Microelectronics News

Fraunhofer MIKROELEKTRONIK

July 2015 59

■ Title

New perspectives in Europe

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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. »» page 3

Interview with Prof. Kornwachs.
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Finding your way around virtual space

Trips to virtual worlds are now part of everyday life. Increasingly, industrial companies, architects, and urban planners are benefiting from things that virtual reality has made possible in the world of computers. Scientists at Fraunhofer IIS are now offering high-performance positioning technology for these application areas.

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"CareJack" strengthens the backs of care staff

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Quality check for fatty foods

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■ From the institutes

Graphene – from miracle material to application in mobile communication

Graphene is considered a miracle material: stronger but lighter than steel, flexible, environmentally friendly, and the world's thinnest material. Researchers at Fraunhofer IAF now plan to produce nearly massless electrodes based on graphene. These are to be used in bandpass filters of smartphones and will improve signal separation precision and energy efficiency.

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Hybrid materials easily tested

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■ The last word …

… comes from Valeria Gracheva from Fraunhofer FHR

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International Year of Light.
© Fraunhofer HHI » page 8

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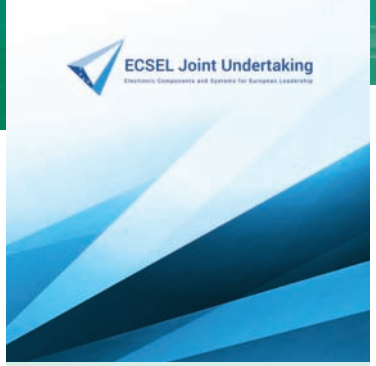
Events

Date	Event / WWW	Location	Group institutes involved
08/30 – 09/04	11th International Conference on Nitride Semiconductors www.icns-11.cn	Beijing, China	IAF
09/02 – 09/04	SEMICON Taiwan 2015 www.semicontaiwan.org/en	Taipei, Taiwan	
09/04 -09/09	IFA 2015 www.ifa-berlin.de/en	Berlin, Germany	HHI, IIS, FOKUS
09/07 – 09/10	SPIE Optical Systems Design www.spie.org/EOD/conferencedetails/physical-optics	Jena, Germany	IISB
09/08 – 09/10	European Microwave Week 2015 www.eumweek.com	Paris, France	IAF, FHR
09/10 – 09/15	IBC 2015 www.ibc.org	Amsterdam, Netherlands	Group institutes
09/10 – 09/12	13th Fraunhofer IISB Lithography Simulation Workshop www.litho-workshop.com	Behringersmühle, Germany	IISB
09/14 – 09/15	Telecoms World Middle East 2015 www.terrapinn.com/conference/telecoms-world-middle-east/index.stm	Dubai, UAE	FOKUS
09/15 – 09/17	Future Security 2015 www.future-security2015.de	Berlin, Germany	IAF
09/15 – 09/17	Battery Show www.thebatteryshow.com	Michigan, USA	
09/17 – 09/27	IAA 2015 www.iaa.de/en	Frankfurt / Main, Germany	ISIT
09/20 – 09/25	GADEST 2015 www.gadest2015.de	Bad Staffelstein, Germany	IISB
09/20 – 09/24	EUROMAT 2015 www.fems.org/index.php/euromat.html	Warsaw, Poland	IKTS
09/27 – 10/01	ECOC 2015 www.ecocexhbition.com	Valencia, Spain	HHI, IPMS
09/30 – 10/02	ICPT 2015: International Conference on Planarization/ CMP Technology www2.avs.org/conferences/ICPT2015	Chandler, USA	ISIT
10/05 – 10/09	22nd IST World Congress 2015 www.itsworldcongress.com	Bordeaux, France	ESK
10/06 – 10/08	SEMICON Europe 2015 www.semiconeuropa.org	Dresden, Germany	Group institutes



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New perspectives in Europe

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). As part of the EU research framework program "Horizon 2020," ECSEL is intended to provide approximately €5 billion for research into microelectronic and nanoelectronic systems, embedded systems, and smart systems. Together with member states, the European Commission is covering up to 50 % of the project costs.

Fraunhofer participates successfully in the call for bids

In the first call, in 2014, invitations were issued to bid for both research-oriented projects and pilot line projects, as they are known. Fraunhofer is particularly pleased that its institutes are represented as partners in nine of the twelve projects approved. This means that 10 % of the total funding will go to Fraunhofer institutes. Three of the approved projects are microelectronics pilot line projects in the state of Saxony.

About the "ADMONT" project

In the "ADMONT" project (Advanced Distributed Pilot Line for More-than-Moore Technologies), €45 million will be available over a four-year period. Fraunhofer expects a funding of €10.6 million. The aim of the project is to set up a pilot line with the aid of X-FAB Dresden and in conjunction with the Fraunhofer institutes Fraunhofer IPMS, Fraunhofer FEP-COMEDD, Fraunhofer IZM-ASSID, Fraunhofer IIS / EAS, and the Fraunhofer research institution EMFT. "We are bringing our expertise and technologies to ADMONT in order to push silicon system integration forward," says Dr. Sebastian Meyer, the coordinator on the Fraunhofer side.

About the "WAYTOGO FAST" project

The Fraunhofer institutes Fraunhofer IPMS and Fraunhofer ENAS and the Fraunhofer research institution EMFT are involved in the "WAYTOGO FAST" project. "Over the next two years, we will support some of Europe's largest semiconductor manufacturers in the development of a 14 nm FD SOI. This will lay the foundation for the chip and system development needed to develop an energy-efficient, forward-looking communication infrastructure," explains Dr. Erkan Isa from Fraunhofer EMFT, who is responsible for the project on the Fraunhofer side. Fraunhofer expects the project volume to total €2.6 million.

About the "Powerbase" project

An additional funding of €700,000 is available to the Fraunhofer institute IWM, the Fraunhofer research institution EMFT, and the Fraunhofer technology center THM for forward-looking developments in the "Powerbase" project. The aim is to develop the power electronics for the smart grid of the future under the auspices of Infineon.

This shows that the path Fraunhofer is taking to bundle its expertise and to join forces to meet current requirements is both forward-looking and the right one to take. To paraphrase Arthur Schopenhauer, "Microelectronics isn't everything, but without microelectronics, everything is (almost) nothing."

In cleanrooms such as this one, scientists are working on moving microelectronics research forward. © Fraunhofer IPMS

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"Having the courage to ask questions"

Do engineers need a basic education in philosophy? Yes, according to physicist and philosopher of technology Prof. Klaus Kornwachs. He spoke to the Fraunhofer Group for Microelectronics about the impulses that philosophy can give when it comes to evaluating technologies and about the necessity of interdisciplinary thinking.

You studied physics and philosophy – how did you decide to pursue this unusual combination of subjects?

Prof. Kornwachs: Originally, I wanted to study theology, but then decided on philosophy. Later, I switched my focus to mathematics and physics, but continued with philosophy in parallel. That worked very well, because I have always been interested in the fundamental questions of physics. One central thing that I learned in college, and still hold to be true, is that interdisciplinarity starts in your head and not in institutions.

Why are the humanities and the sciences so segregated from one another nowadays?

Prof. Kornwachs: The division between these "two cultures" was cemented in the 19th century. The philosophers of German Idealism, Hegel in particular, took the view that experimental results derived from physics reflected only nature's outside, but not what was essentially inside it. Instead of mathematical models, they preferred speculation. At this time, the humanist ideal of education was still dominant: only those who could read classical texts in Greek and Latin were considered educated. That has since changed, of course, but a dialogue between the two cultures continues to be difficult.

Are there any approaches to promoting this dialogue?

Prof. Kornwachs: At the VDI (German Association of Engineers), they long had a working group on the issue of "Philosophy and Technology." What's more, the VDI has issued guidelines on the evaluation of technology and recommendations to include Science, Technology and Society Programme. And for a good reason: if technology is to function, its "organizational closure" must be right, too. If, when considering the topic of automobiles, you were to leave the entire surroundings aside – from the rules of the road and the supply of fuel and spare parts to the driving schools where we learn to drive – a car would be nothing but a pile of metal, electronics, and glass.

Yours is one of the voices calling for interdisciplinary training for engineers. To what extent has this already been put in place?

Prof. Kornwachs: Many technical universities now offer cross-subject contents and degrees. This includes philosophy, history, sociology, law, and cultural studies as well as intercultural communication and languages. With colleagues in Cottbus, I helped to set up the degree course in "Culture and Technology." Our aim was not only to give engineers a background in humanities and cultural studies; I was also of the view that students of the humanities and cultural studies, law students, and students of other subjects should have a certain understanding of technology to ensure that they know what they are talking about. My experience has been that these interdisciplinary approaches have been very well appreciated by students.

In this context, a study of philosophy is bound to be less concentrated on learning the theories of Plato and Hegel by heart.

Prof. Kornwachs: It doesn't do any harm to receive training in primary sources. The most important impulse behind a study of philosophy, however, is to gain the courage to stubbornly ask questions. Technology is always embedded in a context that includes social and cultural as well as ethical, economic, and political dimensions. This leads to questions that go well beyond technical feasibility – so grounding in ethics and political philosophy can be very helpful. Inventors generally don't think about whether and how their developments could be abused. Nevertheless, aspects such as this, need to be considered, considering the range that technology has today. The VDI, by the way, also suggested philosophical and ethical evaluations of this kind in its guidelines.

Prof. Klaus Kornwachs.
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About Klaus Kornwachs:
Klaus Kornwachs studied Mathematics, Physics, and Philosophy. From 1979 to 1981, he was a research associate at Fraunhofer IFA and later at Fraunhofer IAO, where he headed the Qualification Research and Technology Assessment Department. Teaching positions in cybernetics, simulation technology, and model design, as well as philosophy, took him to the universities of Freiburg, Stuttgart, and Ulm. Klaus Kornwachs qualified as a professor of Philosophy at the University of Stuttgart in 1987. From 1992 until 2011, he held the chair of Philosophy of Technology at the Brandenburg University of Technology in Cottbus. There, he directed the Center for Technology and Society from 1997 to 1998 and, in 2006, he founded the bachelor's and master's degree course in "Culture and Technology." From 2001 to 2009, he managed the "Society and Technology" division at the VDI. 1991 he won the ALCATEL Research Award for Communication Technology. He is a member of the German National Academy of Science and Engineering (acatech), and actually teaching at University of Ulm, and Tongji University of Shanghai. Since the foundation of his "Büro für Kultur und Technik" (Office for Culture and Technology), he is largely acting in a publishing and advisory capacity.

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Work today is largely performed in a virtual space. © MEV Verlag

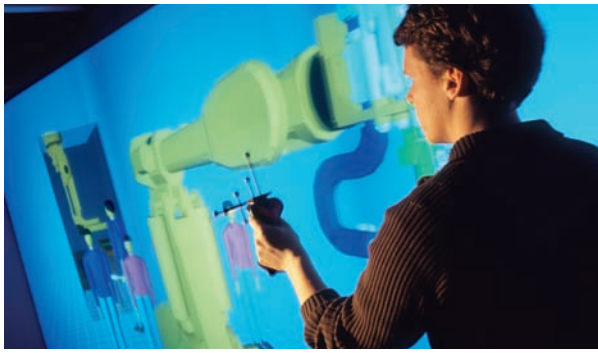
What negative effects can result from a viewpoint that is too centered on technology?

Prof. Kornwachs: To begin with, you may be promoting developments that you later have to undo. One example of this is the communication strategy with regard to nuclear energy in Germany in the 1970s. A lot of conflicts could have been avoided if one set of players had had a social, political, and cultural background and if the other set of players had had a better understanding of technological findings. Furthermore, there is also a risk that engineers can be manipulated by politicians without noticing it. This has happened time and again, particularly – and unfortunately – in totalitarian regimes.

If engineers are only trained in implementing developments in the optimum technical manner, they will also encounter problems in their workdays – particularly when it comes to communication, whether it be convincing an investor of the merits of a development, or working with colleagues from other cultures where other customs prevail.

Current trending technologies such as the "Internet of Things" will have a large influence on our lives. How can philosophy help us to evaluate technologies of this kind?

Prof. Kornwachs: Let me start by saying that a discussion about "true" and "false" needs is doomed to failure. All the same, you can pose a basic question: do we have the technology that we need and do we need the technology that we have? When it comes to today's developments, the question isn't whether they will be technically feasible in the foreseeable future, but whether we really want them and what we can expect of them. With regard to robots – those used to help the elderly or to assist us with household tasks, for example – I do wonder whether it is a good idea to protect ourselves from our own delusions. We tend to develop a subjectifying approach to the tools we use. Just look at the relationship that some people have with their cars! Here, I think that ancient, animist ideas about nature appear, according to these the things around us might have souls. And that brings us right to the heart of philosophy. The discussion about what we really want a robot to do is not just a technical one, but a social one.



The limits of what is technically feasible are moving faster and faster – it is important that the developers of new technologies keep an eye on the organizational environment. © MEV Verlag

To take another example: for almost 60 % of people living in industrialized countries today, the workplace is no longer the local factory, but rather the Internet. That, too, leads us to basic philosophical questions. What significance does work have in a system like that? Can it still provide us with an identity? And what about remuneration? What are the effects of a networked environment on our social relationships? These questions cannot be answered with specialist engineering knowledge alone.

Will interdisciplinary approaches come further to the forefront of the scientific landscape in the future?

Prof. Kornwachs: At the end of the day, we are stuck with the interdisciplinary approach, because problems are generally not obliging enough to align themselves along the lines of historical academic disciplines. Nor can we forget that interdisciplinarity opened up new fields of research in the past – biochemistry, for example. New knowledge often arises at the thresholds between several disciplines. On the other hand, we also need to structure our research, naturally enough, and this can only happen within a framework of organizational boundaries. The real art is respecting these boundaries while also overcoming them.

Prof. Kornwachs, thank you very much for talking to us.

Prof. Kornwachs talked to Tina Möbius.

Finding your way around virtual space

Trips to virtual worlds are now part of everyday life. Increasingly, industrial companies, architects, and urban planners are benefiting from things that virtual reality has made possible in the world of computers. Scientists at Fraunhofer IIS are now offering high-performance positioning technology for these application areas.

Today, anyone can don a pair of virtual reality (VR) goggles and immerse themselves in a voyage of discovery through very realistic graphical scenarios. They can look for treasure, build new cities, or see how they stack up against other players. In the future, natural movements in unlimited space will be possible without a keyboard, mouse, or joystick.

Finding your way – precisely and safely

Scientists at the Fraunhofer Institute for Integrated Circuits IIS now offer powerful positioning technology for these applications. Systems such as "RedFIR®" form the basis of the solution: radio location determines positioning data precisely and with up to 2000 positions per second. The system is currently used for training optimization in soccer and other team sports. This involves tracking player and ball movements and referencing them to specific situations so they can be analyzed.

Positioning technology for VR applications – moving freely indoors and outdoors

The combination of VR and positioning now creates wider usage options in large indoor or outdoor areas: storehouses, buildings, and outdoor facilities can be visited "naturally" when VR is superimposed – even in spaces that are several tens of thousands of square meters in area. A VR radio solution allows machine installations, work processes, escape routes, and other objects to be captured, planned, and optimized at the correct location. Another advantage is that thanks to precise positioning, multiple VR users can move around the VR world completely freely. This means that different steps and their effects on the design of buildings, systems, and processes can be tried out interactively during the planning phase. This improves and accelerates planning and decision-making and means that costly mock-ups are no longer required.

Positioning technology can even be a reliable partner on the soccer field. © pixelio.de / Rainer Sturm

Examples of localization technologies

- "awiloc®" – for precisely positioning objects both indoors and outdoors
- "RedFIR®" – centimeter-precise positioning for indoors and outdoors

A reference application for the awiloc® technology can be found, for example, in Munich's Egyptian Museum, where a museum guide developed by Fraunhofer IIS and its partner NOUS whisks visitors away to a virtual 3D world.

New precision when experiencing virtual spaces.
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Less scrap during the raw production of steel thanks to Fraunhofer FHR's radar. © MEV Verlag

High-precision radar for the steel industry

Steel is an important material in vehicle and machinery construction. Large quantities of offcuts and scraps are left over from raw production, such as from rolling it into strip steel. The radar developed by Fraunhofer researchers measures the width of the strip during fabrication to an accuracy of micrometers and helps to minimize scrap.

Measuring dimensions precisely is crucial for production engineering – for instance in the raw production of steel. Thousands of metric tons of the material are processed in a steel mill every day. 20 cm white-hot ingots of cast steel are rolled out into thin sheet steel kilometers in length and subsequently wound into rolls. The plate steel roars through the rolls at speeds of up to 20 m/s, but the strip often ends up too wide during this process. The excess edges need to be trimmed off afterwards – and that means high material losses. New millimeter-wave radar from the Fraunhofer Institute for High Frequency Physics and Radar Techniques FHR in Wachtberg provides assistance here. It measures the width of sheet steel during processing to an accuracy of micrometers. This permits the rolling facility to be regulated so that less scrap is produced – with considerable savings in costs.

Taking inspiration from bats

Two radar sensors mounted at the side of the rolls measure the distance to the edge of the steel. In principle, the system can be compared to echolocation by bats. The ultrasound signals that bats emit are reflected back like echoes by walls, branches, wires, and mosquitoes. Bats listen to the echoes from objects located in front of them and distinguish prey from obstacles. "Our radar sends out continuous electromagnetic signals that are reflected by the right and left edges of the strip. The transmitted and received signals are then compared to each other with the help of numeric algorithms. The width of the sheet can be calculated from this comparison," explains Prof. Nils Pohl, scientist and head of department at FHR. The radar that determines distances of up to several meters with a precision of just a few micrometers, also measures very quickly – 5000 times a second. New in-house developments in the area of silicon chips for the millimeter wave region will increase the measurement speed and accuracy.

Fraunhofer FHR's sensor helps with the production of strip steel in rollers. © Shutterstock

System operates reliably in fog, dust, and smoke

The system operates even under severe ambient conditions of dust, heat, steam, and fog. "The hot strip steel has to be water-cooled during rolling. This forms dense steam, especially in winter. Lasers and cameras also measure very accurately, of course, but they are not suitable for deployment in environments with high humidity and varying lighting conditions. Radar signals by comparison penetrate dust and fog very well," says Pohl. Due to its low transmitting power, which is less than that of a cell phone, the radar can be operated in any environment without having to meet additional safety requirements. Since the sensors are mounted to the sides of the rolls, the system can be easily integrated into existing plants. There are presently three steel mills in Germany testing its operation. In the future, the high-frequency radar, which operates with electromagnetic waves above 30 GHz, is intended to be mass produced. Its applications will not be restricted to just the steel industry. The plastics sector could also benefit from the precision tool – for instance to measure the thickness of pipes. The possibilities and mode of operation of the system will be presented by the researchers from Wachtberg at booth 227 / 246 at the European Microwave Week in Paris at the beginning of September.

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International Year of Light 2015

2015 is the United Nations' "International Year of Light." For many Fraunhofer institutes, light is a central focal point of research. This is because light is what allows us to see. Light transports information. Light carries energy. Light is a universal tool in science and industry. With their research work, Fraunhofer scientists are making important contributions to the generation and application of light in the areas of energy, production, information and communication, health, safety and security, and mobility. We're happy to present you with some of the exciting light-related developments from our member institutes here.

Fraunhofer HHI

Optical wireless data communication

Optical wireless data communication is an attractive solution for areas that have particularly high security and electromagnetic compatibility requirements. The Fraunhofer Heinrich Hertz Institute HHI has developed a transmission technology that allows commercially available LED lamps – such as those used for lighting rooms – to transmit data. This technology can be used to attain data rates of up to 1.25 Gbit/s. Optical wireless communication allows high-speed data connections in areas where radio systems cannot be used or are not desired. Areas with constant lighting such as open-plan offices, production halls, medical departments, aircraft cabins, or public local and long-distance transportation offer large potential for optical wireless communication. What's more, the transmission technology can also be used for areas of application that are not primarily intended for communication, such as lighting design in larger halls or dispersal of GPS data indoors.

Fraunhofer IZM

Cloud data centers with double performance, and half the power consumption

Led by the Fraunhofer Institute for Reliability and Microintegration IZM, the scientists and their 18 partners from industry and research are working on reducing the energy consumption of data centers and supercomputers as part of the EU project "PhoxTroT." To ensure that these cloud data centers and high performance supercomputers can work more cost- and energy-efficiently in the future, while also being more powerful, their energy consumption is to be reduced by at least 50 % by means of optical data transmission – and the capacity of optical data connections is to be increased from 1 Tb/s to 2 Tb/s. Data transmission using light consumes only a fraction of the energy that conventional methods need. The project partners mix & match existing approaches and provide a new holistic research concept. How can a continuous data connection using light be assured even across distances of hundreds of kilometers? To this end, the project partners are developing on three demonstrators covering different hierarchical levels: they implement high-performance, low-energy, low-cost and small-size optical interconnects on printed circuit boards ("on-board"), between boards ("board-to-board"), and from one server rack to the next ("rack-to-rack").

You can find current light-related projects on
page 10 – “New laser process models glass fibers” – and
page 12 – “Large-format luminescent materials”

United Nations Educational, Scientific and Cultural Organization

International Year of Light 2015

Fraunhofer IAF

LED lamps: less energy, more light

LEDs last a long time and save energy. Now, researchers at the Fraunhofer Institute for Applied Solid State Physics IAF have developed new models of even more compact LED lamps with greater luminosity. The key to their success lies in transistors based on the semiconductor gallium nitride (GaN). The LEDs offer numerous advantages: they are environmentally friendly as they do not contain any hazardous substances such as mercury; they use up to 80 % less energy; and they have a longer service life than conventional light sources. As they react very sensitively to voltage, and particularly to voltage peaks, they need a driver that ensures a constant LED drive current. The voltage converters developed at Fraunhofer IAF, which contain GaN-based transistors, have turned out to be extremely robust. Due to the positive properties of the new semiconductor material, the scientists have been able to boost the efficiency of the GaN driver with galvanic insulation to 86 %. The lamps also offer twice the luminous flux of commercially available LED lamps of the same form factor with silicon transistors.

Laser tests drinking water quickly and automatically

To ensure the purity of drinking water, it is tested continuously in laboratories by water experts. Scientists at the Fraunhofer Institute for Applied Solid State Physics IAF have now expanded the test procedure: their quantum cascade laser – a particular type of infrared laser – forms the core of an analyzer that can test water automatically at the waterworks itself. Costly and time-consuming preparation in the laboratory is not required. The measurement system is only a little larger than a shoebox, works automatically, and requires hardly any maintenance. Infrared radiation – which is found in the long-wave range of light and is not visible to the human eye – can be used to analyze impurities in the water. The analyzer is particularly specialized in identifying higher concentrations of hazardous chemical substances straightaway. Within a few minutes, the analyzer can determine not only if the water is contaminated, but if so, what substance is responsible for the contamination. To examine the components of water, experts use molecular spectroscopy: that is to say, they examine the optical spectra of the molecules in the water. Each chemical compound has a unique spectrum, since individual molecules vibrate and absorb light at characteristic frequencies.

New laser process models glass fibers

Glass fibers are used for vein sclerotherapy in a minimally invasive procedure. Fraunhofer researchers have developed a laser-processing technology that is capable of automated series production of these fibers for the first time. What's more, they can be modeled much more finely than before. This also opens up applications in the area of optical sensors.

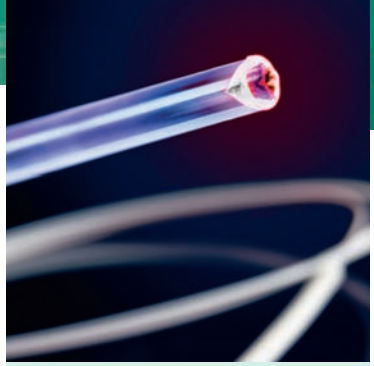
Varicose veins, thromboses, and other afflictions of the veins have developed into widespread diseases in a number of countries. In many cases, vein sclerotherapy can help. In this procedure, a razor-thin glass fiber, which can carry a laser beam inside, is inserted into the affected blood vessel. The light exits the fiber at its tip and the high temperature applied – between 100-200 °C – closes the vein. To ensure that the light at the tip of the fiber can be emitted laterally and directly against the wall of the vein, the far end of the fiber has a pointed tip so that the walls of the cone form reflective surfaces. A protective glass cap ensures that no blood can aggregate directly on the tip, which would change the optical characteristics of the fiber.

Automation ensures consistent quality

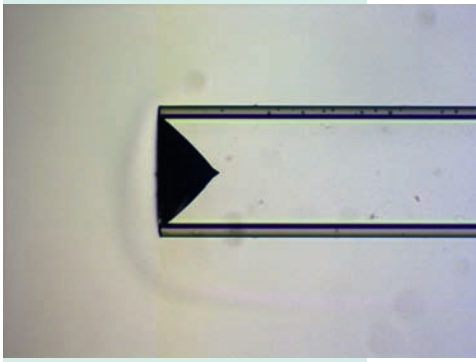
Previously, the fibers have been manufactured mechanically and manually. As part of a project funded by Germany's Federal Ministry of Education and Research, researchers at the Fraunhofer Institute for Reliability and Microintegration IZM have developed an innovative laser-based process to model these glass fibers exactly. In this instance, a laser is used as a tool for structuring the glass, and is unrelated to the laser that will be later sent through the fiber. "This method allows, for the first time, automated production at series production scales," explains Dr. Henning Schröder from Fraunhofer IZM. The automation ensures consistent quality and the reproducibility that products need. The end of the glass fiber is shaped by using a processing laser beam to remove material. In another production step, the cap is put in place and melted to the fiber without the need for any additional equipment. In the new process, it was deemed to be more practical not to form the tip of the fiber like that of a pencil, but rather to model it as a cone-shaped notch that goes into the fiber. This means that the head of the fiber probe becomes shorter, more compact, and more maneuverable and can penetrate even tinier branches of veins.

Application potential for optical data transmission

Using the laser technology, the scientists would like to enter even smaller dimensions that can no longer be processed by hand. The aim is to produce glass fibers with a diameter of only 100-200 µm. These could open up new applications in the area of sensors, too – for example, small-sized, adapted optics for optical data transmission. In this case, to put it in simple terms, the process would be reversed: "The tip of the fiber would absorb data from the environment and send it through the fiber to a detector," explains Dr. Schröder. This detector – a photodiode or CMOS chip, for example – would convert the optical signals into analyzable electrical signals. The scientists recently presented a fiber probe developed for this purpose at the SENSOR+TEST trade fair.



Laser-structured fiber tip with internal cone for radial emission or detection. © Fraunhofer IZM



The laser-fashioned fiber tip has a diameter of 600 µm. The cone shows an opening angle of approximately 90°, in order to be able to emit the laser beam laterally (ideally at a right angle) after the inner surfaces have been metallized. © Fraunhofer IZM

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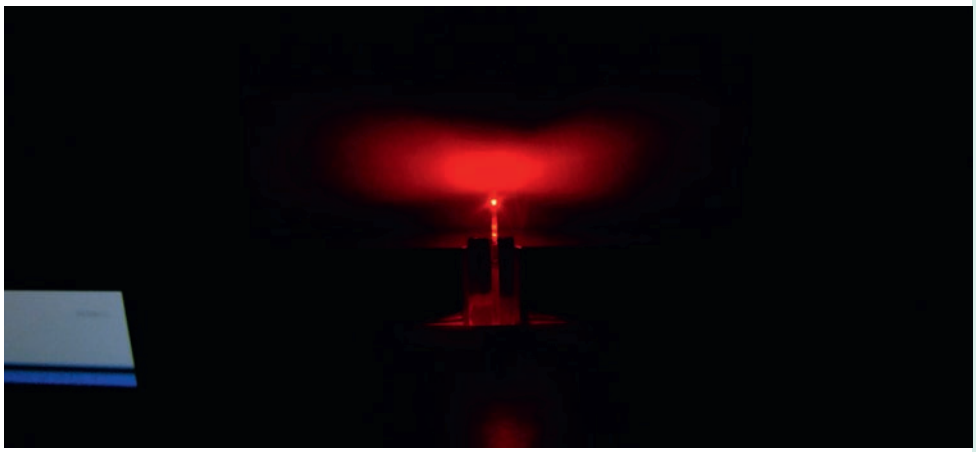
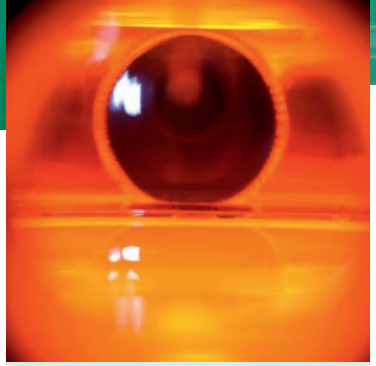


Example of radial emission from a laser-structured fiber tip with an internal cone. © Fraunhofer IZM



View into the process chamber of the reactor, where graphene is grown on a catalyst surface that reaches temperatures of up to 1000 °C. © Fraunhofer IAF

Graphene – from miracle material to application in mobile communication

Graphene is considered a miracle material: stronger but lighter than steel, flexible, environmentally friendly, and the world's thinnest material. Researchers at Fraunhofer IAF now plan to produce nearly massless electrodes based on graphene. These are to be used in bandpass filters of smartphones and will improve signal separation precision and energy efficiency.

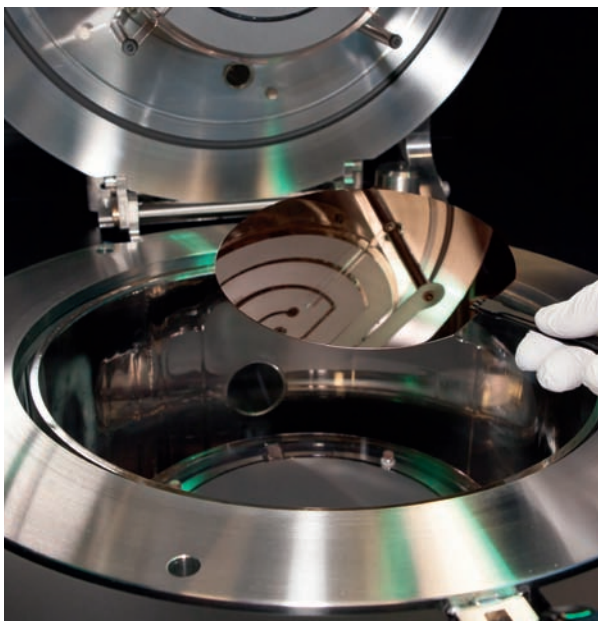
About "Graphene Flagship"
142 organizations from 23 countries are aboard the "Graphene Flagship." In order to make graphene accessible for the European market, the European Union is funding universities, research institutions, and businesses with an overall budget of 1 billion euros.

GSM, UMTS, LTE, Wi-Fi, Bluetooth – for all these wireless standards, signal processing could not be done without the filtering of frequencies. For frequency filtering, piezoelectric resonators are used; these are excited to oscillation by electrodes. The lighter the electrodes, the better the oscillation characteristics of the resonators. This is currently one of the limiting factors: the metal electrodes usually used today are relatively heavy, but cannot be thinned any more without losing conductivity. They do, however, dampen the oscillation of the resonators through their mass – similar to the felt cover on a piano string. Graphene appears to be a promising alternative: the material still remains conductive even as an atomically thin electrode. With new types of graphene electrodes, the oscillation characteristics of the piezoelectric resonators could be improved, higher coupling factors achieved, and thus the signal separation precision and the energy efficiency of the filters increased. The main challenge at hand is to connect the nearly massless graphene electrodes with the currently used mobile communication components based on piezoelectric aluminum nitride.

Industry-compatible graphene deposition technologies

As part of the EU's "Graphene Flagship" funding initiative, scientists at the Fraunhofer Institute for Applied Solid State Physics IAF, in cooperation with the EPCOS AG company, are working on an efficient technology for graphene deposition and graphene transfer to aluminum nitride. One promising approach to graphene deposition on large substrates of the type typically found in the semiconductor industry is chemical gas-phase deposition. In this process, a catalyst surface such as copper is heated to nearly 1000 °C until gas containing carbon is broken down on the hot surface and reorganized into graphene. In the future, this method is intended to be further developed into a technology compatible for industry applications, to directly integrate graphene into existing aluminum-nitride-based bandpass filters. This is because many of the possible applications of graphene have not yet been successful since the series production of the material is still too complex. Hence, the development of economical manufacturing and processing technologies is essential for the use of the outstanding theoretical properties of graphene in practice.

Besides Fraunhofer IAF, the initiative also involves the Fraunhofer Institute for Systems and Innovation Research ISI as well as the Fraunhofer Institute for Chemical Technology ICT. Researchers at Fraunhofer ICT are working on a further large-scale and cost-effective production method for graphene – in the form of graphene flakes. The graphene experts of Fraunhofer ISI, on the other hand, are developing strategic technology and application roadmaps in order to make it easier to gauge future fields of application.



The new CVD reactor "Black Magic" for the deposition of graphene at Fraunhofer IAF. In future, a cost-efficient and simplified technology will make the deposition and the transfer of graphene onto aluminum-nitride-based bandpass filters possible. © Fraunhofer IAF

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Panel of fabric with integrated LEDs.
© Fraunhofer EMFT / Bernd Müller

Large-format luminescent materials

Light has a significant effect on our mood and capabilities and therefore plays an important role in the design of our living and working environments. Textiles that can act as light sources open up entirely new horizons for aesthetic and functional illumination. Curtains, for example, could become light sources once evening falls. In high-end tents, luminescent textiles could eliminate the need for expensive and difficult installation of lamps and light strings. But how can large-format surfaces of this kind be made to light up? Scientists from Fraunhofer EMFT, together with partners from research and industry, are working on a solution to this challenge as part of the EU project "i-Tex." They are integrating LEDs into textiles that are lined with fine circuit boards. The components – LEDs, sensors, and circuit boards – are integrated into the material using the roll-to-roll process. The experts at Fraunhofer EMFT are responsible for the aspects of "characterization and reliability" in the project. They are investigating such elements as the optical qualities, the conductivity of the electrical connections, and the insulation between the conductors as affected by temperature and moisture, as well as the tensile and bending strength of the textiles. What's more, they are also measuring the electrostatic discharges that may occur during the manufacturing process and are developing suitable protective measures against them. This prevents the load-sensitive LEDs from being exposed to dangerously high static charges of several kilovolts during the production stage.

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"CareJack" strengthens the backs of care staff

Care staff in hospitals or nursing homes have to do tough physical work. The constant strain often leads to back problems. It's true that there are aids such as orthoses: shell-shaped protectors that support the spinal column. But these are not only uncomfortable; they also restrict the musculoskeletal system, which makes it more difficult to work. Researchers at Berlin's Fraunhofer institutes Fraunhofer IZM and Fraunhofer IPK, together with partners from industry, have developed "CareJack," a flexible orthosis with integrated electronics that takes the strain off the spinal column during heavy work without getting in the wearer's way. It is light, soft, and can be slipped on as easily as a piece of clothing. This smart medical aid uses the wearer's motions to strengthen his or her back: when a caregiver bends down to lift a patient up, the smart medical aid stores the kinetic energy and can release it again when required. Above all, the orthosis ensures that caregivers perform movements correctly. Lots of orthopedic problems are a result of improper movements. The smart vest features a myriad of sensors that continuously monitor the way the wearer is moving. A processor compares this data against the optimum movement pattern. As soon as it detects any irregularity, a warning lamp is activated. Not only that, but innovative synthetic actuators with adjustable rigidity help avoid incorrect movements and support correct ones. The wearers can decide themselves what level of support they want. In this project, the scientists from Fraunhofer IZM focused on the development of miniaturized components, flexible circuit boards, and the required sensors. A prototype of the vest should appear this year.

The "CareJack" vest supports the back without restricting freedom of movement.
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Secure and reliable nanoelectronics for vehicle systems

Many innovations in vehicle development are based on the use of highly modern microelectronics. To meet these goals, electronic systems need increasing processing power and memory even as their energy consumption is minimized – this, however, poses the risk of higher sensitivity to operating and environmental stresses. To guarantee reliability, ten partners from business and research are working together in the "RESIST" project to develop particularly powerful and robust components that also reduce fuel consumption and CO_2 emissions. Methods are being developed that permit precise prediction of the behavior of individual chips as well as entire systems, even during the early design phase. This will make it possible to significantly increase the service life of electronic assemblies. This requires a new development approach for electronics, as well as additional circuit components. These advances will ensure that components can better tolerate operating stress conditions over the entire life of the vehicle. An "early warning system" is also being developed that will report any electronic degradation in good time. Fraunhofer IIS / EAS is coordinating the research work on new methods, chip designs, and systems. Germany's Federal Ministry of Education and Research is funding the work to the tune of approximately €5 million.

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Hybrid materials easily tested

In the construction of aircraft or automobiles, there is a definite trend towards the use of "new materials," as they are called. Carbon or glass fiber-reinforced plastics, high-strength steels and light metals are in great demand due to their low weight and robustness. Often, a combination of different materials is used, in which case the parts are referred to as hybrid parts. To really put parts and components of this kind through their paces before they are installed in end products, new processes are needed that are designed for the specific properties of these new materials. Researchers at Fraunhofer IZFP in Saarbrücken have contributed to a further development of contactless, non-contaminating material testing in the form of air-coupled ultrasound inspection. In comparison with existing products, the newly developed probes allow a higher-frequency inspection of thin materials. This enhances and optimizes defect detection capability. An improved probe structure allowed the scientists to reach such a high noise level that even strongly absorbing hybrid materials could be inspected without contamination. Each inspection application has specific requirements concerning accessibility, defect resolution, robustness against environmental influences, and special probe type.

That's why Fraunhofer IZFP's air-coupled ultrasound transducers are custom-made for a particular application.

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Air-coupled ultrasound: an industrial robot linked to the ultrasound testing system scans the component.
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CATRENE workshop on semiconductor technologies for smart cities

"EUREKA" – the European initiative for research and development – is intended to strengthen Europe's technological competitiveness. The EUREKA cluster "CATRENE" focuses on research and development in the area of semiconductor technologies and applications of nanoelectronics. CATRENE's lifespan is now nearing its end. In the final phase of the CATRENE scientific committee, Dr. Joachim Pelka from the Group's business office coordinated a study at the end of 2013 in which an overview of what smart cities will require of semiconductor technology was drawn up.

This study was presented as part of a workshop marking the ECSEL Consortium Building Day in the middle of April of this year. Speaking before around 50 attendees, the editors of the individual chapters presented the requirements that will be placed on semiconductor technology from various points of view and using various example scenarios, and then analyzed the results as part of a panel discussion. One significant result of the study is that the expected transition from the existing technology "push" to a real application "pull" is still far from complete, and indeed is only slowly getting going. One reason for this is that urban planners, architects, and microelectronics technicians often fail to speak the same language, and – what is more – binding standards and interfaces have yet to be established in many areas.

There is a plan to continue the study under the umbrella of "AENEAS." The first step will be to get all players to the table as part of a stakeholder forum in order to add a new quality to the dialogue between technology and application.

The study has been available to download from the CATRENE website (www.catrene.org) since the beginning of the year.

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Quality check for fatty foods

A lot of people would like better and more reliable information about how fresh their food is – and food scandals in recent years have only strengthened this desire. Particularly in the case of packaged products, it is very difficult to detect if the contents have already gone bad. While it's true that packaging always bears an expiration date, this is usually only a guide. Errors during packing, interruptions to the cold chain during transport, leaky packaging, and incorrect storage in the home can all mean that food spoils faster. Scientists at Fraunhofer EMFT are now pursuing a promising approach that should increase safety when it comes to handling food: sensor dye systems integrated into food packaging that can warn when food turns bad due to changes in their color or fluorescence. Potential solutions range from large-scale packaging film that changes color to a small test strip on the packaging that customers can read using their smartphones. In collaboration with Fraunhofer IVV, as part of the "Hexanalsensor" project the scientists have developed innovations such as a color-changing sensor system. This system measures volatile aldehydes in the gas phase and can be integrated into packaging films or closure seals. This allows changes in the quality of oily or fatty foods such as cooking oils, roasted nuts, or confectionery and baked goods, all of which can spoil faster if exposed to oxygen (i.e. through oxidation).

The change in color indicates that there has also been a change to the product's quality.
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Editorial notes

Microelectronics News, Issue 59
July 2015

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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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... comes from Valeria Gracheva

Ms. Gracheva, what are you working on at the moment?

For my doctoral thesis, I am looking at how to find small boats using an airborne radar system. If we could detect small boats quickly and reliably, we could, for example, find refugee boats and help their passengers. The greatest challenge lies in distinguishing between the signal from the boat and the backscatter produced by the water, as both produce similar signal strengths and both are moving. Together with a team from our department, I have carried out experiments with our radar system "PAMIR" and a small boat provided by the German Maritime Search and Rescue Association. These experiments showed that advanced signal processing is needed to be able to distinguish between the echo of a boat and that of the water. One particularly successful method is simultaneous reception of a radar signal with several antennas. The subsequent multi-channel processing of the data allows us to find the boat in most cases. For my doctoral thesis, I have investigated this method for the described scenario theoretically and I have confirmed the theory with real data.

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

The Human Factors department of our neighboring institute, the Fraunhofer Institute for Communication, Information Processing and Ergonomics FKIE, sometimes asks me if I would like to take part in their experiments. In one experiment, you run on a treadmill through a virtual village and have to carry out various tasks. You have to remember certain information about individual houses, for example, or work out how to find your way around using a map. The scientists use these experiments to find out the best way for people to remember certain information. I always find that quite fascinating.

Imagine that you receive a visit from some nice colleagues and would like to show them something of your town, apart from the usual tourist sights. Do you have any insider tips?

I live in Aachen and carpool to Wachtberg every day with some very nice people. I would take the visitors to Aachen, as it is a very beautiful town. We would start on Pontstrasse: it has tons of student bars and we could get something to eat. We could then buy a cold drink and sit on the stones on the market square. There's always a good atmosphere there in summer.

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

Our dishwasher was once broken for two weeks – it was a nightmare!

What do you wish you had more time for?

Because the area covered by my thesis is very new, I could imagine looking at other aspects of it, or working out new ideas. Unfortunately there isn't enough time to pursue every idea, however. In my free time, I volunteer at an animal rescue organization, and of course I feel that I could do more there if I had more time.

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

I recently submitted my doctoral thesis to my advisor for him to read. So I hope that I will soon have my doctorate. Will life go on after I get it? At the moment, it's hard to imagine.

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

It's difficult to name just one. When I was little, I found the "Moonlight Sonata" incredibly romantic and wanted to be able to play it myself. After many years of piano lessons, however, I still can't play it. All the same, the melody has had an effect of some kind on my life.

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

There is a Russian saying that my grandmother always used: "whatever happens is for the best." I always say it to myself whenever something goes wrong.

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About Valeria Gracheva:
Valeria Gracheva studied electrical engineering and Information technology at RWTH Aachen University. She wrote her diploma thesis at the Institute of High Frequency Technology in 2009. Since 2010, she has worked as a research associate at the Fraunhofer Institute for High F requency Physics and Radar Techniques FHR in the Array-based Radar Imaging department. She is writing her doctoral thesis in the department on the topic of "Multi-channel analysis and suppression of sea clutter for airborne radar systems."

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