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RESEARCH NEWS

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Phone: 089 1205-1302
presse@zv.fraunhofer.de
www.fraunhofer.de/presse

1 Early Detection Of Lung Cancer

The earlier cancers can be detected, the better the chances of a cure. Researchers are now working to develop a new diagnostics platform with which the illness can be diagnosed in its early stages, even during a visit to the general practitioner: protein biomarkers in exhaled air divulge the presence of pathological cells in the lung.

2 Laser welding in the right light

Laser welding is on the advance, but it also has its limits: it has been impossible to fuse two transparent plastic components together – up until now. Researchers have now succeeded in circumventing this hurdle – by choosing the right wavelength. The new welding process is revolutionizing bioanalytics.

3 Emergency Detection Systems for Senior Citizens

Elderly people living alone have a dangerous life: after a fall, they often spend hours lying on the floor before their situation comes to anyone's attention and a doctor is contacted. A new system automatically detects predicaments like this and informs a trusted person. This makes it possible to live an independent life in one's own four walls.

4 Getting cars onto the road faster

Auto manufacturers are looking for shorter production times, faster logistics processes, new materials and technologies. A novel software platform will help companies to achieve these goals by reducing not only the development times but also the development costs.

5 Government mashups – better contact with public authorities

Mashup technologies and mobile applications will help to close the communication gap between government bodies and the general public. They can be used, for example, to send messages to local authorities. Fraunhofer research scientists have developed individual solutions to facilitate rapid contact with government institutions.

6 UV-transparent coating for image sensors

Image sensors as used in cell phones are partially color-blind. This is because of their coating, which prevents UV light from passing through. CMOS chips have as a result not been suitable for spectroscopy up to now. A new production process makes the coating transparent – and the sensors suitable for special applications.

The Fraunhofer-Gesellschaft is the leading organization for applied research in Europe. Its research activities are conducted by 60 Fraunhofer Institutes at over 40 different locations throughout Germany. The Fraunhofer-Gesellschaft employs a staff of around 17,000, who work with an annual research budget totaling 1.7 billion euros. Roughly two thirds of this sum is generated through contract research on behalf of industry and publicly funded research projects. Branches in the USA and Asia serve to promote international cooperation.

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Early Detection Of Lung Cancer

Lung tumors are the number one cause of death among cancer patients, and one cancer in three is lung cancer. Each year, there are 50,000 new cases of the disease in Germany alone. The earlier a tumor can be detected, the greater the chance of healing the patient. But early detection is difficult. In its initial stages, the tumor-related complaints resemble chronic inflammatory reactions. To get a more complete diagnosis, the patient must undergo an X-ray examination or an bronchoscopy. The last procedure often involves irritation of the lung or removal of tissue samples and, as a result, it is particularly unpleasant for the patient undergoing the procedure. In recent years, scientists at the Fraunhofer Institute for Cell Therapy and Immunology IZI in Leipzig have teamed up with colleagues at the University Clinic of Leipzig to develop a procedure that can detect special protein biomarkers in exhaled air. The presence of biomarkers suggests the presence of tumor cells in the lung. In a project sponsored by the Federal Ministry of Education and Research (BMBF), the specialists want to work with partners in industry – two medium-sized companies in the regional – to produce a first prototype that can then be further developed into a diagnostic tool that can be used in practice.

"Since 2006, working with the working groups of Professor Hubert Wirtz and Professor Ulrich Sack of the University Clinic, we first identified various biomarkers that are particularly well-suited for the identification of lung-cancer cells," notes Dr. Jörg Lehmann, head of the Cell Engineering/GLP Unit at IZI. "The main difficulty lies in finding a reliable way to distinguish cancer from chronic inflammatory disease." The researchers have developed a laboratory method for reliably identifying biomarkers specific to lung cancer in special samples of exhaled air. To accomplish this, the patient must breathe into a piece of equipment for roughly 20 minutes. The exhaled breath condensate is then evaporated. Biomarkers are detected by means of special antibodies that recognize substances such as the protein VEGF. This protein is responsible for stimulating the growth of new blood vessels. This laboratory method is still too "elaborate and expensive" for normal everyday use, the scientist adds. "Working in our joint project, the goal for the next two years is to produce a prototype that will then be validated in a clinical-diagnostic study and further developed to the production stage," Lehmann says.

In their new testing platform, the scientists have actually applied two new developments: in addition to the method enlisting protein biomarkers to identify cancer cells, they also make use of the antibody specially developed for this procedure. This way,

within just a few years, every physician investigating a suspicion of lung cancer can use the diagnostic platform right in his or her practice to test whether there really is a tumor and quickly initiate treatment.

Fraunhofer Institute for Cell Therapy and Immunology IZI
Perlickstraße 1 | 04103 Leipzig, Germany | www.izi.fraunhofer.de
Contact: Dr. Jörg Lehmann | Phone +49 341 35536-1205 | joerg.lehmann@izi.fraunhofer.de
Press: Jens Augustin | Phone +49 341 35536-9320 | jens.augustin@izi.fraunhofer.de

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Laser welding in the right light

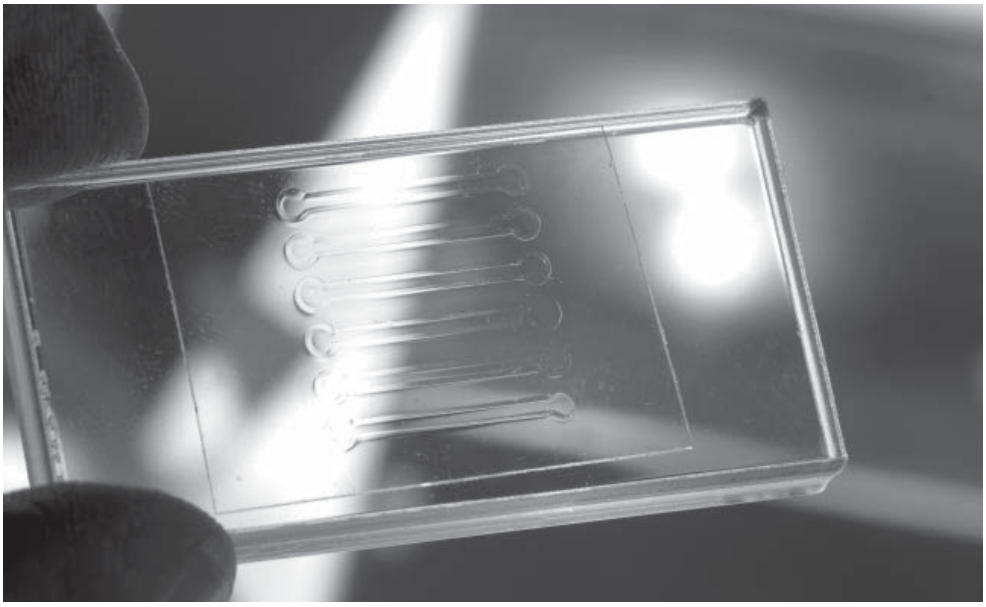
It's a quick process, generates almost no waste and is extremely precise: within a few seconds, a laser beam has welded the casing and speedometer cover together – without any screws, clamps or glues whatsoever. The result is a perfect weld seam scarcely visible to the naked eye. There are no sparks or particles flying through the air during welding. What's more: the resulting heat is confined to a minimal area. This protects the material. Many industries have now turned to welding plastics with a laser.

Still, the technology has its limits; when it comes to fusing two plastic components together, for instance, there is little freedom of choice. Up until now, the upper joining part had to be transparent to permit the laser to shine through unimpeded while the lower joining part absorbed the radiation. This usually meant soot particles had to be blended into the plastic. These particles absorb the energy of the laser beam and transmit the fusion heat generated to the upper joining part. "Up until now, you usually had to choose a single plastic combination: transparent and black. There are lots of applications – in medical technology, for instance – where what's needed is a combination of two transparent plastics," explains Dr.-Ing. Alexander Olowinsky, project manager at the Fraunhofer Institute for Laser Technology ILT in Aachen, Germany. The researcher and his team have now managed to erase the previous boundaries of laser welding.

"The industry now also makes infrared absorbers that are nearly transparent, but these are not only very expensive but also have a green, yellowish tint to them," Olowinsky elaborates. "So our goal was to find a way to get the job done completely free of absorber materials." To accomplish this, researchers studied the absorption spectra of a range of transparent polymers in search of wavelength ranges within which plastic absorbs laser radiation. Then the scientists tested and perfected the laser systems to match: systems that emit light of the right wavelengths. "Before, you didn't have the right light source," Olowinsky adds. "It was only during the past few years that laser sources have been developed that emit light in these wavelength ranges." To deliver the light energy to the joining level – to the seam along the border between the two transparent plastics – the experts at ILT came up with special lens systems. These systems focus the beam so that the highest energy density occurs at the beam waist – where the beam diameter is the smallest – so that the highest temperature is delivered precisely to the joining level.

The researchers' most promising results were achieved at a wavelength of around 1700 nanometers. "This is the peak welding-efficiency range," Olowinsky summarizes. Nevertheless, the researchers are also continuing work on the EU Commission-sponsored "PolyBright" project (www.polybright.eu) in search of the combination of the right absorption bands with the matching light sources. "The result has to be the most cost-effective laser system possible that can execute high-precision welding tasks at the highest possible speed."

Medical technology and bioanalytics in particular are among the main beneficiaries of the new welding process: The magic word is "lab on a chip." This refers to automatic, miniature-sized laboratory analysis on the surface of a chip. Whether fluids, protein or DNA analyses – the spectrum of applications is a broad one.



Transparent plastics can be joined via laser beam at a wavelength of around 1700 nanometers. (© Fraunhofer ILT)

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Fraunhofer Institute for Laser Technology ILT
Steinbachstr. 15 | 52074 Aachen, Germany | www.ilt.fraunhofer.de
Contact: Dr.-Ing. Alexander Olowinsky | Phone +49 241 8906-491 | alexander.olowinsky@ilt.fraunhofer.de
Press: Dipl.-Phys. Axel Bauer | Phone +49 241 8906-194 | axel.bauer@ilt.fraunhofer.de

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Emergency Detection Systems for Senior Citizens

Ms. K. is vision-impaired and can't get around very well any more. Still, the 80-year-old, who lives alone, has no intention whatsoever of moving to a retirement home. Most elderly people think the same way. They want to stay in their accustomed surroundings as long as possible, where they can lead an autonomous life. What many fail to realize is that they are risking their health in the process. Cardiovascular problems are more frequent among the elderly, and the risk of falling is more prevalent: one person in three above the age of 65 falls once a year; among those over 80 the ratio is nearly one in two. Many of these accidents occur in private homes in the course of everyday activities, and often at night. Frequently it is hours before the injured are cared for. Even home emergency-call systems are of limited help when senior citizens cannot sound the emergency signal. They may be injured or disoriented, or may simply not have the emergency button on their person. Help could be forthcoming from an intelligent system that automatically identifies and responds to emergency situations such as these. One such solution is under development by researchers at the Fraunhofer Institute for Experimental Software Engineering IESE in Kaiserslautern, Germany. Their project is dubbed "ProAssist4Life" – shorthand for "Proactive Assistance for Critical Life Situations." Project partners include the company CIBEK technology + trading, Binder Elektronik and the Westpfalz Klinikum.

IESE scientists are working on an unobtrusive system that provides constant "companionship" to elderly people living in single households or in retirement facilities. Multisensory nodes mounted to the ceiling of a room register an individual's movements. "Our system records how long a person spends in what part of the home," notes Holger Storf, a scientist at IESE. A radio signal transmits the data to a computer. Software documents the individual's daily activities, constantly learning the person's "normal behavior." The analytical software compares the resident's current activity with the model that has been generated. This is how it identifies situations that deviate from the norm – situations that could be an indication that the person has fallen, is lying unconscious on the ground and is in a helpless situation. "If a person spends considerably longer in the bathroom, for instance, or in some other place in the home, this is registered. To prevent false alarms, the first response is to prompt the individual," Storf explains. This can be accomplished with a telephone call, for instance, or by means of a touchscreen monitor with an integrated speaker. The individual can then respond by touching the monitor. Should the elderly person fail to respond, the software sends a text message to a trusted individual such as a family member or caregiver.

"Our solution is not designed to replace home emergency-call systems but is intended to serve as a kind of airbag to give people living in single households a sense of safety," the researcher emphasizes. Unlike comparable competitor products, neither cameras nor microphones are required. Senior citizens do not need to carry sensors on their person, either. Because the system operates via radio signal, there is no need to install wiring. The system is easy to install.

"To date, there has been no comparable, learning-capable system on the market that constantly adapts to an individual's behavior," Storf notes. The researcher and his team have applied for patents of the software and the multisensory nodes. The experts will be exhibiting a prototype of "emergency detection in the home" at the CeBit 2011 in Hanover, Germany, where they will demonstrate its operation, in a kitchen built for the purpose, at the Fraunhofer joint stand (Hall 9, Stand B36).

In the future, a new sensor system will automatically detect whether an elderly person is in an emergency situation and will automatically inform a trusted person. (© Fraunhofer IESE)

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Fraunhofer Institute for Experimental Software Engineering IESE
Fraunhofer-Platz 1 | 67663 Kaiserslautern, Germany | www.iese.fraunhofer.de
Contact: Holger Storf | Phone +49 631 6800-2117 | holger.storf@iese.fraunhofer.de
Press: Yvonne Ortiz Guadalupe | Phone +49 631 6800-1002 | yvonne.ortiz@iese.fraunhofer.de

Fraunhofer

Getting cars onto the road faster

The auto industry faces major challenges. New models are entering the market at ever shorter intervals, products are becoming more complex, and the trend towards electric cars requires modified vehicle structures. European production sites are coming under increasing cost pressure from low-wage countries. Cost reductions, shorter production times, new materials and innovative assembly techniques are needed if companies are to remain competitive. To achieve these goals, 23 business and research organizations are participating in the EU's Pegasus project (www.pegasus-eu.net). One of the research partners is the Fraunhofer Institute for Chemical Technology ICT in Pfinztal, which is contributing its expertise in the polymer engineering sector. The project partners have jointly developed a software platform to reduce development times and costs.

The Integrated Design and Engineering Environment (IDEE) is a CAD/CAE/CAM software system which is connected to an intelligent database. It analyzes the functional requirements of a product and identifies appropriate materials at an early stage of the development process. If, for example, a car roof is to be made in a different material than before, it is not necessary to conduct a new development process. Instead, the design engineers enter the component data into the software system, which assesses the information and then selects suitable materials and manufacturing processes. The platform also provides engineering guidelines for designing the tools that will be used to produce the component. The project partners have demonstrated how this platform could work on the example of a fender with integrated LED tail light. "We used the original fender from a Smart. Our project demonstrates how this complex component can be produced more quickly and cheaply with new processing techniques, materials, bonding agents and tools," says Timo Huber, a scientist at Fraunhofer ICT. Instead of conventional lamps, the project partners fitted LED tail lights to the fender. This reduced the number of separate parts from eight to five, and the number of processing steps from twelve to five. Material and cost savings were also achieved by using conductor paths made of electrically conductive polymer. The conductive carbon nanotubes conduct the electricity from the connector to the LEDs and render metallic conductor structures superfluous.

A further example application: So that components such as the LED tail lights can be dismantled more quickly, they are bonded using a special adhesive. For this the research scientists at Fraunhofer ICT and their project partners developed a new microwave-active adhesive bonding system. When irradiated with microwaves the

individual components lose their adhesion and can be easily taken apart. This means that parts can be efficiently recycled into different categories. "In addition, we dyed the fender using newly developed pigments based on special nanoparticles," states Huber. These nanostructures can be worked in particularly evenly, to dye plastics such as polypropylene. This means fewer pigments are needed than usual. "We have also taken the importance of protecting the climate into account. Further developments in local fiber reinforcement of structural vehicle components will reduce weight and therefore emissions of CO2," the scientist adds, and sums up: "All in all the IDEE system will shorten development times, cut the number of assembly steps and reduce the amount of material consumed." IDEE is still under development, but it can already be used to produce simple components. The software should be ready and available to the auto industry in about a year's time.

The fender with integrated LED tail light developed in the Pegasus project has been produced for demonstration purposes. (© Fraunhofer ICT)

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Fraunhofer Institute for Chemical Technology ICT
Joseph-von-Fraunhofer-Straße 7 | 76327 Pfinztal, Germany | www.ict.fraunhofer.de
Contact: Timo Huber | Phone +49 721 4640-473 | timo.huber@ict.fraunhofer.de
Press: Dr. Stefan Tröster | Phone +49 721 4640-392 | stefan.troester@ict.fraunhofer.de

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Government mashups – better contact with public authorities

Potholes in the road or a park bench in need of repair – we all come across these or similar problems every now and then. If only there were a simple way of reporting them to the right department of the public administration! The latest mashup technology and mobile applications make it possible to come up with solutions.

Inspired by the UK website www.fixmystreet.com, the Fraunhofer Institute for Open Communication Systems FOKUS in Berlin is taking this approach further. Damage reports can be assigned GPS coordinates by cell phone and entered. The system then provides an overview of communications received and indicates whether the same matter has been reported by someone else.

As used in information and communication technologies, the term 'mashup' refers to the mixing or combination of data, types of presentation and functionalities from various sources in order to create new services. One example is the placing of restaurant reviews in online maps such as Google Maps. Fraunhofer FOKUS's Government Mashups research project is putting the technology at the public sector's disposal. Solutions that already exist are being developed further to meet the requirements of government administration and the relevant public sector staff are being assisted in the technical implementation of these new services. "Mashups hold enormous potential for public authorities because they link up internal and external data quickly and cheaply," says project manager Dipl.-Ing. Jens Klessmann. "Without any knowledge of computer programming and at little cost administrative staff can create new mashups which can be adapted effortlessly to changing requirements."

Numerous possible applications exist: In addition to complaints management, the use of public funding can for instance be graphically represented, restaurant reviews can be linked to the results of food hygiene inspections, statistics and other official data can be made more easily accessible, and capacity utilization at different airports can be illustrated in order to coordinate rescue services in the event of a disaster.

Such projects are underpinned by statutory regulations and political requirements. For example, laws on the freedom and re-use of government information already require public bodies to provide official data. In its current program to promote networked and transparent administration the German government has announced that it intends to develop a common strategy for open government. This will include the provision of open data, which are the raw material for government mashups. In

addition, governments and public bodies find themselves under growing pressure to justify and explain the increasingly complex procedures underlying their actions. Mashups can be used to explain and visualize these matters.

At CeBit 2011 Fraunhofer FOKUS will present two advanced demonstrators for mashups. Visitors will be invited to take a photo of a pothole on a smart phone and send it to a fictitious city authority as a complaint. And the research scientists will use statistical data from the World Bank to demonstrate how such information can be translated, processed and visualized so that anyone interested can download it.

Mashups will enable people to inform public authorities about potholes and cracks in the road quickly and without bureaucracy. (© Fraunhofer)

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Fraunhofer Institute for Open Communication Systems FOKUS
Kaiserin-Augusta-Alleee 31 I 10589 Berlin, Germany I www.fokus.fraunhofer.de
Contact: Dipl.-Ing. Jens Klessmann I Phone +49 30 3463-7285 I jens.klessmann@fokus.fraunhofer.de
Press: Eva Sittig I Phone +49 30 3463-7212 I eva.sittig@fokus.fraunhofer.de

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UV-transparent coating for image sensors

They have been used as standard in multimedia electronics for a long time, and now they are making rapid inroads in high performance applications: CMOS image sensors are no longer only used in cell phones and digital cameras. The automotive industry, for instance, has discovered the potential of optical semiconductor chips and is increasingly using them in driver assistance systems – from parking aids and road lane detection to blind-spot warning devices. In special applications, however, the sensors that convert light into electrical signals have to cope with diffi cult operating conditions, for example high temperatures and moisture.

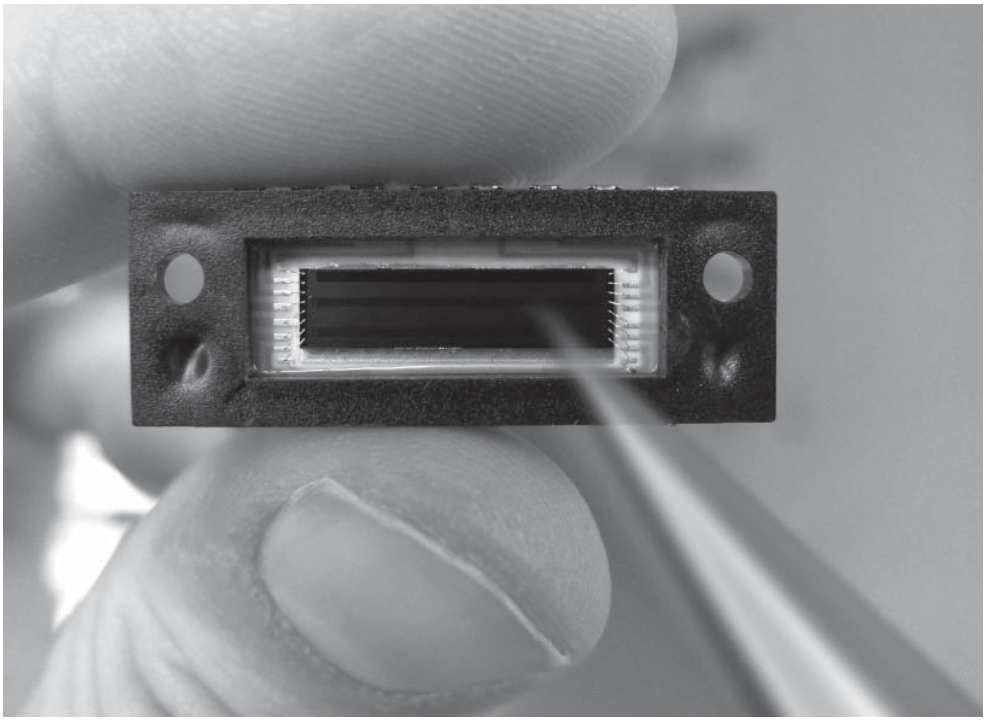
For this reason, CMOS devices are covered with a silicon nitride coating. This chemical compound forms hard layers which protect the sensor from mechanical influences and the penetration of moisture and other impurities. The protective coating is applied to the sensor in the final stage of CMOS semiconductor production. The process is called passivation, and is an industry requirement. Unfortunately, up to now this passivation has entailed a problem: the silicon nitride coating limits the range of optical applications because it is impermeable to light in the UV and blue spectral range. CMOS sensors for high-performance applications, used in special cameras are therefore partially color-blind.

Scientists at the Fraunhofer Institute for Microelectronic Circuits and Systems IMS in Duisburg have found a solution to this problem: "We've developed a new process step," says Werner Brockherde, head of department at Fraunhofer IMS, "that allows us to produce a protective coating with the same properties but which is permeable to blue and UV light." The trick is to increase the proportion of nitrogen in the coating. "This reduces the absorption of shortwave light," explains Brockherde.

In simplified terms, the new coating material will absorbless light of an energy higher than blue light, which means the sensor becomes more sensitive at the blue and UV range. "This makes CMOS image sensors suitable for use in wavelength ranges down to 200 nanometers," states Brockherde. "With standard passivation the limit was about 450 nanometers." To change the structure of the silicon nitride for the coating, the Fraunhofer research scientists had to fine-tune the deposition parameters such as pressure and temperature.

With this process development the experts have expanded the range of applications for CMOS image technology. This could revolutionize UV spectroscopic methods,

which are used in laboratories around the world, significantly improving their accuracy. Likewise, CMOS image sensors stand to take up a new role in professional microscopy, e.g. in fluorescence microscopes, providing scientists with images of even greater detail.



CMOS image sensors can now be covered with a transparent protective coating that is permeable to light in the UV and blue spectral range. (© Fraunhofer IMS)

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Fraunhofer Institute for Microelectronic Circuits and Systems IMS
Finkenstraße 61 l 47057 Duisburg, Germany l www.ims.fraunhofer.de
Contact: Werner Brockherde l Phone +49 203 3783-230 l werner.brockherde@ims.fraunhofer.de
Press: Martin van Ackeren l Phone +49 203 3783-130 l martin.van.ackeren@ims.fraunhofer.de