SEMICON EUROPA OCT 25–27, 2016 GRENOBLE, FRANCE CONNECT

Fraunhofer

Towards Zero Power – Smart Systems Make All the Difference

J. Pelka
Managing Director
Fraunhofer Group for Microelectronics, Berlin, Germany

Fraunhofer MIKROELEKTRONIK

Abstract
Micro-/nanoelectronics and MEMS have become the most important key enabling technologies for all branches. Sensors, actuators and electronic signal processing are used everywhere. Communication has become an important part of daily life, and a dramatic increase in machine-to-machine communication is expected by introduction of “industry 4.0”. However, power consumption of information technologies is now becoming a major issue in a world where an upcoming shortage of resources is expected and sustainability has become a need. Fraunhofer Microelectronics has just decided to focus its strategy on this power issue and to concentrate research and development efforts on the reduction of energy consumption. Combining the technological expertise of the 18 member institutes, the development of smart systems with ultra-low power consumption and energy harvesting as well as of highly efficient power electronics will help to solve the power issue, one of the major societal challenges of today.

Biografie
Dr. Joachim Pelka is the Managing Director of the business office for the Fraunhofer Group for Microelectronics. He studied electrical engineering, with an emphasis on semiconductor technology, at Berlin's Technical University and was awarded a doctorate there for his work on semiconductor components. He has been with the Fraunhofer-Gesellschaft since 1983.
Today, following many years in the organization, Dr. Pelka is the Managing Director of the Fraunhofer Group for Microelectronics. His previous position was as the Fraunhofer ISIT's department head responsible for the simulation of semiconductor patterning processes. He also spent two years in the JESSI coordination office (also located at the ISIT). As managing director he is responsible for strategic planning and for the coordination of work in the microelectronic institutes of the Fraunhofer-Gesellschaft.
Under his directorship, the business office carries out studies on current areas of research that form the basis for the Group's strategic planning. In the past, this included for example the “MST fireside chats”, a series of workshops conducted on behalf of the project sponsor, Mikrosystemtechnik VDI/VDE IT and a study concerning road mapping activities of microelectronics on behalf of the CATRENE Scientific Committee.
In keeping with deepening European integration, Dr. Pelka today functions more and more as a contact person for other European research facilities such as CEA-Leti, CSEM, IMEC and VTT. He represents the Group, complementing the Chairman of the Group, in the Heterogeneous

Technology Alliance HTA. He is also involved in the AENEAS Management Committee and Scientific Council.

CMOS Integrated Microsystems: A Cost Efficient Basis for Smart Systems

A. Goehlich
Head of the Department CMOS and Microsystem Technology
Fraunhofer Institute for Microelectronic Circuits and Systems IMS, Duisburg, Germany

Abstract
In view of the upcoming challenges and opportunities of the internet of things (IoT), the industry 4.0 and the social challenges as the aging society an increasing number and diversity of sensors and actors will be used in future in electronic smart systems. These will require suitable cost effective and flexible technological platforms.
CMOS-integrated microsystems can be the perfect basis for such future applications, connecting intelligence to functionality.

The monolithic integration of micro- or nanostructures i.e. MEMS or NEMS (micro/nano-electromechanical systems) on pre-processed CMOS-substrates is a promising approach for the next generation of intelligent sensors and actuators. Post-CMOS-processing allows the 3D-integration of sensors and actuators on top of the read-out circuitry thus enabling a considerable reduction of chip area. The decoupling of the complex manufacture of the CMOS-substrate from the processing of the functional MEMS/NEMS-device allows to concentrate the development efforts on the functionality. In this way short and cost effective development cycles for new sensors and actuators are made possible.

In the Fraunhofer Alliance Microelectronics a multitude of complementary competences of different institutes is bundled, that target to the integration of MEMS and NEMS on intelligent CMOS-substrates as a technological platform for the next generation of sensors and actors.

Some examples of ongoing technology developments are presented that cover different applications such as sensors for industrial application in harsh environment, integrated energy harvesters, CMOS-integrated optical devices and integrated nanostructures on CMOS.

Biografie
to be continued

III-V Semiconductor Devices – Full Potential to be Unleashed by Heterogeneous Integration

J. Wagner
Deputy Director
Fraunhofer Institute for Applied Solid State Physics IAF, Freiburg, Germany

Abstract
III-V compound semiconductors offer unique physical properties which allow to realize electronic and also optoelectronic devices with properties far superior to those of their silicon based counterparts. This includes ultra-high-frequency (up to almost 1 THz) low-noise amplifiers, high-power broadband amplifiers and switches, high-efficiency light emitters as well as MEMS devices exploiting the piezoelectric properties of certain III-V materials.

On the other hand, processing technology for III-V materials is less advanced than for e.g. silicon CMOS and, furthermore, the maximum wafer size of III-V substrates is limited to 6 inch the most. To combine III-V technologies and devices with e.g. silicon CMOS, heterogeneous integration is an attractive approach.

Here we present examples of the integration of GaN-based power electronics with silicon, either by direct growth of GaN on silicon or by heterogeneous integration via transfer printing of GaN power transistor chips onto silicon. Furthermore, we report on high-performance mm-wave Radar modules based on metamorphic GaInAs high-electron-mobility transistors (HEMTs) and a 3D mm-wave MIMO camera based thereon. This mm-wave Radar technology will benefit greatly from advanced heterogeneous integration concepts, which will allow to integrate GaN-based transmitter with GaInAs receiver chips onto silicon in order to reduce size, weight and also cost. As a third example we will report on the integration of InP-based quantum cascade lasers with silicon-based optical MEMS scanning gratings, which allows the realization of a compact and fast scanning MIR laser source for spectroscopic sensing, diagnostics and process analysis.

Biografie
Joachim Wagner received the Ph.D. degree in physics from the University in Stuttgart, Germany, in 1982. From 1982 to 1984 he worked at the “Max-Planck-Institut für Festkörperforschung”, Stuttgart, Germany, in the group of Prof. M. Cardona before joining the Fraunhofer-Institute for Applied Solid State Physics, Freiburg, Germany, in 1985. There he is currently Deputy Director and Division Director, responsible for the institute´s business units. He is also Professor at the Institute of Physics of the University of Freiburg and an associated member of the Materials Research Center Freiburg (FMF). His current research interests include III/V-semiconductor based optoelectronic devices in particular for the infrared spectral range, as well as their integration into modules and sensing systems. He is author or coauthor of 470 scientific publications including several review papers and book chapters.

Smart Systems as Enabler for Industrie 4.0 and Internet of Things

H. Lakner
Executive Director
Fraunhofer Institute for Photonic Microsystems
IPMS, Dresden, Germany

Abstract
Internet of Things and Industrie 4.0 are current megatrends that promise enormous chances for the European industry, especially for markets like plant construction and engineering, automotive, electronics industry and industrial automation. Besides intelligent software, optimized hardware components are required so that the digital transformation of the industry becomes a success and competitiveness of the European industry can be ensured. Electronic data and signal processing by cyber physical systems requires an interface to the real world. Micro Electromechanical Systems (MEMS) comprising the sensory element as well as read-out and driving circuitry, realized as ASIC, are already widely established in certain markets like automotive and consumer industry. However, they are also of great importance for Industrie 4.0. They collect physical or chemical information via the sensing element, the electronics transforms the signal into a usable form and by means of analog and digital interfaces information is transferred to the central processing unit. Applications in the field of Internet of Things and Industrie 4.0 often have special requirements like low energy consumption and monolithic integration of all functionality in order to minimize costs. Here, additional research and development is necessary to provide solutions that meet those demands. Systems to be used for Industrie 4.0 shall typically act autonomously. Hence, a wireless data transmission is preferred. Since power consumption of the entire system is dominated by RF transmission, alternative solutions are sought. One promising candidate is optical wireless transmission which achieves much higher bandwidth than RF modules. Sending a given amount of data from a sensor node to the central processing by optical transmission becomes much more energy efficient. The talk will feature recent developments of the Fraunhofer Microelectronics Group in all mentioned areas.

Biografie
Hubert Lakner (born 1958) received his diploma-degree in physics from Eberhard-Karls-Universität Tübingen in 1986. After one year in industry he joined the Gerhard-Mercator-Universität (Duisburg) working in the field of nanocharacterisation of mesoscopic semiconductor structures. He received his PhD in Electrical Engineering in 1993. From 1994 until September 1998 he hold a post doc position (Oberingenieur) at the Gerhard-Mercator-Universität. He focussed on high frequency and high speed circuits based on compound semiconductor heterostructures. In October 1998 he joined the Fraunhofer Institute for Microelectronic Circuits and Systems (IMS) in Dresden where he was the Acting Director in 2002. Since January 2003 he is the (founding) Director of the new Fraunhofer Institute of Photonic Microsystems (IPMS) in Dresden. Additionally, he is Professor for Optoelectronic Devices and Systems in the Department of Electrical Engineering and Information Technology at the Technical University Dresden since February 2004. He is chairman of the board of directors of the Fraunhofer Microelectronics Group since 2005, representing about 3500 employees in 11 Fraunhofer institutes, and member of the Fraunhofer Präsidium (Presedential Council).
Prof. Lakner is engaged in many European and German initiatives e.g. AENEAS supervisory board, member of the ELG (Electronic Leaders Group), member of ECSEL Germany, chairman of the scientific advisory board of SILICON SAXONY.

Requirements & Challenges for Heterogeneous System Integration

J. Wolf
Head of Department, Management ASSID
Fraunhofer Institute for Reliability and
Microintegration IZM, Berlin, Germany

Abstract
Traditional single packaging solutions are not able to deal with the required system specifications related to high functionality, miniaturization, high speed data transmission, and multi-device integration. There is a need of highly miniaturized and flexible systems solutions that can be applied in various sectors and meet the requirements of current application trends especially in the realms of Internet of Things (IoT), Cyber Physical Systems (CPS), Ambient Assisted Living (AAL) as well as information & communication, logistics, security, automotive, health care and industrial electronics (Industry 4.0). Heterogeneous integration of multiple electronic devices is a key enabling technology which covers wafer level e.g. CSP, 3D, 2.5 integration as well as board level approaches. The presentation will give an overview of current heterogeneous integration technologies under the perspective of “More Than Moore” through Heterogeneous System Integration. 3D integration with Through-Silicon-Vias (TSV) is one of the most important topics in current packaging and interconnection.

Biografie
M. Juergen Wolf received a M.S. degree in Electrical Engineering. In 1994, M. Juergen joined Fraunhofer Institute for Reliability and Microintegration IZM and worked e.g. as group & project manager in the field of wafer level packaging and system in package. Since 2011 he is head of the department Wafer Level System Integration and also coordinates and manages “ASSID - All Silicon System Integration Dresden” with its 300 mm WL process line. He manages as well as participates in a number of research projects on European and international level. Wolf is European representative in the technical working group Assembly & Packaging of ITRS, board member of EURIPIDES as well as member of IEEE and SMTA. He has (co) authored numerous scientific papers and reports in the field of microelectronic packaging and holds a number of patents.

Modules and Systems for Improved Smart and Healthy Living

T. Knieling
Deputy Department Chief of the Module Integration Group
Fraunhofer Institute for Silicon Technology ISIT, Itzehoe, Germany

Abstract
Smart and Healthy Living at Fraunhofer Group for Microelectronics means doing research into all the ways that technology can support our lives and our work in a modern world.

Fraunhofer research covers the whole chain starting with developing new materials for getting functional or easily cleanable and clean remaining surfaces, the development of Silicon based ICs and of electronic modules made by using heterogeneous integration and hybrid electronics methods, means the combination of traditional Silicon manufacturing or PCB soldering combined with new techniques like organic, flexible electronics. High 3D integration, wafer level fan out packaging and encapsulation are now on their way to be proved and qualified for mass production. Electronics substrates are no longer consisting only of rigid PCBs - today all kinds of conductive and non-conductive foil materials, stretchables and textiles are assembled and even being printed or coated by electronics parts, sensors, light and energy sources as well as by suited encapsulation or barrier layers.

With these techniques amazing new products can and have already been created: For instance Fitness T-Shirts and functional sensor insoles for obtaining health parameters like heart rate, motion and gait analysis are only few examples. But only getting data is not enough: Visual, acoustic and even haptic feedbacks are provided instantly for supplying the user with valuable data of his actual performance and how to improve it by intuitive learning.

This presentation provides an actual overview of Fraunhofer Microelectronics research in Smart & Healthy Living and focuses on all electronic assistance as a symbiotic cooperation between humans and technology.

Biografie
Thomas Knieling studied physics at the Max-Planck Institut für Strömungsphysik in Göttingen, Germany in the field of particle optics. Afterwards he prepared his PhD thesis at the University of Bremen (IMSAS), Germany, in the areas of microtechnology, microoptics and surface science. Next he worked as a scientist at the Fraunhofer IPMS in Dresden, covering topics in microoptics and display technologies. Since 2009 he is deputy department chief of the module integration group at the Fraunhofer ISIT in Itzehoe, Germany, where he is working on quality and reliability issues of PCBs and MEMS as well as on printed electronics for medical and sports applications. Moreover he is leading the business field of Wearables and Printed Electronics.