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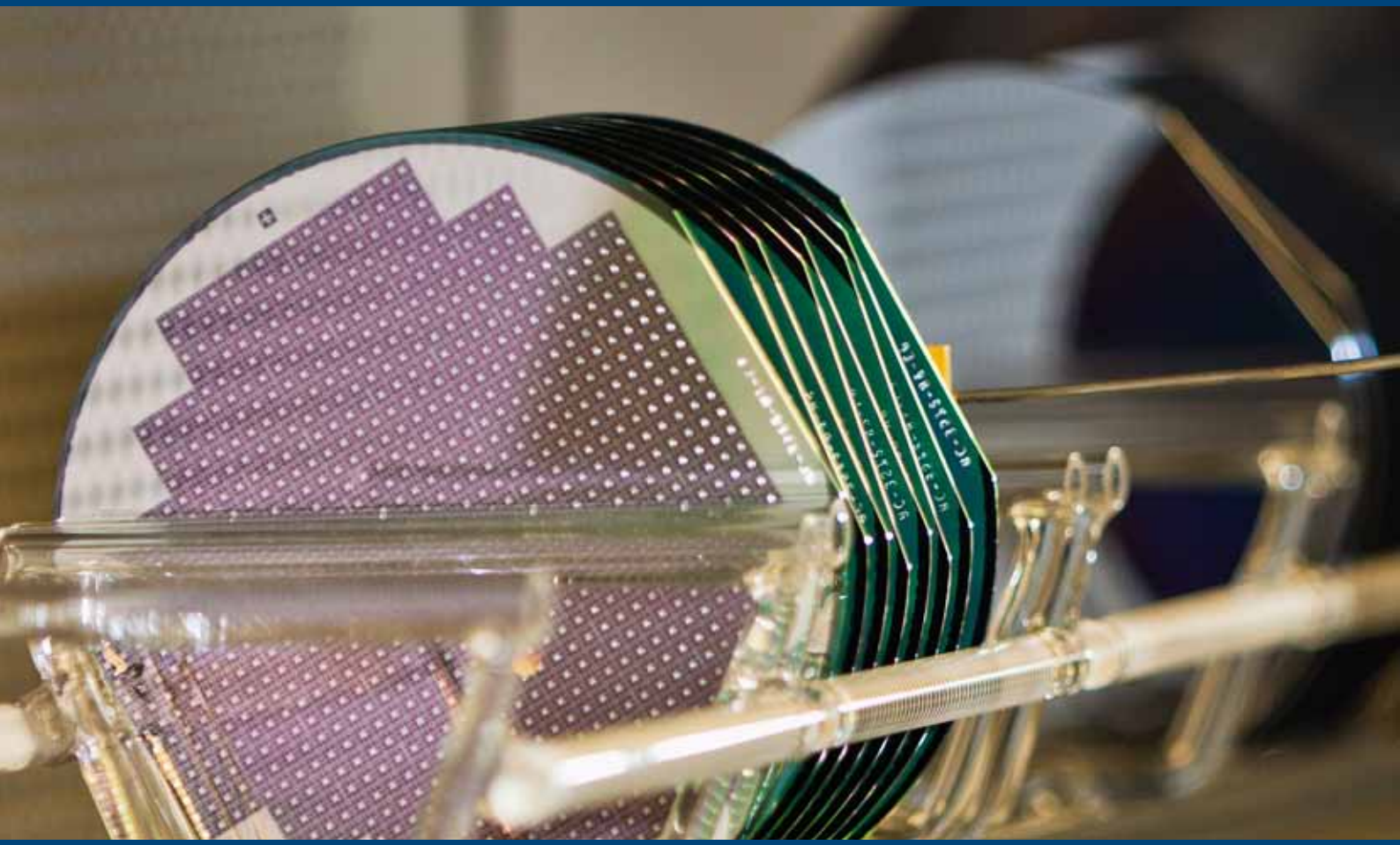
FRAUNHOFER INSTITUTE FOR PHOTONIC MICROSYSTEMS IPMS

MEMS REPORT

JAN – MAR 2012



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◄ Cover picture: Wafer with photo diodes for precision measurements.

Prof. Dr. Hubert Lakner
Director of Institute

Dear clients, partners, and friends of Fraunhofer IPMS,

welcome to the first edition of the "MEMS Report", the Fraunhofer IPMS quarterly newsletter. We would like to use this newsletter as a simple and direct way to keep you up to date about the latest developments at our institute, and we hope that the information will be helpful in achieving your goals.

The main focus of this first edition is on a very promising variation of our long standing, field-tested scanner technology. We would like to inform you about LinScan – the name of this new component – and its applications. Further topics in this edition that Fraunhofer IPMS are involved with are wireless optical communication, as well as the mobile personal authentication with optical technology, which will probably make our online banking transactions much safer within the next few years.

And now I wish you an interesting read of the first edition of the IPMS MEMS Report.

Prof. Dr. Hubert Lakner

QUICK NOTES

Photonics West

Huge demand for our R&D services, very promising customer contacts – the industry gathering this year was also a great success for Fraunhofer IPMS. And the presentation of the "Best Student Awards" on top of it all. There can be no doubt that the Photonics West in San Francisco will remain a permanent entry in the Fraunhofer IPMS event calendar, as will also be the case in 2013 with the event taking place from the 2nd to the 7th of February (two weeks later than usual).

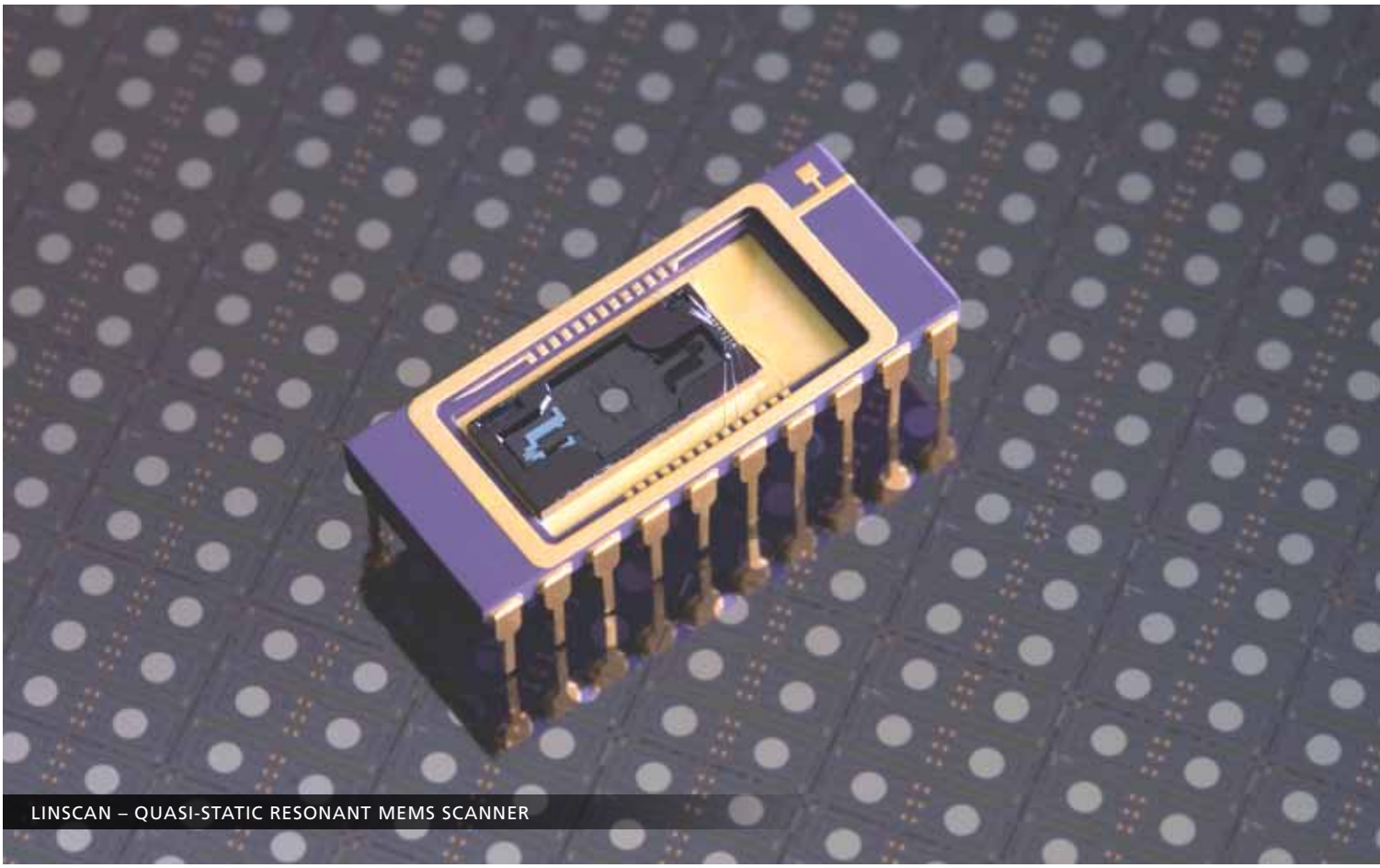
Arab Health

At the end of January, Fraunhofer IPMS was represented as an exhibitor for the first time at the trade show Arab Health in Dubai. Following only the Medica in Düsseldorf, this is the second largest medical trade show in the world. Numerous potential customers from the Arabian area and the Indian subcontinent were able to get information about the relevant developments at the Institute on a personal basis. The Saxonian Minister for Economics, Employment and Transportation also paid a visit to the Fraunhofer IPMS stand.

Online Product Range of Scanning Mirrors Expanded

In order to make scanner technology fast, affordable and accessible for our customers, Fraunhofer IPMS is offering standardized scanner chips that are based on a platform technology and are manufactured on pre-processed base substrates. Along with single-axis mirrors, samples with two axes vertical to each other (2D) are available effective immediately. Furthermore, evaluation kits (for single-axis mirrors), so-called Light Deflection Cubes (LDC) can also be configured according to the building block principle and can be ordered at www.micro-mirrors.com.

NEW MEMS MIRROR MAKES LINEAR SCANNING POSSIBLE



LINSCAN – QUASI-STATIC RESONANT MEMS SCANNER

Fraunhofer IPMS has been working on scanning mirrors that deflect light in one and two dimensions for years. Up until now, the components that have been field-tested in numerous customer projects could only resonate continuously at one set frequency. A new concept for a quasi-static scanner – called LinScan – now makes the variable adjustment of the motion pattern possible, opening up new application possibilities.

For a few years now they have already been considered the ultimate feature of future mobile telephones: Projectors so small that they can be integrated into the mobile device ("pico-projectors"). Whether it's the holiday pictures that were taken with the phone or videos downloaded from YouTube that are shown privately or presentations made to small groups in daily business; the integrated projector is certain to open up additional advantages and new applications for smart phones or Tablets. At present a projection the size of a television screen seems possible from a short distance, and HD resolution is also in demand.

Fraunhofer IPMS has already been active for a few years in making customer solutions for pico-projectors available. The Institute has been focusing on the principle of laser beam steering for image generation (please see box on the next page). Just like an old tube television in which an electron ray was deflected so that it stimulated one image point after the other to light up, one brightness-controlled laser beam (or three in red, green and blue for full-color display) is directed so quickly over the projection surface by a single miniaturized scanning mirror that an image cohesive to the human eye appears. The scanning mirrors typically have a diameter of about one millimeter and are manufactured from mono-crystalline silicon wafers with established processes in cost-effective lots in the microsystems technology clean room at Fraunhofer IPMS.

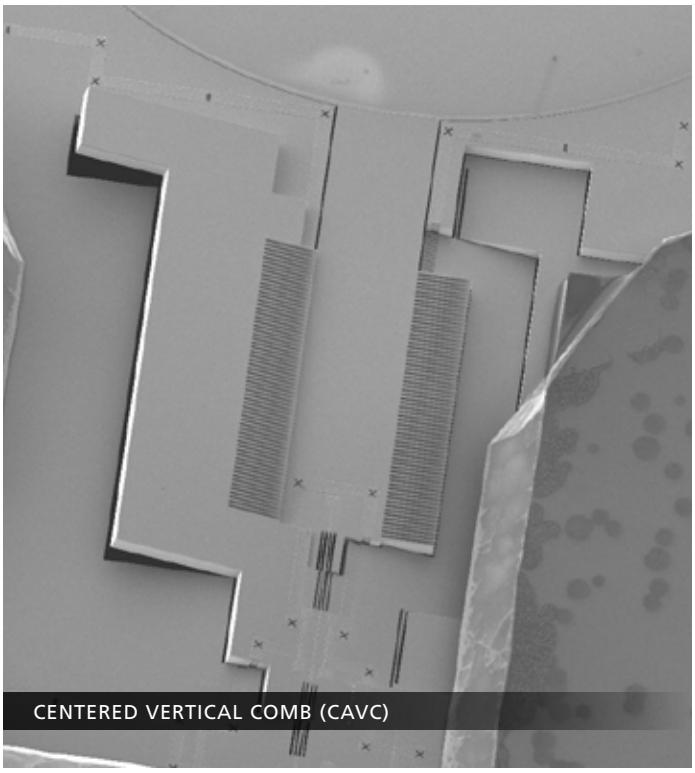
Fraunhofer IPMS utilizes an electrostatic actuator with comb-shaped electrodes for the necessary movement of the mirrors. It was easy to make one and two dimensional scanners with conventional planar structures (i.e. mirror, outer frame and actuator combs lay on one plane). As well suited the resonant scanners

Pico-Projectors: How do they work?

At the moment there are three technologies for pico-projectors being pursued worldwide: DLP™ (Digital Light Processing) from Texas Instruments, LCoS (Liquid Crystal on Silicon) and LBS (Laser Beam Steering). The first two follow about the same concept of image generation: One component with an identical number of single elements such as pixels in the image to be projected is illuminated by a light source (LED or laser). With DLP, individually controllable mirrors in micrometer dimension direct the light into or past the projection lens depending on position. Grey-scales are realized with time division multiplex. With LCoS, a liquid crystal layer reflects the desired amount of light depending on the locally applied voltage according to the image content. In both cases the size of the component is scaled with the number of image points to be projected. In order to achieve the dimension requirements of the end device manufacturers, compromises regarding resolution of commercially available systems had to be made. Furthermore, projection optics that make the pico-projector larger and heavier are necessary. In contrast, LBS uses a single, two-dimensional scanning mirror to project image point for image point at higher speeds, so that a cohesive image is created due to the slowness of the human eye. The size of the component is for the most part independent of the image resolution. The only suitable light sources are lasers. Because no projection optics are required, the result is a clear image regardless of the distance between the projector and the screen.

From this perspective it appears that it is easiest to use LBS to construct a high resolution pico-projector simultaneously small enough to integrate into a mobile phone, without changing its currently acceptable dimensions.

from Fraunhofer IPMS are for pico-projectors, there is nothing that can't be improved upon. For one thing, the resonating frequency is set, and changing the horizontal frequency, for example, is hardly possible. For another thing, the high scan frequencies bound to the double resonant principle are contrary to the trend toward increasing pixel counts in the projected image – right up to full HD.



CENTERED VERTICAL COMB (CAVC)

These disadvantages will be overcome with the new quasi-static scanner concept from Fraunhofer IPMS called LinScan, which makes the targeted alignment of the mirrors possible. This was accomplished without having to change the basic technology, so that our customers continue to profit from the seasoned manufacturing process. It is even sufficient to tilt the actuator combs toward each other permanently with a subsequent micro-assembly step, along with a small modification of the mechanical design. The Institute was able to show that a combination of resonant actuator on the quick horizontal axis and LinScan on the slower vertical axis is possible for a two-dimensional scanner like those necessary for pico-projectors. The laser beam can now make targeted jumps from line to line according to an externally configured frequency. Pico-projectors with a SVGA resolution (800 × 600) and higher will be easily practicable. LinScan is naturally suited to all applications

that demand the static alignment of a laser beam or scanning with variable frequencies. The LinScan technology is available to Fraunhofer IPMS customers for cooperative development projects effective immediately.

The LinScan concept was presented to the larger public for the first time at the end of January at the conference "MOEMS and Miniaturized Systems", which is part of the "Photonics West" in San Francisco, and won the "Best Student Paper Award".

FIVE QUESTIONS FOR DENIS JUNG

Fraunhofer IPMS: "First of all, congratulations for being chosen for the "Best Student Paper Award". How would you explain the special interest about quasi-static resonant scanner technology?"

Denis Jung: "LinScan makes large static angles of deflection in a continual scanning area on one of two optional scan axes possible, as well as linear scanning. Linear scanning makes a line by line image format with pico-projection displays possible, that construct an image for the human observers from a sequence of single pixels similar to a cathode ray tube. With LinScan the image resolution and contrast can be improved compared to existing scanners that work on the resonant principle. Because LinScan also uses an electrostatic actuator principle, the energy consumption is reduced to one thousandth compared to alternative electromagnetic operated components with the same level of performance."

"MEMS components like the LinScan scanning mirrors go through far more than a hundred process steps in the clean room. Who was involved in the development, and how long did your team take in order to reach the present state of development?"

"We started with the implementation of the first ideas five years ago. How many colleagues have contributed to the success of LinScan is hard to say. Component conception and the development of the manufacturing technology demand comprehensive know-how in modeling, industrial process and control, in conceptual planning, design, layout, in process development and processing, characterization and error analysis."

"When you are developing such complex components, setbacks are a part of the business. Which were the greatest challenges for you?"

"Businesses in tough competition with each other often shy away from investing in projects that often don't produce usable results for quite a few years, like LinScan. On the other hand, the funding for preliminary research is often unavailable. We accepted this challenge, and, for the first time, we now even offer individualized MEMS components and evaluation kits with short delivery times and at moderate prices on the internet. We want to expand this strategy and carry it over to other technologies"

Denis Jung has been a member of the research staff and project manager at Fraunhofer IPMS since 2006. The technology behind LinScan was the topic of his dissertation. As main author of his publication about the LinScan concept, he won this year's "Best Student Paper Award" at the "Photonics West" in San Francisco.

"Fraunhofer IPMS is even financed over 50 percent by customer commissions. What are the cooperational opportunities you offer for LinScan?"

"Our products range from the evaluation of initial test sample for customer applications, customer-specific component development, qualification and manufacturing, right up to systems integration and the development of complex total systems. The Fraunhofer approach is to support the customer with research, development and manufacturing wherever assistance is required or whenever the customer is unable to come up with resources himself."

"Let's finish with a look forward: What are your goals for the further market development of the LinScan technology?"

"As key components, LinScan has the potential to effect a change in the trend of portable high resolution displays. In order to do that, we want to find business partners quickly, who will transfer the LinScan technology over to the mass markets of head-up, head-mounted and ultra-compact portable laser projectors."

WIRELESS COMMUNICATION IN THE GIGABIT RANGE

Instruments for wireless data transfer are presently based almost exclusively on radio-based solutions like WLAN or Bluetooth, and at gross data rates of a few hundred Mbit/s, they are less and less able to fulfill the present demands for the fast transfer of data amounts. Fraunhofer IPMS has now developed a multi-gigabit communication module that utilizes infrared light for data transfer and supports data rates up to 3 Gbit/s. Cable connections such as USB or gigabit Ethernet could thus soon be replaced by wireless high speed connections.

In order to satisfy the growing demand for manageable, wireless communication interfaces in the multi-gigabit range, Fraunhofer IPMS has developed and successfully tested a communication module. It supports 512 Mbit/s and 1 Gbit/s Giga-IR compatible wireless communication and can be expanded to 3 Gbit/s. The module utilizes infrared light and can be operated in half or full-duplex mode. It is energy efficient and offers high net data rates as well as a reliable and robust data transfer.

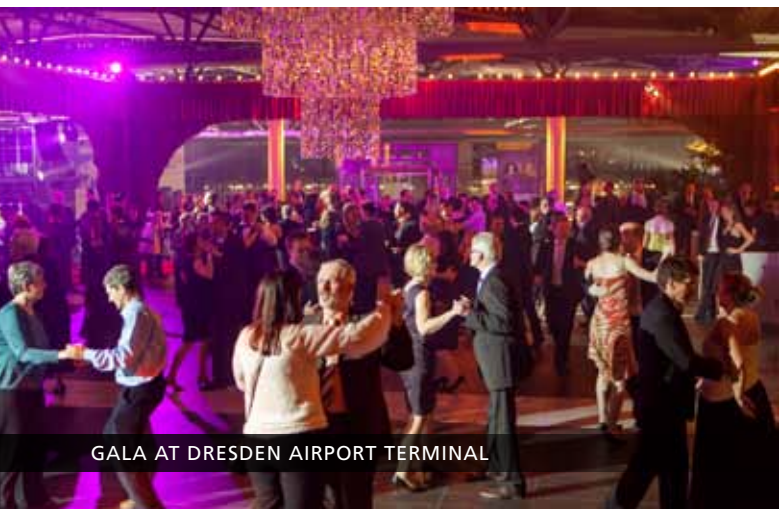
The wireless multi-gigabit communication module, along with hardware and software IP solutions, makes up a product development platform. This can be implemented in stand-alone controllers, protocol bridges or in multimedia system on chips (SoC). On the other hand, when these circuits are integrated into portable devices such as smart phones, tablets, cameras, notebooks or kiosk applications, the user is able to transfer data quickly and reliably, and is witness to a whole new communication experience.


WIRELESS MULTI-GIGABIT COMMUNICATION MODULE

Fraunhofer IPMS is a founding member of the Li-Fi Consortiums (www.lificonsortium.org), which is furthering this technology.

RESEARCH OF PRACTICAL UTILITY – 20 YEARS OF FRAUNHOFER IN DRESDEN

Exactly 20 years ago Fraunhofer opened its first location in Dresden – the Dresden branch of the Fraunhofer Institute for Microelectronic Circuits and Systems which later became Fraunhofer IPMS. This anniversary was celebrated by the employees of the now 12 Dresden Fraunhofer institutes and branches on March 2, 2012 together with the Fraunhofer Executive Board, the Minister-President of the Free State of Saxony, Dresden's Mayor for Economy and the rector of the Dresden University of Technology as part of a commemorative event which took place at the Dresden Airport Terminal.


GALA AT DRESDEN AIRPORT TERMINAL

The location at Dresden has developed into the largest Fraunhofer agglomeration over the past 20 years. A few examples of the success the Dresden Fraunhofer scientists have had are inventions like AutoTram®, laser technologies, OLED surface illumination or technology based upon MEMS mirror arrays for light exposure of photo masks in the semiconductor industry. The concept for success: Strong networking with the industry and close cooperation with the Dresden University of Technology.

Alongside its partners, funders, and advisors, Fraunhofer honored above all the accomplishments of its more than 1000 employees with this gala.

MOBILE AUTHENTICATION WITH RETINA SCANNING

The presently used authentication systems, such as passwords or PIN codes for example, have only limited security, because they can be lost, stolen, forged or spied on. It is the goal of the project "Mobile Authentication with Retina Scanning (MARS)", which was started on January 1, 2012, to increase the control security of access and access rights with an innovative mobile personal authentication process.

The project is founded upon the idea to make everyday use of a biometric user verification based upon a scan of his or her retina in a mobile device. For this, a scanning mirror is to be integrated into a mobile, personalized end-device, for example a mobile telephone, to make it possible to detect the identity of the user and collect information from the retina at the same time. With this technology it will be possible to communicate confidential information to the user without allowing third persons access to it.

PERSONAL AUTHENTICATION THROUGH RETINA SCANNING

Based upon the verified user identity, various applications can be carried out on the mobile device – from mobile banking through electronic mail, right up to access control of sensitive areas and critical infrastructures.

MARS is subsidized by the Federal Ministry of Education and Research (BMBF) within the programme "Research for Civil Security". There are seven businesses and two research institutes from five German Länder that belong to the consortium lead by Dr. Uwe Schelinski from the Fraunhofer IPMS.

UPCOMING EVENTS

Sensor und Test
Nuremberg, hall 12, booth 202 May 22 - 24. 2012

Optatec
Frankfurt, hall 3, booth D-50 May 22 - 25. 2012

SID Displayweek
Boston, USA June 3 - 8, 2012

Sensors Expo
Rosemont, USA, booth 320 June 6 - 7, 2012

Lange Nacht der Wissenschaften
Dresden July 6, 2012

Micromachine MEMS
Tokyo July 11 - 13, 2012

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

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