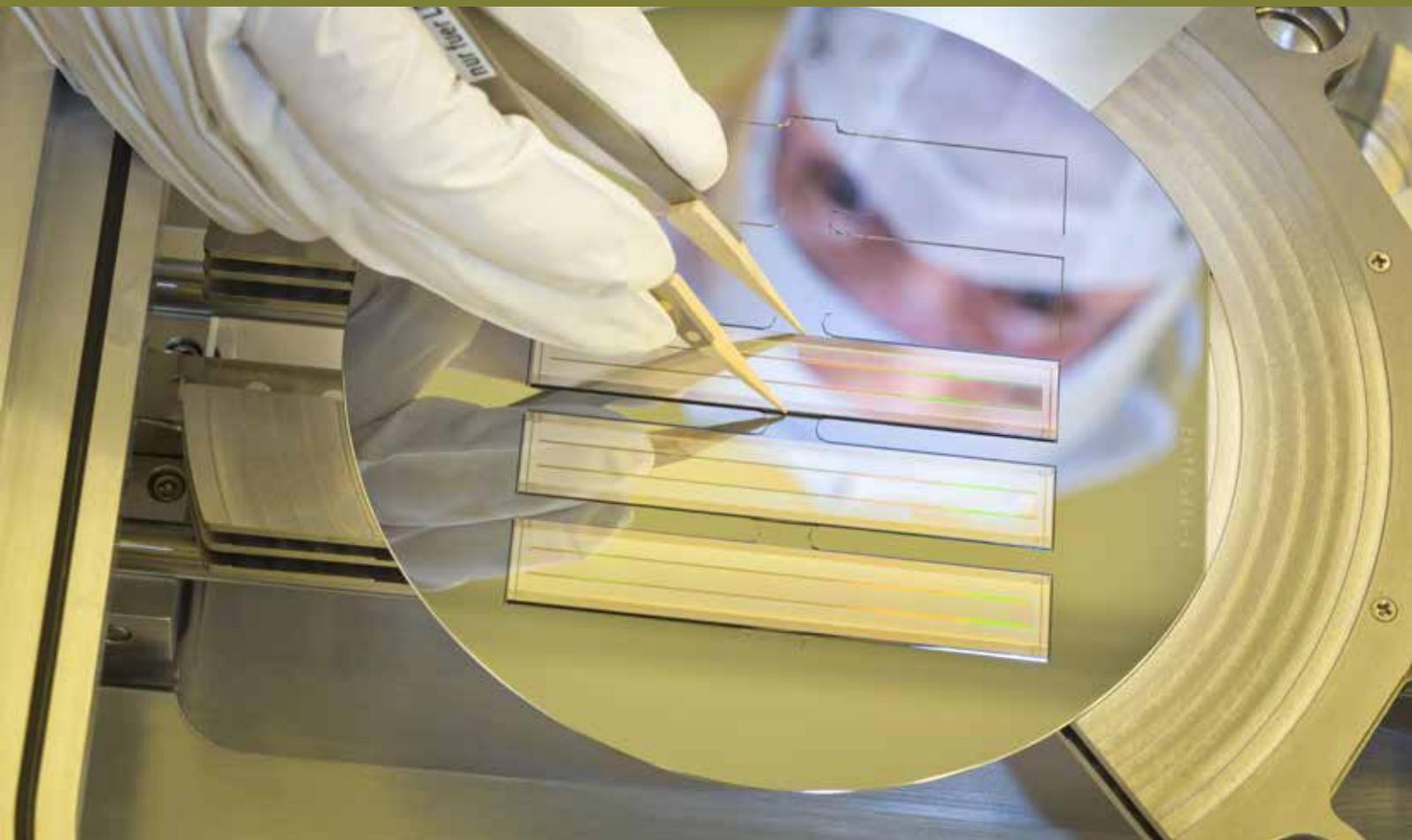


MEMS REPORT

3 / 2014



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Prof. Dr. Hubert Lakner
Director of Institute

Dear Customers, Partners and Friends
of Fraunhofer IPMS,

Safety is a valuable asset in our society. Each and every one of us wants a carefree life without having to worry about possible threats in every situation in daily life. The general progress of technology leads to ever new scenarios. One problem, for example, is the diligent control of access to critical infrastructures, and this does not only relate to established areas such as airports but also data centers, for instance, upon whose availability and integrity our daily life in the mobile world is becoming increasingly dependent. Furthermore, an increasing number of people are dealing with money matters over their smart phone or other mobile devices. Here again, every effort is made to ensure that unauthorized persons do not gain access to the data. The Federal Ministry of Education and Research has spotted the need for new kinds of biometric solutions that allow the authentication of persons more reliably than with the familiar fingerprint. The Fraunhofer IPMS is involved in this development with various partners and has come up with a solution within the "MARS" project which we will present in more detail in this MEMS report. You will also learn about our latest contributions in the fields of ultrasonic converters and optical transmission technology.

I wish you an informative read of the latest MEMS report.

Prof. Dr. Hubert Lakner

QUICK NOTES

"Science Campus 2014" – the springboard for women in research

The "Science Campus" is being held between August 18 and 21, 2014 in Dresden for female graduates and students of mathematics, engineering sciences, natural sciences and informatics. The aim of this 4-day event is to show the creative potential and strengths of women in MINT courses and to capture their imagination and interest in scientific work at Fraunhofer. In top-class seminars, workshops and lectures they gain in-depth insights into research work, strengthen their personal and professional competences and also make contacts for their future career in application-oriented research. The Fraunhofer IPMS will also be taking part in this year's science campus for the first time.

Trade fair review

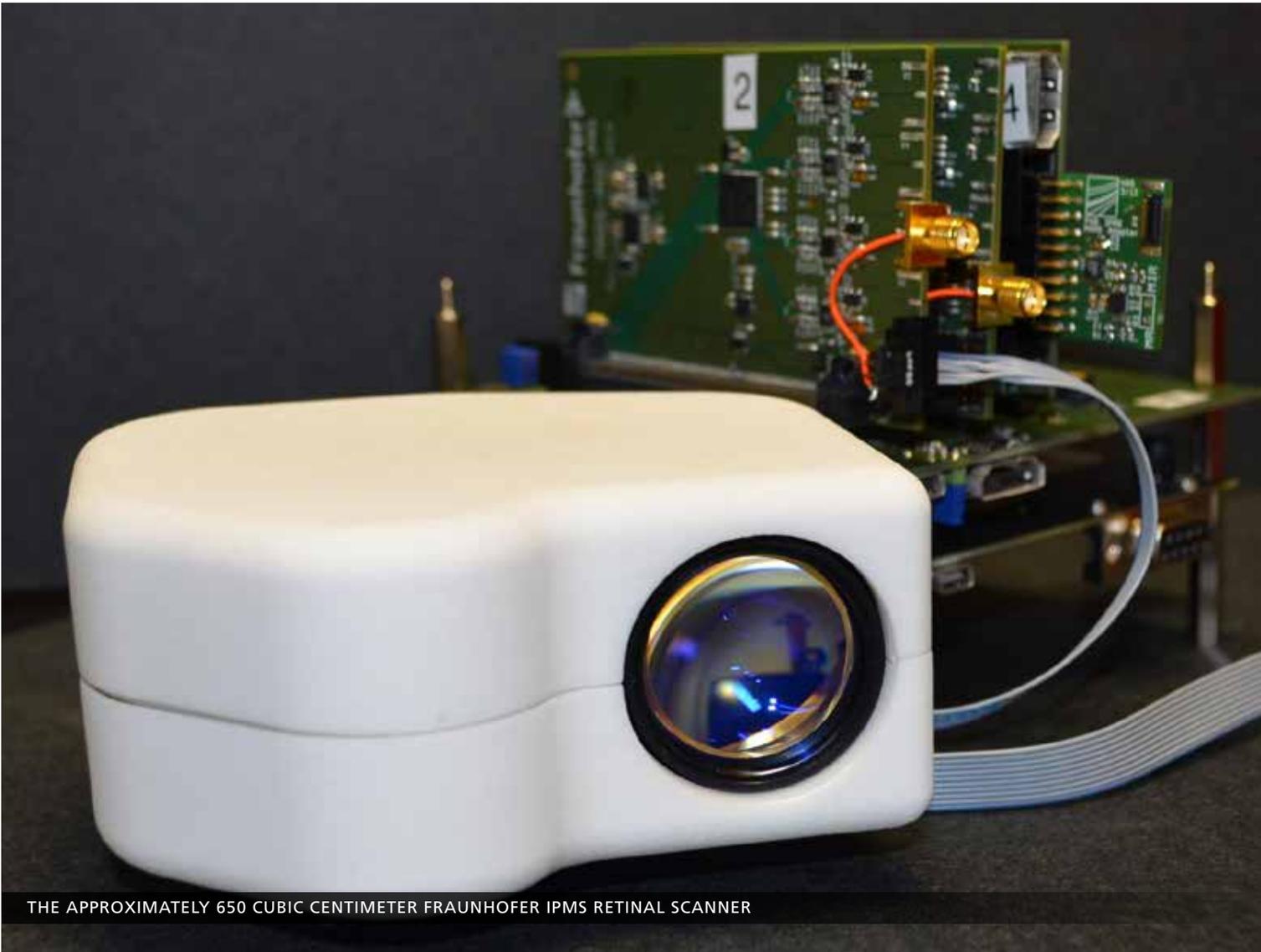
The Fraunhofer IPMS attended a number of trade fairs as usual to inform the general public about the latest results of its research and developments. We traditionally kicked off at the Photonics West in San Francisco, where we have been presenting our services for the past 10 years. Trade fairs such as Arab Health, Smart Systems Integration, OFC, Optatec, Sensor+Test and Sensors Expo are also firm dates in our trade fair agenda for the first six months of the year.



PROF. DR. SCHENK AND DR. PIYAWATTANAMETHA (RIGHT)

However, for the first time we also used the Photonix in Tokyo in April to present the Fraunhofer IPMS on the Japanese market, which is eminently important for photonics. The success of this visit has convinced us to return next year.

RETINAL SCANNER THAT FITS IN A PURSE



THE APPROXIMATELY 650 CUBIC CENTIMETER FRAUNHOFER IPMS RETINAL SCANNER

The process of globalization in economy affects society as well as privacy. On one hand, people take advantage of growing opportunities to communicate, to access services and goods, to live and travel freely. On the other hand this liberality gives more space for beguilement, non-legal, criminal, or even terroristic activities. Consequently, societies, communities and individuals are interested in more security and care to defend themselves against these threats. In particular, critical infrastructures need adequate security measures.

One opportunity to improve security is to authenticate each person before allowing specific actions or getting access to critical resources. A simple approach of authentication is to own a token, e.g. a key or a personal ID card. Another opportunity is to have special knowledge like a password or a PIN code. However, these solutions are not very safe: tokens may be lost or stolen, knowledge can be

spied out or extorted. Banking cards combine both: the card itself acts as token, and the PIN code is needed to get cash at an ATM. However, even this does not safely protect against fakes!

Human individuality helps

One more opportunity to prove personal identity is the use of individually formed traits of the human body, so-called biometric modalities. Fingerprints or DNA profiling used in criminal prosecution are well known. Other useful methods of biometric authentication are face and speech recognition as well as the analysis of the irides or the retinae of our eyes. The retina lets us see. However, it also reveals who we are. Because the blood vessels supplying every human retina form a very individual pattern which is excellently suited to biometric recognition of persons, and which is almost impossible to fake.

RETINAL SCANNER THAT FITS IN A PURSE

In medicine detailed retinal images (see figure below) are captured by scanning laser ophthalmoscopes (SLO) which use a quickly moving laser spot illuminating the retina through the eye lens, collect the light reflected out of the eye, and reconstruct the entire image along the spot trajectory.

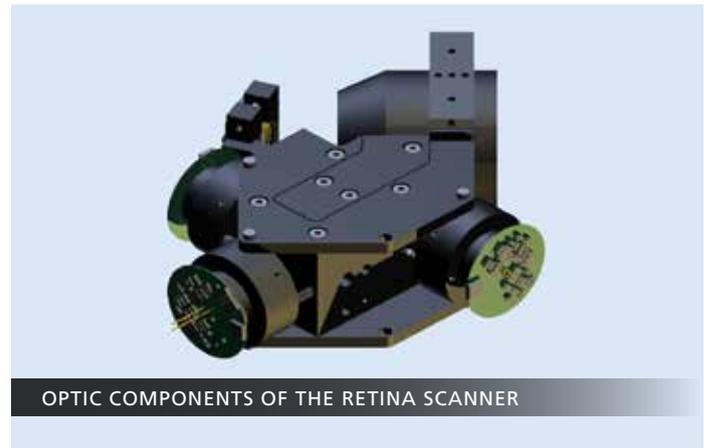


Using special eye scanners, a person could give proof of identity safely, securely and unambiguously while on the go. For example, in order to conduct bank transactions, to pay at the supermarket cash register or to unlock the car. However these devices are much too large and cumbersome for mobile use.

MEMS based approach

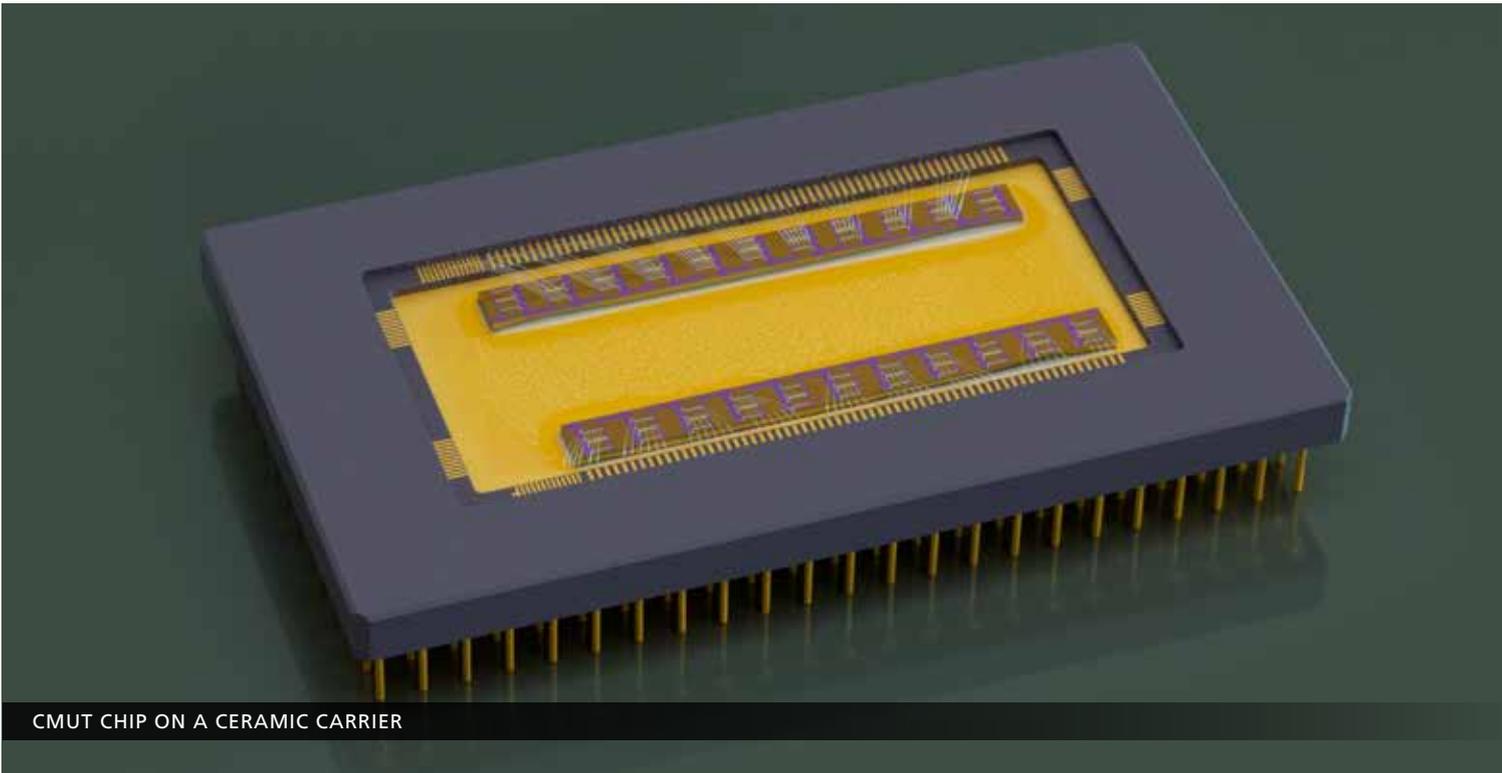
Therefore, scientists from the Fraunhofer IPMS developed the prototype of a retinal scanner that is small, ergonomically adequate for the human hand and suitable for those who wear eyeglasses. "Based on our research, this device is unique with respect to its compactness," says Dr. Uwe Schelinski, group manager of Systems Integration at Fraunhofer IPMS. Researchers housed the optical components needed to image the retina within a volume of about twelve-by-nine-by-six centimeters. These components include, for example, the infrared laser, the ocular and the MEMS-scanner mirror. Above all, the latter is responsible for helping the scientists succeed in putting the optical system into such a compact space. The silicon-based micromechanical components are no bigger than tiny microchips. They deflect the optically-safe laser beam in a way that touches the retina in a targeted manner and allow the built-in optical instruments to produce an image of the retinal surface from the reflected laser beams. Since the blood vessels of the retina reflect less light than the rest of the surface of its nerve cells, their pattern can be mapped in a graphically distinct way and compared with one of its owner that was previously stored. This pattern is uniquely individual to each human being, just like a fingerprint, the iris, the facial features or the voice, and proves his or her identity. The

portable retinal scanner is the result of the "MARS" research project sponsored by the BMBF. MARS stands for "Mobile Authentication via Retina Scanning." The system is already mobile – at least, the optical components – thanks to its size. By the end of the project the scientists also want to have integrated the electronics in such manner that the device is only minimally larger. Concurrently, the last phase of the MARS project deals with improving the understanding of the technology through experimentation, and with honing the valuation software. The Dresden-based scientists are supported by their colleagues at the Fraunhofer Institute for Systems and Innovation Research ISI in Karlsruhe. The innovation researchers are responsible on the project for ergonomics, acceptance and the legal aspects of the technology. Other partners are Dermalog GmbH, Hamburg, Fraunhofer ISI, Karlsruhe, Institut für Mikroelektronik-und Mechatronik-Systeme GmbH, Ilmenau, Pitcom GmbH, Plauen, SECURITAS Aviation Service GmbH, Berlin, P3N Beratungs GmbH, Zwickau, Loxi GmbH, Hamburg as well as IMM Holding GmbH, Mittweida.



It's still a long way until we can integrate the technology into a smartphone. Another possibility would also be small accessory modules that communicate with the smartphone via Bluetooth, NFC or WLAN. Perhaps that is also the more prudent option in the first stage, since smartphones are still too insecure," states Schelinski. From his viewpoint, the technology has two essential advantages compared to stationary solutions: "First, the scans remain on the device and do not land in a database. Second, I am more willing to scan myself with my own device than with a permanently installed third party system." The idea behind this: it is not the retinal comparison itself that is necessary in order to use applications. In fact the device – either the smartphone or the portable scanner – must unambiguously identify the respective owner. If that is the case, then this device itself is the key to collect money, to lock the car, etc." Before the technology can conquer the market, we have to build it even more compactly. Our prototype is an important milestone on this path," says Schelinski.

ROBUST, RELIABLE, VERSATILE: NEW GENERATION OF ULTRASONIC SENSORS



CMUT CHIP ON A CERAMIC CARRIER

Scientists at Fraunhofer IPMS have been using their experience in MEMS technologies to fabricate Capacitive Ultrasonic Micromachined Transducers (CMUT). CMUTs can send and receive ultrasound in an energy efficient manner, are environmentally friendly, provide miniaturization capabilities, and expand the applications of ultrasound beyond today's state of the art. Fraunhofer IPMS recently presented its first generation of CMUT chips and an initial demonstrator showing the functionality of a CMUT component to the public.

Ultrasonic sensors have already become an integral part of our everyday lives. They support car drivers as parking aid, control filling levels and material flows in the food and beverage industry and enable medical imaging tools, such as fetal imaging and organic tissue imaging. This versatile sensing principle is based on the propagation and evaluation of high frequency sound pulses, and enables contactless detection of objects with millimetric precision for a wide variety of materials regardless of their state, form and color, and in practically any environment.

Today's ultrasonic transducers are typically manufactured using piezoelectric materials and have proven to be successful in many applications. "CMUTs are not intended to replace these, but rather complement them and open up new fields of application for ultrasonic technology," stresses Dr. Anartz Unamuno, manager of

the CMUT activities at Fraunhofer IPMS. Several designs of CMUTs have been developed at the institute covering the frequency range between 1 and 50 megahertz. Anartz Unamuno explains the construction and functionality of the CMUTs as follows: "CMUTs are basically MEMS structures consisting of two opposing electrodes. One of the electrodes is static and the other deflectable. There is an insulating layer and a gap between the two electrodes. As an emitter, an electric signal is applied between the electrodes which deflects the movable electrode and generates an acoustic wave. The inverse energy transformation, acoustic to electric, is used with CMUTs to sense ultrasound waves."

Microelectronic technologies such as surface micromachining or wafer bonding processes are used for the fabrication of CMUTs, enabling a monolithic integration of the CMUTs with CMOS ASICs. In addition, CMUTs provide greater sensitivity and broader frequency ranges than the established piezo-based transducers. Fraunhofer IPMS offers many years of experience in the pilot fabrication of MEMS components and the integration of MEMS on CMOS products. Dr. Unamuno intends to use this know-how together with his team in order to achieve a commercial breakthrough for CMUTs.

The first generation of CMUT arrays realized at Fraunhofer IPMS has already been characterized using electric and optic techniques. Their acoustic performance has also been positively evaluated.

LI-FI MODULE DOUBLES THE DATA RATE TO 10GBIT/S

In order to transfer large amounts of data from one terminal device to another in next to no time and without an interfering cable, researchers at the Fraunhofer Institute for Photonic Microsystems IPMS are working on using light as a transmission medium. Optical wireless data transmission should serve as an alternative to wired data transfer and replace established standards such as USB3.0, USB3.1, Gigabit-Ethernet or 10-Gigabit-Ethernet.

Dr. Frank Deicke, group manager for optical sensors and data transmission at the Fraunhofer IPMS, had already come up with an optical wireless communication module at the end of 2013 that allowed a data transfer rate of up to 5 gigabits per second (Gbit/s). He has now succeeded in doubling this rate. Deicke and his team developed a transceiver for optical wireless communication that is no bigger than a sugar cube and that can transfer data via infrared at up to 10 Gbit/s. Compared to familiar radio technologies such as Bluetooth or WLAN, this communication module has a much higher data throughput, an extremely low bit error rate and saves more energy (power consumption of approx. 100mW at 10Gbit/s). Mobile, battery-operated devices such as smartphones or digital cameras with only a short battery life in particular profit from this latter feature.



The transceiver will be used in both the consumer sector as well as for industrial applications – wherever large amounts of data have to be transferred as quickly as possible from one terminal device to another, for example in automation, safety and process control or medical technology. The Fraunhofer IPMS offers various evaluation kits that give interested parties the chance to evaluate an optical wireless data transfer with data rates of up to 1 Gbit/s, 5 Gbit/s or 10 Gbit/s in their target system. What's more, the performance and size of the transceiver can be adapted to customer-specific requirements.

FRAUNHOFER IPMS-CNT SECURES RESEARCH LOCATION WITH INFINEON TECHNOLOGIES DRESDEN

The Fraunhofer IPMS has extended the existing lease and service contract for its business unit Center Nanoelectronic Technologies with Infineon Technologies Dresden for five further years. At the same time, Prof. Hubert Lakner, the managing executive director of the Fraunhofer IPMS (right), and Pantelis Haidas, CEO of Infineon

Dresden (left), affirmed their intention of continuing to cooperate on research and development topics in the future.



By signing these contracts, both parties secure one of the most up-to-date research institutions in the field of microelectronics in Germany in the long term. Research has been going on into new materials and processes under industrial conditions since 2005 on the Infineon site in Dresden-Klotzsche in close cooperation with chip manufacturers and suppliers. "These agreements create the best requirements for us to provide long-term, top-class research for our partners and customers in future, and in particular to address new problems together with Infineon.", says Prof. Hubert Lakner.

The Minister of Science Sabine von Schorlemer said: "I am delighted by the fact that the best, and above all long-term, basis has been established for the future development of the business unit Center Nanoelectronic Technologies of the Fraunhofer IPMS. This will lead to a further strengthening of Saxony as a microelectronics location."

12TH DRESDEN LONG NIGHT OF SCIENCE AT THE "MICRO NANO NORTH" LOCATION

"Mitmachen, Schlaumachen, Durchmachen!" (Join in, gen up, keep going!) This was the motto of the 12th Dresden Long Night of Science that was held on Friday July 4, 2014 between 6 pm and 1 am, where Dresden universities, independent research institutions and research-oriented companies opened their buildings, laboratories and lecture theatres to the public. The Fraunhofer IPMS in the north of Dresden, which has developed into one of the most popular venues over the past few years, naturally took part again. Together with Infineon Technologies, Globalfoundries, Von Ardenne and X-FAB, nearly 900 visitors to the "Micro Nano North" site could once again expect some fascinating moments with exhibitions on several floors, lectures, join-in activities for children and guided tours of the clean rooms.

The focus this year was on the younger generation: scientists had organized a paper chase especially for this target group during which the children had to complete four tests such as "wafer jigsaw" or "wafer run". Older school children were also able to build and keep their own "photonic system" with soldering irons from an electronic construction kit. Visitors could also slip into a protective suit and pose as a model in front of a clean room backdrop.



And last but not least, the Fraunhofer IPMS offered this year for the first time, a tour of the clean rooms especially for the 10+ age group entitled "Fascination clean room". The emphasis was not so much on the technical manufacturing processes or products but rather to explain what a clean room actually is, what it is needed for and what everyday work in a clean room is like. Adults were able to delve deeper into the world of microelectronics in numerous lectures and exhibitions.

UPCOMING EVENTS

ECOC

Cannes, France Sept 22 - 24, 2014
Palais des Festivals et des Congrès de Cannes, Booth 332

Semicon Europe

Grenoble, France Oct 7 - 9, 2014
Exhibition Center ALPEXPO

Vision

Stuttgart, Germany Nov 4 - 6, 2014
Exhibition Center Stuttgart, Hall 1-H 73

Electronica

Munich, Germany Nov 11 - 14, 2014
Exhibition Center Munich

Medica

Düsseldorf, Germany Nov 12 - 15, 2014
Exhibition Center Düsseldorf

www.ipms.fraunhofer.de/en/events.html

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