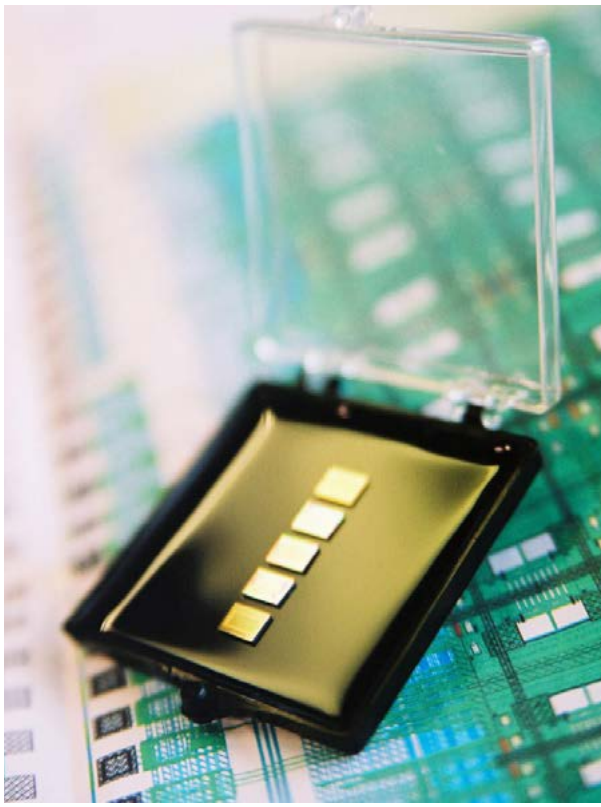
The team of Dr. Rainer Hintsche from Fraunhofer ISIT, Dr. Roland Thewes from Infineon Technologies and Dr. Walter Gumbrecht from Siemens was awarded the German Future Prize 2004 for their project "Laboratory on the chip - electrical biochip technology" on November 11 in Berlin. Then German Federal President Horst Köhler presented the award during a ceremony in Berlin.

(From left to right) Dr. rer. nat. Walter Gumbrecht, Dr. rer. nat. habil. Rainer Hintsche, Dr.-Ing. Roland Thewes.
© Fraunhofer ISIT

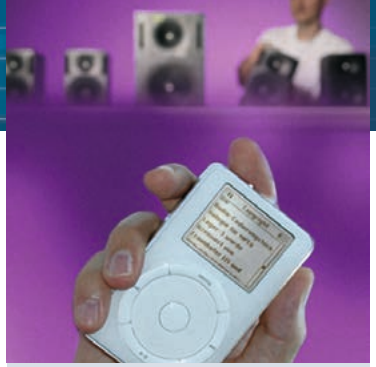
Optical chips from Berlin

Compact and cost-effective semiconductor lasers which can generate short light pulses in a very fast time sequence play a central role in fiber optic networks for high-speed data transmission.

Compact pulse laser module with monolithic integrated 40 GHz pulsed laser chip, coupled fiber optics (left) and electrical High frequency connector (right), mounted on an electronic plug-in card. Chip production: Fraunhofer HHI, Berlin; module design: u2t Photonics AG, Berlin.
© Fraunhofer HHI



The fingernail-sized, highly sensitive chip sensor system made it possible to analyze hereditary traits and determine disease-relevant substances and toxins much more quickly, easily and cost-effectively. © Fraunhofer ISIT



With the MP3 player, ten years later a completely new market in consumer electronics evolved.
© Fraunhofer IIS

Ten years of MP3

On Friday, July 14, 1995, the eight-member research team at Fraunhofer IIS, headed by Prof. Karlheinz Brandenburg, agreed on the name MP3 for all audio files using the new "MPEG Audio Layer 3" method. An e-mail – sent to all employees – is considered as a historical birth certificate.

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Datum:   Fri, 14 Jul 1995 12:29:49 +0200
Betreff: Endungen fuer Layer3: .mp3
Hallo,
nach der überwältigenden Meinung aller Befragter:
die Endung für ISO MPEG Audio Layer 3 ist .mp3.
D.h. wir sollten für kommende WWW-Seiten,Shareware,
Demos, etc. darauf achten, dass keine .bit
Endungen mehr rausgehen.
Es hat einen Grund, glaubt mir :-)
Jürgen Zeller
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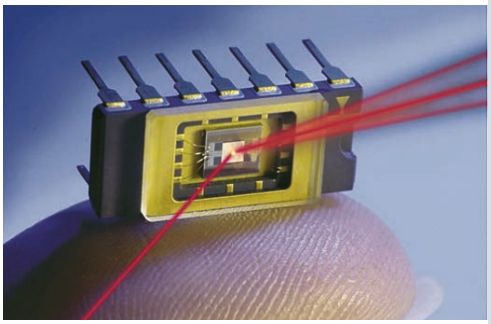
The audio team from 1987 (from left to right): Harald Popp, Stefan Krägeloh, Hartmut Schott, Bernard Grill, Heinz Gerhäuser, Ernst Eberlein, Karlheinz Brandenburg and Dr. Thomas Sporer.
© Fraunhofer IIS / Kurt Fuchs

Innovative light sources of the future

Together with 24 European companies and major scientific institutions facilities, Fraunhofer IPMS took part in the OLLA project and worked on the research on white, extremely bright OLEDs. The goal of this major European project (IP in Framework 6 program) was to implement the technology in new lighting systems by 2008.

Highly efficient RGB-OLED light sources.
© Fraunhofer IPMS

Barcode scanning thanks to silicon



The mini-projection module is based on a microscanner mirror.
© Fraunhofer IPMS

Fraunhofer IPMS developed a revolutionary micro scanning mirror technology together with the company Intermec. It is based on monocrystalline silicon and can be used for barcode scanners or highly miniaturized projection modules in cell phones.

Insight into the world of microchips on Girls' Day

As part of the nationwide Girls' Day on April 28, 2005, schoolgirls were able to learn about the career opportunities and scientific secrets of micro- and nanoelectronics at Fraunhofer IISB in Erlangen. The girls spent an exciting day in the world of semiconductors, transistors and crystals.

The seven female guests with a self-processed wafer in front of the clean room. © Fraunhofer IISB

At the symposium "Perspectives on Electronics and Sustainable Development" Dr. Nissen presented the new research program of Fraunhofer IZM "Sustainable Technology Development". © Fraunhofer IZM

Ecological perspectives for the electronics industry

Sustainability in the electronics industry is a central topic for economy, science and politics. Whether it's about energy efficiency or the minimization of ecological follow-up costs – Companies are increasingly looking for approaches enabling them to cut costs and reduce environmental impact at the same time.

Next, please!

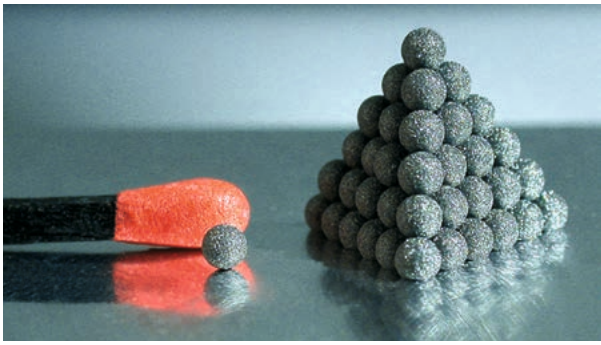
It's unpleasant enough when you have to receive medical treatment. But it's unbearable to sit in a room full of waiting patients, hoping for their turn. The waiting time can be shortened considerably with the mobile laboratory system from Fraunhofer IZM, as it allows faster diagnosis of diseases.

The finished "laboratory": assay processor for fully automated processing of several BioChip cartridges. © Fraunhofer IZM

Data race: world record in data transmission

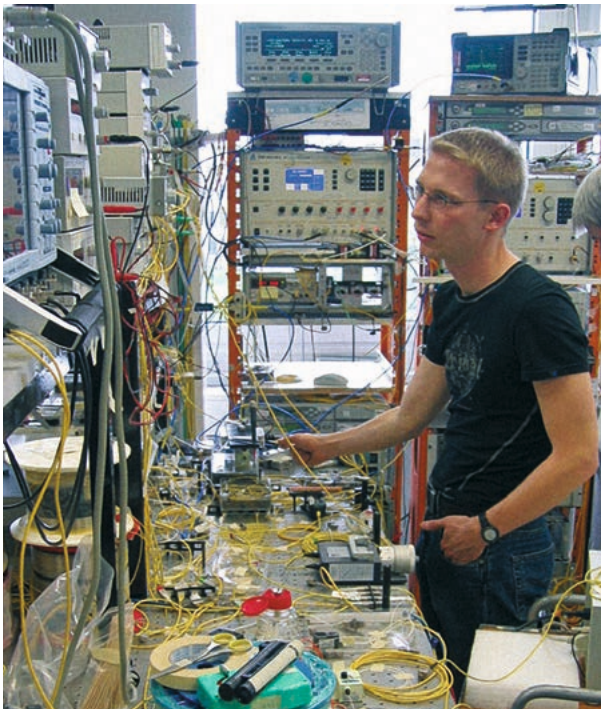
With their new technology, researchers at the Fraunhofer Institute for Telecommunications, Heinrich Hertz Institute have developed a data rate of 2.56 Tbit/s in a wavelength channel over a distance of 160 km. This data rate corresponds to the content of 60 DVDs, which can be sent every second, and it´s twice of what a Japanese working group had accomplished five years earlier.

Diamond spheres for the energy of the future



Diamond balls in unpolished raw state. © Fraunhofer IAF

Small sphere – big bang. Researchers at Fraunhofer IAF manufacture tiny, high-precision hollow spheres out of synthetic diamonds. The starting point are small silicon spheres, which get coated with diamonds in a patented plasma reactor developed by Fraunhofer IAF. In contrast to the disk, the balls have to be moved permanently in the reactor for a homogeneous coating. Nevertheless the silicon is still in the sphere. To get it out and to create a hollow sphere, the researchers drill with a laser a only few micrometers tiny hole and dissolve the silicon with a special ultrasound-assisted etching technology. Christoph Wild, Eckhard Wörner and Dietmar Brink from Fraunhofer IAF were awarded with one of the Joseph von Fraunhofer Prizes 2006 for their development work.



Laboratory for data transmission at 2.56 TBit/s. © Fraunhofer HHI

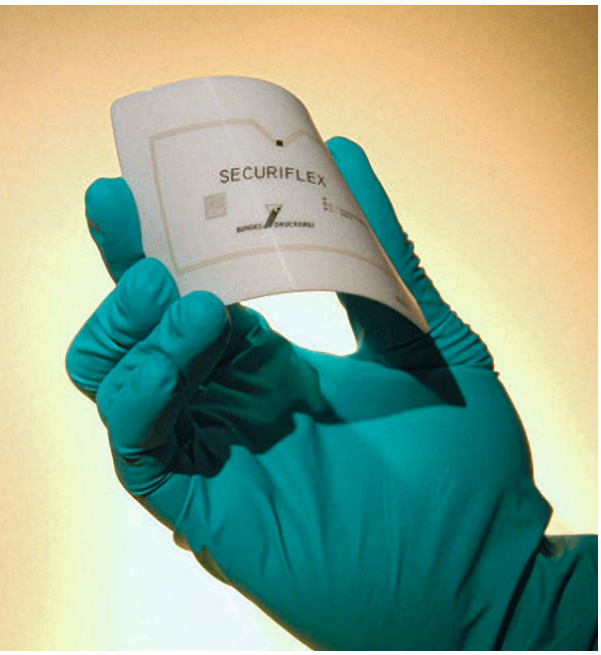
Mirror, mirror on the wall

Fashionwise Paris has always set trends. In addition to extravagant cuts and fine fabrics, the Champs Elysées now has yet another attraction: In the Adidas store, a virtual mirror from Fraunhofer HHI eliminates the need for tiresome fitting.

Spoilt for choice: The decision for the most beautiful pair of shoes cannot (yet) be made by the virtual mirror. © Fraunhofer HHI

Future technologies for secure identification

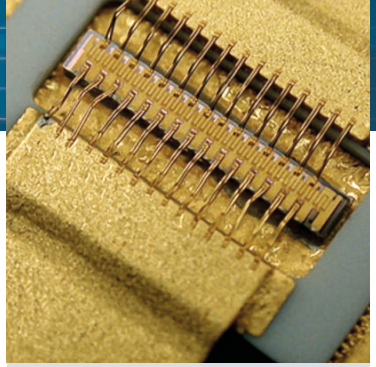
The chips that could be used for ID cards and smart cards are 10 times thinner than a hair. The German Federal Printing Office and Fraunhofer IZM have joined forces to research technologies for chip-based ID security documents. On July 11, 2007, the "SecurityLab", which was set up specifically for this purpose, opened in Berlin.



Flexible smart card with integrated antenna: The RFID chips are so thin that they can be easily integrated into paper and the contacts are so fine that they can be wired with an antenna that is no longer visible. In addition, the hardware is designed to be so reliable that it can withstand daily use. © Fraunhofer IZM

Strategic Technology Alliance for Europe

Gallium nitride (GaN) semiconductor chips are key components for modern mobile communications. They can be used to build particularly energy-efficient and flexible base stations for future radio networks. The companies NXP and UMS joined forces together with the Fraunhofer IAF in Freiburg to create an independent European source for this strategic technology.



Fraunhofer IAF has been conducting research and development in the field of GaN technology since the early 1990s. © Fraunhofer IAF

Keeping an eye on the traffic

Modern on-board electronics prevent many traffic accidents. Nevertheless, the systems are not perfect. Especially the crossing traffic causes problems. Objects, but also pedestrians, who approach quickly from the side, are hardly detectable. The Fraunhofer IMS developed a small, robust and, above all, inexpensive camera to monitor the blind spot in cars.

The novel camera determines the distance and three-dimensional shape of an object. © Fraunhofer IMS

Localization via WLAN only requires additional software on the existing terminal device. © Fraunhofer IIS

First test environment for autonomous WLAN localization in Nuremberg

Foreign city, unknown streets – how do I get to my destination? The days of helpless searching could soon be over thanks to the first self-sufficient WLAN localization. In January 2008, Fraunhofer IIS and other partners in an open consortium started to work on a standard for WLAN localization and location-based services in the public sector.

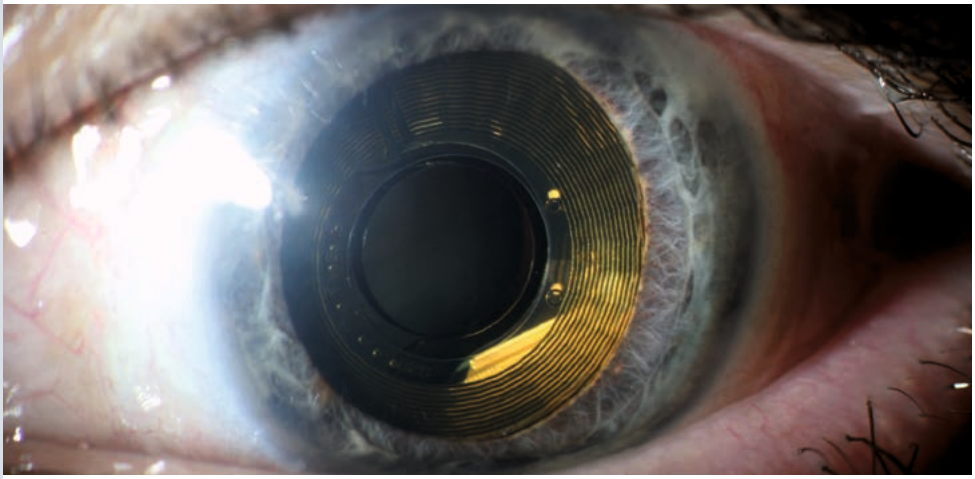
Light at the end of the tunnel thanks to a visual prosthesis

Approximately 30 million people around the world suffer from retina diseases that lead to blindness. For twelve years, researchers in the EpiRet project worked to find a way to help patients. Their efforts have now resulted in a fully implantable visual prosthesis.

"Magically" controlling computers by hand

Without direct contact: The images are rotated only on the basis of gestures. © Fraunhofer HHI

A woman stands in front of a large screen and points hectically around. As if by magic, suddenly pictures appear on the Display. They can be moved simply with the index finger, be rotated with a slight tilt, or increased and decreased in size. Sounds like science fiction, but it's reality, because the "iPoint Presenter" developed at Fraunhofer HHI makes exactly this possible.



The visual prosthesis is so small, durable and at the same time flexible that it easily fits into the eye. © Fraunhofer IMS

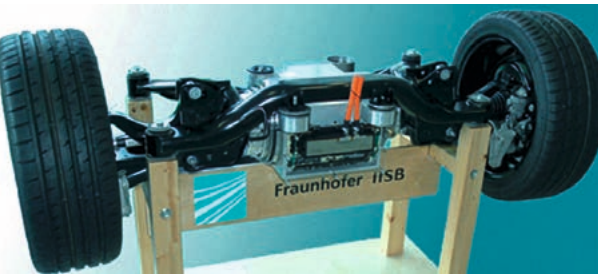
Heading for new shores

The SpreePalais near Berlin Cathedral is the new home of the Fraunhofer Group for Microelectronics VµE. Since the middle of November 2008, Fraunhofer VµE has been coordinating activities in microelectronics and microintegration directly from the center of Berlin.

The new offices of Fraunhofer VµE (now Fraunhofer Group for Microelectronics) are located directly on the river Spree, in close proximity to the Berlin Cathedral and the Museum Island. © Fraunhofer Mikroelektronik / Jens Kracheel

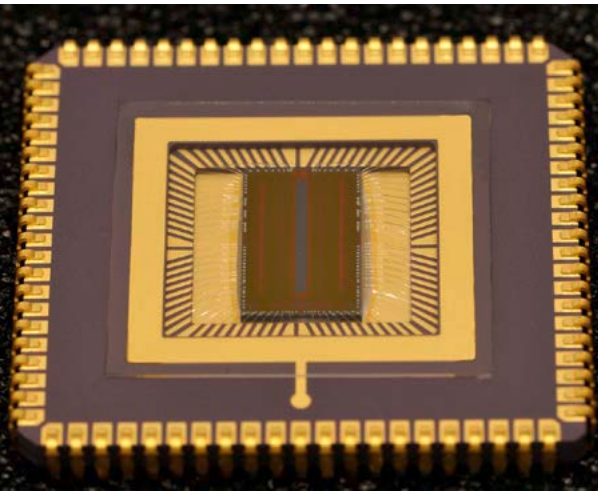
Energy storage on wheels

Our future mobility belongs to the electric car, which has shown itself to be a real all-rounder. This is because, when they are not in use, e-mobiles can also be used to store energy. In the field of e-mobility, Fraunhofer IISB deals with all components required for electric drives, charging technology and electrical energy management.



Electrical rear axis. © Fraunhofer IISB

Color sensors provide a better view



The new breed of CMOS image sensors detects color and is significantly more light-sensitive than conventional sensors. © Fraunhofer IMS

CMOS image sensors in special cameras, such as driver assistance systems, can usually only see in black and white and have limited light sensitivity. Usually, the image sensors on silicon wafers are manufactured using a semiconductor process called the CMOS process. The Fraunhofer IMS has now integrated a color filter system into this process to enable the sensors to recognize colors. In addition, the researchers have developed special micro-lenses that help the sensor to capture and measure light more efficiently.

Skin-tight electronics

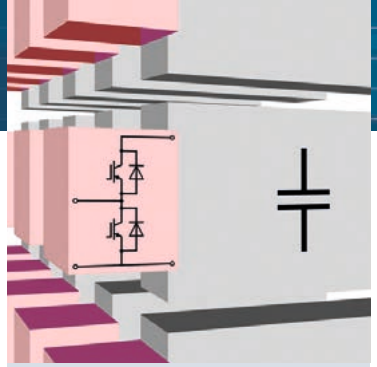
T-shirts which measure our pulse and jackets that can show us around town: Fraunhofer IZM has been developing "intelligent clothes" for some years. Now the Berlin researchers have succeeded in developing a stretchable circuit board. This board ensures that the electronics work reliably, even inside closely fitting textiles, and enable possible new applications and product developments for "smart textiles".

Touching the future

Who doesn't sometimes wish that they could take a look into the future? In Duisburg this wish is now reality: Visitors to the 8000 m² site of the inHaus Center can experience hands-on the ways we will be able to live and work in the future. The inHaus2 research facility is now open with its nextHealth & CareLab, nextHotelLab and nextOfficeLab.

Radiantly beautiful with a light-emitting diode dress. © Fraunhofer IZM

Drinks served by a robot. © Rolf Köppen



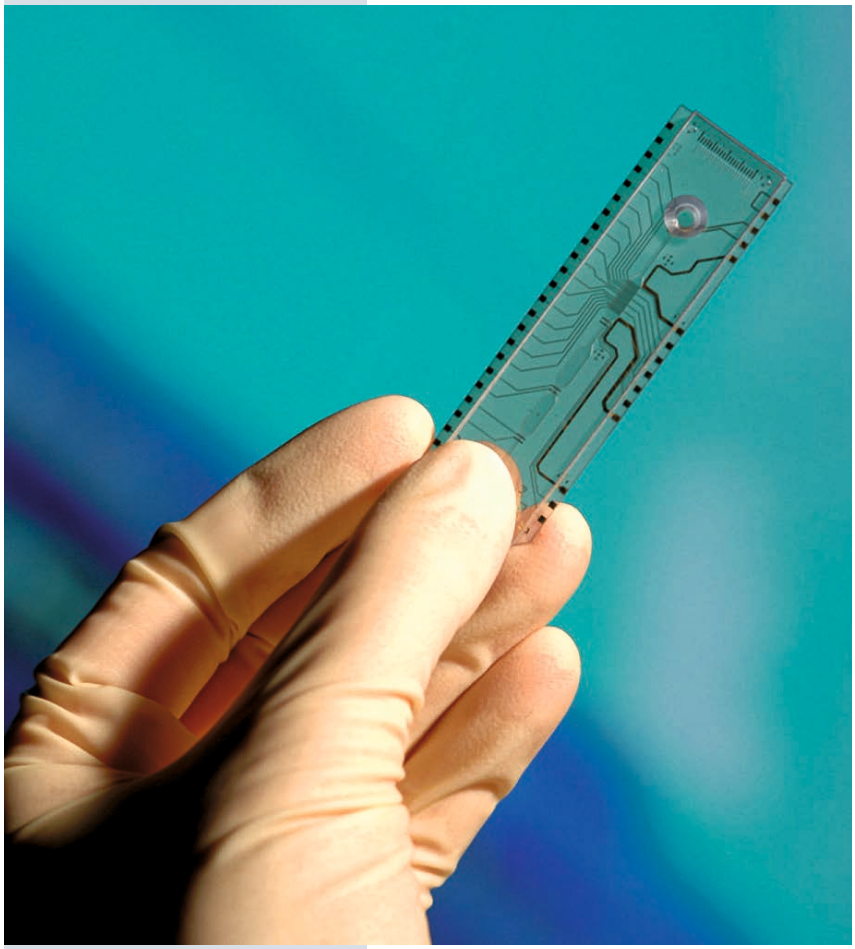
Schematic representation of an explosion-proof frequency converter cell within the cell structure. Explosion-proofing prevents a failure leading to a chain reaction that could cause the failure of the entire frequency converter station. © Fraunhofer IISB

The power grid of the future will minimize energy losses

When electrical energy generated from renewable sources arrives at your wall-plug, it has usually been on a long journey whether from offshore wind farms or regional solar, wind, and biogas power plants. New electronic devices from the Fraunhofer Institute for Integrated Systems and Device Technology IISB are now to be used to prevent large quantities of this energy going missing en route to the consumer.

A laboratory in your pocket

Every year in Germany, around 80,000 people develop thrombosis. This closure of a blood vessel can, in the worst-case scenario, cause a lung embolism or a stroke. Thanks to a mobile mini-laboratory, the risk of blood clots can be detected more quickly, in the future. The core of the new system is a "lab-on-chip" from Fraunhofer IZM in Munich (now Fraunhofer Research Institution for Microsystems and Solid State Technologies EMFT).



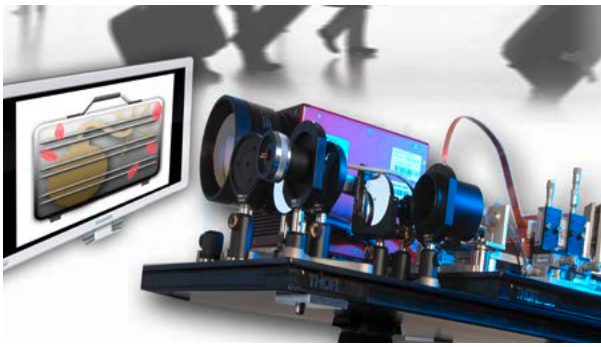
The "lab-on-chip" allows for quick local blood analysis. © Polytronic Systems

A new class of infrared semiconductor lasers

It's hard to imagine many of today's areas of science without laser technology. But for the infrared spectral range in particular for many applications there have been no suitable laser sources. Researchers working within the research project VERTIGO have now developed a new infrared semiconductor laser that closes this gap.

The basis of the new laser technology: a semiconductor chip for the wavelength range between two and three micrometers, fitted in a special heat sink. © Fraunhofer IAF

New way of detecting explosives



Due to the invisible infrared radiation, a contactless and inconspicuous detection is possible. © Fraunhofer IAF / fotolia

Explosives have a high threat potential for public security. At the moment, the stand-off detection of hazardous substances such as TNT or PETN is still an unresolved issue. Within the framework of the research project IRLDEX funded by the German Federal Ministry of Education and Research (BMBF), Fraunhofer IAF is developing a stand-off sensing technique which allows contactless detection of explosives.

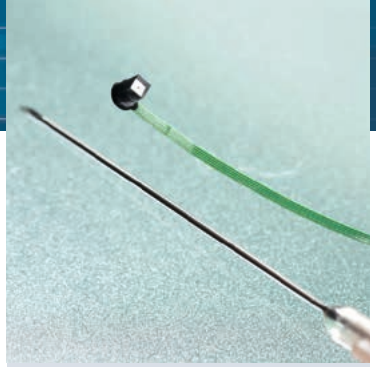
Locating reserves in the power grid

Both the power production capacity and the capacity of overhead lines are very dependent on weather conditions. A self-sufficient sensor network developed by Fraunhofer IZM and ENAS within the framework of the "ASTROSE" project monitors power lines to locate capacity reserves in the cables.

With self-sufficient sensor nodes, reserves in the power grid can be detected. Transmission capacities can thus be significantly increased.
© Fraunhofer IZM

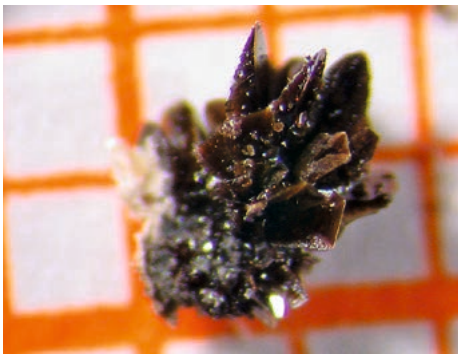
A camera the size of a grain of salt

Microcameras are used in endoscopy to give doctors detailed views inside the human body. Thanks to a new manufacturing process from Fraunhofer IZM, these microcameras are now even tinier and can be produced at a very low cost.



The new microcamera fits perfectly into the tip of the endoscope.
© Awaiba GmbH

Low-cost gallium nitride crystals

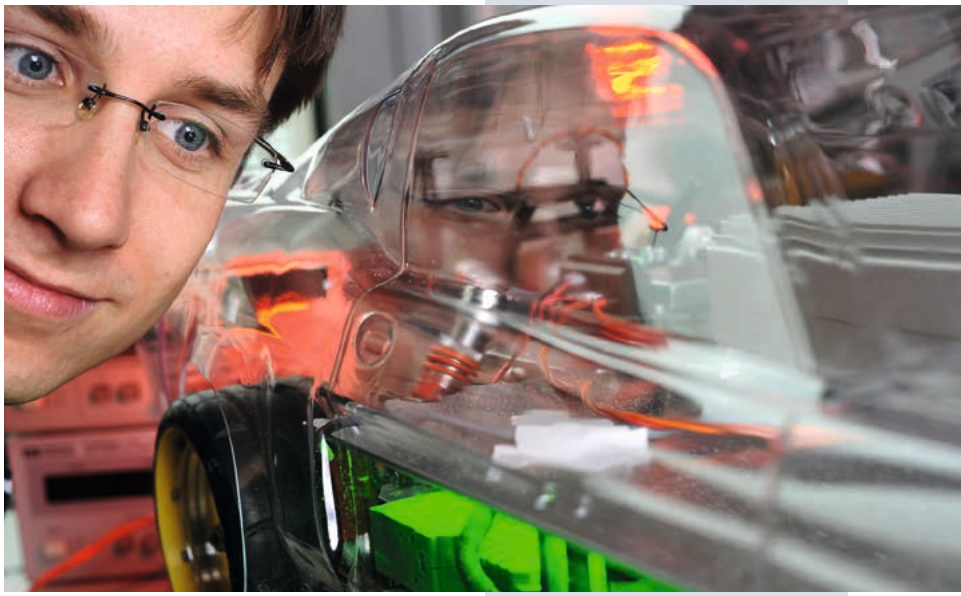


GaN crystals grown spontaneously from a gaseous state.
© Fraunhofer IISB

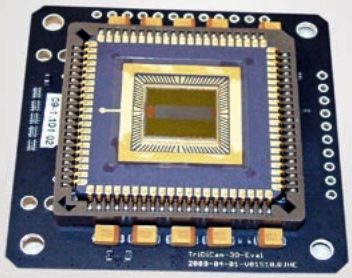
Crystalline gallium nitride (GaN) is needed for special electronic devices such as those found in energy-efficient, robust power converters, but it's very expensive. Fraunhofer THM and the Freiberg-based company Compound Materials GmbH are carrying out joint research on the HVPE process and the analysis of the material produced with it. This technology will enable low-cost manufacture of high-quality GaN crystals that are comparable to the GaN material of competitors in terms of crystal size, material properties and manufacturing conditions.

Driving electric cars safely

A new safety concept is needed for the on-board electronics of electric vehicles, as these make much more use of electronics in their functions than cars with a combustion engine. This increases the safety-critical communication between individual control units. Scientists at Fraunhofer ESK have analyzed the risks and based on that, developed a safety concept.



Researchers at Fraunhofer ESK have analyzed the risks and developed a safety concept that complies with ISO standard 26262.
© Fraunhofer ESK (now Fraunhofer Institute for Cognitive Systems IKS)



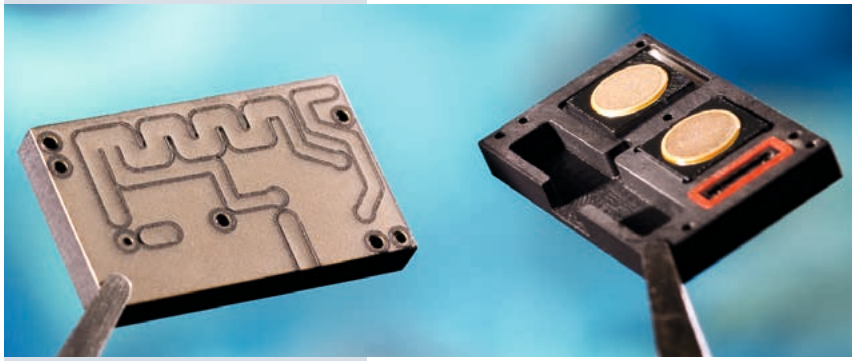
3D camera module.
© Fraunhofer IMS

New device brings CMOS chips up to speed

CMOS image sensors are cheap to produce and also superior in terms of power consumption and handling. However, in applications where only minimal light is available, such as astronomy these semiconductor chips are reaching their limits. This is because large pixels arranged in a matrix do not allow for fast read-out speeds. Researchers at Fraunhofer IMS have now developed an optoelectronic device that speeds up this process.

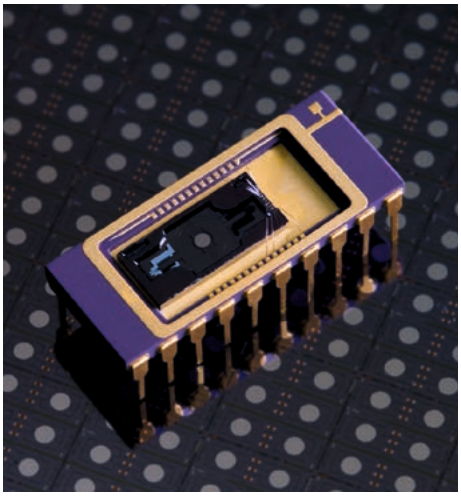
Dosages exact to the nearest microliter

Micropumps that can provide an exact dosage of medication could open up two completely new types of treatment in the future including the treatment of tumors. Within the framework of the "TUDOS" project, the five Fraunhofer institutes EMFT, IBMT, ITEM, IZM and LBF are working on a fully regulated microdosage system that can handle the tiniest quantities. It can provide fluid dosages of 12 µl or one quarter of a drop of water accurate to 4 %.



Microfluid system for tumor therapy.
© Fraunhofer EMFT / Bernd Müller

New MEMS mirror makes linear scanning possible



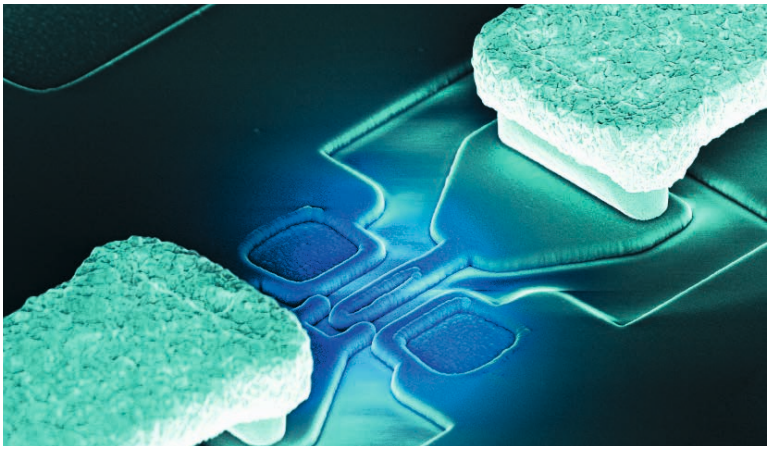
LinScan quasi-static resonant MEMS scanner.
© Fraunhofer IPMS

Fraunhofer IPMS has been working for years on scanner mirrors that can deflect light in one and two dimensions. Devices have, until now, continuously vibrated at a fixed frequency only. A new concept for a quasi-static mirror "LinScan" now allows the motion pattern to be adapted variably.

Terahertz waves: small structures for high frequencies

Ultrafast data transmission, detection of concealed weapons, or diagnosis of diseases – the range of potential applications for terahertz waves is enormous. Around the world, science and industry are working on developing electronic circuits for this previously largely unused spectral range. Fraunhofer IAF has set a European record by attaining a frequency of 0.66 THz.

Section of an integrated circuit with ultrafast transistor. © Fraunhofer IAF



TV satellites: precise positioning in space

In order to be able to receive constant radio signals reliably, the satellites must always maintain their position relative to Earth. From time to time, however, their orbits require correction. Fraunhofer IIS / EAS and SES ASTRA have come up with a new type of technical solution to optimize these correction maneuvers. The result is a highly accurate method for determining the position of geostationary satellites, which opens up new possibilities for their operation.

Geostationary satellites orbit the Earth once a day along the equator. © SES – www.ses.com

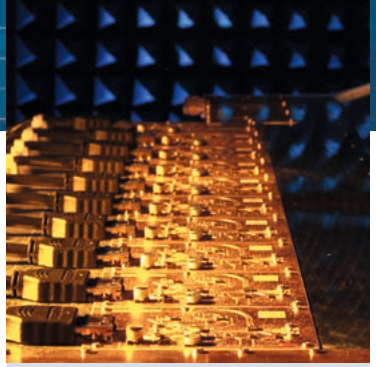
Together into a European future

The European and especially the German industrial landscape is characterized by many small and medium-sized enterprises (SMEs) that produce intelligent system solutions. With the "SIS² Facility", the Heterogeneous Technology Alliance HTA, driven by the Fraunhofer Group for Microelectronics, pointed out a way forward that should give European SMEs easier access to modern high technologies and thus improve their competitiveness.

In the HTA, an association of the four European research institutions CEA-Leti, CSEM, Fraunhofer Group for Microelectronics and VTT, the basis for such an institution has been created since 2005 through joint strategic discussions. © HTA

Safer shipping with high-tech radar

Traffic is building not only on our roads, but also in sea lanes. A new ship radar with improved antenna technology will fulfill the increased requirements of navigation while also protecting against pirate attacks. For this purpose researchers at Fraunhofer FHR have chosen electronically scanned arrays as well as improved generation and processing of signals.



The transmit and receive modules of the array antenna are equipped with silicon-germanium mixed-signal integrated circuits. © Fraunhofer FHR

Test run for the hospital of the future

It is a future workshop at a realistic scale: the Duisburg-based inHaus Center. In the newly opened "Hospital Engineering Laboratory", Fraunhofer researchers, together with partners from research and industry, want to make hospitals fit for the future. They are working on holistic solutions to optimize processes with technological support.

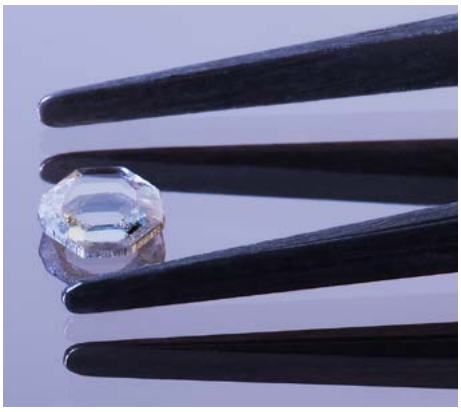
Automatic documentation using RFID radio chips as well as a mobile operating table requiring fewer bed transfers of patients make things easier for staff. © Fraunhofer / Markus Steur

Sound with personal touch

In a room from which no sound penetrates into the outside world, researchers at Fraunhofer IDMT developed the loudspeakers of the future. The idea: sound rays in best sound quality are generated, which can be positioned precisely. This allows every person in one and the same room to listen to a different sound experience without being distracted by the sound of another piece.

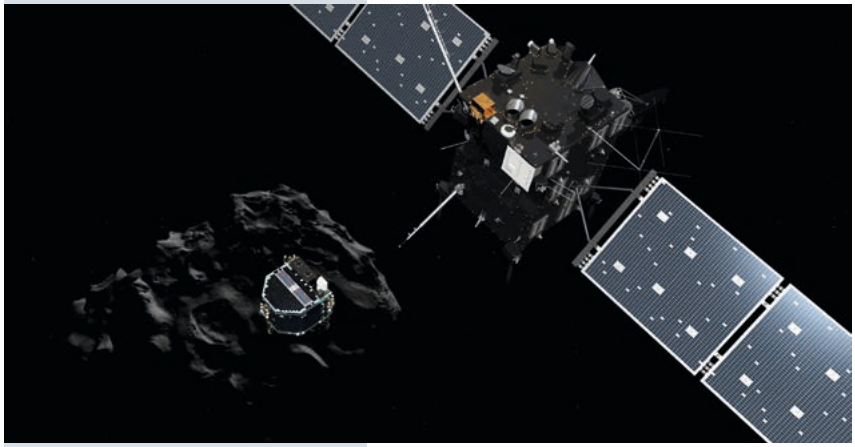
The converter arrays of Fraunhofer IDMT in zoom view.
© Fraunhofer IDMT

Diamond crystals from plasma reactors



A high-purity single-crystal diamond made at Fraunhofer IAF. © Fraunhofer IAF

In research circles diamonds have a special status due to their physical properties. Extreme hardness, unmatched thermal conductivity and broadband optical transparency extending from the ultraviolet to the infrared range make this material ideal for many applications. At Fraunhofer IAF, synthetic diamonds of the highest quality and in all variations can be produced ranging from discs to three-dimensional shapes and even hollow spheres.



Philae separated from Rosetta and began landing on Churi (artistic representation).
© ESA / ATG medialab

Message from Tschuri

After a ten-year journey, on November 12, 2014, the space probe "Philae" landed on comet 67P / Churyumov-Gerasimenko, also called Tschuri. It was a milestone in the history of space travel because never before has it been possible to land on a comet. The mini-laboratory collected data that should provide information about the formation of our solar system. The sensor technology from Fraunhofer IZFP was also on board. Its task was to investigate the properties of the comet's soil.

Going for a virtual stroll across New York's Times Square

Fraunhofer FOKUS developed projector auto-calibration, a procedure that automatically adapts image content to the surface to be displayed. This also makes it possible to display images on curved screens. In order to create a homogeneous image on curved surfaces, the individual projectors must be precisely matched to each other. The overall image is then composed of their partial projections.

Going for a virtual stroll across New York's Times Square. Modern domes make this possible – and now directly via the driver of the PC graphics card. © Fraunhofer FOKUS / Matthias Heyde

New perspectives in Europe

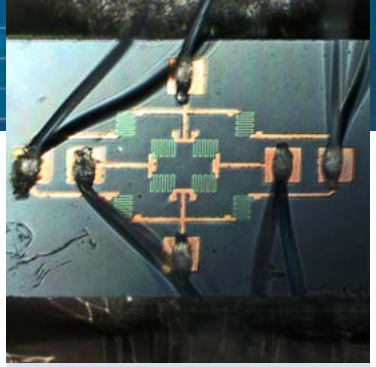
ECSEL Joint Undertaking © ECSEL

European microelectronics research now has a long tradition: microelectronics has become an important pillar of European exports. The electrical industry, as well as vehicle, machinery, and system construction, have all put their trust in a competitive microelectronics sector in Germany and Europe. Of particular importance to Europe is "More than Moore" technology, which allows additional functionalities to be integrated into chips. At the heart of European microelectronics research funding is the "ECSEL" program (Electronic Components and Systems for European Leadership). Fraunhofer successfully participated in the calls for proposals, three of the approved projects are pilot line projects in the field of microelectronics: "ADMONT", "WAYTOGO FAST" and "Powerbase".

A look under the hood gives us a clear view of the battery system and the double drive unit developed by Fraunhofer IISB.
© Fraunhofer IISB / Kurt Fuchs

Monolithic integrated 2D magnetic field sensors based on a GMR spin valve

Magnetic field sensors allow contact-free, high-precision, and reliable measurement of distances, speeds, and angles, even in challenging operating conditions. Researchers at Fraunhofer ENAS have now developed powerful multi-axis magnetic field sensors for MEMS and smart systems



Light microscopic image of a wire-bounded 2D sensor.
© Fraunhofer ENAS

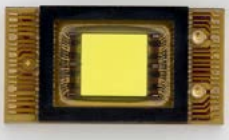
Metal encapsulation optimizes chemical reactions

The chemical industry uses large quantities of packing materials. To protect the millimeter-scale particles against abrasion, Fraunhofer IKTS encapsulates them in a layer of metal that boosts their thermal conductivity by a factor of five.
© Fraunhofer IKTS

Random packing materials are used in many chemical reactors and heat storage systems as catalytic support media or adsorbents. To ensure that these processes produce the desired results, the packing materials have to be able to conduct heat particularly efficiently. The problem, however, is that the gaps between the millimeter-scale particles prevent heat from being conducted optimally. Together with Fraunhofer IWU and Fraunhofer IGB, Fraunhofer IKTS has come up with a solution.

Roll-out of the "IISB-ONE" electric sports car

Fraunhofer IISB has presented its "IISB-ONE" electric sports car, a test vehicle for power-electronic vehicle components that is open to adaptations. The electric drive train is completely realized by systems developed at Fraunhofer IISB. The modular vehicle concept allows the flexible integration of future developments.



The new type of LED component with 1024 individually actuated pixels is about the size of a fingernail. Combining three of these LED components allows for a resolution of 3072 pixels per headlamp.
© OSRAM Licht AG

New automotive lighting revolutionizes road safety

A German research alliance has developed the basis for smart, high-resolution LED headlights, in which the headlight adapts very precisely to the respective traffic situation. Fraunhofer IZM developed a connection technology that allows the resolution of LEDs to be increased by a factor of more than a thousand. Fraunhofer IAF demonstrated a method of eliminating µ defects, which can increase component yield.

Smart protective clothing raises the alarm

Dangerous chemicals, contaminated wastewater, toxic substances: for sewer workers or employees in the chemical industry, handling dangerous substances is often part of their everyday job. The Fraunhofer EMFT was involved in the development of smart protective clothing, which indicates the existing concentration of hazardous substances through color changes and can thus usefully complement to the existing protective measures in the future.

The protective glove changes color when it detects hazardous substances.
© Fraunhofer EMFT / Bernd Müller

The "Proxemic Monitor" is connected to a PC, which in turn is connected to a database that collects the vital statistics of the patients in intensive care.
© Fraunhofer HHI

Medical monitor with its own eyes and ears

In intensive care units, every second counts. Within the framework of the project "Proxemic Monitors", researchers at Fraunhofer HHI have developed a smart monitor that clearly displays all relevant vital parameters. The highlight: speech and gesture control ensure simpler and more hygienic processes.

Recommended drinking temperature: 4 °C

Together with the "SABMiller" brewery, Fraunhofer EMFT has developed a cost-effective cool pack with integrated temperature display. The challenges: Cost-effective production and integration of the technology in a very small space. In the long term, such smart packaging solutions should provide informative added value for consumers.

An ice-cold treat: the display shows whether the recommended drinking temperature of 4 °C has been reached. © Fraunhofer EMFT / Bernd Müller

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.

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

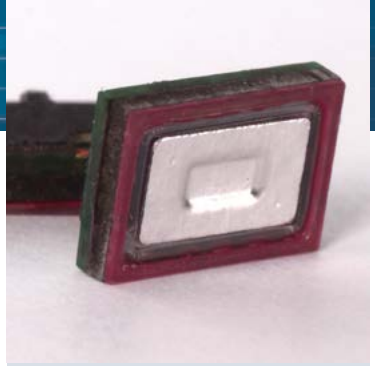
A container full of energy

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

The inside of the innovative container allows efficient power generation and production of hydrogen. © Fraunhofer IISB / Kurt Fuchs

The thinnest loudspeaker in the world

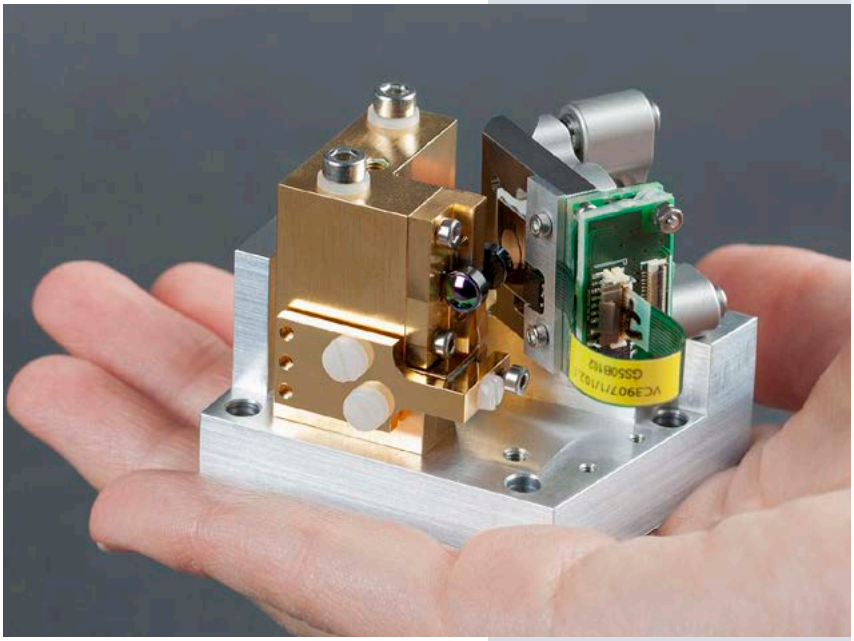
They save space and energy while producing a new sound quality: MEMS-based loudspeakers were developed by an Austrian startup company in co-operation with Fraunhofer researchers from IDMT, IIS, ISIT and IZM. The devices, which are only between two and twelve millimeters thick, offer great potential for use in smartphones, headphones, or even hearing aids.



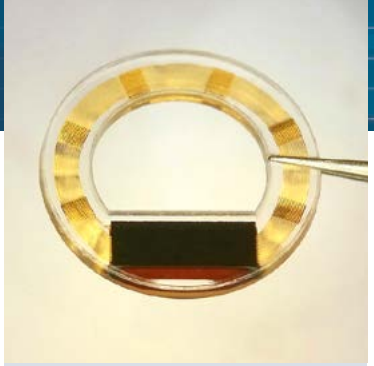
At 5 × 7 × 2 mm³, the world's smallest loudspeaker could give smartphones a whole new sound quality. Its frequency ranges from 2 to 15 kHz. © USound

Pilot line for customized spectroscopy solutions

Every chemical substance absorbs a very specific portion of infrared light. Like a fingerprint, this absorption can be used to identify a substance. The EU-funded MIR-PHAB project, in which the Fraunhofer institutes IAF and IPMS are also involved, helps companies to set up specially customized sensors and measuring technology in the mid-infrared range (MIR).



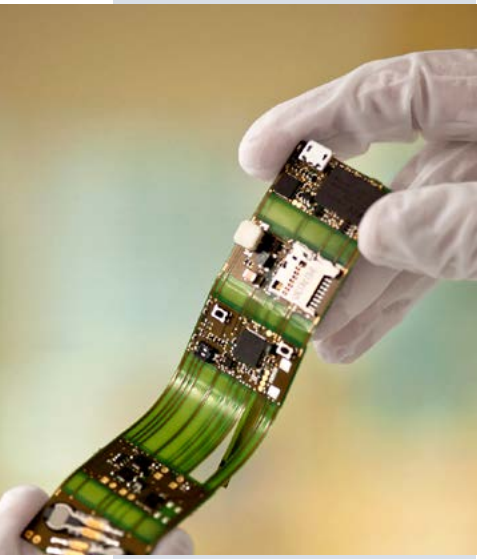
Demonstrator of miniaturized laser source comprising a quantum cascade laser chip and a MEMS grating scanner. © Fraunhofer IAF



Encapsulated sensor implant for measuring intraocular pressure.
© Fraunhofer IMS

Monitoring intraocular pressure with "EYEMATE"

Increased intraocular pressure makes glaucoma more likely. Often, the disease is not recognized in time. The EYEMATE sensor system developed by Fraunhofer IMS and Implandata Ophthalmic Products GmbH makes continuous monitoring of intraocular pressure easier, allowing for optimum treatment.

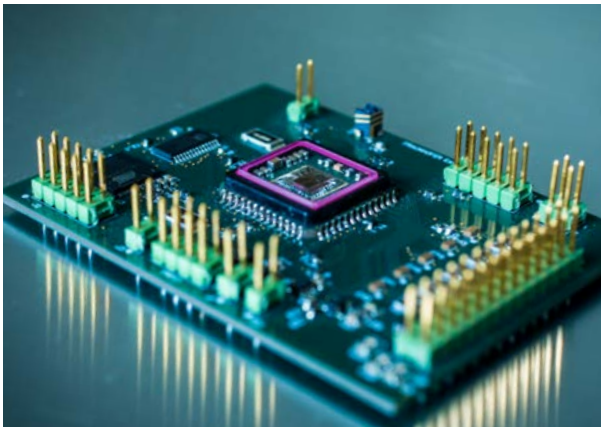


Wristband for personalized dementia therapy

In Germany alone, almost 1.6 million patients suffer from dementia – and the number of new diagnoses is on the increase. The health and care parameters indispensable to professional treatment are often not measured quickly enough – or in a sufficiently structured manner. That is why Fraunhofer IZM is working with partners from industry and research on a wristband that automatically measures and processes this data.

Sample view of a shape-adapted electronic layout in the wristband.
© Fraunhofer IZM / Volker Mai

A "Universal Sensor Platform" for medium-sized enterprises

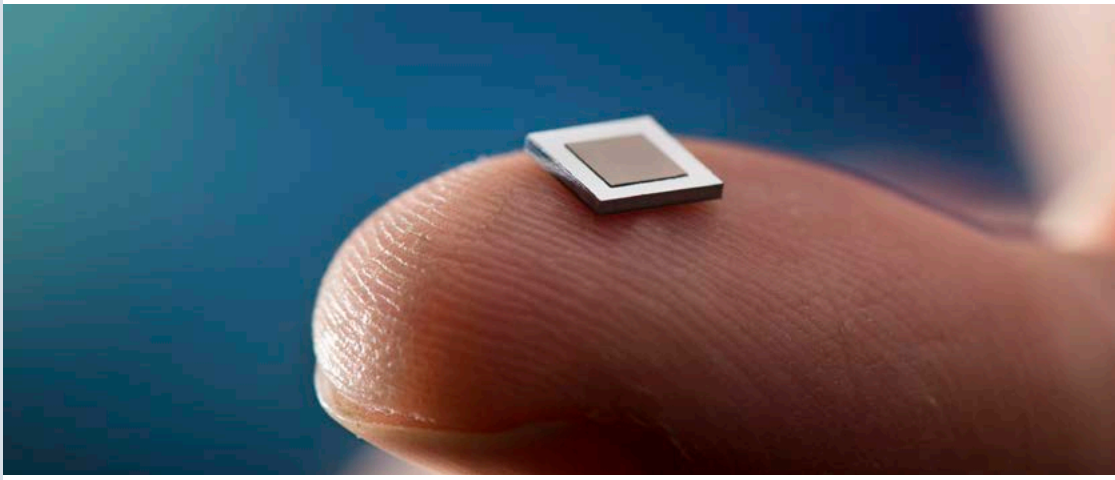


Example of a chip package.
© Fraunhofer IIS / EAS, Katharina Knaut

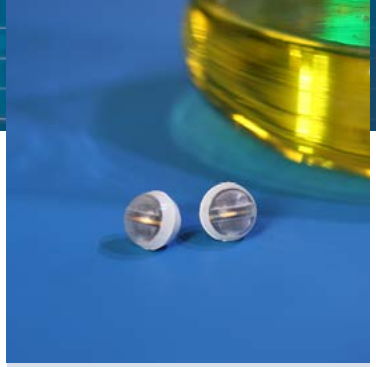
Researchers at Fraunhofer ENAS, IIS-EAS, IPMS, IZM-ASSID and GLOBALFOUNDRIES Dresden intend to develop a modular technology for smaller system providers by 2019. This "Universal Sensor Platform" (USeP) will offer smaller companies without their own chip development department the ability to get involved in the Internet of Things. According to the modular principle, medium-sized companies can take advantage of several design variants in order to be able to make their ideas and visions a reality as simple as possible.

Networked sensors – energy-efficient and powerful

The most important components in the Internet of Things (IoT) are tiny sensor nodes that collect information from their environment and pass it on. The applications are becoming more numerous and more sophisticated. The problem is that the energy consumption is enormous. In Fraunhofer's lighthouse project "ZEPOWEL" nine institutes from the Fraunhofer Group for Microelectronics – Fraunhofer EMFT, ESK, IAF, IIS, IIS-EAS, IISB, IPMS, ISIT and IZM – are working on futuristic solutions for an energy-efficient IoT.



A 5 × 5 mm² silicon micro-pump actively supplies the sensor with air, thus significantly reducing the response time.
© Fraunhofer EMFT / Bernd Müller



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

Acoustic monitoring of machines and systems

Defective or incorrectly installed components in large machines and systems can lead to their failure. This makes final assembly inspection and quality monitoring during operations more important. Often the assembly personnel are entrusted with this testing task if they have good hearing and long experience. However, human hearing is rather subjective: it gets tired after a certain amount of time and ambient noise can have a negative effect. Fraunhofer IZFP has developed the "listening" sensor system "AcoustiX" as a more reliable alternative.

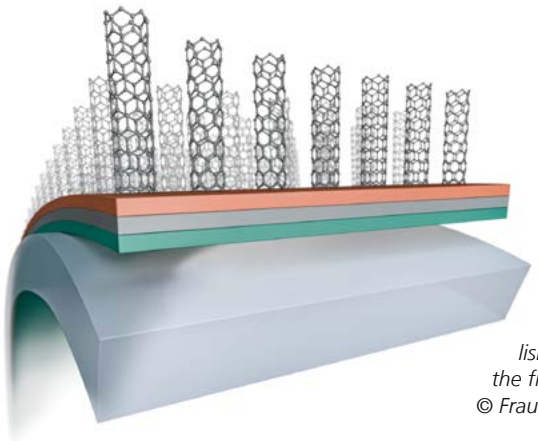
Reliable localization in a bioreactor

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

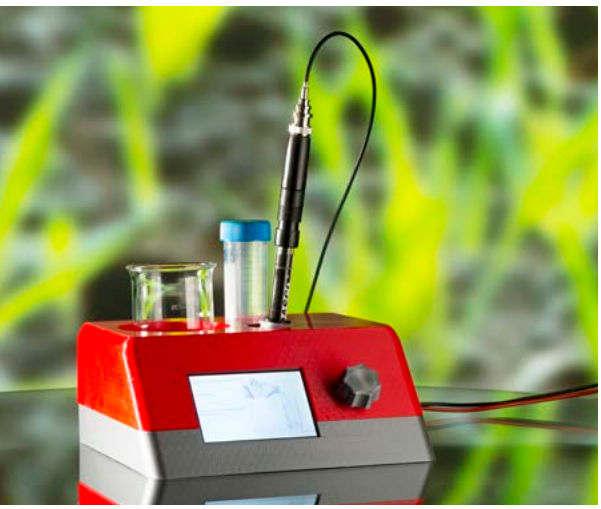
The sensor system inspects the rotating cutting unit of a combine harvester for defective vibrations by means of structure-borne sound sensors and microphones.
© Fraunhofer IZFP / Uwe Bellhäuser

New process for CNT integration

Carbon nanotubes (CNTs) are a promising functional material in nanoelectronics and sensor technology. Therefore, Fraunhofer ENAS has developed a modular process that overcomes previous hurdles in the integration of carbon nanotubes.



This modular technological concept allows a nanolayer system to be established before merging with the final substrate.
© Fraunhofer ENAS



Mobile nitrate laboratory for your garden

In the "Citizen Sensor" project, Fraunhofer EMFT and the FabLab Munich have developed a nitrate measuring instrument for amateur gardeners who can use it to quickly and easily measure the fertilizer status of their vegetable beds or the water quality in their garden pond via the nitrate content in the soil.

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

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Partners Fraunhofer M³Infekt

- Fraunhofer Institute for Integrated Circuits IIS, Division Smart Sensing and Electronics, Division Engineering of Adaptive Systems
- Fraunhofer Institute for Photonic Microsystems IPMS
- Fraunhofer Institute for Ceramic Technologies and Systems IKTS
- Fraunhofer Institute for Electronic Nano Systems ENAS
- Fraunhofer Institute for High Frequency Physics and Radar Techniques FHR
- Fraunhofer Institute for Nondestructive Testing IZFP
- Fraunhofer Institute for Structural Durability and System Reliability LBF
- Fraunhofer Research Institution for Microsystems and Solid State Technologies EMFT
- Fraunhofer Project Hub for Microelectronic and Optical Systems for Biomedicine MEOS

Clinical partners

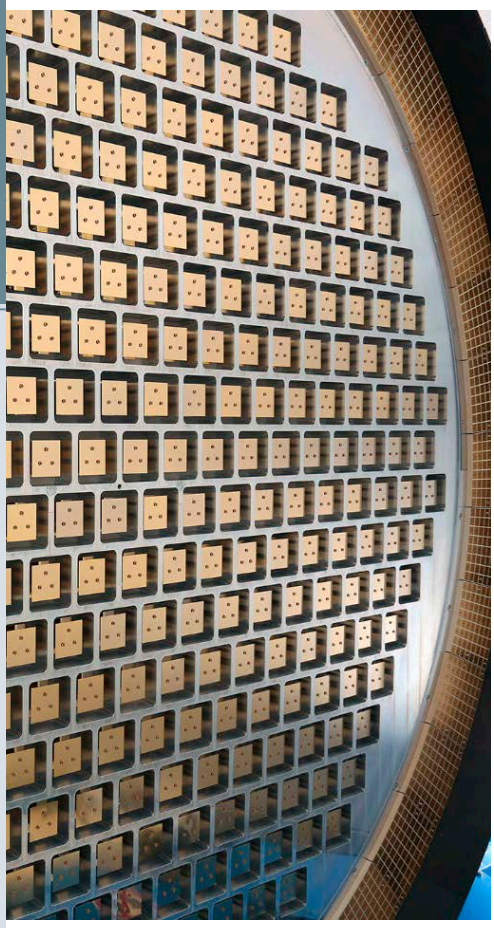
- Klinikum Magdeburg
- Charité – Universitätsmedizin Berlin
- Universitätsklinikum Erlangen
- Universitätsklinikum Dresden

Decentralized patient monitoring

The Fraunhofer cluster project M³Infekt, in which six institutes of the Group for Microelectronics / FMD are also involved, aims to develop a monitoring system that enables rapid intervention in the event of sudden deterioration of conditions. The system should be modular, multimodal and mobile and can be used, for example, in the treatment of Covid-19 patients. By initiating necessary measures at an early stage, the system helps to mitigate the course of disease, shorten the duration of therapy and make flexible use of intensive care units.

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

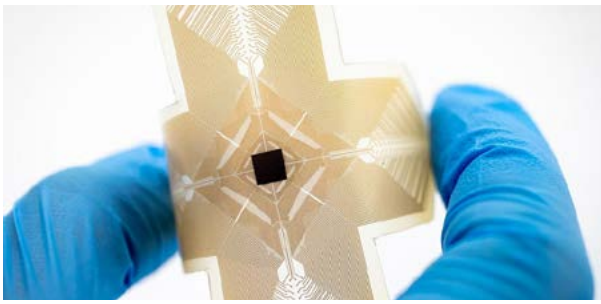
In order to monitor the near-Earth orbit and to know which objects are moving there, a phased array radar with high beam agility is required. Fraunhofer FHR has built such a system on behalf of the German Federal Ministry of Economics and Technology: In Autumn 2020, the researchers officially handed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



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

Electricity, not pills

Fraunhofer IZM and the Delft University of Technology are developing electroceutics for the drug-free treatment of chronic diseases. Electroceutical implants can electrically stimulate nerve cells in a targeted manner to trigger or block body signals or to send them to other places in the body. Physiological processes can thus be activated or inhibited depending on the nature of the disease.



The flexible implant with 324 electrodes and integrated electronics stimulates and records neuronal activity on the brain surface.
© Fraunhofer IZM / Tim Hosman

Smaller, faster, more energy efficient – powerful devices for digital transformation

Highly efficient power semiconductors are to pave the way for a wide range of new applications – from electromobility to artificial intelligence (AI). This is the aim of the project "Power Transistors Based on AlN (ForMikro-LeitBAN)" which was started in 2020 and in which FMD members Fraunhofer IISB and Leibniz FBH are also involved.

Aluminum nitride crystal as semiconductor base material for power electronic devices.
© Fraunhofer IISB / Anja Grabinger

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