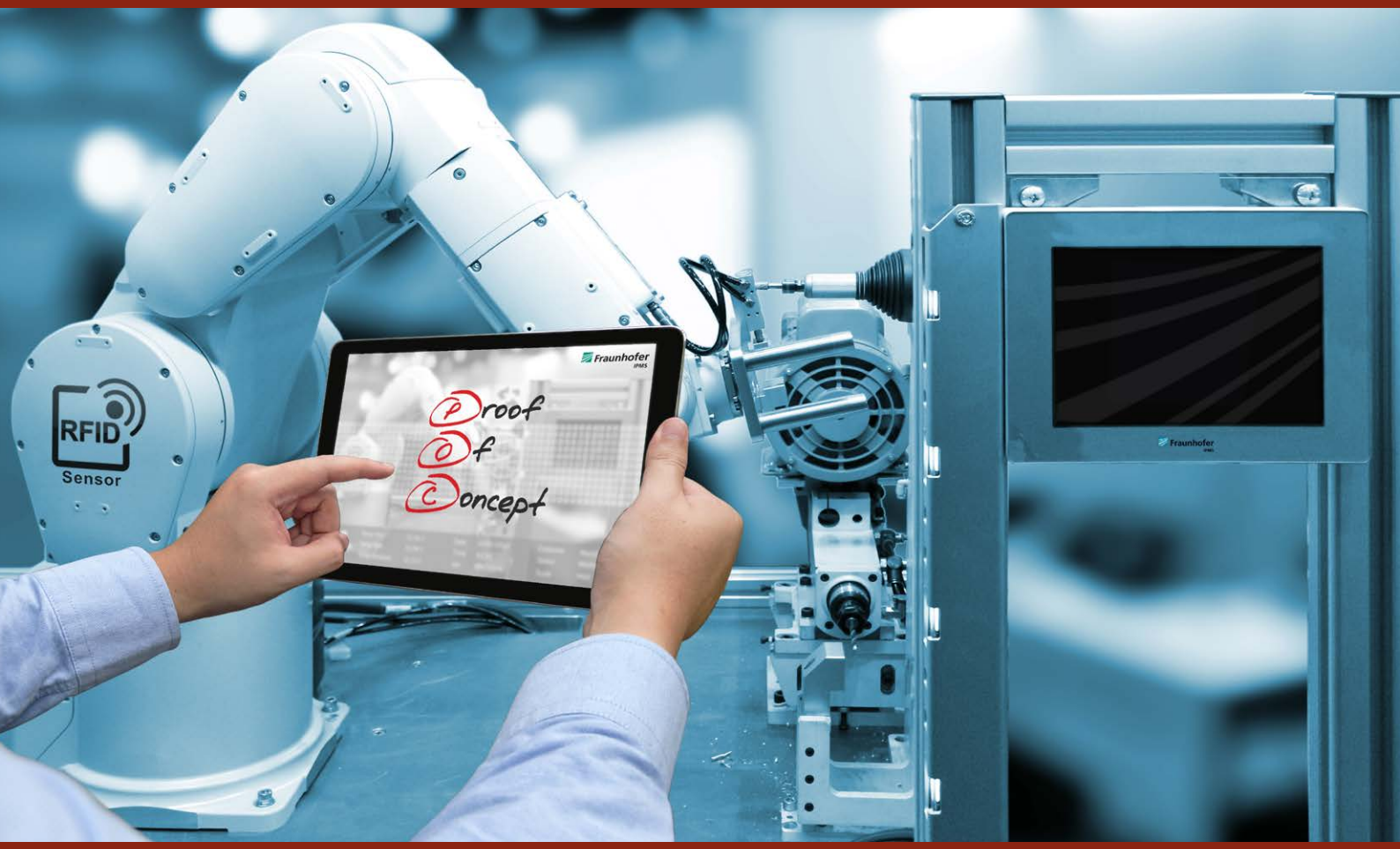
Fraunhofer
IPMS

FRAUNHOFER INSTITUTE FOR PHOTONIC MICROSYSTEMS IPMS

# MEMS REPORT

2 / 2017

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◄ Cover Picture: Fraunhofer IPMS provides customers a Proof of Concept for using RFID-based sensor nodes.

Dear Customers, Partners and Friends
of Fraunhofer IPMS,

The last few weeks have provided important events in respect to both the historical accomplishments and future development of the Fraunhofer IPMS. At the end of May, the Fraunhofer-Gesellschaft recognized 25 years of Fraunhofer in the new federal states with an anniversary celebration in Dresden. During this period, Dresden facilities have prominently participated in applied research and development in the fields of microelectronics and microsystems technology. Fraunhofer IMS Dresden was founded at the beginning of 1992 and later transformed into the independent Fraunhofer IPMS in 2003. Since then, we have more than quadrupled the volume of research and development, which impressively demonstrates the success of the institute.
The presentation on April 6, 2017 of the certificate of approval for the "Research Fab Microelectronics Germany" was a critical milestone for the further development of Fraunhofer IPMS. By 2020, the BMBF will provide more than 60 million euros of investment for the improvement of the two clean rooms. This commitment enables us, together with ten other Fraunhofer and two Leibniz partner institutes, to permanently secure our outstanding position in MEMS research and development and state-of-the-art microelectronic processes.
We wish you an informative reading of the current MEMS report.

Prof. Dr. Harald Schenk  Prof. Dr. Hubert Lakner

# THE "RESEARCH FAB MICROELECTRONICS GERMANY" GETS OFF THE GROUND

To reinforce the position of Europe's semiconductor and electronics industry within global competition, eleven institutes within the Fraunhofer Group for Microelectronics, including Fraunhofer IPMS, have, together with two institutes within the Leibniz community, come up with a concept for a cross-location research factory for microelectronics and nanoelectronics. The Federal Ministry of Education and Research (BMBF) is providing support with the necessary investment. On April 6, 2017, Education Minister Professor Johanna Wanka handed over the grant approvals – 280 million euros for Fraunhofer and 70 million euros for Leibniz.

For more than 20 years, the Fraunhofer institutes within the Group for Microelectronics and the Leibniz institutes have supported German industry with application-oriented research and development for high-tech products. In order to be able to offer even smaller companies top technology under optimum conditions, eleven Group institutes, as well as the Leibniz Institute for Innovative Microelectronics (IHP) in Frankfurt/Oder and the Ferdinand Braun Institute, Leibniz Institute for Maximum-frequency Technology (FBH), in Berlin will combine their technology research into a joint, cross-location technology pool called the "Research Fab Microelectronics Germany," and expand on it. The institutes' existing locations will be retained, while expansion and operation will be coordinated and organized in a shared business office. The aim is to be able to offer customers from large industry, small and medium enterprises, and universities the entire value chain for microelectronics and nanoelectronics in an uncomplicated manner and from a single supplier.

**Pooled expertise bundled in four technology parks – research and development across several locations for the first time**

The focus of the cross-institute work will lie on four future-relevant areas of technology – "Silicon-based technologies," "Compound semiconductors and special substrates," "Heterointegration,"

*From left to right: Prof. Matthias Kleiner (President Leibniz-Gemeinschaft), Prof. Bernd Tillack (Director Leibniz IHP), Dr. Reinhard Ploss (CEO Infineon AG), Prof. Johanna Wanka (Federal Minister of Education and Research), Prof. Reimund Neugebauer (President Fraunhofer-Gesellschaft), Prof. Hubert Lakner (Chairman Fraunhofer Group for Microelectronics and Director Fraunhofer IPMS), Prof. Günther Tränkle (Director Ferdinand-Braun-Institute, Leibniz FBH).*

and "Design, testing and reliability." Having a knowledge edge in these areas is one of the basic prerequisites for important areas of application and will provide Germany and Europe with the necessary clout among international competition. Thematically and logistically connected processes and infrastructures will be pooled, organized, and developed in each of these technology parks, as they will be known. This will allow the member institutes, together, to serve all areas of technology that are essential to the research, development, and (pilot) manufacture of microsystems and nanosystems – whether it is for information gathering and processing, telecommunications, or power electronics. New jobs will also be created: The Microelectronic Fab for Research Germany will represent a reorganization of more than 2000 scientists and the necessary equipment for technological research and development under a single, virtual roof. In the medium term, the measure is expected to create an additional 500 jobs for highly qualified candidates.

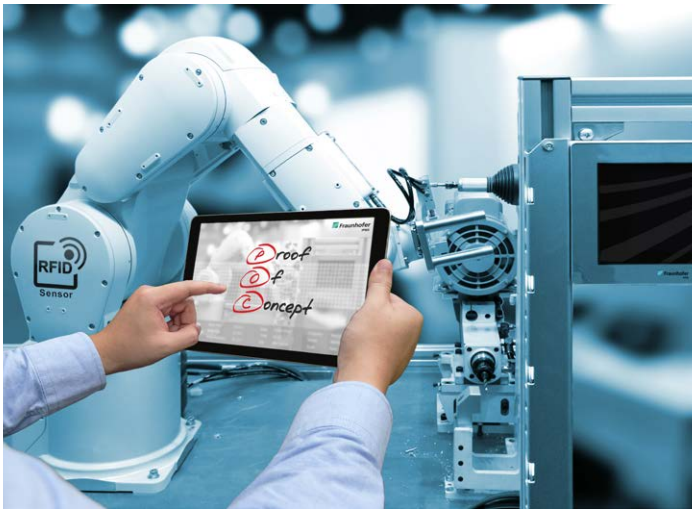
**Research for the future**

The funding from the Federal Ministry of Education and Research (BMBF) is a measure that accompanies the "Important Project of Common European Interest" (IPCEI) for microelectronics that has been applied for at the European level. The Federal Ministry for Economic Affairs and Energy intends to use this project to strengthen Germany's semiconductor industry for the next product generations. While the IPCEI is focused on expanding industrial production capacities, the Fraunhofer-Gesellschaft, in cooperation with the Leibniz Institutes IHP and FBH, will use the Research Fab Microelectronics Germany to provide the accompanying research and development. The activities will cover both contemporary topics such as FDSOI technology (Fully Depleted Silicon on Insulator) and power electronics and future themes such as creating the technological basis for the industrial use of quantum technologies, integration of functional blocks at the atomic level, developing systems for the terahertz range, continued reduction in power requirements, and the storage and transmission of huge quantities of data (petabytes).

The establishment of the Research Fab Microelectronics Germany will be a unique offering available to the German and European semiconductor and electronics industry. The cooperation of a total of 13 research institutes and more than 2000 scientists is already the world's largest pool for technologies and intellectual property rights within the area of smart systems. This new form of cooperation will make a major contribution to strengthening European industry's competitiveness internationally.

# WITH RFID SENSORS INTO THE CLOUD: FRAUNHOFER IPMS PROVIDES A PROOF OF CONCEPT FOR USING RFID-BASED SENSOR NODES

Increasingly more companies rely on RFID technology in industrial sensor networks to replace bulky sensor nodes of conventional battery-powered systems with compact, maintenance-free sensors. At the same time, there is the desire to automatically feed acquired logistics and production data into the web in order to be able to remotely organize complex production processes or to allocate resources in real time. With RFID evaluation kits and accompanying services, Fraunhofer IPMS provides customers a Proof of Concept as the perfect introduction to the use of RFID-based sensor nodes.




*Fraunhofer IPMS provides customers a Proof of Concept for using RFID-based sensor nodes.*

Whether in production to detect machine or product conditions, in environmental engineering or in the mining industry, intelligent wireless sensor networks consisting of numerous sensor nodes and a reliable power supply are prerequisite for the comprehensive and profitable monitoring and remote control of industrial plants. Passive RFID sensors are ideal because they measure and transmit physical quantities of any kind without contact and, since they use the electromagnetic field of a separate reader as a source of energy, don't need an electrical power supply of their own. With a practically unlimited useful life, RFID sensors are maintenance-free and can therefore be placed in hard-to-reach and inaccessible areas.

But, do RFID transponders also work in special applications? Is data then automatically available for further use in corporate networks or Internet applications? To find out, the sensor system, the electronic circuit and the antenna geometry of the RFID sensor nodes must be adapted to the individual needs, application scenarios and environmental parameters of each customer. Furthermore, new RFID components must be successfully integrated into the existing or planned process environments. Fraunhofer IPMS provides its customers feasibility study services as well as advanced development services in the fields of RF simulation, antenna design, RF mixed signal ASIC design, sensor integration, reader implementation, system integration and qualification.

"Our Proof of Concept uses evaluation kits with commercial and proprietary RFID transponder ASICs for different frequency ranges. Thanks to a flexible interface concept for external sensors, we are able to integrate analog and digital sensors. This means that our sensor nodes have a modular design and can be equipped with any sensors, depending on the requirements of our customers." explains Dr. Frank Deicke, head of the Fraunhofer IPMS development team. "In addition, our evaluation kits contain a software solution, the so-called RFID OPC UA AutoID server (ROAD server), as middleware. The ROAD server appropriately converts the OPC UA AutoID Companion specification for RFID components, thereby enabling manufacturer-independent, standard-compliant communication for industrial automation. In this way, any reader, identification or sensor transponder produced by different manufacturers and operating across the various frequency ranges (LF, HF, UHF and NFC) can be uniformly addressed."

Based on this uniform basic framework, Fraunhofer IPMS supports the design and implementation of individual software solutions in order to analyze and evaluate large amounts of data generated during long-term measurements. This includes easy-to-use solutions for data acquisition, the development of customer-specific applications for mobile operating systems, the integration of data acquisition and control systems in industrial environments as well as professional cloud applications. Fraunhofer IPMS developers have presented various sensor-equipped RFID evaluation kits at the 2017 SENSOR+TEST Measurement Fair in Nuremberg in the special "Networked Measurement Technology for Mobile Applications" forum.

## A NIGHT TO SHARE KNOWLEDGE – FRAUNHOFER IPMS PRESENTED AT 15TH ANNUAL "LONG NIGHT OF SCIENCES" EVENT IN DRESDEN

In support of the 15th annual "Long Night of Sciences" event in Dresden held on June 16, 2017, universities, colleges, research facilities and science-oriented companies in Dresden once again opened lecture halls, laboratories and archives to provide the public a chance to discover behind-the-scenes scientific and research activity and development.
Fraunhofer IPMS accepted the invitation to present its latest developments in microsystems and nanotechnologies between 6.00 pm and 1.00 am in the central lecture hall of the TU Dresden. We are extremely pleased to have been able to answer the questions and satisfy the curiosity of young, old, beginner and expert visitors alike while perfectly positioning our excellent scientific location in Dresden at this year's event.

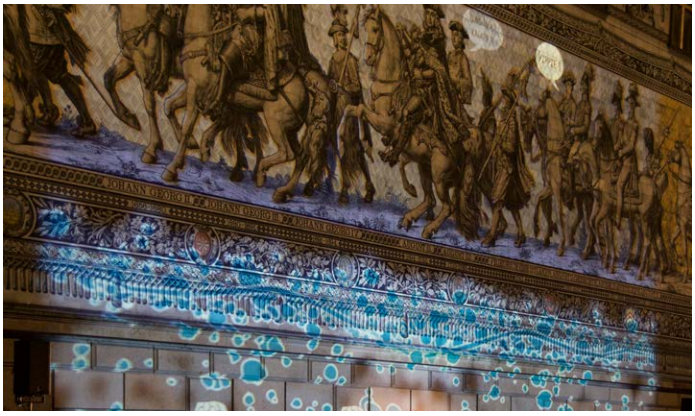
*More than 3000 people attended the central lecture hall of TU Dresden.*

## FRAUNHOFER-GESELLSCHAFT CELEBRATED 25TH ANNIVERSARY OF APPLIED RESEARCH IN THE NEW FEDERAL STATES

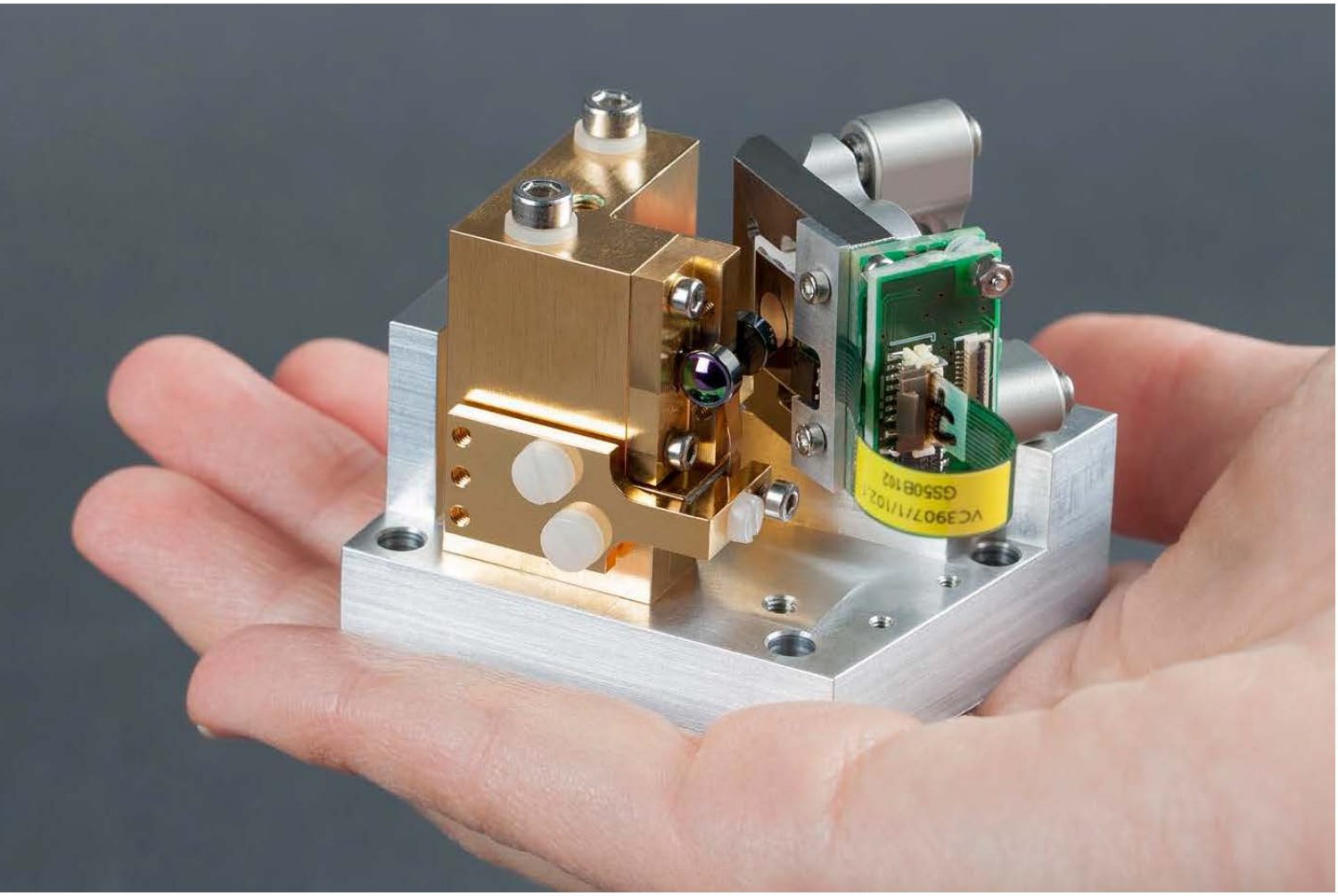
As an innovative research partner, future-oriented employer and a technological, economic and social impetus, the Fraunhofer-Gesellschaft has played a decisive role as a driver of progress in the new federal states for 25 years now. Special events surrounding this particular anniversary honored the unique history of the Fraunhofer-Gesellschaft as well as celebrated the distinguished achievements of both Fraunhofer institutions and facilities located in the region.

From May 29-31, 2017, celebrations marking the 25th anniversary highlighting Fraunhofer research in the new federal states featured the modern and innovative "#real_digital: creating values together" interactive exhibition. The 16 Fraunhofer institutes from the new federal states also presented themselves, their history and their milestones as well as introduced further topics of interest and future projects. In addition, Fraunhofer hosted a large event open to the public. An interactive "experience route" through the inner city informed visitors about research history as well as current networking and innovation topics amid the setting of Dresden "old town". Under the motto "Living and experiencing research – how science changed the world", light and laser projections illuminated the facades of selected buildings to create scenes in which theater actors brought the historical background of Dresden as well as relevant research topics and the science of Fraunhofer to life.

*Exhibition opening "#real_digital: Creating values together".*


*At the public event Dresden´s famous Fürstenzug was also highlighted.*

## PILOT LINE FOR TAILOR-MADE SPECTROSCOPY SOLUTIONS



Every chemical substance absorbs a very individual fraction of infrared light. Like a human fingerprint, this absorption can be used with optical methods for identifying substances. Such methods are used in the chemical industry, for example, but also in the health sector or in criminal investigation. If a company plans a new project, it often needs individually tailored sensor solutions. In the search for a suitable system, they are now supported by the EU-funded pilot line MIRPHAB (Mid InfraRed PHotonics devices fABrication for chemical sensing and spectroscopic applications) for the development of sensor technology and measurement technology in mid-infrared (MIR).

If a company is looking for a sensor solution, such as to identify a certain substance in the production process, it often has very individual requirements. This starts with the substances to be accounted for to the number of required sensors up to the speed of the production process. In most cases, a »one-size-fits-all« solution is not sufficient, and several suppliers are needed in order to develop the optimal individual solution. This is where MIRPHAB comes in: In the pilot line, leading European research institutes and companies from the MIR environment have joined forces to provide customers with tailor-made offers from a single source. Interested parties can address a central contact person, who then compiles the best possible solution from the component portfolio of the MIRPHAB members according to the modular principle.

In order to strengthen the European industry in the long term and expand its leading position in chemical analysis and sensor technology, the development of the individual MIR sensor solutions within the framework of MIRPHAB is supported by EU funding. This

significantly reduces the investment costs and, thereby, the entry threshold for companies in the MIR area. In combination with the virtual infrastructure which has been developed in the course of MIRPHAB, high-quality MIR sensor solutions are therefore also of interest to companies for whom the costs and development efforts have previously been seen as being too high. In addition, MIRPHAB gives companies access to the latest technologies, enabling them to gain an edge over the competition as an early adopter.

**Customized MIR Laser Source**

A central component of the MIRPHAB sensor solutions is being provided by the Fraunhofer Institute for Applied Solid State Physics IAF in Freiburg in cooperation with the Fraunhofer Institute for Photonic Microsystems IPMS in Dresden. The Fraunhofer IAF is introducing the technology of quantum cascade lasers, which emit laser light in the MIR range. In this type of laser, the wavelength range in which the light is emitted is spectrally very broad and can be customized during manufacturing. In order to select a specific wavelength within the wide spectral range, it has to be chosen via an optical diffraction grating and coupled back into the laser chip. By rotating the grating, the wavelength can be tuned continuously. The grating is produced at the Fraunhofer IPMS in miniaturized form in so-called Micro-Electro-Mechanical-System (MEMS) technology. This makes it possible to oscillate the grating at a frequency of up to one kilohertz and to thereby tune the wavelength of the laser source up to a thousand times per second over a very wide spectral range.

The Fraunhofer Institute for Production Technology IPT in Aachen is also involved in MIRPHAB in order to make the production of lasers and gratings more efficient and to optimize them for pilot series production. With its expertise, it transforms the production of the rapidly-tunable MIR laser into industrially applicable production processes.

**Process Analysis in Real Time**

At present, numerous applications in the field of spectroscopy are still in the visible or near infrared range and use relatively weak light sources. MIRPHAB offers solutions based on infrared semi-conductor lasers. These have a significantly higher light intensity, thereby enabling completely new applications. As a result, up to 1000 spectra per second can be recorded with the MIR laser source, which, for example, enables the automated monitoring and control of chemical reactions and biotechnological processes in real time. MIRPHAB is therefore making an important contribution to the factory of the future and Industrie 4.0.

## UPCOMING EVENTS

**Sensors Expo & Conference**
San Jose, CA, USA June 28 - 29, 2017
McEnery Convention Center, Booth 535

**SEMICON West**
San Francisco, CA, USA July 11 - 13, 2017
Moscone Center

**European MEMS & Sensors Summit**
Grenoble, France September 20 - 22, 2017
MINATEC Innovation Campus, Booth 23

**RFID tomorrow**
Düsseldorf, Germany September 27 - 28, 2017
Van der Valk Airporthotel

**MikroSystemTechnik Kongress**
Munich, Germany October 23 - 25, 2017
Hotel INFINITY Unterschleißheim

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

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**PUBLISHING NOTES**

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