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MEMBERSHIP OF MICROTEC SÜDWEST CLUSTER

The Fraunhofer IPMS has been a member of the technology cluster microTEC Südwest since January 1, 2017. In the growth-oriented field of microsystem technology, microTEC Südwest with its over 360 cluster partners is one of the largest technology networks in Europe. In countless fields of application, microsystem technology is a key technology for creating the conditions for intelligent products, processes and services. The highly innovative products developed in the cluster have an effect on a vast variety of user industries.

WORKSHOP: HIGH-PERFORMANCE CENTER “FUNCTIONAL INTEGRATION FOR MICRO-/NANOELECTRONICS”

After one year of operation, the projects and results achieved so far within the High-Performance Center “Functional Integration for Micro-/Nanoelectronics” were presented for the first time in a workshop on February 2, 2017. In the following conversations the implementations in industry and further requirements were discussed by the participants. Fraunhofer IPMS, ENAS, IIS and IZM have joined the Technical Universities of Dresden and Chemnitz as well as the Dresden University of Applied Sciences in the High-Performance Center. In close cooperation with local companies, the partners set out to deepen research expertise and speed up innovation implementation in applications and products in order to strengthen the region.
INTELLIGENT STORAGE BINS USING RFID-BASED WEIGHING AND PICK-BY-LIGHT SOLUTIONS SIMPLIFY PICKING PROCESS

Fraunhofer IPMS came up with a new, RFID-based pick-by-light application solution for efficient and secure picking. The Dresden based research institute has developed an intelligent storage bin that can be identified and controlled by RFID technology which operates without needing its own power supply. In addition, a weighing sensor integrated into the bottom of the bin automatically records any material removal and provides notification for refilling.

So-called “pick-by-light” solutions have been established in order to optimize picking and assembling processes, thereby making intricate and unclear pack-lists in paper form obsolete. A signal lamp located directly on the storage bin indicates which article a warehouse worker must take when filling a commissioning order and a receipt button confirms that the correct article has indeed been picked up. There are many obvious advantages to this method. Personnel responsible for filling orders are guided step by step and steered quickly and clearly by light signals designating correct pick-up locations. There is no need for supplemental lists and there are no documents to carry or fill in. Search time can be dramatically reduced and the speed at which items can be picked up therefore substantially increased. However, until now, pick-by-light systems have been predominantly cable-connected and retrofitting individual storage bins has been cumbersome and cost-intensive.

Fraunhofer proposes an alternative solution using radio-frequency identification (RFID) technology. Research Manager Prof. Dirk Reichelt explains, “RFID tags wirelessly capture the energy required for their operation from the radiated electromagnetic field of the RFID reader. They are maintenance-free and have an almost unlimited lifetime. The advantage of using passive, i.e. battery-free RFID sensors is that cables or batteries are not required for retrofitting a bin”. In the Fraunhofer IPMS solution, for example, warehouse storage or stacking bins are equipped with passive RFID tags. These “intelligent” containers can be unequivocally identified and precisely controlled. Integrated on the RFID tag, an LED indicates the correct pick-up bin by lighting it up. At the same time, an integrated RFID weighing sensor determines the weight and material stock on-hand and, if necessary, initiates a refilling process thereby eliminating the need for material withdrawal confirmation and the manual inventory of current stock.

RFID sensor development for intelligent storage bins is just part of the complete range of RFID services offered by Fraunhofer IPMS. Comprehensive services begin with an initial individual consultation on RFID applications, followed by the development of RFID circuits with an integrated sensor-bridge to allow for the connection of almost any sensor, and the installation of hardware for sensor transponders as well as their individual adaptations to specific application scenarios. Services are completed with final bonding into existing software systems with integrated data analysis and process control. The Fraunhofer IPMS research institute provides customer evaluation kits which allow clients to test the benefits of its RFID sensor technology for a wide range of applications.

The institute introduced its pick-by-light solution at the 2017 LogiMAT international trade fair for distribution, materials handling and information flow to expert audience. Fraunhofer IPMS also present scenarios with exemplary process procedures in production, material flow and logistics. Here, the various, single steps of how moving objects are tracked with AutoID technologies as well as sensors were demonstrated.
The Fraunhofer IPMS developed Li-Fi communications modules meant to expand or replace existing company data networks. The point-to multi-point-capable optical technology combines the speed, stability and security of wired infrastructures with the flexibility and cost advantages provided by wireless radio solutions.

Increasingly more companies are looking to expand or completely replace wired local area networks (LANs) with wireless data networks. Integrating transmission and reception modules (access points) into existing network structure is considerably more cost effective than connecting computers with cables. Easily integrated into the network, these modules make employees more flexible and mobile as they are able to quickly access the Internet as well as real-time corporate data from anywhere in the company.

Currently available wireless (WiFi) solutions, however, cannot meet all expectations. Susceptible to interference, wireless data transmission is less stable and slower when compared to cabled solutions, particularly in situations where transmission speed is impacted because multiple users must share a common radio cell. More importantly, WiFi networks are vulnerable with even encrypted networks being relatively simple for experts to crack. Hackers can, for example, spy on passwords and login information from wireless transmission packets. In cases of damage, companies are solely responsible for their own WiFi network and must bear the corresponding costs.

The optical wireless communication developed at Fraunhofer IPMS is quite different. Fraunhofer Development Leader Dr. Alexander Noack explains, “Our solution uses light in the infrared range as a wireless transmission medium. While physical obstacles such as thick walls only weaken radio signal performance allowing attackers to gain sensitive company data via a receiver within range of the radio signal, our Li-Fi network provides security against hacking attacks even in closed rooms.”

Not only is the Fraunhofer IPMS communications technology safer than radio transmission techniques, it also needs only 15 percent of the energy required by conventional wireless technologies per transmitted user data byte and is up to 10 times faster thanks to a data rate of 1 Gigabit per second at insignificant bit error rates (<10^-9). It is therefore particularly suitable for all areas of application in which large amounts of data must be transmitted practically in real time. The Fraunhofer IPMS team was also able to eliminate a widespread weak spot in Li-Fi technology. Dr. Noack: “Until now, it was not possible for several users to operate in the same spot due to inter-module interferences within the same link. Our technology now allows for point-to-multi-point communication. We can, for example, integrate meeting rooms into a corporate network to provide multiple notebooks simultaneous access.”

Fraunhofer IPMS offers a Li-Fi HotSpot as a prototype for optical wireless communication for distances up to 10 meters. For smaller distances the so-called "GigaDock" technology can be used. With bandwidths of up to 12.5 Gigabits per second, the real-time technology aims to supplement or replace stationary cable connections in highly automated production environments. The driverless send and receive module combines an optical transceiver and a protocol controller with a Gigabit-Ethernet interface, making for easy integration into company networks. Li-Fi HotSpot and Li-Fi GigaDock are available as customer evaluation kits.
Holger Conrad of the Fraunhofer IPMS has been honored with the German Federal Ministry for Education and Research (BMBF) VIP/VIP+ validation award. He was distinguished for the development of electrostatically bimorph-deflectable microactuators within the “Nano e-drive” research project.

Researcher Holger Conrad of the Fraunhofer IPMS in Dresden took first place in the VIP/VIP+ Validation Prize 2017 awarded by the BMBF for his research results in the “Nano e-drive” project. The award was presented by Parliamentary State Secretary Stefan Müller in Berlin on February 1, 2017 within the framework of the Innovation Conference on the “Validation of the Social and Technological Potential of Scientific Research” (VIP/VIP+).

Launched in 2012 in close collaboration between the Fraunhofer IPMS and the BTU Cottbus-Senftenberg, the “Nano e-drive” project was carried out by the Fraunhofer MESYS (Mesoscopic Actuators and Systems) Research Group. Under the leadership of Prof. Dr. Harald Schenk, Institute Director of Fraunhofer IPMS and Professor of Micro- and Nanosystems at BTU, a total of eight scientists at locations in Dresden and Cottbus are working on new electrostatic microactuators – so-called nanoscopic electrostatic drives (NED).

Microactuators are found in a large number of applications and systems such as the smartphone, wearable cars, implantable insulin pumps and pico-projectors. Today, highly-miniaturized electromechanical systems with actively movable components (MEMS) provide the technological basis of countless applications in optics, communication and biotechnology as well as measurement and medical technology. Electrostatic fields are frequently used to drive the actuators. However, currently established drive mechanisms repeatedly reach their physical or technical limits.

The new approach provides the possibility to bypass the pull-in effect of conventional electrostatic actuators or to move them into an area which is no longer relevant for actuation. The quasi-static deflections of such actuators can therefore be significantly greater than electrode spacing currently permits. Holger Conrad explains: “With the new principle, highly integrated and miniaturized actuators can be produced with semiconductors-compatible manufacturing technologies. We are thus able to manufacture electrostatic actuators with extremely small electrode distances, which are far superior to competing drive mechanisms.” The novel actuators are impressive, with a low electrical drive voltage, little energy consumption and short reaction times. In addition, they are CMOS- and RoHS-compatible which, in combination with the easy integration into standard silicon processes, enables cost-effective volume production providing a real alternative to piezoelectric actuators for the first time.

Within the scope of BMBF funding, scientists were able to develop the complete manufacturing chain and process technology for the new actuator principle. The theory of the actuators was validated as highly successful. Results were transferred into a first demonstrator and first sample applications to prove the technical feasibility. Application areas are extremely diverse. The use of the new actuators in micropumps, microvalves and loudspeakers, as well as zoom and image stabilization systems for smartphones is currently being investigated.

The new actuator class developed by MESYS has been patented and was introduced at the end of 2015 in renowned “Nature” magazine. The “Nano e-drive” project was funded by the BMBF in the period from September 1, 2012 to December 31, 2015 (promotion code: 03V0297).
Operating cable-connected or battery-powered measurement systems in hard-to-reach installation locations and challenging environments often poses safety concerns, is too complex or downright impossible. Radio frequency identification (RFID) sensors make the wireless, maintenance-free measurement of temperature and other physical parameters in such situations possible. Experts at Fraunhofer IPMS have developed a flexible, multi-tag RFID sensors system concept to monitor machines in industrial environments and that has also been tested in metal environments.

Whether implemented in production to detect both machine and product conditions, in environmental engineering or in mining, RFID sensors wirelessly measure and transfer all kinds of physical quantities. RFID sensors successfully operate in difficult-to-access or fast, rotating environments in which other measuring devices fail. RFID tags fitted with sensors use the electromagnetic field of a reader as their source of energy and are therefore maintenance-free, because they don’t have their own power supply.

The flexible RFID monitoring system developed at Fraunhofer IPMS measures and evaluates application-specific parameters in order to determine, for example, the risk of plant failures. In concrete application, this allows for the decrease of maintenance and downtimes and the increase of plant availability.

Sensor transponder development is just part of the complete range of RFID services offered by Fraunhofer IPMS. Comprehensive services begin with an initial individual consultation on RFID applications, followed by the development of RFID circuits with an integrated sensor-bridge to allow for the connection of almost any sensor and the installation of hardware for sensor transponders as well as their individual adaptations to specific application scenarios. Services are completed with final integration into existing software systems including data analysis, process control and cloud applications. Fraunhofer IPMS development team leader, Dr. Andreas Weder explains: “Recent testing has shown that our system also works reliably when integrated in permanent installations in metal environments. In addition, the current version is multi-tag-capable at a distance of up to two meters, making it possible to record several sensor tags simultaneously.”

The Fraunhofer IPMS ROAD-server RFID middleware is also part of the system. Dr. Weder continues, “RFID components sometimes differ too much according to manufacturer, frequency band, protocol, interface and sensor and cannot be combined with one another. Our ROAD-server makes it possible to address any reader as well as any identification- or sensor-transponder from different manufacturers in the LF, HF, UHF and NFC frequency ranges via a common OPC UA interface, allowing them to be easily integrated into production processes.”

The Institute offers customers evaluation kits so that they may test the benefits of Fraunhofer IPMS RFID sensor technology for a wide variety of application fields.
**MICRO ENERGY HARVESTING FOR INTEGRATED CHIP SYSTEMS**

The Fraunhofer IPMS is starting the two-year CONSIVA research project focusing on the development of micro-energy harvesters for self-sustaining, integrated chip systems. The use of novel piezoelectric materials in vibration-based harvesters can drastically reduce their size and significantly prolong operation time. This paves the way for the utilization of previously unachievable medical implants and increasingly small, wireless sensor systems.

Energy harvesters can supply self-sustaining microsystems by collecting small amounts of energy from sources such as ambient temperature, light irradiation or vibration. Vibration-based harvesters, in particular, convert existing kinetic energy from the environment into electrical energy. Piezoelectric materials are especially suitable for the development of vibration-based harvesters by the direct mechanical-electrical conversion principle.

In the CONSIVA research project, the piezoelectric coefficient and the application potential of hafnium dioxide thin layers are to be evaluated at the Fraunhofer IPMS Center Nanoelectronic Technologies (CNT). This material has ferroelectric and therefore piezoelectric properties and is qualified in microelectronics. Due to its high dielectric constant, it is already used in modern field-effect transistors. In addition to the material development and the electromechanical characterization of active test structures, a harvester layout adapted to hafnium dioxide is to be conceptualized at the CNT. On the basis of these designs, Fraunhofer scientists want to illustrate new, concrete application scenarios for micro-energy harvesting. Dr. Wenke Weinreich, group leader at Fraunhofer IPMS-CNT explains, “Over the past few years, we have been able to gain extensive experience with the manufacturing, integration and optimization of ferroelectric hafnium dioxide for the most up-to-date storage applications. We see great potential to successfully use these experiences, especially in the field of energy harvesting. Thanks to these novel piezoelectric materials, we can decisively advance the miniaturization of vibration-based harvesters.”

The fields of application for energy-efficient microsystems are mainly found in medical and wireless sensor technology. The findings from the implementation of micro-energy harvesting technology can also be transferred to other fields of application in the Internet of Things (IoT).

The CONSIVA project is funded by the Development Bank of Saxony SAB (project number 100273858).

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**UPCOMING EVENTS**

**Photonix**
Tokio, Japan
April 5 - 7, 2017
Tokyo Big Sight East, Booth 47-6

**SENSOR+TEST**
Nuremberg, Germany
May 30 - June 1, 2017
Nuremberg Exhibition Centre, Hall 5, Booth 248

**LASER**
Munich, Germany
June 26 - 29, 2017
Munich Exhibition Center, Hall B3, Booth 327

**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

[www.ipms.fraunhofer.de/en/events.html](http://www.ipms.fraunhofer.de/en/events.html)

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