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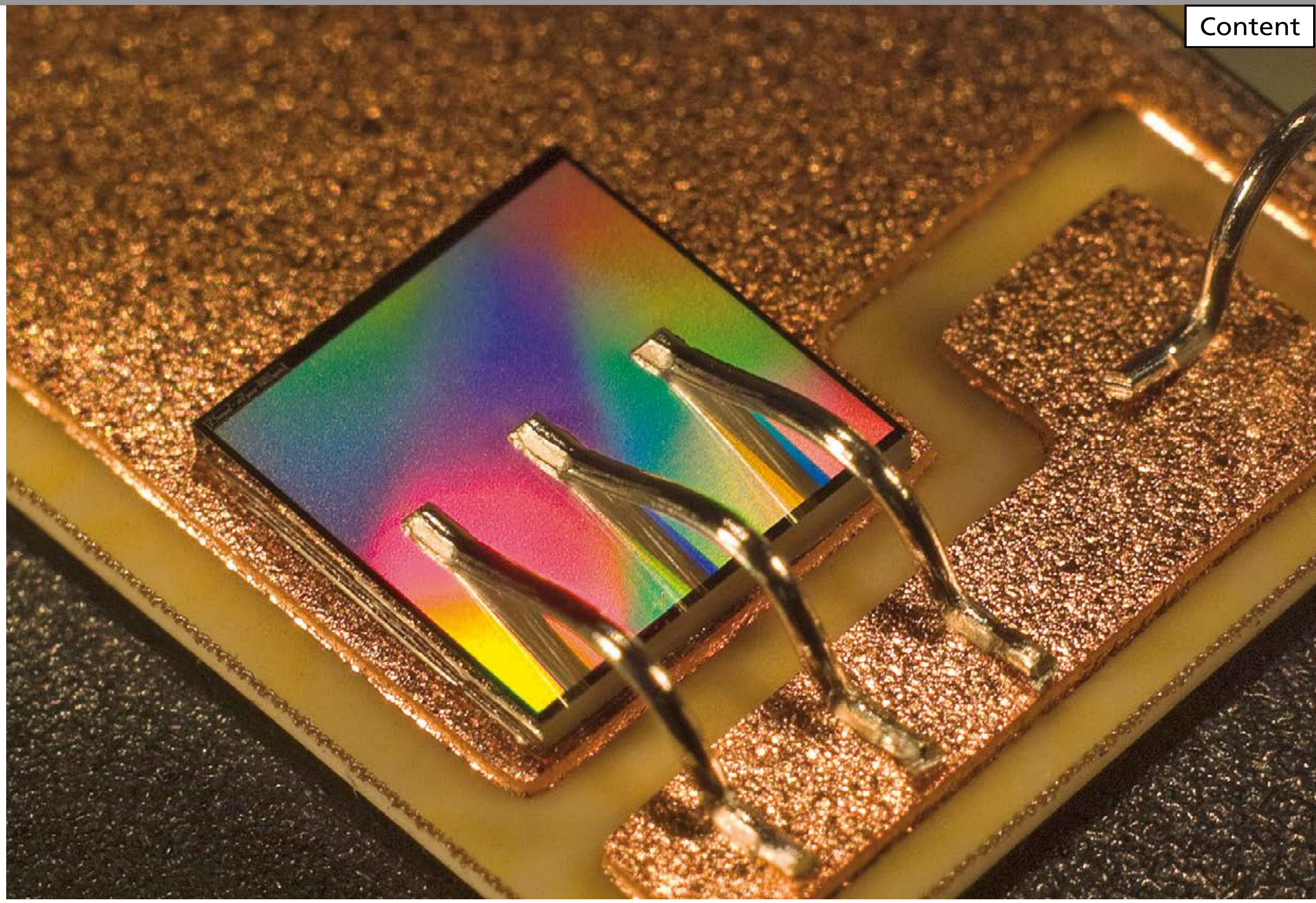
FRAUNHOFER INSTITUTE FOR INTEGRATED SYSTEMS AND DEVICE TECHNOLOGY IISB

Fraunhofer Institute for Integrated Systems and Device Technology IISB

Annual Report 2014

Content



ANNUAL REPORT 2014

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Cover Photo:
Monolithically integrated RC snubber for power electronic applications
sintered on direct copper bond and bonded to adjacent pad.

ACHIEVEMENTS AND RESULTS
ANNUAL REPORT 2014

Content

FRAUNHOFER INSTITUTE FOR

INTEGRATED SYSTEMS AND DEVICE TECHNOLOGY IISB

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PREFACE

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In 2014, semiconductor materials, devices, and electronic systems for energy supply kept characterizing the research work of Fraunhofer IISB. Appropriately, the institute started a close collaboration within the Campus "Future Energy Systems" initiated by Siemens. Together with Fraunhofer IIS and the University of Erlangen-Nuremberg, we prepared the new "Leistungszentrum Elektroniksysteme", which was finally launched in January 2015.

Moreover, our energy research project SEEDs, which aims for a sustainable energy infrastructure under the special boundary conditions of medium-sized industrial environments, has been successfully continued. The results of SEEDs and other Bavarian energy research projects were presented at our Energy Technology Symposium in October under attendance of the Bavarian State Minister of Economic Affairs and Media, Energy and Technology, Ilse Aigner.

Our research activities on local DC grids for efficient energy supply have been significantly extended and have drawn considerable attention. In this area, IISB develops innovative components, such as DC grid managers, switch modules for lighting applications, DC connector systems, or DC fast charging solutions for electric vehicles.

In the field of power converters for energy technology and electromobility, one of the special competencies of IISB, new benchmarks were set, e.g., by the development of a 200 kW DC/DC converter with a power density of more than 140 kW/l, which was introduced at PCIM Europe in Nuremberg in May.

But also for the steps prior to system integration, IISB offers high-class R&D. Our π-Fab service offer for prototype fabrication of electron devices and process development in silicon and silicon carbide technologies has been further expanded. Our branch lab in Freiberg, the Technology Center for Semiconductor Materials THM, was successfully evaluated in a Fraunhofer audition procedure.

Fraunhofer IISB has increased its annual budget to well above 20 million Euros with a staff of 230. I would like to take this opportunity to thank all my colleagues at IISB for their successful work in the past year. I extend my gratitude to our partners at the Friedrich-Alexander-Universität of Erlangen-Nuremberg (FAU) and in industry. I also thank our funding authorities, especially the Bavarian Ministry of Economic Affairs and Media, Energy and Technology, and the German Federal Ministry of Education and Research (BMBF) for their support.

Prof. Dr. Lothar Frey

Erlangen, April 2015

1 *Prof. Dr. rer. nat. Lothar Frey, director of Fraunhofer IISB.*
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FRAUNHOFER IISB AT A GLANCE

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Profile

The Fraunhofer Institute for Integrated Systems and Device Technology IISB conducts applied research and development in the field of electronic systems for application in, e.g., electric vehicles or energy technology. In this connection, the IISB extensively covers the complete value chain from basic materials to entire power electronic systems. With its two business areas, semiconductors and power electronics, the institute provides innovation and solutions in materials development, semiconductor technology and manufacturing, devices and modules, as well as in system development for vehicle power electronics, energy electronics, and energy infrastructures. This is supplemented by broad activities in reliability, simulation, characterization, and metrology.

The headquarters of the IISB is located in Erlangen, Germany. The institute has two branches in Nuremberg and one in Freiberg. As one of the 66 institutes of the Fraunhofer-Gesellschaft, the IISB does contract research for industry and public authorities. Moreover, it closely cooperates with the University of Erlangen-Nuremberg. The IISB has about 230 employees plus numerous students working as research assistants. The institute is equipped with high-class laboratories, such as a test center for electric cars and an application center for DC grid technology. Together with the University, it operates 1500 m² of cleanroom area for semiconductor technology on silicon and silicon carbide.

The IISB is a close partner of national and international industry. Its main objective is to provide excellent research to its customers and to set technological benchmarks as one of the leading research institutions in electronic systems. Cooperation includes research and development projects, prototyping, consultancy, licensing, and studies.

1 *Building of Fraunhofer IISB in Erlangen with test center for electric vehicles and clean-room; behind: cleanroom laboratory and building of the Chair of Electron Devices of the University of Erlangen-Nuremberg.*
© K. Fuchs / Fraunhofer IISB

History

The Fraunhofer Institute for Integrated Systems and Device Technology IISB in Erlangen is an important center of applied R&D for electronic systems, power electronics, semiconductor technology, and materials development in the Nuremberg metropolitan region, Germany and Europe. It was founded in 1985 as the Electron Devices department AIS-B of the Fraunhofer Working Group for Integrated Circuits. In 1993, it became a Fraunhofer institute (IIS-B), but was still formally linked to its sibling institute IIS-A, today's Fraunhofer Institute for Integrated Circuits IIS. In 2003, IIS and IISB became completely independent from each other as two individual Fraunhofer institutes. From 1985 until his retirement in 2008, Prof. Heiner Ryssel was the head of the IISB. Since 2008 Prof. Lothar Frey has been director of the institute. From the beginning, the institute has been closely cooperating with the University of Erlangen-Nuremberg.

FRAUNHOFER IISB AT A GLANCE

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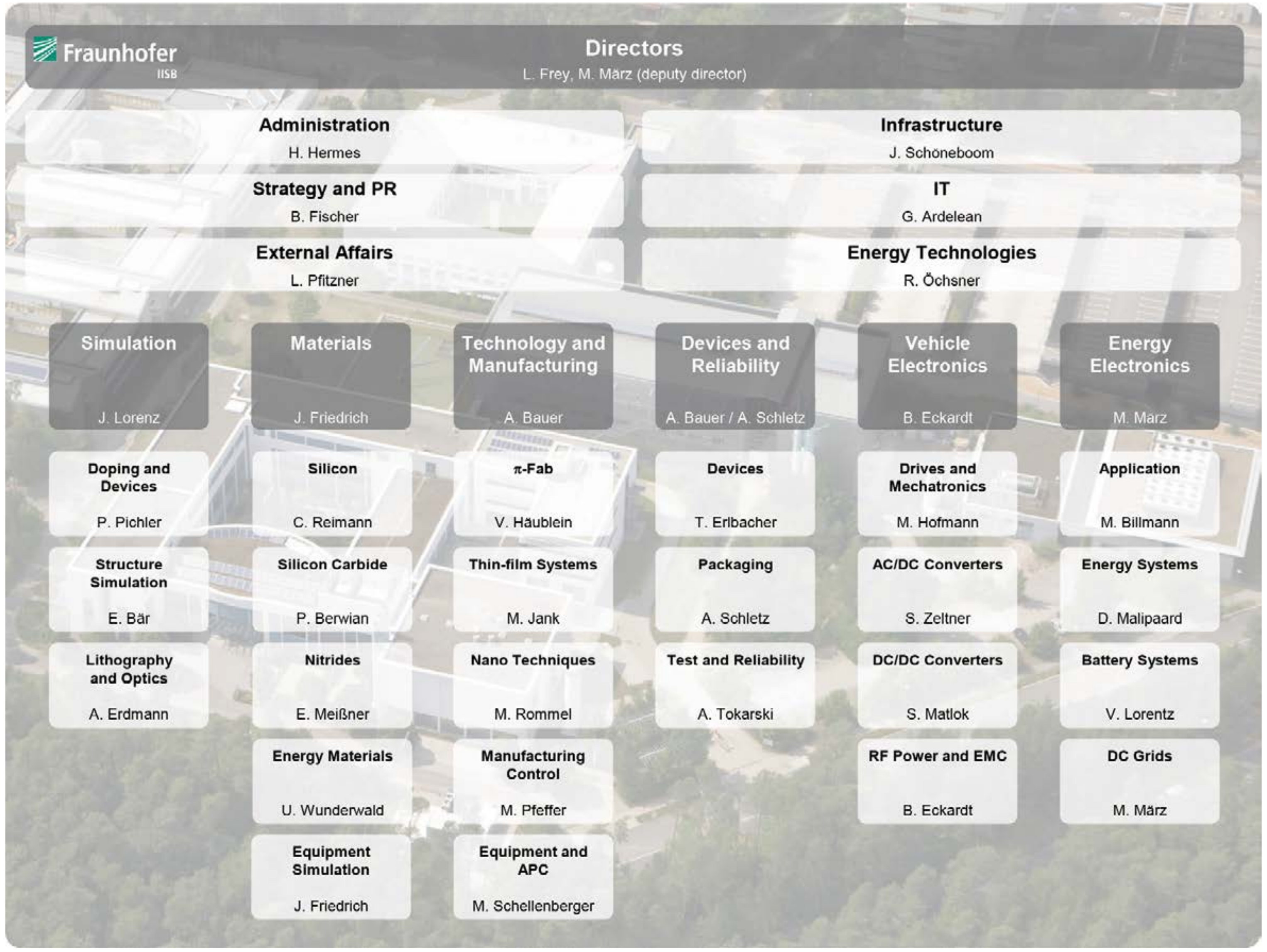

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Research Areas and Organization

Materials

Together with its industrial partners, Fraunhofer IISB develops equipment and processes for the production of crystalline bulk and layer materials for electronics. This comprises silicon, wide-band-gap semiconductors (e.g., silicon carbide, gallium nitride), materials for optical applications, detectors, and energy technology.

Technology & Manufacturing

The IISB operates extensive semiconductor technology lines, cleanroom infrastructure, and metrology on silicon and silicon carbide for the development of custom-tailored processes and prototype devices in power electronics and microelectronics. Furthermore, the IISB works on nanotechniques, particle and thin-film systems. Manufacturing aspects such as process and quality control, equipment optimization, automation, and efficiency are also considered.

Simulation

The research activities of the IISB and its customers are supported by extensive competencies in simulation, modeling, and software development in the fields of, e.g., process and device simulation in semiconductor technology, crystal growth simulation, or thermal simulation for designing power electronic systems.

Devices

The institute develops customer-specific active and passive electron devices on silicon and silicon carbide for application in power electronics, microelectronics, and sensors. This includes novel device concepts and the development of cost-efficient processes tailored towards implementation and realization of customized products.

Packaging & Reliability

New methods and materials for packaging, cooling, lifetime and failure analysis, and reliability play an important role. At the IISB, packaging and reliability research are closely combined with each other. By analyzing the exact failure mechanisms after lifetime and reliability tests, the joining technologies, materials, concepts and mechanical designs are further improved. On the other hand, new packaging designs have a direct impact on the test methodologies and accelerating factors.

1 *Organization of Fraunhofer IISB 2014: The R&D activities of the IISB cover the complete value chain for electronic systems, from basic materials to devices and modules up to application, with power electronics as a continuous backbone of the institute. This is mirrored in the new organizational structure of the IISB, which was introduced at the beginning of 2014.*
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FRAUNHOFER IISB AT A GLANCE

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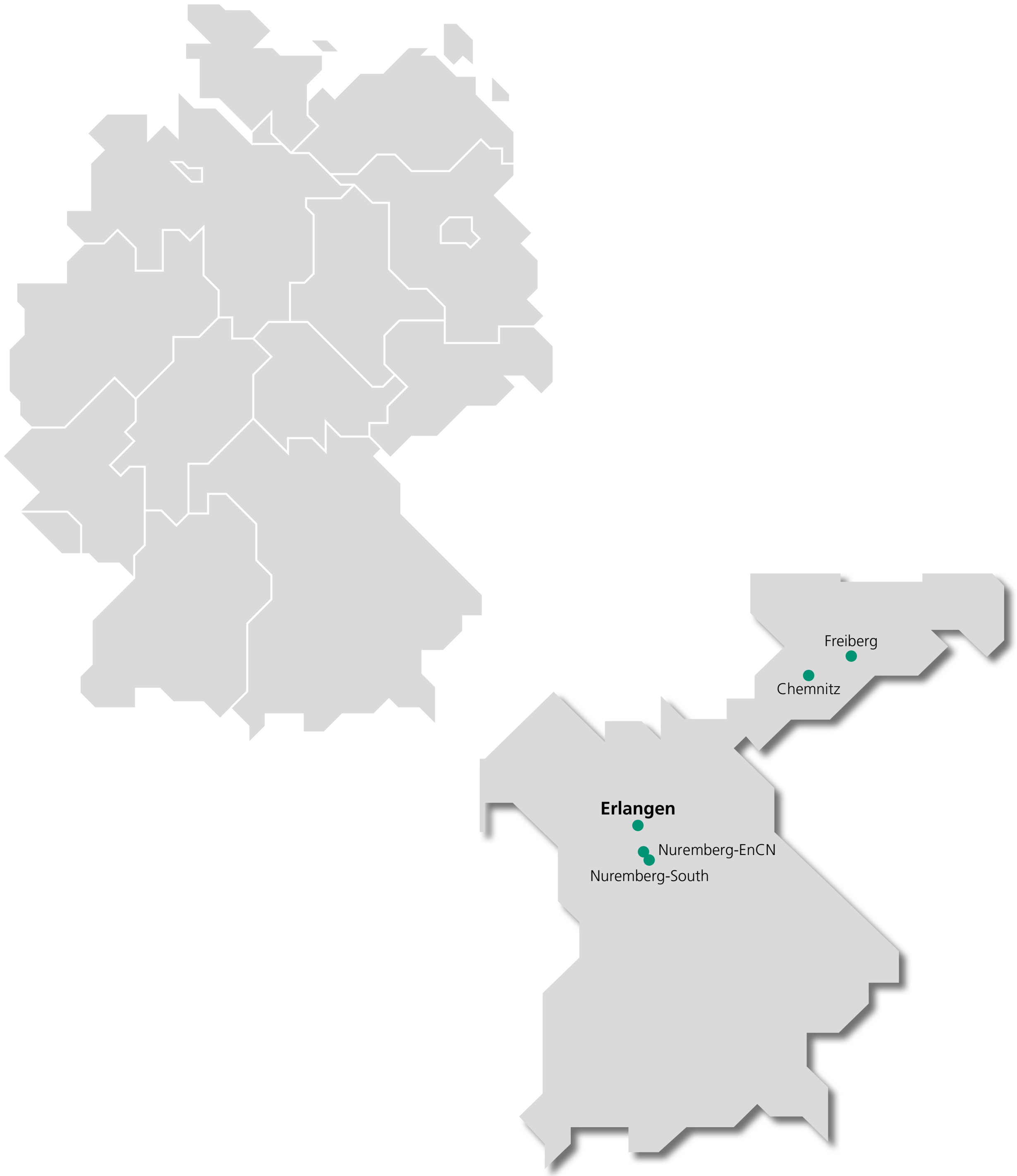

Vehicle Electronics

Efficient, compact, and robust power electronic systems for all kind of vehicles are in the focus of the IISB. This comprises electric drives, battery systems, and the charging infrastructure of electric cars. Benchmark values for energy efficiency and power density are regularly set for the work of the IISB. Further fields of application are shipping and aviation.

Energy Electronics

Power electronic systems are indispensable for realizing a modern energy supply and the transition to predominantly regenerative energy sources. The developments of the IISB contribute to this on all levels of the power grid through, e.g., electronic components for HV DC transport, local DC micro grids or the integration of electrical storages and regenerative sources in the power grid.

Energy Infrastructure Technologies

The goal of this field of activity is the coupling of electric and non-electric energy and the development of the necessary interfaces for implementing a sustainable energy infrastructure, especially for industry-size environments.

Locations

Headquarters of Fraunhofer IISB Erlangen
Schottkystrasse 10, 91058 Erlangen

The headquarters of Fraunhofer IISB in Erlangen are located close to the University of Erlangen-Nuremberg. About 7000 m² of laboratories and office area allow research and development on a broad range of power electronics, semiconductor technology, and materials development. A test center for electric cars and extensive cleanroom area for semiconductor technology on silicon and silicon carbide, which is partly operated together with the Chair of Electron Devices of the University, are part of the available infrastructure.

Fraunhofer IISB Nuremberg-South
Landgrabenstrasse 94, 90443 Nuremberg

At Nuremberg-South, 800 m² of office and lab area are available. Research activities are focused on packaging and power electronic systems for industrial applications and energy technology.

1 *In addition to its headquarters in Erlangen, Fraunhofer IISB has two branch labs in Nuremberg and one in Freiberg, as well as a laboratory for industrial power electronics in Chemnitz.*
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Fraunhofer IISB Nuremberg-EnCN
Fürther Strasse 250, "Auf AEG", 90429 Nuremberg

As a member of the "Energie Campus Nürnberg" (www.encn.de), the IISB operates a 450 m^2 branch lab on megawatt power electronics for energy supply in the joint EnCN building in Nuremberg.

Technology Center for Semiconductor Materials THM Freiberg
Am St.-Niclas-Schacht 13, 09599 Freiberg

The THM is a joint department of Fraunhofer IISB and Fraunhofer ISE. It supports industry in technologies for the production of innovative semiconductor materials to be used in microelectronics, optoelectronics, and photovoltaics. The IISB part of the THM comprises 650 m^2.

Chemnitz Laboratory
Reichenhainer Strasse 29a, 09126 Chemnitz

In Chemnitz, the IISB operates a laboratory of 160 m^2 for the industrial application of power electronics.

Network and Partners

Within its research activities, Fraunhofer IISB pursues cooperation with numerous national and international partners in joint projects and associations, among others:

- Since its foundation, the IISB has been closely cooperating with the University of Erlangen-Nuremberg. The institute is directed by the head of the Chair of Electron Devices of the University. The joint operation of infrastructure as well as the exchange in education and training create extensive synergies.
- The IISB is a core member of the "Leistungszentrum Elektroniksysteme" (www.leistungszentrum-elektroniksysteme.de, www.lze.bayern) .
- The IISB is the coordinator of the Bavarian energy research project SEEDs (www.energy-seeds.org).
- The IISB is the coordinator of the Bavarian Research Cooperation for Electric Mobility (FORELMO, www.forelmo.de).
- The IISB is the coordinator of the Fraunhofer Innovation Cluster "Electronics for Sustainable Energy Use".
- The IISB is a partner of the excellence projects at the University of Erlangen-Nuremberg (www.eam.uni-erlangen.de, www.aot.uni-erlangen.de/saot/).
- The IISB is a member of the "Energie Campus Nürnberg" (www.encn.de).
- The IISB closely cooperates with industry and research associations, such as the European Center for Power Electronics, the Bavarian Clusters for Power Electronics and Mechatronics & Automation, the German Crystal Association DGKK e.V., or the International Technology Roadmap for Semiconductors (ITRS).
- The IISB is the coordinator and partner, respectively, of numerous European research projects.
- Together with the Federal Ministry for Education and Research (BMBF), the IISB initiated and operates the joint student program of BMBF and Fraunhofer for electric mobility, DRIVE-E (www.drive-e.org).
- The IISB is a close partner of the "Förderkreis für die Mikroelektronik e.V."

The IISB is member of the following Fraunhofer groups and alliances:

- Fraunhofer Group for Microelectronics (www.mikroelektronik.fraunhofer.de)
- Fraunhofer Energy Alliance (www.energie.fraunhofer.de)
- Fraunhofer Battery Alliance (www.batterien.fraunhofer.de)
- Fraunhofer Nanotechnology Alliance (www.nano.fraunhofer.de)

Chair of Electron Devices (LEB), University of Erlangen-Nuremberg

The Fraunhofer IISB and the Chair of Electron Devices (German abbreviation: LEB) of the University of Erlangen-Nuremberg are both headed by Prof. Lothar Frey.

Within the framework of a cooperation agreement, the two institutions not only jointly operate the University's cleanroom hall and other laboratories but also work closely together with regard to teaching and research.

The cooperation of the Chair of Electron Devices and the Fraunhofer IISB makes it possible to cover the entire chain of topics from basic research to the transfer to industry. For many years, the vocational training as a "microtechnologist" has been offered jointly by IISB and the Chair of Electron Devices. Employees of IISB assist in courses and internships at the University.

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The following staff members of Fraunhofer IISB regularly give lectures at the University of Erlangen-Nuremberg:

Dr. Andreas Erdmann
- Optical Lithography: Technology, Physical Effects, and Modeling

Dr. Tobias Erlbacher
- Semiconductor Power Devices

Prof. Dr. Lothar Frey
- Semiconductor Devices
- Process Integration and Components Architecture
- Nanoelectronics
- Technology of Integrated Circuits

Dr. Michael Jank
- Nanoelectronics
- Introduction to Printable Electronics

Dr. Jürgen Lorenz
- Process and Device Simulation

Prof. Dr. Martin März
- Automotive Electronics
- Architecture and Systems Technology for Electric Mobility

Prof. Dr. Lothar Pfitzner
- Semiconductor Equipment Technics

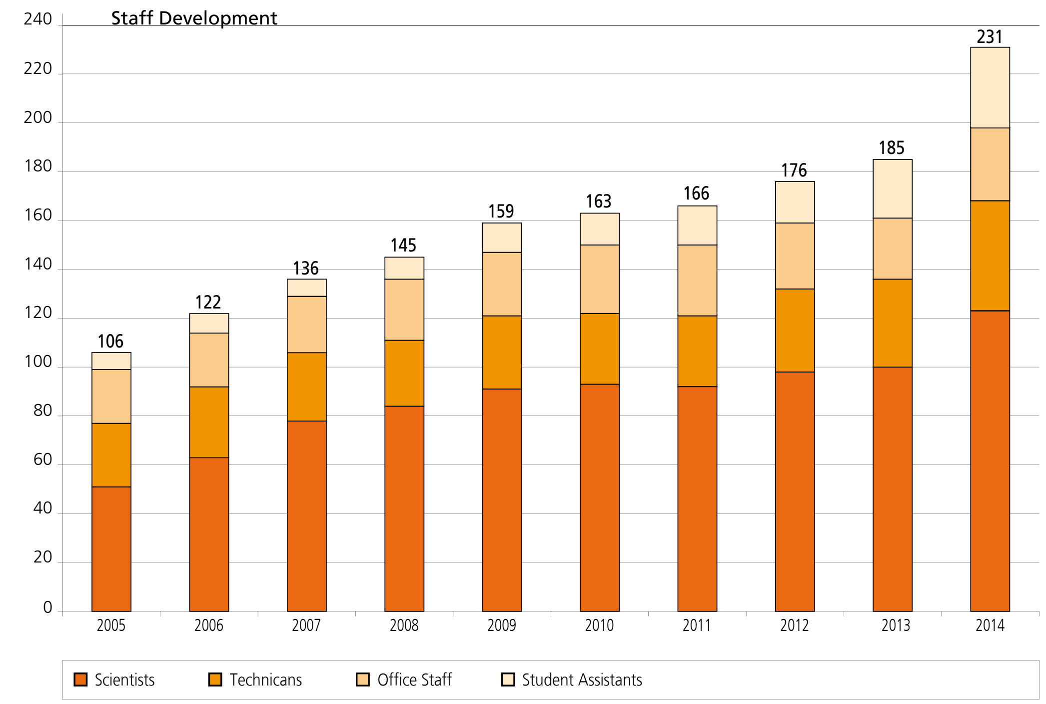
Priv.-Doz. Dr. Peter Pichler
- Reliability and Failure Analysis of Integrated Circuits

Prof. Dr. Heiner Ryssel
- Cleanroom Technology

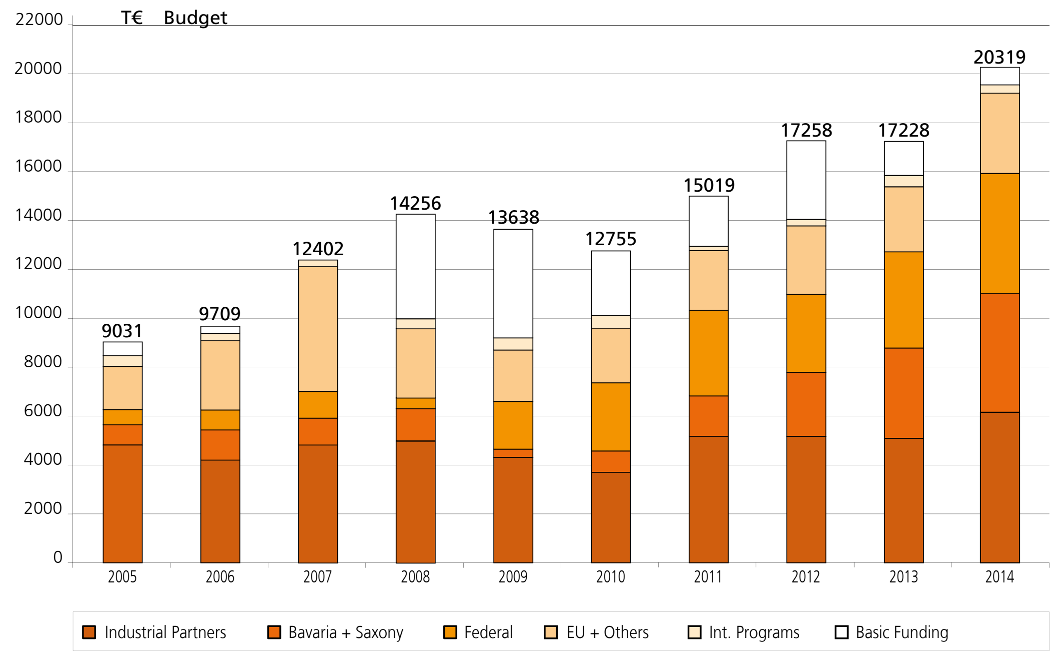
1 *Chair of Electron Devices of the University of Erlangen-Nuremberg: main building and clean room laboratory. © LEB*

Content

Staff Development, Investments, and Budget



1 *Staff development 2005 - 2014.*
© Fraunhofer IISB



3 *Operating budget according to financing domains 2005 - 2014.*
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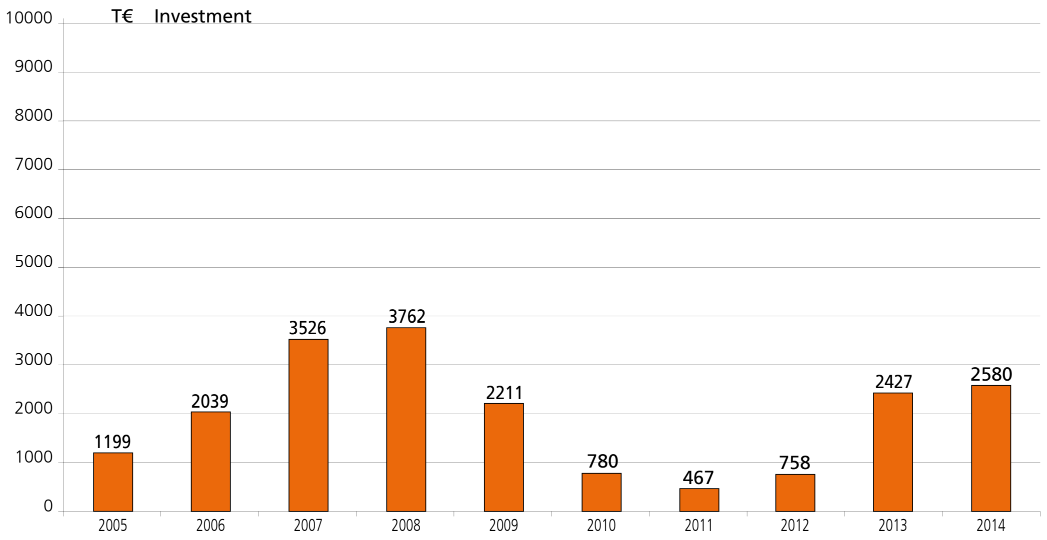

3 *Capital investment (without basic equipment and special funds) 2005 - 2014.*
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Advisory Board (December 2014)

IISB is consulted by an Advisory Board, whose members come from industry and research:

Dr. Reinhard Ploß (Chairman of the Advisory Board)
Infineon Technologies AG

Thomas Harder
European Center for Power Electronics (ECPE)

Dr. Stefan Kampmann
Robert Bosch GmbH

Markus Lötzsch
Nuremberg Chamber of Commerce and Industry

MinR Dr. Stefan Mengel
Federal Ministry of Education and Research (BMBF)

Prof. Dr. Marion Merklein
Dean of the Faculty of Engineering of the University of Erlangen-Nuremberg

Dr. Andreas Mühe
Siltronic AG

Dr. Georg Ried
Bayern Kapital GmbH

Dr. Martin Schrems
ams AG

Dr. Karl-Heinz Stegemann
X-FAB Dresden GmbH & Co. KG

Dr. Thomas Stockmeier
ams AG

MR Dr. Stefan Wimbauer
Bavarian Ministry of Economic Affairs and Media, Energy and Technology

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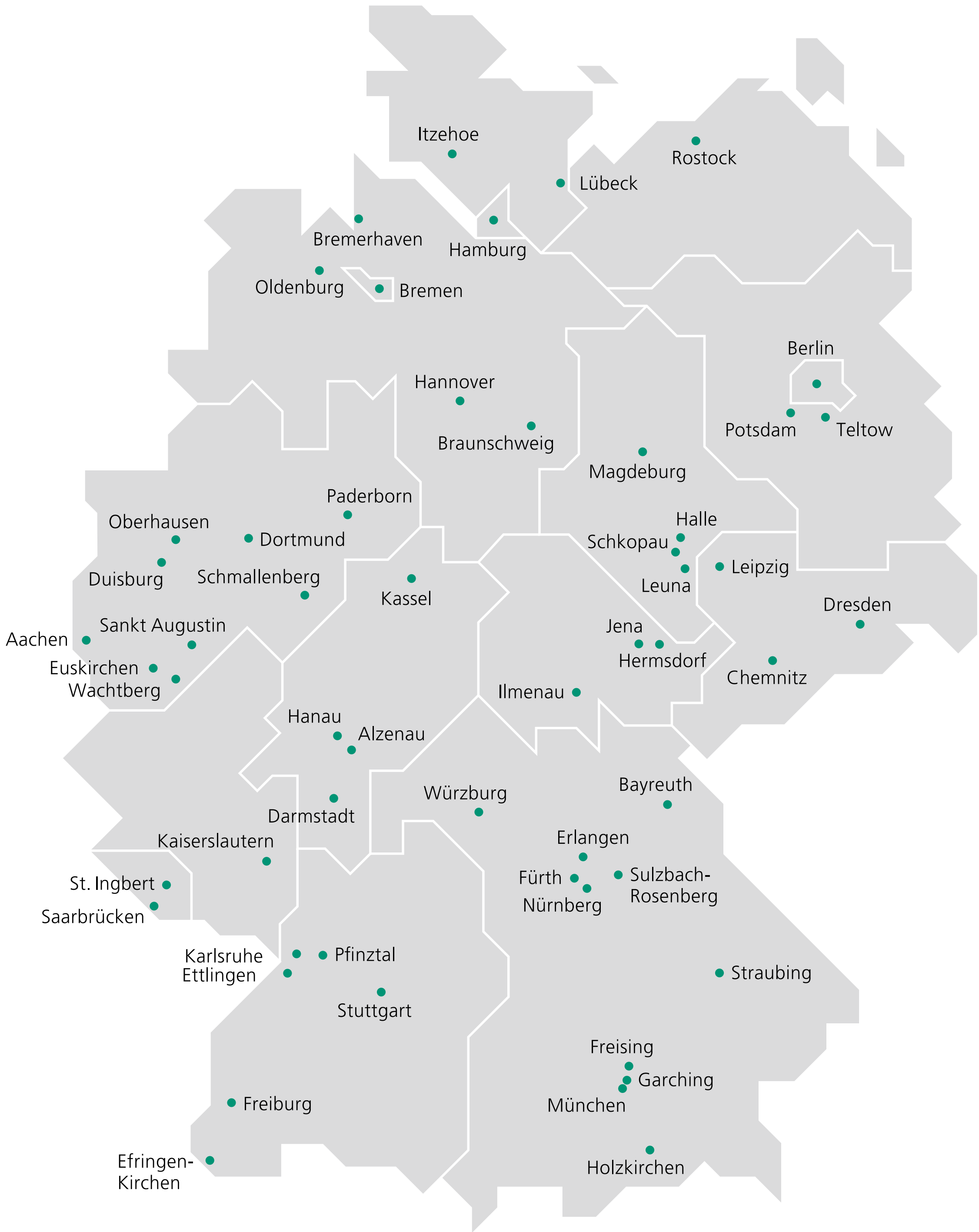

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The Fraunhofer-Gesellschaft

Research of practical utility lies at the heart of all activities pursued by the Fraunhofer-Gesellschaft. Founded in 1949, the research organization undertakes applied research that drives economic development and serves the wider benefit of society. Its services are solicited by customers and contractual partners in industry, the service sector and public administration.

At present, the Fraunhofer-Gesellschaft maintains 67 institutes and independent research units. The majority of the more than 23,000 staff are qualified scientists and engineers, who work with an annual research budget of 2 billion euros. Of this sum, more than 1.7 billion euros is generated through contract research. More than 70 percent of the Fraunhofer-Gesellschaft's contract research revenue is derived from contracts with industry and from publicly financed research projects. Almost 30 percent is contributed by the German federal and Länder governments in the form of base funding, enabling the institutes to work ahead on solutions to problems that will not become acutely relevant to industry and society until five or ten years from now.

Affiliated international research centers and representative offices provide contact with the regions of greatest importance to present and future scientific progress and economic development.

With its clearly defined mission of application-oriented research and its focus on key technologies of relevance to the future, the Fraunhofer-Gesellschaft plays a prominent role in the German and European innovation process. Applied research has a knock-on effect that extends beyond the direct benefits perceived by the customer: Through their research and development work, the Fraunhofer Institutes help to reinforce the competitive strength of the economy in their local region, and throughout Germany and Europe. They do so by promoting innovation, strengthening the technological base, improving the acceptance of new technologies, and helping to train the urgently needed future generation of scientists and engineers.

As an employer, the Fraunhofer-Gesellschaft offers its staff the opportunity to develop the professional and personal skills that will allow them to take up positions of responsibility within their institute, at universities, in industry and in society. Students who choose to work on projects at the Fraunhofer Institutes have excellent prospects of starting and developing a career in industry by virtue of the practical training and experience they have acquired.

The Fraunhofer-Gesellschaft is a recognized non-profit organization that takes its name from Joseph von Fraunhofer (1787–1826), the illustrious Munich researcher, inventor and entrepreneur.

1 *Locations of the Fraunhofer-Gesellschaft in Germany.*
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SIMULATION

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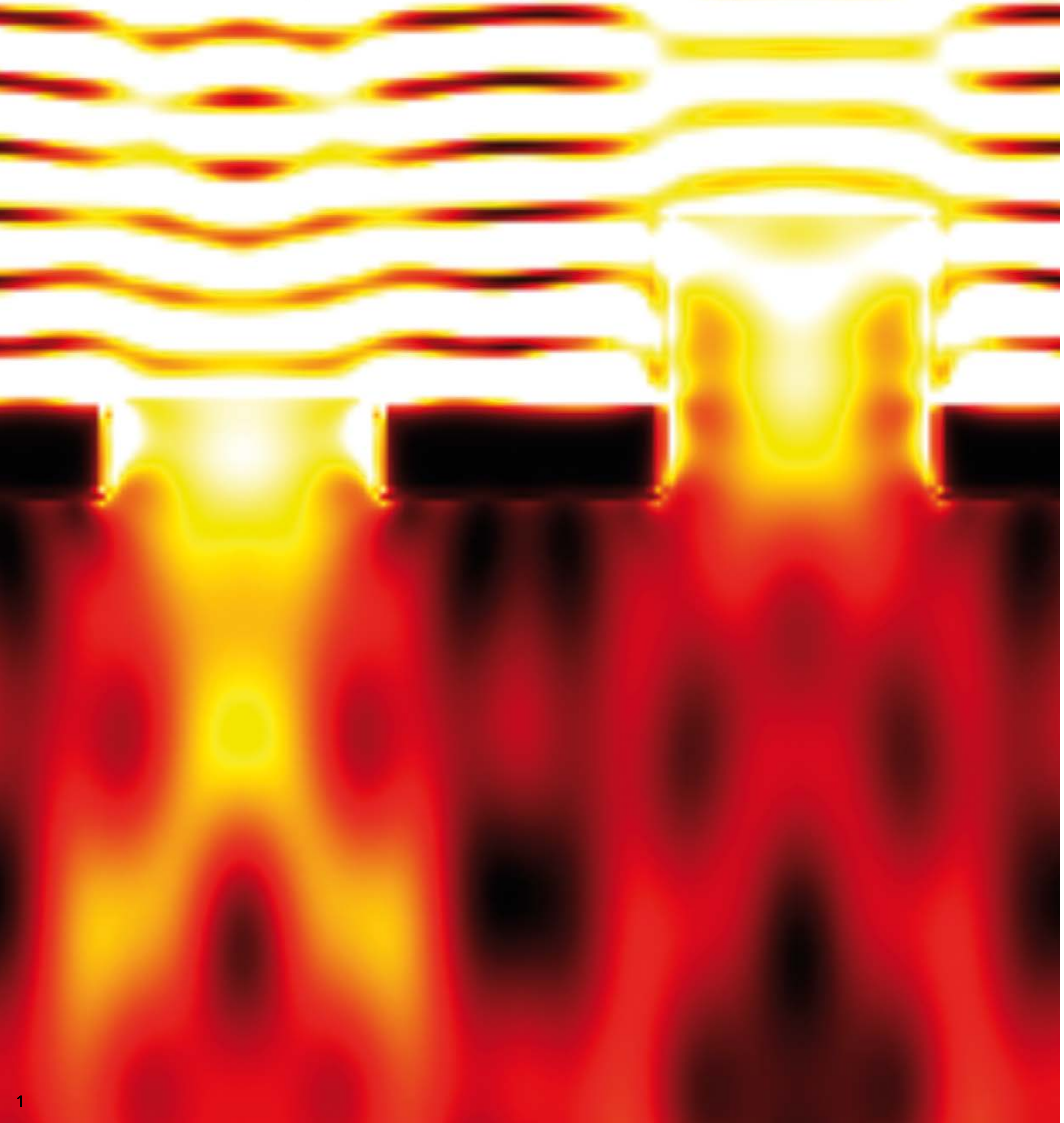

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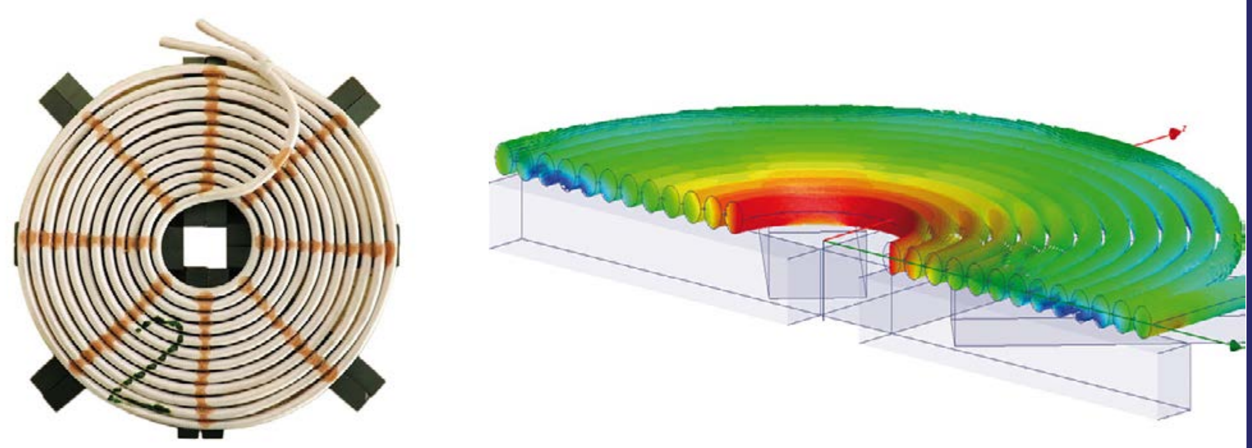
The simulation of semiconductor fabrication processes, devices, circuits, and systems greatly contributes to the reduction of development costs in the semiconductor industry. Among others, this has been confirmed for micro- and nanoelectronics in the International Technology Roadmap for Semiconductors (ITRS). The Simulation department contributes to this with the development of physical models and programs for the simulation and optimization of semiconductor fabrication processes and equipment. Furthermore, it supports the development of processes, lithography (incl. masks, materials, and imaging systems), devices, circuits, and systems by providing and applying own and third-party simulation and optimization tools.

While process and device simulation has meanwhile become largely established in industry as an indispensable tool for the development and optimization of highly scaled devices ("More Moore"), the area of "More than Moore", which consists of fields such as analog / RF, low-power electronics, power electronics, and microsystems technology, offers a large variety of additional applications. On the other hand, these new fields of application in particular often require the combination of heterogeneous competencies, because thermal, mechanical, optical, and chemical effects also occur in addition to electronic effects. This gives rise to an additional demand for research. In consequence, the majority of the activities of the Simulation department now deal with the application of own and third-party simulation programs to support the development of technologies, devices and systems in various "More than Moore" fields. Nevertheless, the department also continues to make important contributions to support the further scaling of advanced nanoelectronic devices. These activities are mainly being carried out in three cooperative projects on the European level: The EU FP7 project "Circuit Stability Under Process Variability and Electro-Thermal-Mechanical Coupling" (SUPERTHEME) coordinated by the department deals with the simulation of the impact of process variations on advanced transistors and circuits. The EU FP7 project "Computational Lithography for Directed Self-Assembly: Materials, Models and Processes" (CoLiSA.MMP) coordinated by the department deals with a very promising material-driven resolution enhancement method for the patterning of small structures. The traditionally optics-driven resolution improvements through extreme ultraviolet (EUV) lithography are addressed in the ENIAC KET pilot line "Seven Nanometer Technology" (SENATE) by a consortium of about 40 companies, research institutes, and universities, coordinated by ASML (German part by Zeiss), the leading vendor of lithography steppers. Here, the department contributes with the extension and especially with the application of its leading-edge lithography simulator Dr.LiTHO. Furthermore, the department also earns license fees for software developed within "More Moore" projects. Our solid expertise gained in the field of "More Moore", for instance regarding tailored numerical methods for model implementation, provides a sound basis for the development and application of simulation in other fields, such as "More than Moore". Our department has been correspondingly involved in several recent cooperative projects funded by German or European authorities. In the EU FP7 project "Multi Sensor Platform for Smart Building Management" (MSP), for example, the department applies its own and commercial third-party

1 *Rigorous electromagnetic field simulation of light diffraction from advanced phase shift lithographic mask using Fraunhofer IISB Lithography simulator Dr.LiTHO.*
© Fraunhofer IISB

2 *Dr. Jürgen Lorenz, head of the Simulation department.*
© K. Fuchs / Fraunhofer IISB

SIMULATION



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software for the optimization of the three-dimensional integration of sensor systems, especially via so-called "through silicon vias" (TSVs). Within the EU FP7 project "Large Area Solid State Intelligent Efficient Luminaires" (LASSIE), the department applies its lithography simulator Dr. LiTHO for the optimization of advanced LED-based lighting systems. Within the CATRENE project RELY funded in Germany by the BMBF, the department developed thermal compact models for transistors and interconnects in order to contribute to reliability-aware system design. In both the areas of "More Moore" and "More than Moore", the expertise gained or expanded in publically funded cooperative projects also provides the foundation for several research and development projects directly commissioned and financed by industry, e.g. for the optimization of lithography masks, the simulation of platinum diffusion for power devices, or inductive coupling.

The department will continue its approach to performing focused work on physical models and algorithms in order to develop the necessary skills and tools on the one hand and to transfer these results to applications in industry on the other. Here, a close and trustful cooperation based on sharing work according to the individual competencies and requirements of the partners has been a key element of the success achieved for many years.

Pushing SiC MOSFETs to Their Limits and Beyond

The reduction of the emission of greenhouse gases to keep the increase in global average temperature below 2 °C is the ultimate challenge on which the future of our earth will depend. This requires an expansion of renewable energies, their efficient distribution over long distances, and more efficient utilization. A key enabler of all this is improved power electronic devices. Particularly power electronic devices based on materials with large bandgaps show the capability to overcome the material-dependent limits of today's state-of-the-art based on silicon and to open the door to applications in power electronics which are impossible today.

Among the materials with wide bandgaps, silicon carbide (SiC) is generally considered one of the best candidates for future high-power, high-frequency, and high-temperature devices. In comparison to silicon, the 4-H polytype of SiC has a roughly three times as large bandgap, a two times as large electron-saturation mobility, and an eight times as large breakdown electric field. This can be used in principle to design smaller devices with much lower static and dynamic losses, even at much higher temperatures. The three times as large thermal conductivity of 4H-SiC also ensures that heat losses are dissipated effectively to the cooling system. The main reason why SiC MOSFETs with superior properties in particular are not already available on the market is the low channel mobility of such devices, which is usually only a few percent of the bulk mobility. To find out the reasons for the low channel mobility, the Fraunhofer IISB, the Chair of Electron Devices (LEB) of the University of Erlangen-Nuremberg, and the LAAS and CNRS institutes of the French National Center for Scientific Research (CNRS) joined forces in 2010. Co-funded at first within the Program Inter Carnot Fraunhofer (PICF 2010) on the German side by the Federal Ministry of Education and Research (BMBF) and on the French side by the Agence nationale de la recherche (ANR), the project "Mobility Engineering for SiC Devices" (MobiSiC) was continued after 2014 with own resources, resources of the French RENATECH network, and via the J.E. Purkyně fellowship awarded to V. Mortet by the Academy of Sciences of the Czech Republic. To this partnership, IISB and LEB contributed their superior capabilities in SiC processing while the CNRS institutes added predominantly unsurpassed expertise in physical and electrical characterization. The team's capabilities were completed by the expertise of IISB in device simulation, which was used for an advanced interpretation of the measurements and to verify the concepts for the observed mobility degradation quantitatively.

Using the combined expertise of the partners, various concepts offered in literature as explanations for the bad channel mobility in lateral 4H-SiC MOSFETs could be rejected outright in an early stage of the cooperation. This suggested the deleterious influence of electron traps at the interface between the silicon carbide channel and the oxide below the gate as the principle reason for the mobility degradation observed. To verify this assumption on the basis of the experiments and measurements quantitatively, a self-consistent TCAD simulation strategy had to be developed first. To avoid misinterpretation of current-voltage measurements, our MOSFETs were also characterized by Hall-effect measurements. This has the advantage of giving direct information about mobility and sheet carrier concentration of electrons in the inversion channel of MOSFETs. However, for a correct interpretation of such measurements, the so-called Hall factor needs to be known. While in literature a value of one is usually assumed, it was possible in this work to calculate the Hall factor accurately and to correct the Hall-effect measurements accordingly. Ignoring the Hall factor was found to lead to errors of up to some 40% in mobility. A further key point in the newly developed simulation strategy was an improved methodology for the characterization of the electron trap density as a function of the trap level energy in the band gap. It is based on self-consistently reproducing the current-voltage and Hall-effect measurements in numerical TCAD simulation loops by adapting the trap density distribution accordingly. Applying the developed simulation methodology to SiC MOSFETs with different channel doping concentrations characterized at different temperatures, a comprehensive interpretation of the scattering mechanisms for electrons in the channel of the MOSFETs could be given. The knowledge gained was finally used to improve the performance of the SiC MOSFETs. An important milestone towards a reduction of the interface traps was the growth of oxides in compounds of oxygen and nitrogen. A second milestone, referred to as "bulk engineering," was based on the insight that it is not the total density of electron traps that limits the mobility, it is rather the concentration of occupied traps. Reducing the channel doping concentration also reduces the occupation of the traps and the transistors obtained with 145 cm²/Vs, which had the highest mobilities reported so far for normally-on 4H-SiC MOSFETs.

1 *Inhomogeneous magnetic field strength distribution in a coil due to cross-shape ferrite design. Based on these data, frequency-depended power losses are calculated for different litz wires types. © Fraunhofer IISB*

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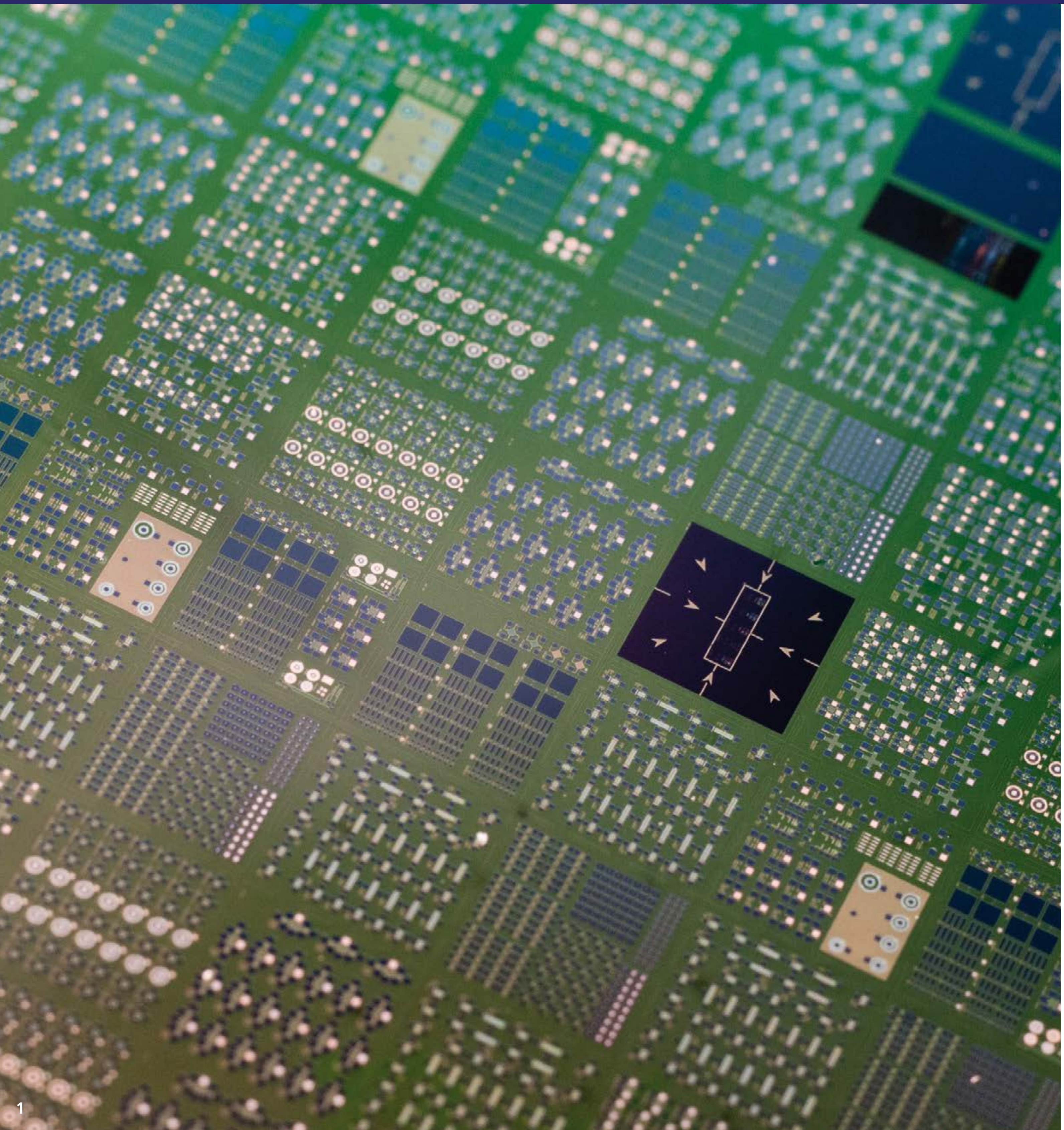

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This high mobility value was accomplished in MobiSiC with lateral MOSFET devices manufactured on the semiconductor process line of Fraunhofer IISB. For that, the process line designed originally for silicon had to be complemented and upgraded. One such piece of equipment is a specialized epitaxy reactor used to grow doped layers with the correct polytype. Since dopants do not diffuse noticeably in SiC at admissible temperatures, ion implantation is used beside epitaxy for doping. This required on the one hand ion implantation equipment with sufficiently high energy and on the other hand equipment for damage annealing and dopant activation at temperatures around 1900 °C. For the latter, a suitable annealing furnace with a graphite tube was developed in cooperation with an equipment supplier. The second generation of this furnace is now on the market and a great success for the equipment supplier. Based on the experience in the construction of the high-temperature annealing furnace, a second furnace was developed for the growth of gate oxides on SiC in atmospheres containing compounds of oxygen and nitrogen. Since graphite is unsuitable as tube material for oxidizing ambient, novel materials had to be considered. An oxidation furnace is now available at Fraunhofer IISB in which silicon carbide wafers can be oxidized in oxygen, nitrous oxide and nitrogen monoxide at temperatures up to 1350 °C. This allows growing the advanced gate dielectrics necessary to achieve the high channel mobilities mentioned above. At present, the development of the oxidation furnace continues to allow the oxidation of silicon carbide in a wet atmosphere at temperatures of up to 1400 °C. Such processes are required to inject carbon interstitials into the bulk of the silicon carbide to eliminate undesired defects associated with carbon vacancies. Such point-defect engineering may be a key step in reducing the resistance in vertical silicon carbide devices, especially for such designed for voltage classes above 1000 V. Based on the design and process know-how attained with lateral MOSFET devices, we are now also able to support the research, development, and manufacturing of vertical power devices with breakdown voltages of up to 3.3 kV.

We offer our customers a one-stop solution from numerical TCAD simulation via the development of custom-tailored silicon carbide processes and the fabrication of prototype devices up to the characterization of the devices. Our pilot line includes complete in-house technology for wafers with 100 and 150 mm diameter from epitaxy, implantation, and trench patterning to device packaging and module assembly. In consequence, our customers profit from reduced R&D costs and short times-to-market for their devices, reduced work effort due to our all-in-one solution, and competitive fabrication costs even at small volumes. This helps us to promote the commercialization of silicon carbide material and power devices and, in the end, to contribute to reaching the currently very ambitious climate targets of the industrialized nations.

1 *Top view of a 4H-SiC wafer with various types of electron devices: n- and p-channel MOSFETs, MOS-gated Hall bars, JFETs, PiN diodes, lateral IGBTs, test patterns.*
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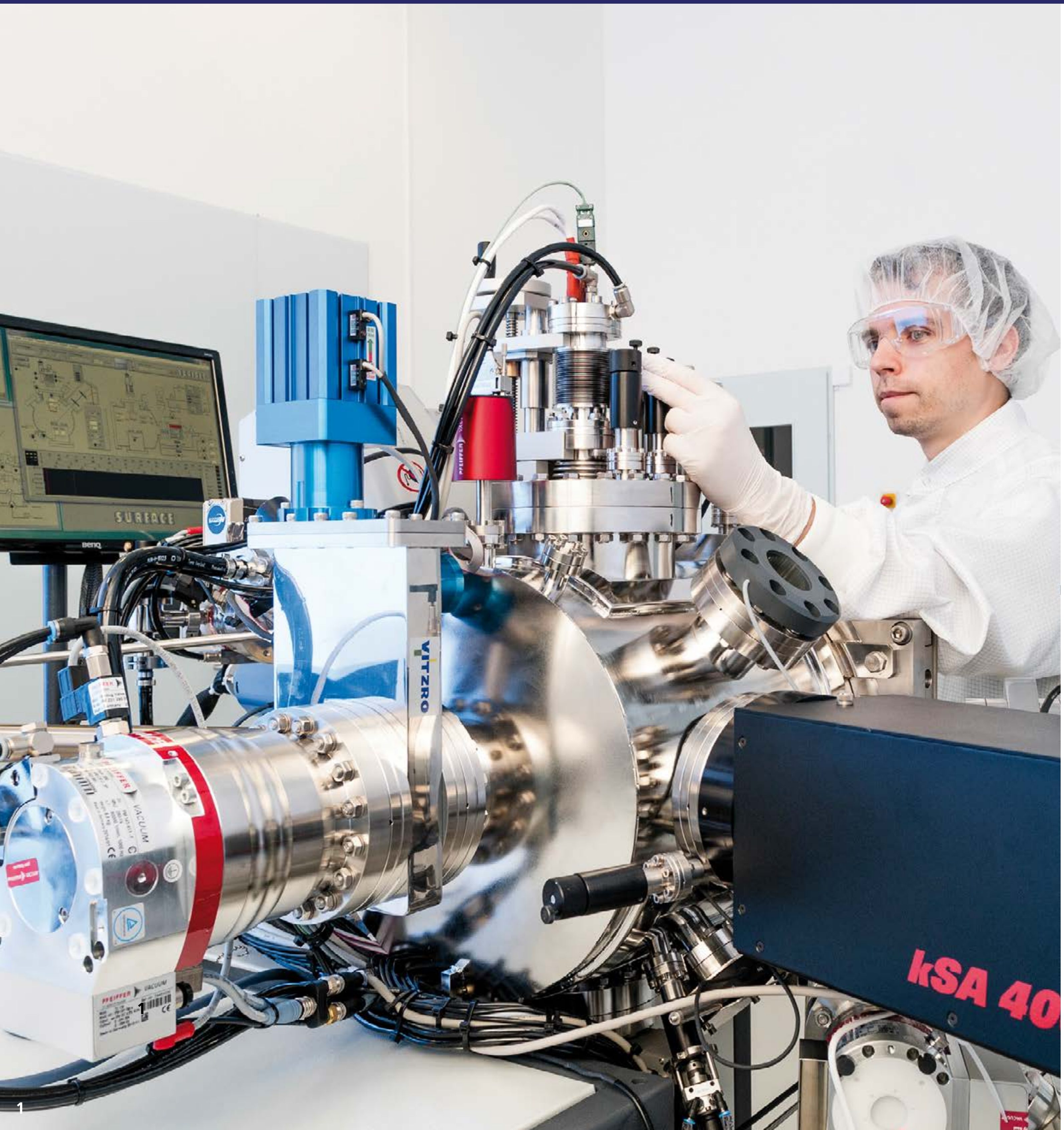
MATERIALS



The objective of the Materials department is to provide outstanding scientific and technological solutions for the development and characterization of crystalline materials and their production processes. A key aspect is the commercialization of these materials to enable novel applications. Special emphasis is placed on semiconductors, oxides, halides, and other dielectric materials for electronic, energy, and optical systems. The main task is to support material, device, and equipment manufacturers and their suppliers in the areas of crystal growth, epitaxy, thin film deposition, and the synthesis of nanometer-sized powders. Particular focus is on the development of processes and equipment for material production and the adaptation of material properties to production conditions. Our materials are further processed into devices and integrated in system demonstrators in house or by partners. We test the performance and reliability of the materials in their respective applications.

The strategy adopted by IISB, together with its branch in Freiberg, the Fraunhofer Technology Center for Semiconductor Materials (THM), is the optimization of crystal growth processes through a combination of thorough experimental process analysis, tailored characterization techniques, and numerical modeling. These efforts are supported by a well suited infrastructure consisting of R&D-type furnaces and epitaxial reactors, state-of-the-art metrology tools for determining the physical, chemical, electrical and structural properties of materials, as well as powerful and user-friendly simulation programs. These programs are especially suitable for heat and mass-transport calculations in high-temperature equipment with complex geometry.

The Materials department is an interdisciplinary team consisting of materials scientists, physicists, chemists, as well as electrical, mechanical, chemical and computer engineers. They have extensive experience in the areas of crystal growth, epitaxy, thin film deposition, and synthesis of nanometer-sized powders, including characterization and modeling. The investigated materials are used in microelectronics, power electronics, communication technology, photovoltaics and optical technologies. Multiple national and international research awards within the last several years underline the scientific and technological achievements of the Materials department. These awards were granted for outstanding scientific and technological results as well as for excellent contributions to the education of students and engineers. In collaboration with the University of Erlangen-Nuremberg, the Technical University Georg-Simon-Ohm in Nuremberg, and the Technical University Bergakademie Freiberg, the Materials department supervises students carrying out research projects, bachelor's or master's theses.

In 2014 the research topics of the Materials department were in the areas of silicon, silicon carbide, gallium nitride, and energy materials. As the topic of silicon carbide is treated in a separate article, the research highlights of the other topics are discussed below.

In the field of silicon crystallization for photovoltaic applications, the Materials department and

1 *PLD equipment for deposition of thin films. © Fraunhofer IISB*

2 *Dr. Jochen Friedrich, head of the Materials department. © K. Fuchs / Fraunhofer IISB*

MATERIALS

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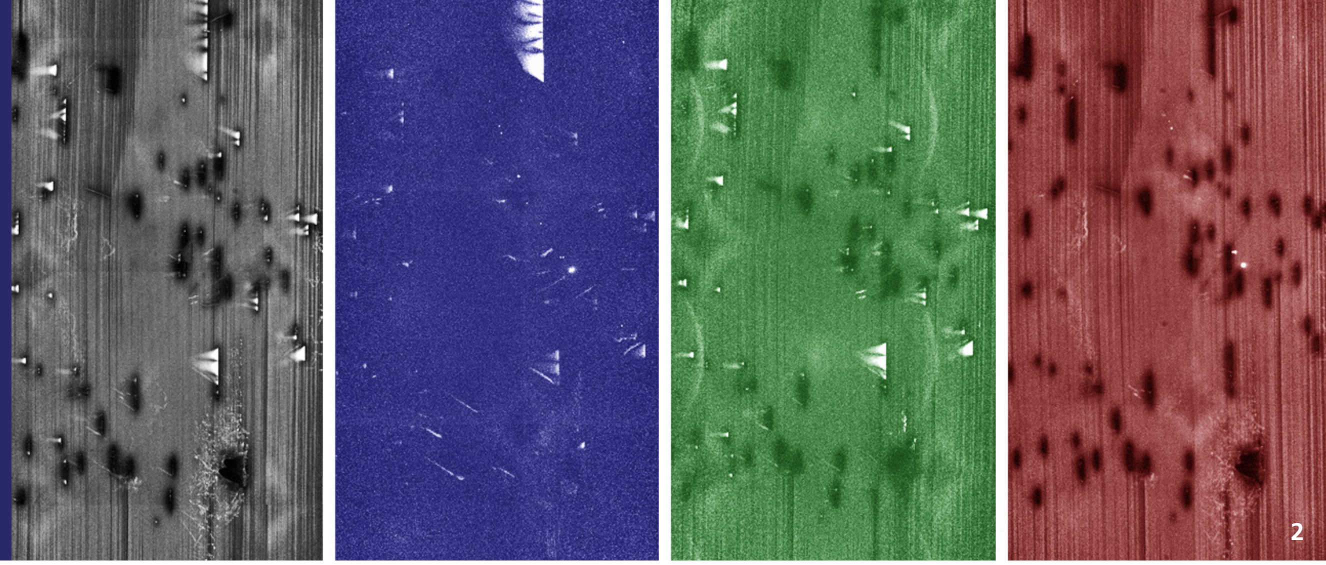
its partners from industry and academia have made much progress in understanding the reduction of detrimental dislocation clusters in multicrystalline silicon, which limit the efficiency of solar cells. In systematic experimental analyses, it was found that a fine-grain structure with a high amount of random grain boundaries is the key to reducing the occurrence of dislocation clusters during directional solidification. These investigations were honored with the E-MRS Symposium W Graduate Student Award. Such a fine-graine silicon material, called a high performance multi (HPM), is usually produced by seeding on silicon particles at the beginning of the directional solidification process. As this procedure has disadvantages, such as less throughput and an increased red zone area compared to seeding directly on the crucible bottom, the department has investigated in detail how the heterogeneous nucleation of liquid silicon at the crucible bottom can be influenced to produce a fine-grain structure with a high amount of random grain boundaries. Several technological solutions for this HPM 2.0 were found by experiments in a G1 furnace. The high quality of this material was confirmed by a low amount of electrically active dislocation clusters. Solar cells made from this material had efficiencies equal to or even better than conventional HPM silicon. In the field of quasi-mono crystalline silicon, the Materials department has performed special experiments to study how to reduce the formation of dislocations in the seeds during the heating up and melting phase due to contact with hot melt or due to indentation of feedstock particles, how to explain the degradation of the seed material in respect to minority carrier lifetime, and how to suppress the evolution of dislocations from seed joints. These scientific-technological findings were transferred to the industrial partner to grow G5 quasi-mono ingots. Solar cells made of these quasi-mono ingots showed record efficiencies up to 21.44%. In order to transfer the results from a lab scale to industrial size, the temperature and flow conditions of the lab-scale experiments were simulated by 2D and 3D models and validated by experimental data. A great deal of effort was made to easily prepare 3D geometries and generate numerical meshes according to the special requirements of thermal and flow simulations. In addition, novel models were developed that describe the heat transport phenomena in the feedstock more accurately.

In the field of heavily doped Czochralski silicon for power electronic applications, the Materials department has investigated the causes of the higher probability of structure loss during crystal pulling and has analyzed the point defect behavior in comparison to conventionally doped silicon. It was found that dislocation-free growth frequently already ends during the growth of the starting cone. Under unfavorable growth conditions, excessive fluctuations may exist in the process that cause instable growth of the solid-liquid interface in the vicinity of the triple point, eventually resulting in structure loss. Therefore, an optimized hot zone and carefully adjusted control parameters are necessary to minimize the occurrence of structure loss. Concerning the point defects, it was confirmed that so called COPs are not present in heavily doped silicon. Based on NAA measurements, it can be excluded that a dopant-vacancy complex, which would consume vacancies and prevent them from agglomerating, is responsible for this observation. Most likely, the cause of the point defect behavior in heavily doped materials is connected to the electrical charge state of vacancies and interstitials.

In the field of gallium nitride, the Materials department has two focal research areas: I) development of the HVPE process for growing GaN boules and II) reliability investigations of GaN power devices. Regarding I), the crystal growth process in the new HVPE reactor was optimized in such way that crack-free GaN boules with a 2" diameter and a thickness of a few mm were demonstrated. Accompanying TEM studies found that the nucleation of the template at the beginning of the HVPE growth process is a crucial step for obtaining a low-strain material that does not promote the formation of cracks. For a better control of the HVPE growth process, an in-situ measurement system was developed that allows the detection of the curvature and thickness of the growing GaN based on a fiber-optical interferometric sensor in combination with an optimized differential measuring head. The monitoring system was successfully tested during the growth of mm-thick HVPE GaN. In addition to the experimental work, numerical modeling was intensively used. For example, 3D models were applied to optimize the geometry of the gas nozzles during HVPE growth of GaN. Furthermore, complex 3D models including chemical reactions were developed to describe the convective heat and species transport during ammonothermal growth of GaN for the first time. Regarding II), the electrical performance and reliability of GaN power devices was correlated with the structural properties of GaN epitaxial layers grown on silicon substrates. Electrical and optical methods with a high spatial resolution (e.g. C-AFM, CL) were combined with structural methods (e.g. SEM, TEM). It was found, for example, with C-AFM measurements that threading dislocations in the GaN layer can act as pathways for vertical leakage currents. CL spectroscopy revealed that non-uniform incorporation point defects during epitaxial growth may be responsible for a shift in the breakdown voltage.

In the field of energy materials, the Materials department has worked in close collaboration with the TU Bergakademie Freiberg on two material systems in particular: the tetragonal phase of barium titanate (BTO) and the λ-phase of manganese oxide (MnO_2). The first one not only has excellent dielectric properties but is also pyroelectric, which makes it very attractive for future energy recovery systems, for example for converting low-temperature waste heat into electricity or hydrogen. Phase-pure, nanometer-sized powder was synthesized by the sol-gel method and a subsequent functionalization step. It was demonstrated that such pyroelectric material can be used to produce hydrogen through a cyclic temperature variation. Furthermore, the electrical properties of dense BTO layers that were deposited by spray pyrolysis open up new applications in the field of passive electrical components. Metastable λ-MnO_2 is the ideal candidate for a cathode material for aluminum-ion-based, all-solid-state batteries, but its synthesis is very difficult. A chemical route was developed to obtain relatively pure λ-MnO_2 with a high amount of the λ-phase. This material was assembled in battery test cells, and initial cyclic voltammetry measurements were carried out, which are the basis for future material development.

1 *Defect-selective etching of GaN samples.*
© Fraunhofer IISB



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Improved Quality Control of Silicon Carbide Wafers with a New, Fast, and Contactless Inline Inspection Tool

A new, fast, and contactless defect luminescence scanner (DLS) for photoluminescence imaging of 4H-SiC wafers was developed by Fraunhofer IISB in cooperation with Intego GmbH. This DLS system enables a more efficient optimization of the production process of SiC wafers as well as an inline quality control along the device production chain. This will help to reduce costs in material and device production and accelerate the further commercialization of SiC power devices.

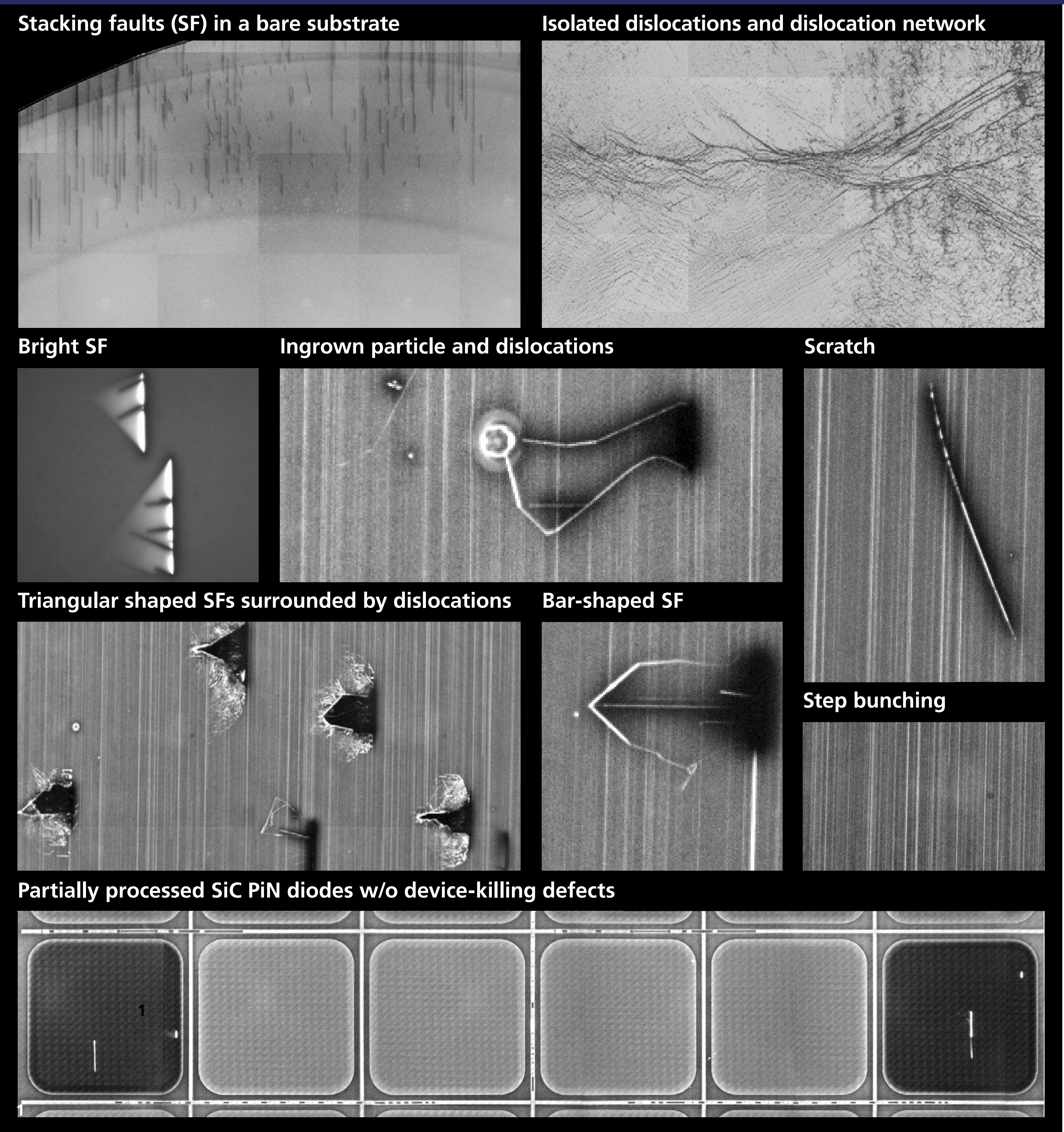
Silicon carbide (4H-SiC) is the ideal material for power electronic devices, due to its material properties and its availability in large wafer diameters and high volume. The material quality has been greatly improved within the last years with respect to structural defects, such as micropipes or other dislocation types, and their densities in substrates and epilayers. Nevertheless, the performance of next-generation SiC devices and the yield of device production could be limited by residual structural defects in the epiwafers. Such defects originate in the substrate material or are generated during the epitaxial process, e.g. down-fall particles, stacking faults, and dislocations.

Several characterization methods have become established for identifying the presence and distribution of such defects on the wafer level. However, they are either destructive (defect-selective etching), cost-intensive (synchrotron x-ray topography), or time-consuming (both defect-selective etching and x-ray topography). Hence, they are not suitable for a fast inline quality control of the material preparation and device production. Surface-related defects, e.g. down-fall particles or scratches, and stacking faults, are usually counted by light-scattering techniques, but these techniques are only sensitive to surface defects. On the other hand, the photoluminescence (PL) technique is known as a non-destructive, contactless method that allows the identification of structural defects of 4H-SiC at room temperature. In PL images, structural defects on the sample surface as well as inside the material appear either as bright or dark items on the "gray" SiC background, as 4H-SiC itself has a low PL intensity due to its indirect band gap.

Until now, there has not been a PL setup that allows for fast inline detection of bulk and surface-related defects. This obstacle has now been overcome in the framework of the "SiC-WinS" project, funded by the Bavarian Research Foundation (BFS) under contract number AZ-1028-12. Together with the metrology specialist Intego Vision Systeme GmbH, Fraunhofer IISB has designed and fabricated a new PL imaging tool called the defect luminescence scanner (DLS). The DLS allows for short PL measurement cycles and high throughput of SiC epiwafers at a high lateral resolution of 5 µm.

1 *Typical structural defects in silicon carbide (4H-SiC) substrates, epilayers, and partially processed devices, imaged by defect luminescence scanner (DLS).* *© Fraunhofer IISB*

2 *Example for spectral fingerprints of defects in 4H-SiC epiwafer: "panchromatic" image with full spectral range, band-pass filter in blue, green, and red ranges (images from left to right, respectively).* *© Fraunhofer IISB*



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The DLS system is installed at Fraunhofer IISB and consists of a UV laser operating at 325 nm wavelength for PL excitation, a sample stage for scanning the SiC epiwafer, and an electron multiplying charge-coupled device (EMCCD) camera for fast image recording at a high signal-to-noise ratio. The high lateral resolution of 5 µm is achieved by a magnifying objective lens in front of the camera. Additionally, defect types can be identified by their spectral fingerprints using different band-pass filters. A routine for automated defect identification and counting has been developed in order to directly predict the device yield per epiwafer. The DLS system can determine the defect types and their distribution on SiC epiwafers up to 150 mm in diameter in less than 15 minutes.

The DLS has been optimized for detecting defects in substrates, epilayers, and partially processed wafers. This makes it possible to detect defects along the processing chain and draw conclusions about the evolution of defects in substrates, epilayers, and devices, which will accelerate material development. Furthermore, we have proven that the DLS is able to detect critical defects in partially processed devices that cannot be revealed by standard electrical testing. In this way, defective electronic devices can be reliably detected and directly sorted out. The DLS helps to improve device reliability, reduce production cost, and optimize device yield.

1 *Operator loading a 100 mm SiC epiwafer in the defect luminescence scanner at Fraunhofer IISB.*
© Fraunhofer IISB

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TECHNOLOGY AND MANUFACTURING

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Technology at Fraunhofer IISB means above all research and development in the field of electronic devices on a micro- as well on a nano-dimensional scale. To focus more on facility services for customers, the service sector is organized in a separate organization unit called π-Fab. The purpose of π-Fab is the fabrication of custom-tailored prototype electron devices. Furthermore, from nano-technology to printable macro-electronics, the Technology department is your contact for the realization and characterization of single process steps and devices up to prototypes. Based on comprehensive cleanroom facilities, silicon and silicon carbide processing form the backbone of the department. Examples of current activities are high-resolution nano-imprints on a large scale, low-temperature depositions of inorganic materials using printing techniques, and especially the fabrication of advanced integrated power devices. In addition, the heterogeneous integration of various technologies is becoming more and more important.

For this purpose, IISB and the Chair of Electron Devices of the University of Erlangen-Nuremberg operate joint clean room facilities of 1000 m² (primarily class 10) with CMOS-compatible equipment. This allows the implementation of important process steps on silicon wafers with diameters of up to 200 mm and on SiC wafers with diameters of up to 150 mm. An industrial CMOS process transferred to IISB and adapted for research and development purposes is used as a reference and as the basis for developing advanced process technologies.

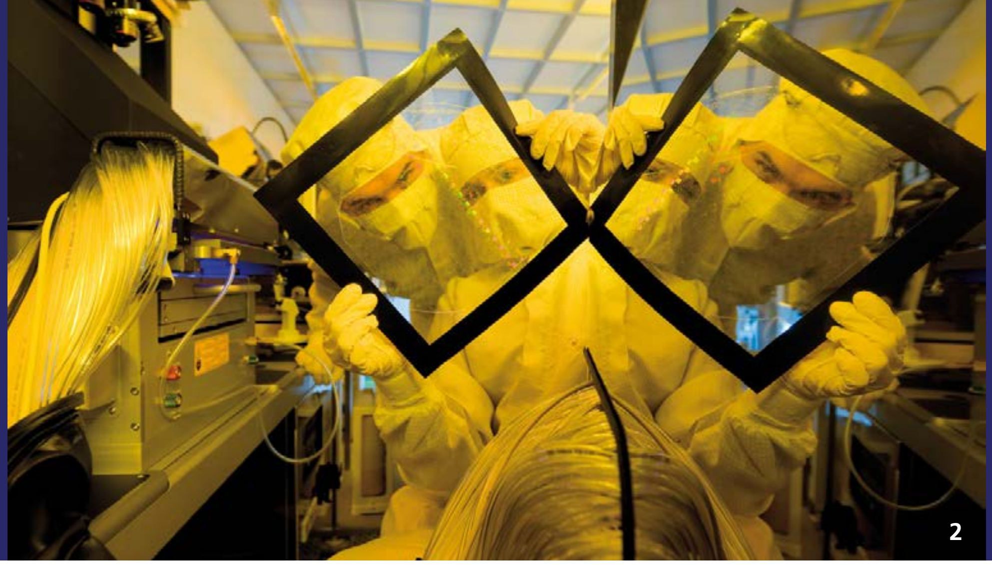
The main activities focus on the fields of power semiconductors and silicon carbide electronics. IISB has increased its commitment to these fields by implementing new equipment and processes to meet special requirements necessary for Si and SiC power device processing. This above all concerns the etching and refilling of deep trenches and high-temperature processing of SiC. A smart-power IGBT technology with integrated trench isolation has been successfully realized. All of this allows the department to strengthen its competence in manufacturing smart-power or high-voltage devices. By now, IISB has developed its resources and expertise to the point where it can perform nearly all manufacturing steps on SiC substrates. The devices currently under development include diodes and pin diodes in the voltage range above 1 kV, as well as MOSFET devices such as vertical or lateral DMOS.

For the development of novel process steps in the field of dielectrics and metallization, IISB operates advanced sputter and chemical vapor deposition tools on the basis of ALD that are used for the deposition of high-k and metallic layers. Adaptation of the process to the particular chemistry of the precursor, deposition of a multiplicity of precursors, and the characterization of the deposited layers are the main tasks of the department. Furthermore, special activities focus on ion implantation technologies. At IISB, implantation tools with acceleration voltages ranging from a few eV up to 800 keV are available. Special implantations for CMOS as well as for power semiconductors have been established (for example, commercial tools have been modified to be able to implant several wafer diameters and manifold elements at elevated temperatures).

1 *Operator with SiC wafer in front of horizontal oxidation furnace in cleanroom environment.*
© K. Fuchs / Fraunhofer IISB

2 *Dr. Anton Bauer, head of the Technology and Manufacturing department.*
© K. Fuchs / Fraunhofer IISB

TECHNOLOGY AND MANUFACTURING



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The physical and electrical characterization of process steps and device structures is of the utmost importance for the manufacturing of semiconductor devices. Important steps in this respect are the determination of the topography, doping profile, and further physical and chemical parameters, as well as SEM & TEM investigations, energy-dispersive X-ray analysis, and AFM surface characterization of layers. The specific competence of the department consists of the combination of several methods for failure analysis during the processing of semiconductor devices and tracing the causes of failure. The spectrum for electrical characterization has been further increased (e.g., lifetime measurements and high voltage measurements).

Another focal area of the department's work is the processing of structures in the range of a few nanometers as well as the repair and analysis of electronic device prototypes by means of focused ion beam (FIB) techniques and electron beams. In addition to that, UV nano-imprint lithography, a cost-effective fabrication technique that allows the transfer of nano-sized features to photo resist without the use of advanced optical lithography, by applying small rigid stamps and, most importantly, by applying large-area (up to 150 mm) flexible stamps as well, is now well-established at the Technology department.

The focus of the department's activities in the field of printable electronics is on the investigation and development of manufacturing methods for the solution processing of inorganic thin films for electronics, especially printable electronics. A special emphasis is placed on the interaction of processing with the resulting electrical properties for specific applications. Based on inks with semiconducting, conducting, and insulating nanoparticles or their respective molecular precursors, thin-film transistors (TFTs) are created that comprise printed features. The properties of functional thin films made by means of liquid processing are also analyzed in detail.

The core competence of the Semiconductor Manufacturing Equipment and Methods groups is multidisciplinary research and development for manufacturers of equipment, materials, and semiconductor devices. The decisive factor for this is the expertise in process development, metrology, analytics, software, simulation, and device integration combined to develop tailor-made solutions together with customers. The scope of developments ranges from lead research for novel processes and measurement methods to the application of new research results in cooperation with corporate industrial partners and the assessment and optimization of equipment in an industry-compliant environment. The IISB analysis laboratory for micro- and nanotechnology with various chemical, physical-chemical and physical test methods is essential for a conclusive and comprehensible assessment. Two working groups at Fraunhofer IISB are contributing their expertise in advanced process control, manufacturing science, productivity, contamination control, and yield control aspects to the ENIAC project "EPPL", which aims to combine research, development and innovation to demonstrate the market readiness of power semiconductor devices fabricated in leading European 300 mm pilot lines.

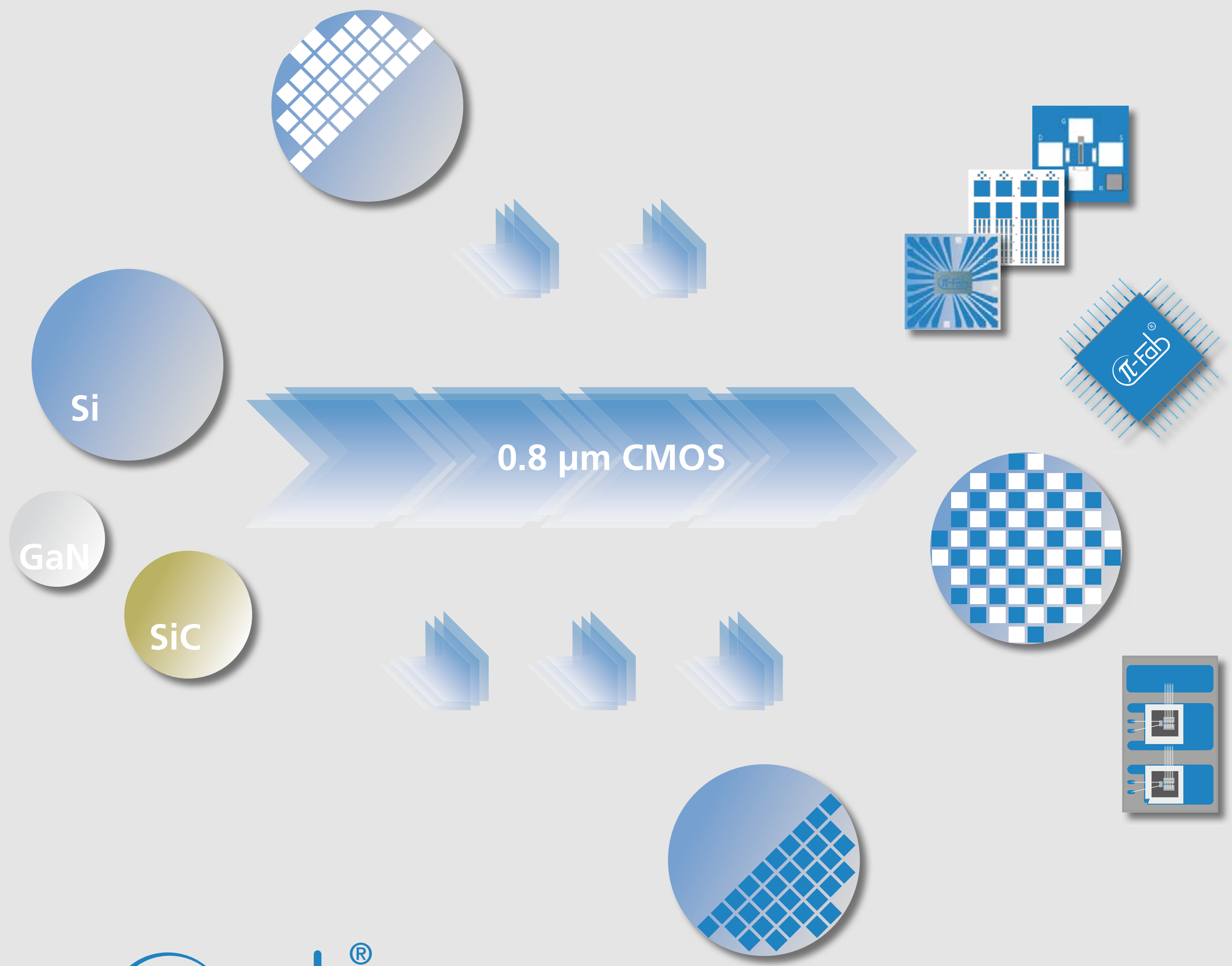
π-Fab: Customized Prototype Fabrication and Device-related Services

π-Fab was launched by IISB in order to fill the gaps left in the industrial landscape by traditional, mass-production-oriented fabs with their severe restrictions regarding wafer size, process variety, and lot size. π-Fab offers adequate solutions, irrespective of whether a single process step (for example, an oxidation or an ion-implantation step), a process module (e.g., a lithography step with

1 *View of the cleanroom.* *© K. Fuchs / Fraunhofer IISB*

2 *IISB scientists inspecting a flexible SCIL stamp.* *© K. Fuchs / Fraunhofer IISB*

TECHNOLOGY AND MANUFACTURING



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subsequent ion implantation and annealing), or a full prototype process sequence is required. With the emphasis on high grades of flexibility, π-Fab runs a process line for industry-oriented, low-volume prototype fabrication with a focus on custom-specific power devices, CMOS devices, sensors, MEMS, and passives. The customer benefits from completely new possibilities. According to their needs, customers decide whether π-Fab processes the devices from the beginning to end or, alternatively, if they only require certain process modules, in which case they determine the point of entry and exit from the process line.

With a clean room area of 1000 m², π-Fab runs a fully equipped and certified 0.8 µm Si-CMOS line with ion implanters, furnaces, mask aligners, steppers and many process tools and wet chemistry for depositing and structuring dielectric or metal layers. Moreover, π-Fab runs dedicated process equipment such as high temperature furnaces for annealing and oxidizing silicon carbide. Unique in the field of device processing is the high degree of flexibility with regard to wafer material and wafer size. Silicon wafers with diameters of 150 mm and 200 mm are handled by default. In addition to silicon technology, special attention has been given to silicon carbide (SiC) device processing on 100 mm and 150 mm wafers. The qualifications for maintaining these high levels of flexibility are excellent, as π-Fab is based on three central pillars:

- A highly skilled, experienced and motivated team of technicians and scientists
- A well-balanced mix of modern state-of-the-art process equipment and well proven process tools in all of the disciplines
- Sophisticated quality management with emphasis on process stability, process and delivery reliability. Customer satisfaction is a major aim. π-Fab has achieved ISO 9001:2008 certification for customized prototype fabrication of semiconductor devices and device-related processing. The pool of certified process steps and modules is being continually extended (e.g., for more complex SiC prototype fabrication).

Three Decades of Experience

Fraunhofer IISB looks back on 30 years of experience in microelectronics research and development. In the beginning, the emphasis was on developing process modules, such as ion implantation and annealing, gate oxide growth, or high-k dielectrica. Soon, research activities were extended to silicon carbide as a promising material for power devices. Later activities required the integration of developed skills and modules in order to process electron devices, which have become more and more important. Today, IISB covers the value chain from materials to electronic systems; π-Fab, which focuses on the manufacturing of electron devices, plays a decisive role.

π-Fab is now a registered trademark of Fraunhofer IISB.

1 *Flexibility as a matter of principle: π-Fab handles various wafer sizes and types, the customer may determine the points of entry and exit from the process line.*
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quality austria
SYSTEM CERTIFIED
ISO 9001:2008 No.16300/0

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Content

1 *Flatness measurement to a hairbreadth in the area of the city of Erlangen.*
© Fraunhofer IISB

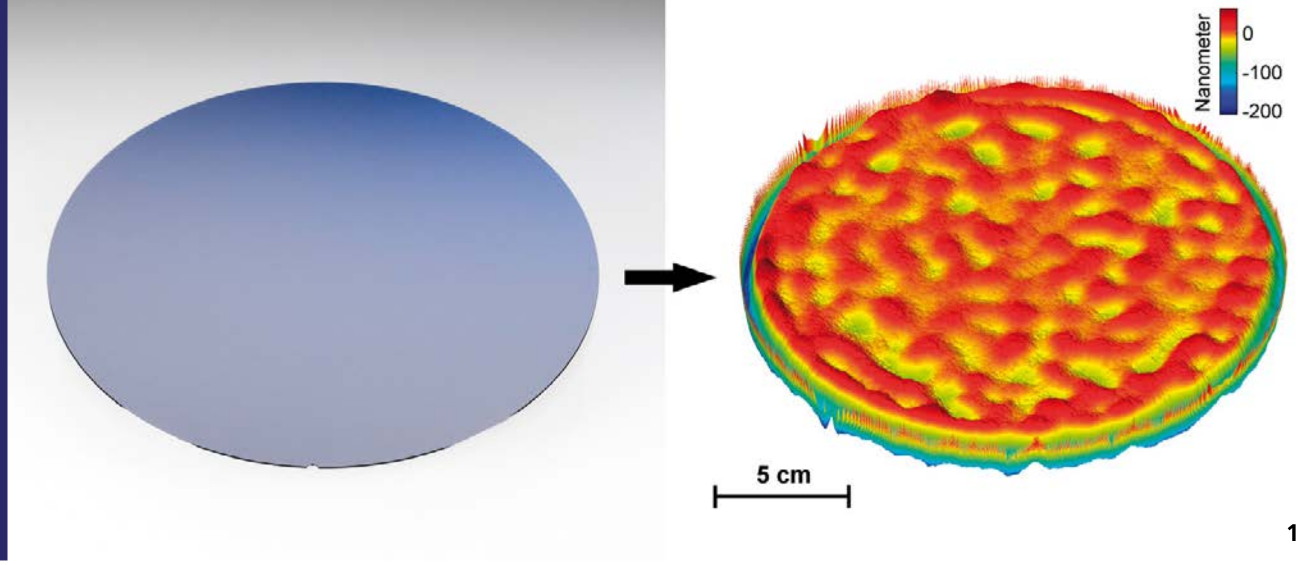
Measurement for Microchips – Precise to a Hair

Microchips and memory devices, the "brains" of intelligent cars, smart phones and modern medical technology, are becoming increasingly smaller and more powerful. The smallest structures of integrated circuits are now in the range of a few 10 nm (1 nm equals 10^{-9} m) – a single transistor is so small that several hundred thousand of them can fit into the period at the end of this sentence. These tiny structures are formed in a complex process sequence in which the imaging of desired structures by means of photolithography plays an essential role. As known from photographic technology, a sharp image is only possible within a certain spatial depth (depth of field). For lithography in semiconductor manufacturing, this means that the silicon wafers on which the chips are produced must be perfectly flat – even a bump in the order of several hundred atoms reduces the yield of working chips. Besides the decreasing structure sizes, scaling is also an important aspect for the wafer. The diameter of the wafers has steadily increased. This is because more chips can be manufactured cost-efficiently on a larger wafer. The current wafer diameter is 300 mm, and the next generation will be 450 mm. This affects the demands that are placed on the metrology for characterizing wafers. Tools that can measure the flatness of wafers with a high precision over a large area are required.

At Fraunhofer IISB, a new sensor concept for measuring wafer surfaces has been developed over several years. This new method was originally based on the Makyoh method and was developed further to a fully quantitative 3D method. The key idea is to apply structured illumination. A special micro display is therefore used. It makes it possible to generate an optical pattern that is projected onto the wafer surface. The light that is reflected from the wafer surface is then captured by a camera. In the case of a non-planar surface, the optical pattern recorded by the camera is distorted compared to the pattern that was originally projected. This distortion is related to the local slopes of the wafer surface. When the setup is calibrated, the surface slopes can be calculated from the camera data. Since the slope corresponds to the gradient of the surface, the actual wafer topography can be reconstructed in a second step by proper integration algorithms. This simple principle has an enormous sensitivity. Surface deviations in the lower nanometer range can be detected. The performance achieved with the new method can also be described this way: if the surface of a silicon wafer is extrapolated to the area of the city of Erlangen, an appropriate measuring device could detect any unevenness of the thickness of a hair on this area - in one single measurement step.

The First Prototype

Considering the requirements discussed above, the plan was to realize a tool with a measuring area the size of the wafer to avoid difficulties with mapping and stitching procedures. The aim was to enable a one-shot measurement of a whole 300 mm wafer surface. The wafer can



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then remain at rest during the measurement. This, however, requires large optics. After a special 300 mm objective lens was designed, the first 300 mm topography sensor could be built. Apart from challenges related to large lenses, the optical setup itself is ambitious because the lens objective comprises the illumination part on the one hand and the imaging part on the other hand. The optics therefore need to project the illumination pattern and display the wafer surface on the camera simultaneously. Furthermore, since nanometric precision is required, high demands are placed on the optical quality of the lenses. The complete prototype was built at the IISB, including the control software, processing algorithms, as well as the mechanical design. The illumination unit that enables the projection of optical patterns is comparable in principle to a video projector – with the difference, however, that it was specially designed for the requirements of the measurement method. The achievable precision of the prototype is in the lower nanometer range. Laterally, approximately 100 µm can be resolved, which corresponds to approximately 7 million data points across a 300 mm wafer surface.

Market perspectives – the “Global Nano Scope”

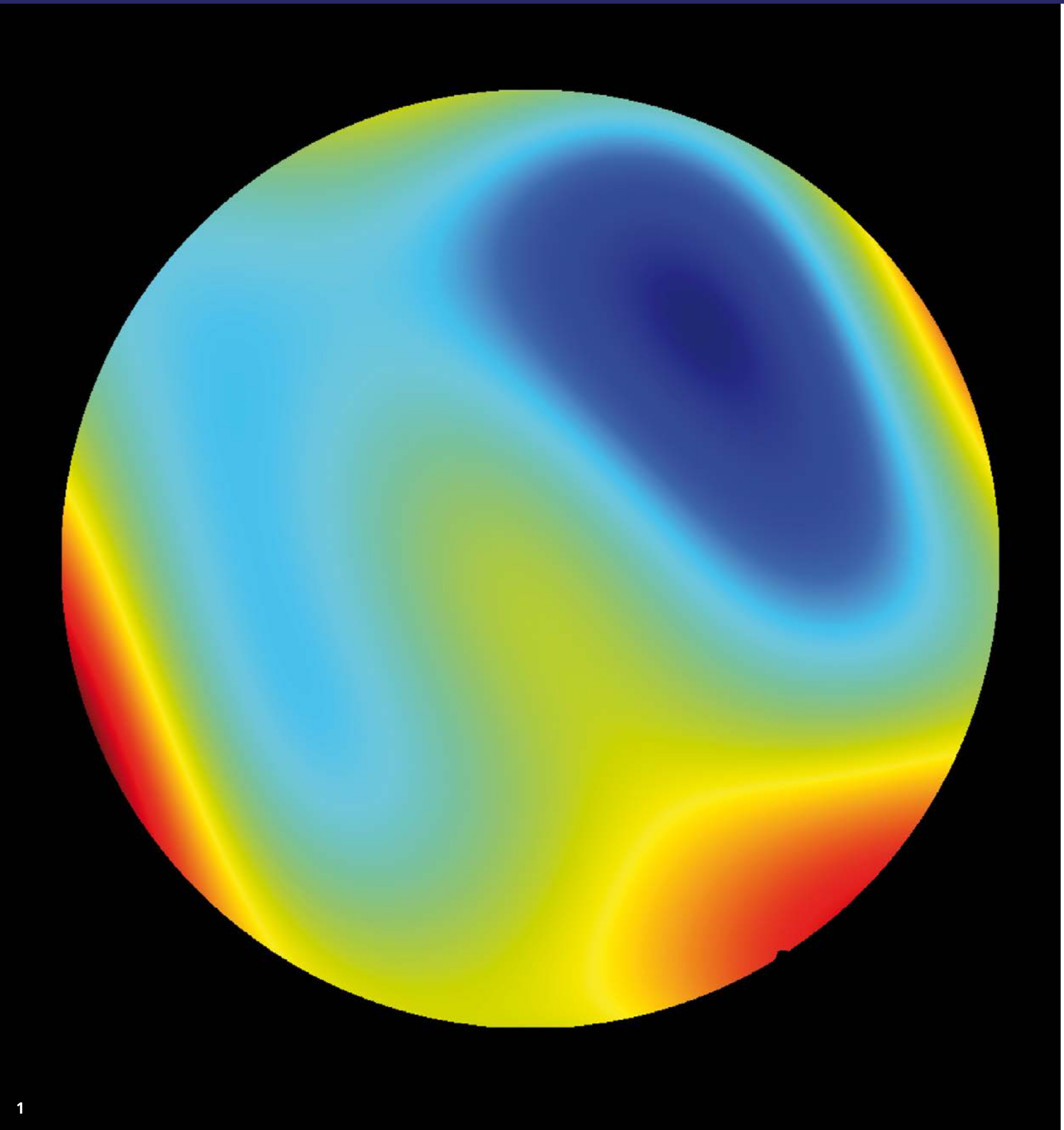
In 2013, a cooperation was established with the company E+H Metrology – a German tool manufacturer with more than 30 years of experience in the semiconductor industry. The aim is to develop a tool ready for the semiconductor market. Different applications are considered and concrete demands from industry are taken into account. E+H produces sensor systems especially for the characterization of semiconductor and solar wafers. They mainly use electric sensors such as capacitive or inductive sensors. The new technology from IISB broadens their portfolio. It complements the metrology with regard to optical methods and thus allows the development of new applications that go beyond the existing possibilities. The new method is especially beneficial when it comes to fast and above all high-resolution measurement of wafer surfaces such as nanotopography. Furthermore, the new method is very robust and flexible compared to existing nanotopography tools. It is also expected to be better suited for use in integrated metrology and an intended 100 percent control of wafers. Market potential is also seen in an all-in-one solution for the measurement of wafer topographies. The idea is to enable the measurement of several parameters, such as bow, warp, flatness, and nanotopography, in a single tool. The method will be marketed by E+H Metrology under the product name “Global Nano Scope”.

Current developments

Currently, a second prototype is being developed. The main objective is to identify all the improvements that are necessary to pave the way for an industrial application of this technology. Findings that were obtained from the first prototype were taken as a basis for further developments. A lot of work was done to enhance the optics. Together with a lens manufacturer, an improved design was worked out to eliminate known problems, especially concerning lens aberrations and false reflections. The new optic design was developed using ray trace simulations. Importance was also attached to the manufacturing of the bulk material for the large lenses. The glass blocks were fabricated in a time-consuming process that took several months. The reason for this is to avoid inhomogeneity in the glass material during production. Apart from the optics, improvements were also made to the mechanical design. A higher degree of automation will be present in the new setup. For instance, apertures and the adjustment of the focus are motor-driven. That makes it possible to set major measurement parameters more precisely and automatically via software. Moreover, a new calibration procedure was developed. A precise mirror is used for calibration. It is assumed to be perfectly flat, so that remaining deviations in the measurement of this mirror can be identified as artifacts resulting from the measurement tool itself. These artifacts can then be corrected in an actual wafer measurement. To allow for quantitative data, several parameters have to be calibrated. For this reason, a special calibration stage has been developed. It was mentioned before that the primary measurement of the method is the surface slope. This is why the system will set predefined tilts of the reference mirror. For this reason, the calibration stage includes actuators that make it possible to change the tilt of the stage in all directions.

1 *200 mm silicon wafer and its nanotopography measured by the new optical sensor developed by Fraunhofer IISB. © Fraunhofer IISB*

Work was not only done regarding improvements of the setup but also regarding the underlying theory and the physics. To discover the achievable specifications such as resolution, repeatability or accuracy, a deep understanding of the physical and technical limitations is necessary. This is related to the question of how to choose all the measurement parameters the best for a given measurement task. The first thing to be investigated was the role of noise, which basically affects the repeatability of a measurement. Analytical calculations were made to derive the underlying relations. Aside from noise, the method is limited by quantization effects resulting from the hardware. Nowadays most components, e.g. cameras, are electronic and thus digital. This means that the lateral dimension as well as the depth resolution are quantized. Not only the camera but also the micro display used for generating optical patterns is digital. There are a finite number of pixels and a finite number of brightness values available to form the desired pattern. The influences of those effects on the measurement performance are too complex to be calculated analytically. It was thus necessary to work out a simulation model of the whole measurement procedure. A geometrical optical model with wave optical elements was developed. The real optical imaging parameters are used in the simulation. In addition, all the hardware parameters such as the specifications of the used micro display and the camera are considered. The different noise sources known from the experiment are taken into account as well. The resulting camera image for a given topography can be simulated. The synthetic camera data is then processed with the same algorithms as is done for real experimental data. All kinds of measurement or hardware parameters can be changed, and their impact on the measurement performance can be investigated. The initial results of the simulation show that the influences of the different quantization effects are complex. However, it could also be shown that errors arising from quantization effects can be reduced by a multiple when the parameters are chosen correctly. The results will have to



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be verified by experiments but are already very promising. In general, the simulation helps to understand the method better. It also makes it possible to judge the different components so that a statement can be made, for example, on whether it may be reasonable to use a more expensive camera with a higher bit depth. When a setup is planned, the simulation model helps to evaluate the measurement performance that can be achieved within the given constraints a priori. Insights from the simulation were thus used for the new prototype.

Towards 450 mm

The latest developments were done in the European Project SEA4KET. A major task in SEA-4KET is the focus on 450 mm activities. The feasibility of the method for measuring topographies of 450 mm wafers will be evaluated. An area of 450 mm in diameter will be measured by stitching several neighboring measurements of the 300 mm measuring area. Special equipment for 450 mm wafers is needed. A metrology module for handling and positioning wafers up to 450 mm was constructed. It consists of a table, an automatic positioning system, and a chuck for 450 mm wafers. The metrology module is integrated in the existing 450 mm cluster at the IISB. The topography sensor will be mounted on top of the metrology module. It will be the first tool that can measure 450 mm wafers with a high resolution. Beyond that, the metrology module serves as an assessment platform for other 450 mm metrology components that are evaluated in the project.

1 *Pseudocolor image of the global topography of a 200 mm silicon wafer. © Fraunhofer IISB*

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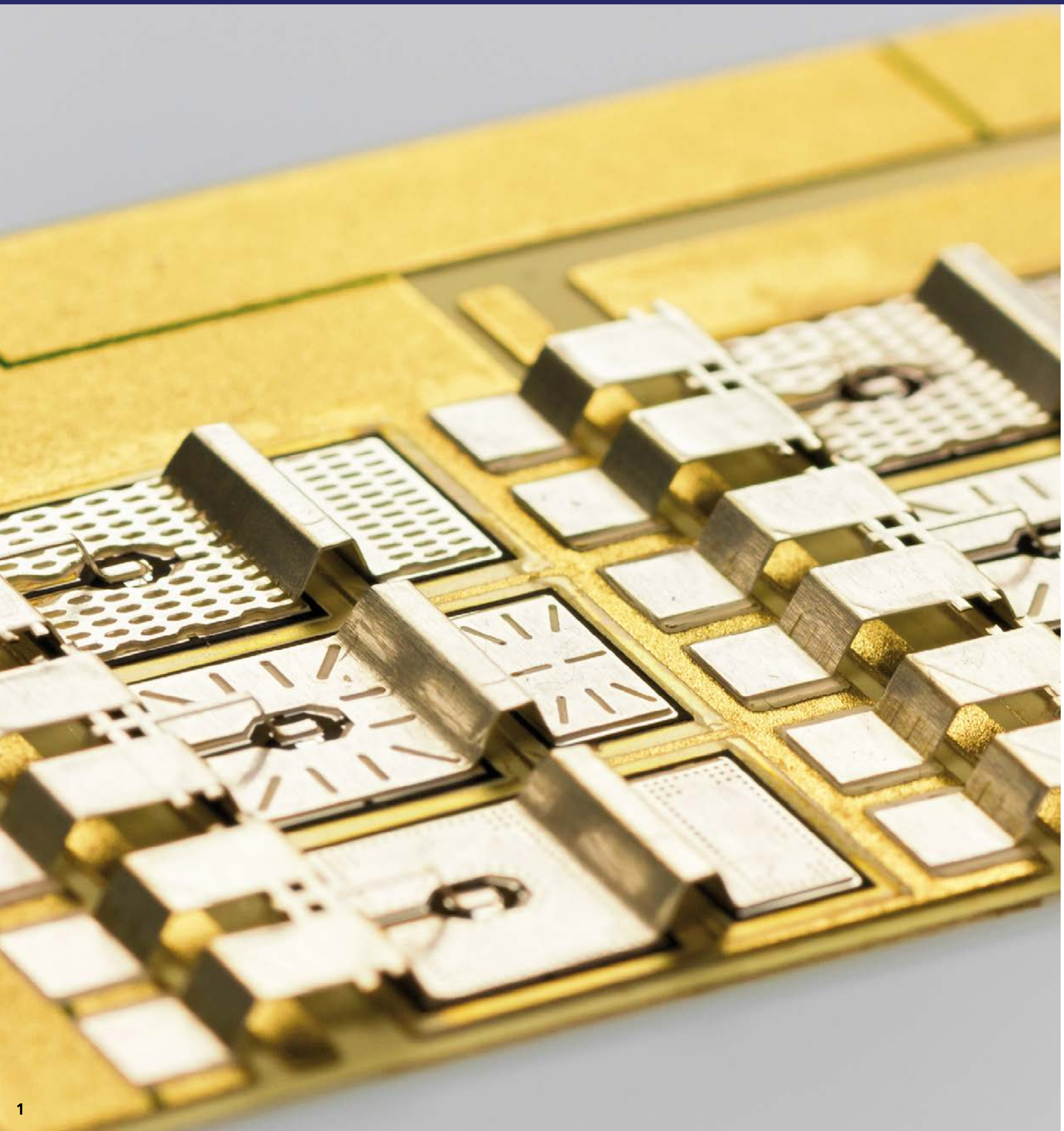
DEVICES AND RELIABILITY



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Devices and their packaging have a deep link to each other from the applications' perspective. New joining technologies with high temperature capabilities have an impact on the overall device design. Fast switching devices rely directly on the design of their packaging. To strengthen the research and development work in this field the institute started reorganization in 2013. This process was finalized in 2014.

As a consequence of the realignment of the organizational structure, the former group "Materials and Reliability" was split up into three separate units. All research and development work in the field of active and passive devices were merged in the group "Devices". The former group "Devices", belonging to the technology department, was active in the field of semiconductor devices only. Now it is supplemented by all other kind of passives and their research topics. Two new groups were founded: "Packaging" and "Test and Reliability."

The new department functions as a bridge between the, on material and process focused, "semiconductor technology" business unit and the system orientated "power electronics". The new structure perfectly fits into the institute's strategy process.

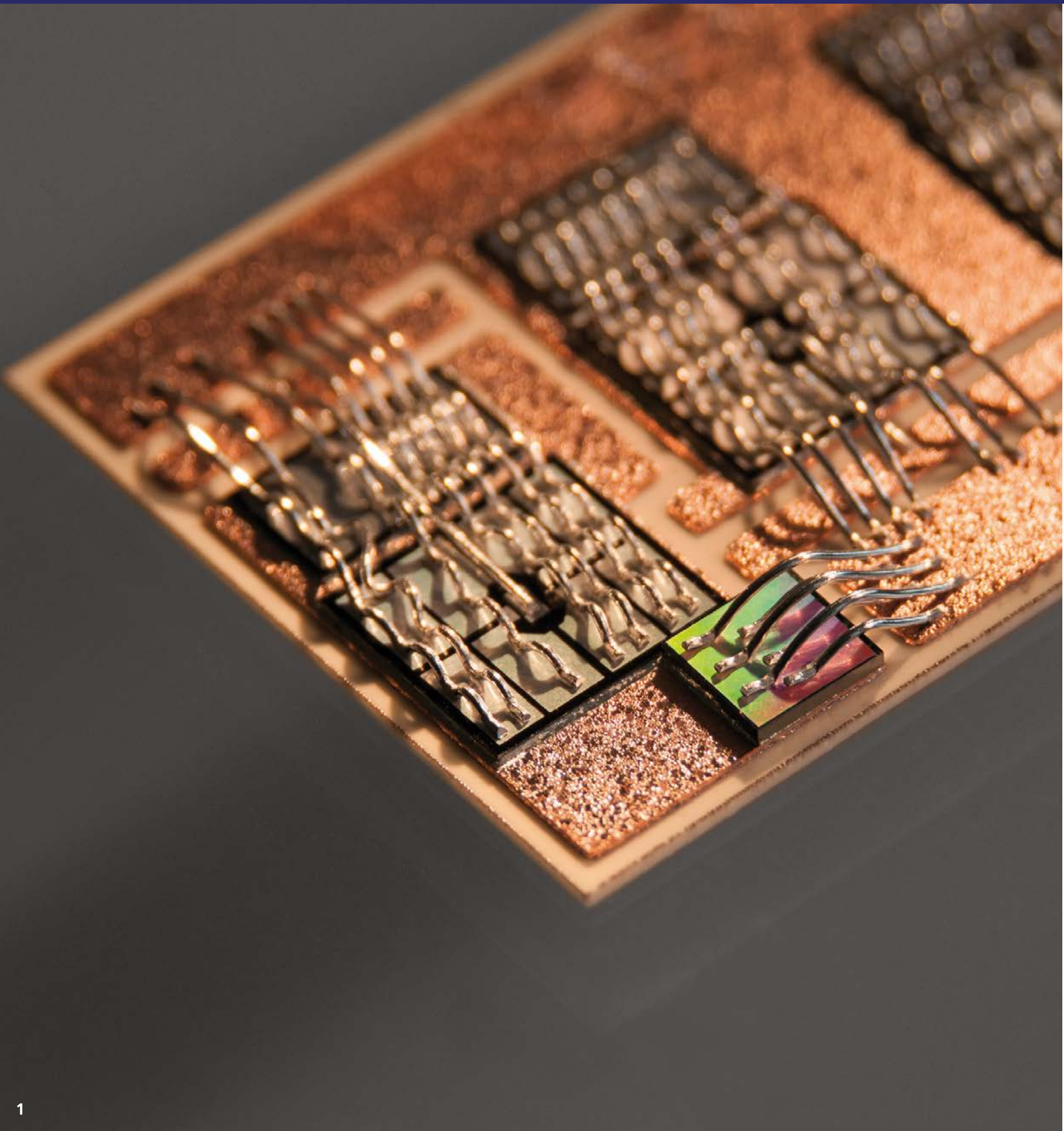
The research and development work on monolithic integrated snubber devices has been extended. There is now a new voltage available for the class of 600 V switching devices that enables a mass market for these devices. The work done in cooperation with the in-house P-Fab® allows stable processes in manufacturing. The development of blocking voltages in the 48 V region also started. The wide band gap silicon carbide activities are driven by high voltage. The Carnot-Fraunhofer research project MobiSiC was completed. The results, together with the actual work on trench etching, provide the basis for SiC-trench field effect transistors. The new EU project SPEED was been started. The work will comprise surge-current-resistant unipolar SiC diodes for wind power applications. The blocking voltage is 4.5 kV and above. This fits perfectly into the framework of the institute's strategy.

Important activities were introduced in the field of megawatt electronics for energy transmission. This covers complete high-voltage direct-current submodules down to investigations on power module levels. New concepts were developed for rearranging electric insulation for an optimized system cost. Electric field control and thermal management are key topics. The results of the research project APEx are also very good. Automotive applications and their topics still play a big role as a driver for new packaging technologies. Solutions for new devices based on wide-bandgap silicon carbide, as well as gallium nitride, were developed to take advantage of the high-speed switching, low static power losses, and the high temperature capability. As a result, the finite element analysis for the different disciplines was optimized by new tools and additional manpower.

1 *Double-sided sintering of semiconductor devices for enhanced lifetime.* *© Fraunhofer IISB*

2 *Andreas Schletz, head of the Devices and Reliability department.* *© K. Fuchs / Fraunhofer IISB*

DEVICES AND RELIABILITY



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Lifetime testing of power electronics moved to high temperatures. The unbelievable effect was found that high temperature leads to high lifetime. This behavior is valid for the right semiconductor chip metallization, joining technologies, and power module concepts. The team is keen on collecting more data to derive new lifetime models covering the new effect.

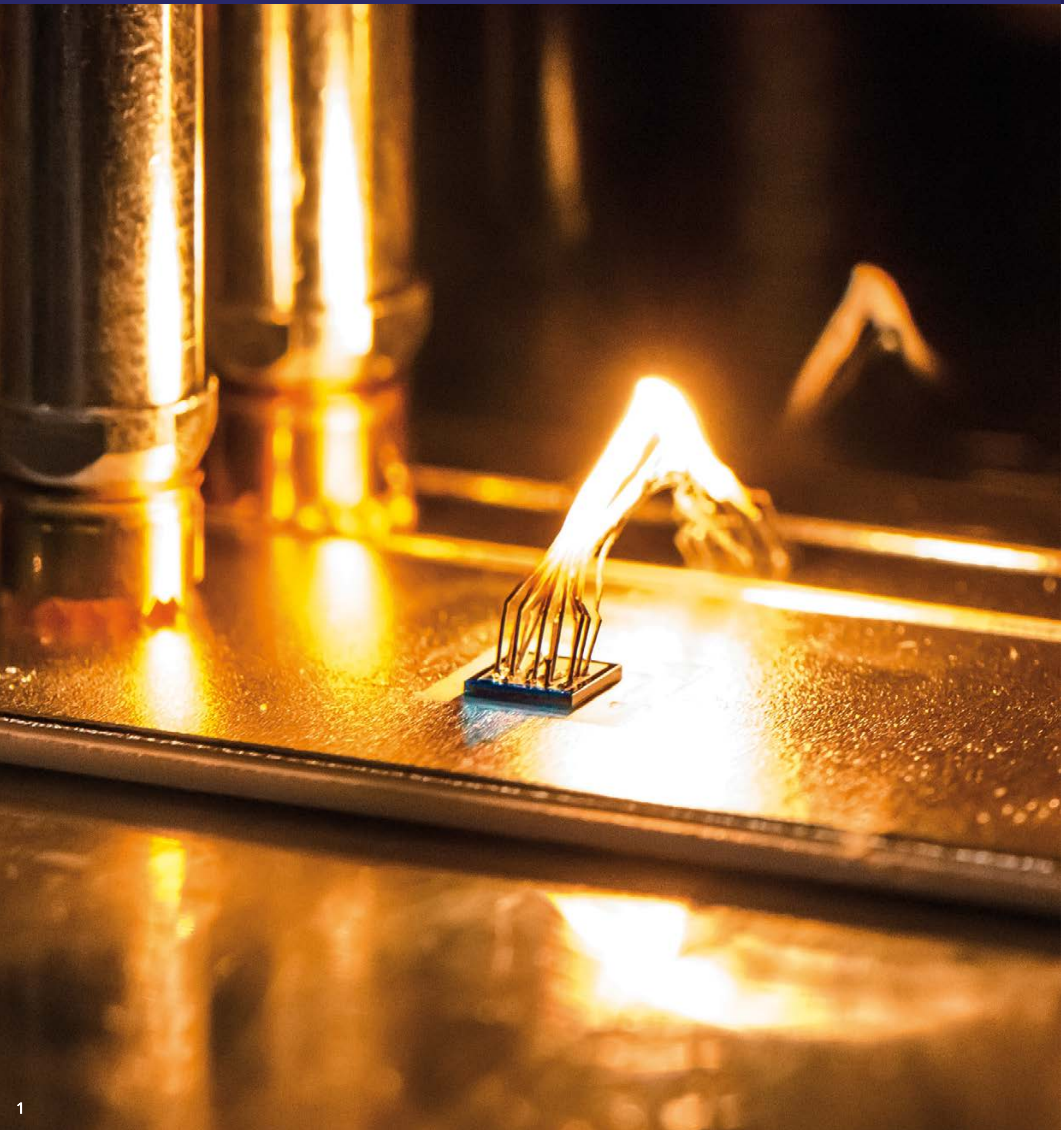
In addition to some new publically funded projects started in 2014, there were quite an impressive number of bilateral industrial projects. The topics range from assistance and consulting to large feasibility studies and process developments for devices, packaging, and testing. The applied research at Fraunhofer is financed by an industrial budget contribution well above the thirty percent target. Many thanks to all colleagues for their support during the organizational changes, and the excellent work in designing the future.

1 *Monolithically integrated RC snubber for power electronic applications sintered on direct copper bond. © Fraunhofer IISB*

Increasing Lifetime at High Temperature

Increasing the temperature in power electronic applications usually causes the lifetime to decrease. However, recent research investigations of the department have shown that packaging materials and technologies such as silver sintering or gold germanium solder can easily withstand temperatures above 150 °C. Furthermore, their power cycling capability can be much better at increased temperatures than at room temperature. According to popular empirical lifetime models, the load cycling capability of these electronics will always decrease when the absolute temperature increases. The packaging is well known as the bottleneck of today's electronics. Nevertheless, there is a bright light at the end of the tunnel: It has been shown that one part of the packaging, the die attach, does not follow this hypotheses.

The involved team performed active power cycling tests on a large number of test specimens. More than two hundred devices were tested and analyzed to produce the data. The power cycling test method is more practically oriented than passive thermal cycling, because a certain periodic electrical current is flowing through the devices under test. As a result of power losses, the semiconductor devices and all material layers are heated up and cooled down. The minimum temperature at which the devices cool down is defined as the coolant temperature. This temperature is the dominant testing parameter and is varied throughout the procedure. Different technologies have different numbers of cycles to failure, which yields the so called lifetime. The distribution of failures is described as the reliability. It has been shown that tests at a coolant temperature of 120 °C produce many more cycles to failure than at 40 °C. To give the reader an impression of the temperature capability, the tests were run with a temperature swing of 130 K, which is in addition to the minimum temperature. This means that the maximum temperature of the semiconductor devices was 250 °C. The state of the art is somewhere around 175 °C.



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The reason for this effect was found in the material properties. It is well known that the Young's modulus decreases with increasing temperatures. This is a common behavior of metals. Analytical models for stress calculation stipulate that a decreased elastic modulus leads to a lower mechanical stress. If all other material properties are neglected, a higher absolute temperature in the application, which is representative of the coolant temperature during the test, will reduce the thermo-mechanical load and therefore increase the lifetime of the assembled power electronics. The elastic modulus is only one of many material properties which influence the thermo-mechanical load capability of an electronic packaging. A more important factor for the die attach is the ductility of the material. The yield strength may be an appropriate parameter to characterize the ductility. Its response to temperature follows the direction of the Young's modulus. This means the materials become more plastic. There is also the ultimate strain, which describes the amount of plastic deformation the material can withstand. The measurements show that the tested materials experience a dramatic transformation at high temperatures. The materials become much more resistant to load cycling at higher temperatures.

In addition to the promising high-temperature outcome, there is another result that should not be neglected: the specimen was equipped with aluminum bond wires during all the various active power cycling tests. Aluminum wire bonding normally has an adverse effect, decreasing the lifetime with state of the art technologies. In this case, however, the team used an uncommon diameter for the bonding, which helped to increase the lifetime far beyond what was needed.

In conclusion, there are packaging materials that can withstand higher temperatures than the materials used in today's power electronics. Exotic solders as well as the promising silver sintering technology are candidates for the die attach. Silicon carbide semiconductor devices in particular require improved die attach technologies to gain benefits besides electrical ones. Another important step towards high temperature electronics has been taken.

Let's try it out!

1 *Active power cycling test of silicon carbide devices at high temperature and overcurrent.*
© Fraunhofer IISB

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VEHICLE ELECTRONICS

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After the successful reorganization of the power electronic activities, the Vehicle Electronics department, which was newly formed in 2014, was well established. More than ten years of experience in developing automotive power electronics, many links to the automotive industry, and several ongoing research projects offered an excellent starting point. Our close cooperation with the Devices and Reliability department, the Energy Electronics department, and the Simulation department enables us to realize automotive power electronic solutions with unrivaled power density, efficiency and functionality.

We are a member of the "Nationale Plattform für Elektromobilität" (NPE), which was established by the federal government of Germany. The NPA reports directly to the German chancellor, Dr. Angela Merkel, and the Ministries for Economics (BMWi), Transport (BMVBS), Environment (BMU), and Research (BMBF). We work closely with industry and academic partners on pinpointing the necessity of research in special fields of automotive power electronic systems.

Based on the need for further research in automotive power electronics, several proposals were presented to the BMBF. The research projects "Luftstrom", focusing on GaN semiconductors for highly efficient chargers and converters, and "HV-Modal", focusing on a modular, up to 800 V power train, were approved to start in the beginning of 2015. The research project "InSeL" focuses on the improvement of EMC and started in January 2014.

With our focus on advanced mechatronic integration and new wide band gap semiconductors such as SiC and GaN power semiconductor devices, we were able to realize automotive DC/DC converters and drive inverters with outstanding power densities and very high efficiencies that give our partners a glimpse of the future of automotive power processing. These new power electronic systems make it possible to evaluate new power train concepts for the mobility of the future.

At the PCIM 2014 exhibition, we presented a power stage of a bidirectional, non-isolating 200 kW DC/DC converter using 1200 V SiC MOSFETs with an impressive power density of up to 140 kW/dm³.

This focus has enabled us to achieve a very good distribution between publically and industry-funded projects, with an industry rate of well above 30% in the first year.

I am sincerely grateful to all of my colleagues, our industry partners, and the political support that made the new Vehicle Electronics department successful from the beginning.

1 *Bidirectional, non-isolating 200 kW DC / DC converter using 1200 V SiC MOSFETs: power density of up to 140 kW / dm³.*
© Fraunhofer IISB

2 *Dr. Bernd Eckardt, head of the Vehicle Electronics department.*
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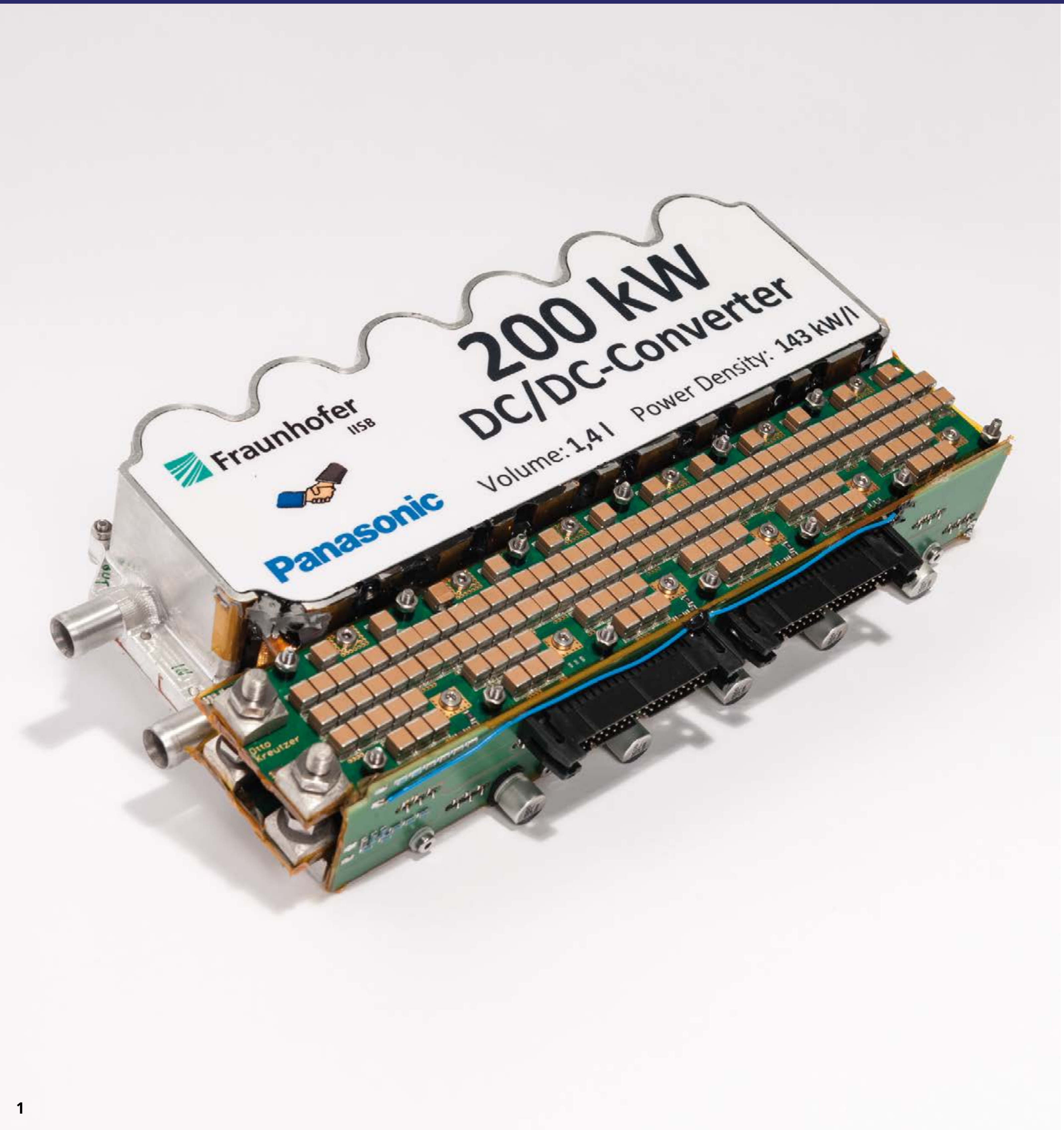

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Smart Inverter Systems for In-wheel Drives

Performant, safe, and cost-efficient electric drive systems are – in addition to competitive energy storages – the key element for the electrification of the vehicle drive train.

Electric wheel hub motors are a fundamental shift from classic electric traction drives due to their direct placement in the wheel. Bulky and costly torque transmitting elements, such as mechanical gears, differentials and axle shafts, are completely avoided. In addition to the possibility of advanced safety features and driving performance due to single-wheel torque control, the use of wheel hub motors offers revolutionary degrees of freedom on the vehicle level in terms of design, packaging, and vehicle functionality (e.g., maneuverability).

Following the approach of integrated smart drives with a direct placement of the power electronics in or attached to the electric drives, Fraunhofer IISB has successfully developed a broad range of inverter solutions for in-wheel motors in industrial and publically funded projects. The systems cover a broad range from 10 kW to 300 kW output power, 48 V to 900 V DC-link voltages and are suitable for a variety of vehicle concepts and cooling types (liquid and air cooling).

Resulting advantages of the integrated approach are cost-efficient and compact traction systems due to the standard use of subcomponents such as housings and cooling circuits. In addition, the vehicle installation is simplified due to the reduced amount of components, interfaces and the missing external AC cables – also avoiding one of the main sources of EMC emissions and problems. The main challenge, and therefore one of the IISB R&D focuses, is the significantly higher shock and vibration loads on the electronics resulting from the installation in the unsprung part of the vehicle.

To address these requirements in the design phase, FEM analysis tools and experimental equipment (e.g., shakers) are used to quantify the impact on electronic components and interfaces.

Successful Cooperation with Schaeffler Technologies in the Field of In-wheel Drives

The Schaeffler eWheelDrive is an advanced in-wheel traction drive with high function and component integration. An output power of 50 kW at a nominal DC-link voltage of 400 V is supplied to the system, which consists of a PMSM motor with integrated brake system and a 3-phase IGBT inverter. The inverter power electronics was developed and realized in close cooperation with the Fraunhofer IISB. Maximum power densities, drive-cycle efficiencies, and a modular system design have been achieved despite the high level of mechatronic integration.

1 *Air-cooled drive inverter for 20 kW wheel hub motor.*
© Fraunhofer IISB

2 *Custom made power modules an mechatronic integration: the key for future vehicle power electronics.*
© Fraunhofer IISB

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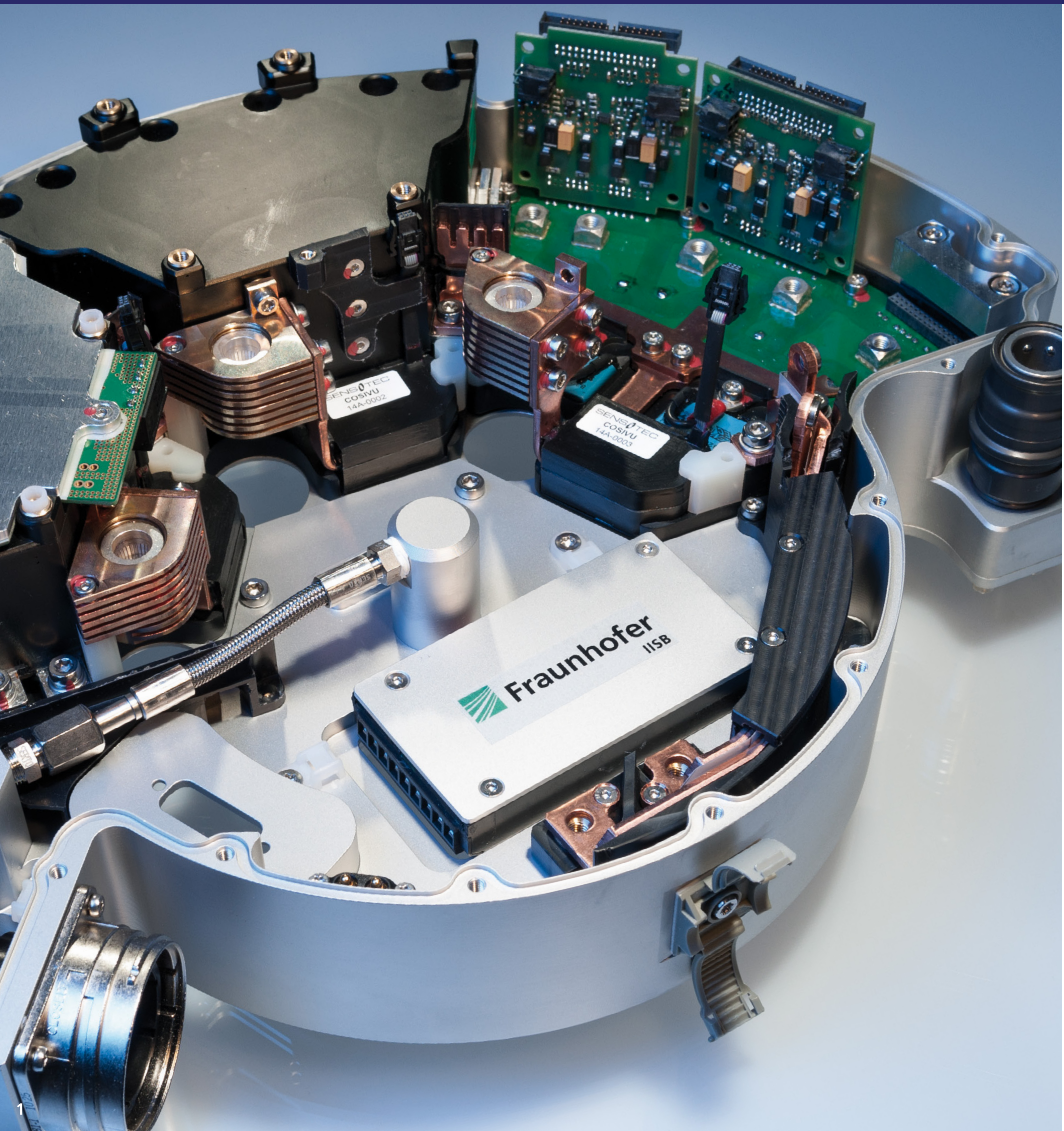
VEHICLE ELECTRONICS



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In a variety of tests, including the successful participation of a Schaeffler experimental vehicle in the Silvretta Classic Rally, the system could already prove its maturity despite its prototype status. In 2014, the joint R&D cooperation was awarded the "Georg-Waeber-Innovationspreis 2014".

Modular 1200 V SiC Inverter for Volvo Commercial Vehicle

Within the FP7-funded project COSIVU, an in-wheel drive inverter was developed for dual use in passenger cars and in commercial vehicles from Volvo. For maximum efficiencies and higher DC-link voltages, the inverter power electronics is equipped with 1200 V SiC transistors. An output power of 290 kVA with a maximum phase current of 300 A_{rms} could be achieved with the water-cooled systems.

A modular "plug & play" inverter system design was developed to meet the challenging demands in terms of vehicle up-time and serviceability in commercial and construction vehicles. All electrical and hydraulic connections are established when the inverter system is plugged into the electric machine, which allows very short repair times. The internal design also follows the modular approach using smart inverter building blocks (SIBB) consisting of power modules with integrated DC-link capacitor, gate driver and current sensor.

1 *Water-cooled 290 kVA SiC drive inverter for wheel hub motor of an excavator. © Fraunhofer IISB*

2 *Wide range of applications and power demands for wheel hub drives. © Fraunhofer IISB*

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ENERGY ELECTRONICS

The newly established Energy Electronics department focuses on power electronic systems for electrical energy supply. The range of applications includes the entire power range, from a few watts up to gigawatts. The department has about 35 employees, including 28 engineers, plus around 30 students and includes four working groups.

The Application group, under the leadership of Mr. Markus Billmann, supports our customers with power electronic application problems. Whether development support or problem analysis on running facilities, the list of strengths of this group is long: standing application experience, fast response time, and familiarity with industrial work processes.

The focuses of the Energy Systems group, headed by Mr. Dirk Malipaard, are research and development on multi-level inverters for applications in all power and voltage ranges. This group is located in our branch lab in the "Energy Campus Nürnberg" (EnCN).

The Battery Systems group, headed by Dr. Vincent Lorentz, is working on innovative solutions for Li-ion based electrical energy storage systems for stationary and mobile applications. The activities range from the development of embedded energy management software up to the design of full-custom high-power energy storage systems for smart grid applications.

The DC Grids group develops solutions for local DC systems. Their work ranges from basic research, e.g. stability analysis of DC networks, through concept studies and up to the development of network components such as DC/DC converters or innovative solutions for DC plugs or DC protection devices. The head of the group, Mr. Bernd Wunder, also represents the DC topic on boards such as VDE/DKE, IEC, eMerge Alliance, or IEEE Smart Grid.

In 2014 the work on the Bavarian state-funded projects EnCN and SEED were well on schedule, along with the work on the EC projects AVTR, EDAS, E2SG, and DCC+G. The interim evaluation of the project EnCN (NET) was very positive. The EC projects SuperLib, Motorbrain, Estrelia, and Rely could be brought to a successful conclusion. In the project DCC+G, the IISB provides its DC grid demonstration center as an experimental platform for system components that were developed by the international partners within this project. The integration of the partner contributions was largely completed in 2014 and the trial operation under everyday conditions could be started.

A highlight in 2014 was certainly the completion of an agreement with Siemens for a strategic cooperation under the Campus "Future Energy Systems" (www.campus-fes.com). In Campus FES, Siemens is working with the Fraunhofer IISB, the University of Erlangen-Nuremberg, the KIT, and a few other selected partners to develop sustainable, reliable, and affordable next-generation energy systems. Focuses of the IISB are power electronics and specifically issues around mod-

1 *Stationary smart battery system, compatible with 19" racks and based on safe, robust, and durable lithium-titanate cells. Several of these battery systems are used for solar energy storage and peak-load buffering in the local 380 V DC network at Fraunhofer IISB.*
© K. Fuchs / Fraunhofer IISB

2 *Prof. Martin März, head of the Energy Electronics department.*
© K. Fuchs / Fraunhofer IISB

ular multilevel converters. The Campus FES cooperation underlines the importance of the Erlangen/Nuremberg site as a national performance center for electronic systems.

2014 was also marked by the plans for the extension B of the Institute building in Erlangen. With this building, the department will get an ultra-modern medium-voltage test facility (20 kV, 2 MVA). In addition, our 380 volt DC power technology will be used and tested in this new building on a larger scale.

Today, the department covers the entire range of power conversion applications, from power supplies on building infrastructure components, to grid and energy generation systems of the highest power. It is therefore well prepared for the challenges and opportunities of the "energy revolution" and has already become a powerful and sought-after development partner for industry.

Apart from this, an impressive number of industrial projects could be processed successfully. There were also 22 supervised bachelor's and master's theses, 10 scientific publications, and 16 lectures. Four seminars were organized for the Bavarian power electronics cluster, including the highly successful 2nd cluster seminar and IISB annual symposium on local DC grids.

Sincere thanks to all colleagues in the department for their extraordinary dedication, and to all our industrial supporters, political supporters, Fraunhofer, and the entire institute.

Smart Battery Systems

Powerful electrical energy stores are rapidly increasing in importance for all types of vehicles – whether in the air, in water or on land – for mobile equipment as well as for stationary applications. A vehicle consuming the energy of its own PV system instead of feeding it to the mains supply is becoming more and more attractive, and not just economically. However, since generation and consumption seldom occur at the same time, this can only function with suitable "electricity stores". Central requirements for storage batteries include the issues of safety and functionality, in addition to costs. Fraunhofer IISB addresses these three issues with their concept of a smart battery system, which has already been implemented in various demonstrators.

A smart battery system means, among other things, a consistent safety concept that starts with the design of the cell modules and extends from comprehensive monitoring of all critical cell parameters to integrated protection measures against mishandling – such as short-circuits, overloads or overcharging. The design of the cell modules already determines important characteristics related to safety and service life. For this reason, design specialists at the IISB are working,

1 *Smart battery system of the electric sports car IISB-ONE developed at the institute, which is approved for road traffic.*
© Fraunhofer IISB

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ENERGY ELECTRONICS

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for example, on cooling solutions that minimize the temperature gradients within the cell block, even with a high electrical loading of the battery cells. This is the prerequisite for an even aging of all cells and minimizes the danger that individual cells will excessively "weaken" over time and then, as the weakest link in the chain, bring down the performance of the entire storage system or even produce a safety risk.

A new type of temperature sensor developed at the IISB can be directly printed on battery cells with an ink-jet or screen printing method, allowing economical monitoring of the cell temperature.

If an individual cell should still fail, special antifuses developed at the IISB make it possible to eliminate the defective cell from the group and maintain the function of the battery system. These antifuses are fuse elements that, when tripped, generate a short-circuit that can even be loaded with high currents – unlike classic fuses, which interrupt the current when they are tripped. Two innovative solutions for antifuses, for which a patent has been applied, have been developed at the IISB: one version is automatically tripped when an error occurs and another can be "ignited" via a digital signal.

In the framework of an European research project at the IISB, it was also demonstrated that a low-cost, commercially available gas sensor could be used to identify an imminent catastrophic error. The error was recognized so early that the storage system was able to implement protective measures itself before unstoppable destruction processes started inside the cell that would cause it to open or catch fire.

Lithium-ion batteries react extremely sensitively to the over- and undershooting of particular voltage limits; for this reason, precise voltage monitoring of all cells is imperative. In the area of cell monitoring, the IISB cooperates with a number of renowned IC manufacturers. One of the issues here is guaranteeing the functional safety required for a high safety integrity level (SIL).

A further important research topic is reducing assembly costs for battery modules by minimizing the wiring effort for electrical and thermal cell monitoring. Another innovative method for which a patent has been applied allows contact-free communication between cells or cell modules and the higher-level battery management system.

The most precise possible information on the charge state, the health status and the operational capability of the battery system is important for every application. For this purpose, the IISB is developing physically based models for condition monitoring. The algorithms run on an open battery management system developed at the IISB that is based on a powerful 32-bit processor.

1 *Assembly of smart battery modules for stationary application at Fraunhofer IISB. © K. Fuchs / Fraunhofer IISB*

2 *Ideally suited to buffering peak loads and regeneration energy in industrial-scale environments: local DC voltage networks combined with intelligent electrical storages. © K. Fuchs / Fraunhofer IISB*

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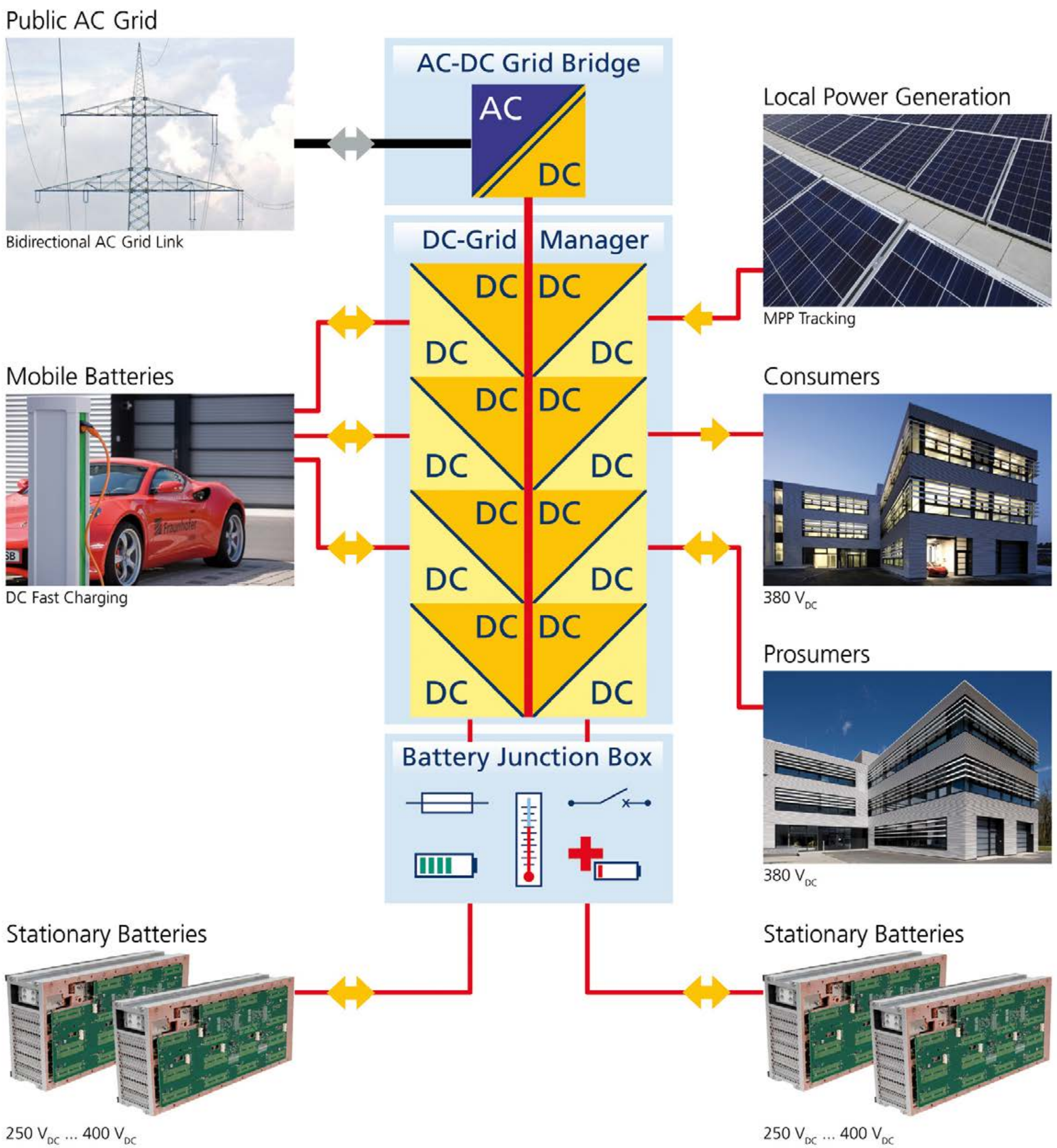

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A smart battery system means maximum functionality for the user, in addition to very high safety. As the result of its integrated DC converter (DC/DC converter), the battery system provides an output voltage that can be freely selected within a wide range – stable under load and independent of the charge state of the cells. The DC/DC converter is also the first protection level for the battery system against short-circuits and overcharging and thus significantly contributes to safety.

The DC/DC converters developed at the institute with capacities up to 500 kW continuously achieve efficiencies of over 98%, and that even with output voltages of the battery system in the range of 400 to 850 volts. The latest SiC power semiconductors are mainly used in this voltage range.

The DC/DC converter integrated in the battery system takes care of the entire charge control. No special charging device is required, and it is ensured that the store is always operated with the optimum charging parameters for the cell technology used. Each battery system additionally has an interface (CAN bus) for communication with the higher-level system control of the user. All relevant measurement data and operating parameters can be called up via this interface.

At Fraunhofer IISB, a smart battery system for solar energy storage and peak load buffering is installed in the institute building. This stationary battery system is based on an especially safe, robust and durable lithium-titanate cell technology. The cells are combined into battery modules that are compatible with 19" racks. Depending on the number of equipped modules, storage capacities of up to 20 kWh for each switch cabinet and peak outputs of 100 kW are possible. Several of these cabinets are integrated in a local 380 V DC network. A version for operation in a +/-380 V DC network will be available shortly. With an external conductor voltage of 760 V, this battery system is ideally suited to buffering peak loads and regeneration energy in industrial production plants, for example. In the future, this will be done with a drive technology that will mainly be networked on the DC level.

Due to the lowered costs, increased efficiency and reduced installation space that this makes possible, local DC voltage networks combined with intelligent electrical stores will considerably help to implement future Industry 4.0 concepts at economical costs.

1 Schematic view of the local DC network infrastructure with stationary smart battery system at Fraunhofer IISB.
© Fraunhofer IISB

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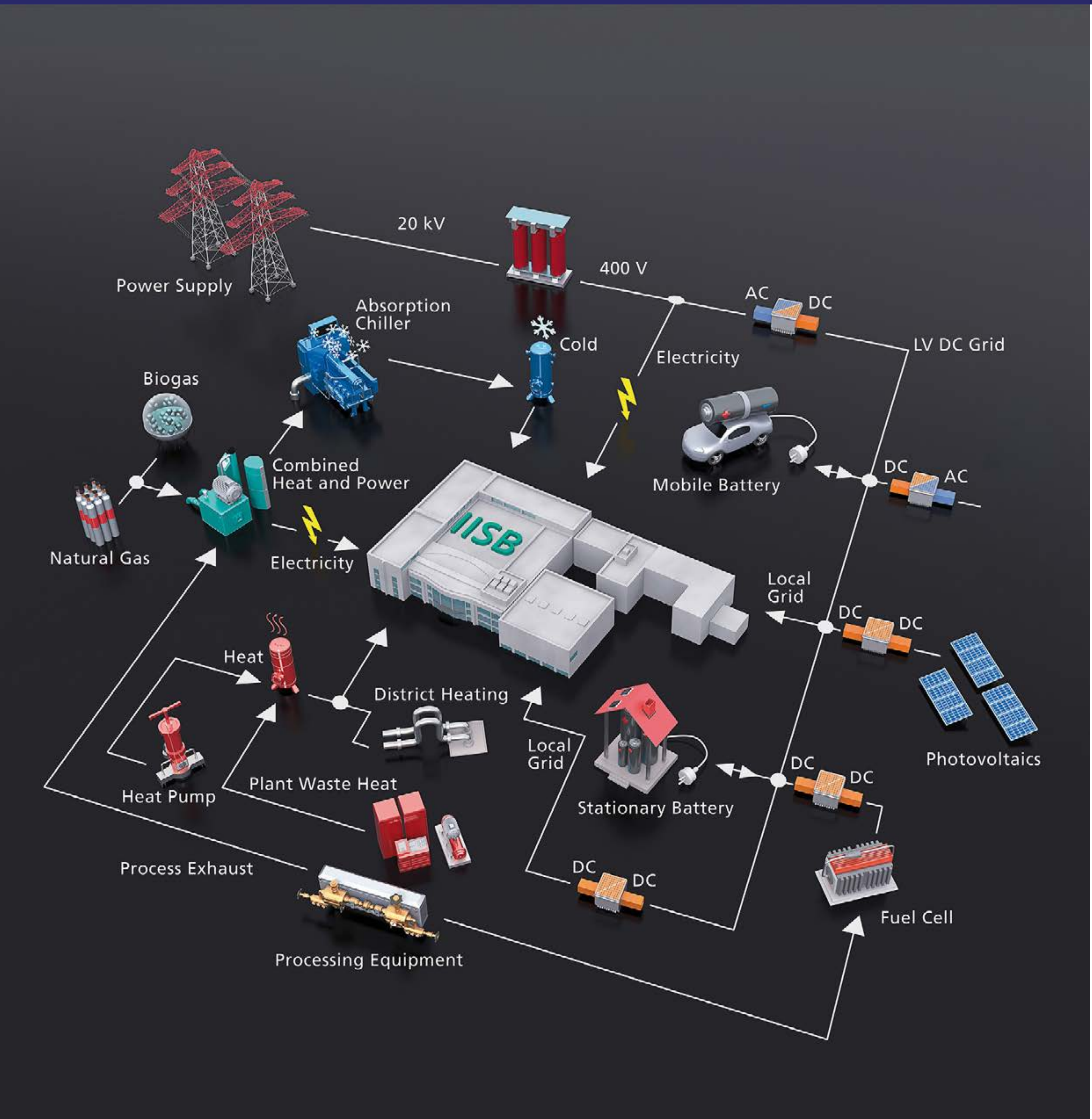

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Intelligent Use of Energy in Small and Medium-sized Industry – Project SEEDs

The basic idea of the SEEDs project is to reconstruct and optimize the local energy systems for small and medium-sized companies (industrial level) by utilizing and further developing existing approaches and techniques. The goal is to research, develop and implement sustainable energy production, energy storage, energy supply, and efficient energy use at a local industrial level. In this connection, the focus is on maximum efficiency, cost effectiveness as well as the security of supply and stability autarchy.

The areas covered in SEEDs are microgrids, energy storage, gas-to-power coupling, grid connection, load shift, sustainable creation, and the use of energy, as well as energy efficiency. The whole chain of energy technology is therefore investigated. Specific attention is paid to an efficient interlinking of power electronics and interfaces with different components of the local energy system, in order to set up a stable overall local energy system with respect to controlling. These interfaces are a core competence of Fraunhofer IISB. The Fraunhofer institutes IIS and ISC are also participating in the project. IIS covers communication-related topics, and ISC handles material aspects for electrical battery development.

The main institute building of the Fraunhofer IISB serves as a research and demonstration platform. The requirements for different energies (heat, cold, and electricity) as well as the range, infrastructure, and energy consumption of the IISB are comparable to those of small and medium-sized companies. IISB shows a high load fluctuation, high peak loads, and a substantial need for secondary energy due to a considerable amount of labs and equipment for semiconductor processing as well as manufacturing. A clean room is in continuous operation, and a large number of labs and offices are in use. Therefore, the IISB platform covers office as well as industrial and lab aspects, which means that nearly all facets of energy management and the energy sector of a local energy system are dominant. Production-related activities are continuously performed, but no direct production cycle will be disturbed for research and development. Therefore, this research and development platform seems to be ideal for applications such as research and demonstration activities.

The activities and highlights of the project are briefly described in the following.

Monitoring and Energy Efficiency

The energy monitoring system of IISB, established in 2013, has been continuously expanded. The system currently monitors more than 60 data sources. It continuously monitors all main power

1 *Overview of the topics and components of the SEEDs research and development platform: the main institute building of Fraunhofer IISB.*
© Fraunhofer IISB

2 *Dr. Richard Öchsner, head of the Energy Technologies group.*
© K. Fuchs / Fraunhofer IISB

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consumers and energy flows in the areas of heating, cooling, and electrical power. Additionally, many portable measurements have been performed to achieve a more detailed insight into specific areas and consumers. The measured and stored data now covers a period of more than a year. This real data allows a detailed analysis of the performance of infrastructure systems and is the basis for numerical simulation to investigate the behavior of changes in the local energy system. The analysis reveals optimization potentials for heat distribution, cooling (production and distribution), and air-conditioning.

In 2014, a research photovoltaic system with 175 kW_{peak} was installed on the roof of the main building and integrated into the electrical power distribution and monitoring system. The energy is entirely consumed in the institute and allows daily peak load reduction.

Gas-Electric Coupling

A test center for hydrogen components was built and successfully put into operation, including all safety certifications. Within the test center, a gas mixing system for binary gas mixtures is available to investigate and characterize hydrogen filters and fuel cell systems up to 10 kW. A special objective is electric energy recovery from the waste gas of industrial processes. For that purpose, filter systems were analyzed and assessed, and a membrane filter was chosen as a promising technology. A PEM fuel cell system with 8 kW of electric power, which was specially constructed for gas mixtures, was designed in cooperation with a fuel cell manufacturer and installed. Especially for hybrid hydrogen systems consisting of a fuel cell, an electrolyser and a battery, a simulation model and a new energy control approach based on a finite state machine was developed. The energy control allows several grid services to be investigated, and the simulation model enables an optimized component dimensioning.

Cold and Warm Water Supply Systems

Different approaches to increasing the energy efficiency of cold water supply systems have been investigated in the framework of the project. The main instruments for raising the overall efficiency are the use of thermal energy storage systems and non-invasive testing of operating strategies via simulation of refrigeration networks. Regarding the application of thermal energy storage, a cold water storage system with an absolute volume of one cubic meter has been developed and assembled at the institute. It is used for investigating different types of inlet geometries and their impact on the thermal stratification quality inside of the tank. A later use for studying different storage materials is also intended. As for the simulation of energy systems, models of major refrigeration components within a cold water supply system have been developed that can be run in various combinations. With this approach, arbitrary properties of refrigeration networks can be modeled and improved regarding their utilization and operation strategies.

1 *Hydrogen test center at the Fraunhofer IISB for PEM fuel cell systems and hydrogen filter. One special objective is the electric energy recovery from waste gas of industrial processes.*
© B. Müller / Fraunhofer IISB

2 *Central heating facility in Extension Building A of Fraunhofer IISB.*
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The main focus in the area of heating systems is based on cogeneration of heat and power systems of optimized size, which are connected to heat storage tanks, photovoltaic installations and the heat distribution grid. A numerical simulation uses measurements of heat load, electric load and photovoltaic load. Data was collected throughout the whole year of 2014. Sized to 225 kW electrical CHP power and 25 m³ heat storage volume, the institute can save a six-digit amount of energy costs. Moreover, a heat pump was investigated for efficient integration to reuse industrial waste heat from air pressure production and air-conditioning equipment. Feeding will be connected to the heat supplier serving air-conditioning for laboratories and workshop area. The start of operation is planned for autumn 2015. The system can save about 260 MWh of thermal energy per year, which is equal to a seventh of the total thermal energy consumption per year.

Local Energy Distribution through DC Microgrids

Steadily increasing quantities of decentralized energy resources such as photovoltaics, micro wind and gas turbine systems, batteries, fuel cells, and redox-flow systems bring the power generation closer to the power demand. In consequence, micro grids offer the opportunity to bring sources and loads closer together in one independent, locally controlled grid, which itself may be connected to the regular AC power grid.

Employing a local DC micro grid in a commercial or industrial building offers the operator several benefits. High efficiency, reduced costs, smaller cable diameters, and simpler electronics are some of the advantages. DC microgrids typically have only one central AC/DC converter to serve as a connection to the AC grid with very high efficiency. This centralization of the huge number of low-power and low- efficiency AC/DC adapters increases the efficiency even if no regenerative energy is available and the AC/DC connection is necessary.

Because virtually every device is ultimately powered with DC, many applications can benefit from a DC microgrid. Examples include the areas and equipment in datacenters, commercial and office buildings, industrial manufacturing halls, electric vehicles, and public transportation.

SEEDs is funded by the Bavarian Ministry of Economic Affairs and Media, Energy and Technology in the framework of the Bavarian initiative for research and development of technology.

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1 *Newly installed research photovoltaic plant on the roof of the main building, integrated into the electrical power distribution and monitoring system.*
© K. Fuchs / Fraunhofer IISB

2 *For the implementation, safe operation, and control of centralized DC micro grids, a system called DC Grid Manager was developed. The proposed approach improves the system reliability and efficiency for a stand-alone or grid-coupled micro grid. It is also possible to feed in power from different sources (e.g., photovoltaics, fuel cells) and distribute it efficiently to different battery stores or loads. For an efficient and modular way to connect the DC microgrid to the conventional AC mains, a separate AC/DC controller was realized.*
© B. Müller / Fraunhofer IISB

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Fraunhofer IISB Shows New Developments at PCIM Europe 2014 in Nuremberg

Local direct current systems in buildings or industrial plants can effectively contribute to a considerably more efficient energy use. Especially when it is generated and stored locally. The development of future-oriented solutions for DC technology is a focal area of Fraunhofer IISB. At the PCIM Europe 2014 in Nuremberg from 20 - 22 May, the institute presented a wide range of power electronic innovations for energy supply – including a 200 kW DC/DC converter with a power density of over 140 kW per liter.

Direct current technology not only offers advantages in the form of low transmission losses in the transport of electric energy over long distances; there are great potentials for energy savings in residential, office and industrial buildings. Local direct current systems that directly supply specific consumers on different voltage levels and are only connected with the alternating current system via a central converter make it possible to avoid a multitude of power supply units and thus lossy conversion processes, since most applications require direct current for operation. In addition to the current consumption, this also reduces the construction volume required for electronics, the material expense and costs.

Small consumers such as computers, entertainment electronics or mobile phone chargers can be supplied with 24 V DC voltage. This also eliminates the jumble of cables and power supply units under desks. For higher outputs required by lighting or cool chains, for example, a 380 V DC system is a good idea. In addition, solar systems and electrical energy stores also provide direct current, so that current that is regeneratively produced on site can be directly fed into the building network and efficiently stored locally. Only a few less complicated and low-loss DC/DC converters are then needed to link the various components. The power electronic systems required for this are researched at Fraunhofer IISB in Erlangen and developed in an application-oriented way in cooperation with industry.

With a new type of "DC Micro Grid Control System", the IISB presented a central unit for the management of local battery-based DC networks in buildings. The DC grid controller contains the total power electronics for using renewable energy from two independent photovoltaic lines with a high efficiency directly via DC consumers and for storing it in a local storage battery. It is designed for plug & play use and can be easily installed in a rack of the storage battery cabinet. To meet the highest safety requirements, the entire DC network is electrically isolated from the connected 230 V AC network via a bidirectional converter. Such a DC system could also be used to operate DC fast charging stations for electric vehicles efficiently and economically.

1 *At PCIM Europe 2014, the institute ignited fireworks of innovations. PCIM Europe is the leading international trade fair for power electronics, intelligent drive technology, renewable energy, and energy management. PCIM Europe 2014 was held at the Nuremberg exhibition center from 20 to 22 May 2014.*
© Fraunhofer IISB

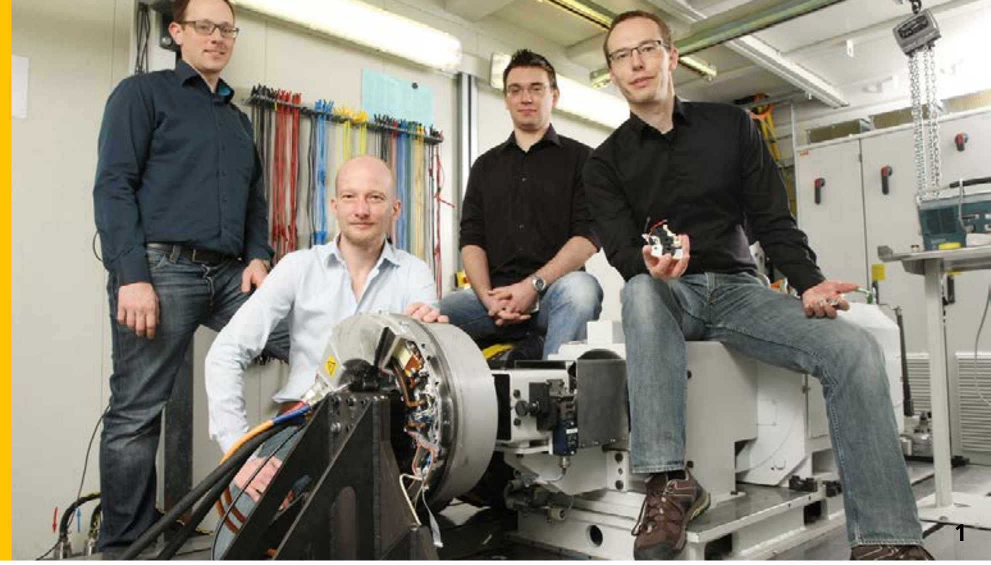
For "electrical fueling" electric vehicles, the IISB showed their inductive charging system at the PCIM Europe, which is geometrically designed as a frontal, bidirectional charging/discharging system via a coil arrangement behind the front license plate. This modular approach, which works with a transmission capacity of 3 kW per module and frequencies up of to 150 kHz, is characterized by a high transmission efficiency of 93%, high operator protection due to low stray fields, a high position tolerance and very economical feasibility.

For small DC consumers in households and offices, the IISB has developed a low voltage direct current (LV-DC) plug system that works with one plug for all applications, such as e.g. mobile phones, laptops or monitors, and automatically supplies each consumer with the right DC voltage in the range of 5 V to 24 V via a simple coding mechanism. The system has arc protection when the plug is pulled out and does not consume any power in standby operation. It can provide an output of up to 100 W with an efficiency of up to 98%. Such a system eliminates the need for many AC power supply units and reduces costs and construction space.

For stationary use as an energy store in single-family houses, office buildings or for network stabilization, the IISB provides a battery system based on lithium titanate cells (LTO cells) that was developed by the institute. The energy store has a storage capacity of 20 kilowatt hours with a continuous charging and discharging capacity of 100 kW and a maximum current of 320 A. Although LTO batteries have a somewhat lower energy density than classical lithium ion batteries, they have a high power density, high safety and stability and can be operated and quickly charged in a wide temperature window of -30 °C to +55 °C. They are characterized by a high cycle stability and a long lifetime – the IISB system is designed for 6,000 full charging/discharging cycles.

Important components in local DC networks as well as in electric vehicles are low-loss and compact DC/DC power converters, which are one of the areas of expertise of the IISB. The institute has demonstrated international reference values in efficiency and power density here several times. New electronic components on the basis of so-called wide-band-gap semiconductors such as silicon carbide (SiC) or gallium nitride (GaN) make it possible to increase these characteristics further. For example, in the past year, the IISB was able to achieve an efficiency of up to 99.3% (with a switching frequency of 100 kHz) for a DC/DC converter with 600 V GaN components. The latest highlight that the institute showed at the PCIM Europe is a 200 kW DC/DC converter based on SiC MOSFETs with a construction volume of 1.4 liters and the extreme power density of 143 kW per liter – that is better than the state of the art by over a factor of 10.

Fraunhofer IISB is thus continuing to implement their road map of reference values to increase the power density of power converters, which they have been consistently pursuing for over 10 years.



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Electric Cars Run Smoothly – Innovation Prize for Microelectronics 2014

1 *The winners (from left to right): Thorsten Schubert, Jan Ortner (Schaeffler Technologies, Herzogenaurach), Stefan Arenz and Hubert Rauh (Fraunhofer IISB) on the engine test at the test center for electric vehicles of the Fraunhofer IISB.*
© K. Fuchs / FKME

The Innovation Prize for Microelectronics, which is awarded annually by the Förderkreis für die Mikroelektronik e.V. ("Sponsorship Association for Microelectronics"), recognized the development of an innovative wheel hub drive for electric automobiles this time. The innovation prize was awarded during the meeting of the Technology and Innovation Network of Central Franconia (tim) in Nuremberg.

The recipients of the innovation prize are Thorsten Schubert and Jan Ortner from Schaeffler Technologies, Herzogenaurach, Germany, as well as Hubert Rauh and Stefan Arenz from the Fraunhofer Institute for Integrated Systems and Device Technology IISB, Erlangen / Nuremberg. They were recognized for a new type of wheel hub system, the "Schaeffler E-Wheel Drive" for electric vehicles, which was developed by Schaeffler in cooperation with the IISB.

Electric vehicles with so-called wheel hub drives could replace classical drive concepts. Since motors and electronics disappear into the wheels, completely new design possibilities result for automobile construction. The innovative wheel hub system from Schaeffler sets new standards for the integration of mechatronics and functions, in the opinion of the jury. The "Schaeffler E-Wheel Drive" contains all components that are necessary for the drive, brakes and additional driving dynamics functions.

A wheel contains a 40 kW strong electric motor (approx. 54 hp), a frequency inverter for 400 V DC voltage and a mechanical drum brake. As a result, only a few connections are required between the wheel and the vehicle. The rear wheels can be individually driven and braked. This makes it very easy to implement innovative functions such as torque vectoring (cornering support by driving the outer wheel) as well as safety functions such as ABS and (active) ESP. The challenges that Schaeffler and IISB faced in the development were the spatial narrowness in the wheel rim, the heat development and the mechanical shocks during operation. The system can be integrated in commercially available wheel rims of 16 inches and up, and further development up to production by 2018 is planned.

About the Förderkreis für die Mikroelektronik e.V.

The Förderkreis für die Mikroelektronik e.V. is an association of approx. 15 companies, two Fraunhofer institutes, four Chairs at the University of Erlangen-Nuremberg and the Nuremberg Chamber of Commerce and Industry for Central Franconia. The promotion association awards the innovation prize each year, promotes technical and scientific events and cooperation between

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research, development and application. The Innovation Prize for Microelectronics is awarded annually for outstanding scientific achievements and is endowed with 3.000 euros. In their assessment, the jury especially takes into account the advancement of knowledge and attaches value to the practical utilization by businesses.

Energy Technology in Transformation – Bavarian Research Projects Give Impetus

On the occasion of the symposium "Energy Technology in Transformation – Bavarian Energy Research Projects" on 27 October 2014 in Nuremberg, experts from industry and science discussed the latest results of large energy research projects at Bavarian Fraunhofer institutes and their potential for application in the energy system of the future. In addition, the Bavarian Minister of Energy, Ilse Aigner, gave a welcoming address in which she provided an insight into the perspective and plans of the Bavarian state government for restructuring the energy supply.

During the event at the Museum for Industrial Culture of Nuremberg, the large Bavarian energy research projects SEEDs, EnCN-NET and DEGREEN introduced themselves and reported about their results together with their industrial partners. The projects are supported by the Bavarian Ministry of Economic Affairs and Media, Energy and Technology and coordinated by the Fraunhofer institutes IISB, IIS and ISC.

"The energy transition also means a technology transition," explained Ilse Aigner, Bavaria's Minister of Energy. "We are faced with the decisive question of how we can help new ideas in energy technology break through. The energy symposium will give an important impetus for this."

The objective of the SEEDs project, which is also supported in the framework of the Bavarian energy concept, is the implementation of sustainable energy production, storage and supply for units on the scale of small and medium-sized industrial companies. SEEDs is coordinated by the Fraunhofer Institute for Integrated Systems and Device Technology IISB in Erlangen, Germany. During the symposium, the primary focus was on discussing the advantages of state-of-the-art direct current systems for building complexes.

ENCN-NET, coordinated by the Fraunhofer Institute for Integrated Circuits IIS in Erlangen / Nuremberg, is the largest subproject of the Energie Campus Nürnberg (ENCN). Topics include new electronic and IT solutions for the power grids of the future. Areas of focus during the event were energy management and energy measurement systems.

1 *Prof. Lothar Frey, director of Fraunhofer IISB, explained Bavaria's Energy Minister Ilse Aigner the use of DC power in local energy networks , for example, for high-voltage LED lighting.*
© K. Fuchs / Fraunhofer IISB

1 *FORELMO joins Bavarian research competences on electric mobility.*
© Fraunhofer IISB / TUM

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DEGREEN, coordinated by the Fraunhofer Institute for Silicate Research ISC in Würzburg, Germany, is part of the Bavarian concept for research and technology development in the energy field. Here it is investigated how the unused potentials of regenerative energy production, e.g. in small flowing bodies of water, can be developed economically and without any negative impact on the environment, with generator systems made of elastic foils. This innovative technology allows electrical energy to be directly produced from mechanical energy.

All projects are carried out in cooperation and coordination with Bavarian industrial partners. The object is to develop new markets for business and to demonstrate possibilities for supplying energy to industrial plants in an economical and environmentally-friendly way.

The projects EnCN-NET, SEEDs and DEGREEN are supported by the Bavarian State Ministry of Economic Affairs and Media, Energy and Technology.

Bavarian Joint Research on E-Mobility – FORELMO Presented Itself at CoFAT 2014

The Bavarian Research Cooperation for Electric Mobility (FORELMO) presented its activities at the third Conference on Future Automotive Technology (CoFAT), which was held on 17 and 18 March 2014 at the campus of the TU Munich in Garching, Germany. Under the motto "The electric drive train of tomorrow – efficient, safe, economical", FORELMO deals with selected questions regarding the focal areas of electric motors, battery systems and power electronic key components.

The introduction of electric mobility produces extensive opportunities and challenges for Bavarian business. Five research institutions and eight industrial partners are therefore working on innovative solutions dealing with the electric drive train in the Bavarian Research Cooperation for Electric Mobility FORELMO (www.forelmo.de). The focus is on safety, efficiency and cost-effectiveness. The activities of the cooperation members are concentrated in three subject areas: electric motors, battery systems and power electronic key components.

In the subject complex of electric motors, FORELMO is especially concerned with one particular machine type: externally excited synchronous machines (ESM), which have not been used much as a drive concept in the area of electric mobility. However, ESM are characterized by very good performance values and eliminate the need for expensive magnet raw materials. As a result of the integration of an inductive and thus contactless and slipring-less energy transmission to the rotor of the motor, the concept of ESM has been developed further to a reliable drive solution in the framework of FORELMO. At the same time, the well-known safety problems of permanently excited synchronous machines are avoided.

A further main aspect of the work in FORELMO is battery systems for electric vehicles. Here, above all the optimization of the battery packs and battery management offer a great potential for improvements. Studies of the characteristics, arrangement, size and wiring of the battery cells, new methods for condition monitoring and module monitoring as well as a closer link to power electronics make it possible to increase the degree of efficiency and safety at the same time. As a result of material optimization for electrodes and new filling processes, the cell technologies are also improved and adapted to the requirements of electric mobility in the cooperation.

In an electric drive train, power electronic systems link the motor and the energy storage. For the low-loss and needs-based provision or processing of electrical energy, highly efficient and reliable power converters and inverters are the most important components. In FORELMO, capacity materials are improved for this purpose that allow more powerful and smaller intermediate circuit capacitors with an increased reliability and energy density – an important prerequisite for more compact drive inverters. Especially in automotive technology, the reduction of construction space and weight through increased system integration plays an important role.

In addition to scientific innovation, the research cooperation promotes the public image of Bavarian competences in the field of electric mobility. The players from industry and research are linked together more intensively, and qualified young people are better prepared for their later work in industry through a subject-specific education.

FORELMO is coordinated by the Fraunhofer Institute for Integrated Systems and Device Technology IISB in Erlangen, Germany. Further research partners are the Institute of Automotive Technology and the Institute for Electrical Energy Storage Technology at the TU Munich, the University of Applied Sciences Nuremberg and the Technology Centre Energy of the University of Applied Sciences Landshut. The group of industrial partners consists of Clariant Produkte Deutschland GmbH, EPCOS AG, FMS Systemtechnik GmbH, IAV GmbH, Infineon Technologies AG, LION Smart GmbH, Modelon GmbH and TÜV SÜD Battery Testing GmbH. The Power Electronics Cluster provides advice to the cooperation.

The cooperation project has a total volume of around 3.4 million euros for a duration of three years. FORELMO is supported by the Bavarian Research Foundation with approximately 1.7 million euros.

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DRIVE-E Study Prizes Awarded – Scientific work on the Electric Drive Train Convinced the Jury

There were supposed to be four award recipients, but the decision among the excellent applicants for last year's DRIVE-E study prizes was a difficult one. For this reason, five young junior scientists were given the award this time.

Dr. Georg Schütte, State Secretary in the German Federal Ministry for Education and Research (BMBF), and Prof. Dr. Alexander Verl, Member of the Board of the Fraunhofer-Gesellschaft, were extremely pleased with the quality of the applications during the awards ceremony at the Mercedes-Benz Center in Stuttgart."More than 50 students applied for the Drive-E study prizes with their seminar papers and degree theses, more than 120 applications were received for participation in the DRIVE-E Academy – that is a great response. At the same time, the quality of the submitted papers was never as high as this year, as the jury confirmed to me. This is an encouraging sign, since electric mobility makes great demands – not only on technology, but especially on the qualifications and the inventiveness of the people involved in it. Electric mobility can only progress through interdisciplinary thinking and working. We want to motivate students to do this," said Dr. Georg Schütte, State Secretary in the Federal Ministry for Education and Research. "The research results of the young applicants that are oriented to the sustainability and efficiency of electric mobile vehicles are impressive. This commitment is an important sign for the future of electric mobility in Germany, and we are pleased to award the selected papers with the DRIVE-E study prizes 2014," said Prof. Dr. Alexander Verl.

The first prize in the category of "Degree / Master's Theses" was shared by Lisa Braun from the Karlsruhe Institute of Technology (KIT) and Jonathan Jürgens from Leibnitz University of Hanover. Borth wrote a paper on the design and evaluation of electric travel drive motors. Braun developed strategies for evaluating different concepts for electric motors according to the driver and driving situation, while Jürgen's paper concerned the suitability of an electrically excited synchronous machine as a wheel hub motor.

Both papers had a comparable, innovative approach to improving the development and evaluation of electric motors, and the prize was therefore shared. It has a value of 4,500 euros for each recipient.

1 *Participants of the DRIVE-E Academy 2014 in Stuttgart.*
© S. Rauh / DRIVE-E

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The second prize and the associated prize money in the amount of 3.000 euros went to Raja Sangili Vadamalu from Technische Universität Darmstadt for his master's thesis on creating a simulation and developing an operating strategy for a drive train that consists of a range extender and an electric motor.

The first prize in the category "Project / Study / Bachelor's Theses" and thus 4.000 euros was received by Marcus Koschmieder, who dealt with the modularization, reliability and safety of electronic components in electric vehicles in his bachelor's thesis at the Friedrich Alexander University of Erlangen-Nuremberg. Michael Hetzenecker from the Technische Hochschule Regensburg was awarded the second prize, worth 2.000 euros. His bachelor's thesis on the development of control strategies for electric machines in electric vehicles and increasing the energy efficiency of power electronics addressed important challenges in electric mobility.

For the fifth time, the German Federal Ministry for Education and Research (BMBF) and the Fraunhofer-Gesellschaft honored excellent student papers on the topic of electric mobility. The award recipients participated in the DRIVE-E Academy together with 52 other students for one week and dealt intensively with electric mobility. In addition to excursions to the Porsche Museum as well as to Bosch and Daimler, the participants dealt with a different subject area of this future-oriented technology – from vehicle and drive concepts to stores and networks up to the electric drive and power electronics – each day in the week of events. The study prize recipients also each presented a short lecture on the papers for which they received the DRIVE-E study prizes. The DRIVE-E study prizes are part of the DRIVE-E program that was established by BMBF and the Fraunhofer-Gesellschaft in 2009 to inspire young academics to work in the area of electric mobility. Students at German colleges can apply with papers from all areas of electric mobility.

Orientation Guide to Solar Cells – Award-winning Research on Multicrystalline Silicon

At the E-MRS meeting 2014 in Lille, France, Mr. Toni Lehmann from the Fraunhofer THM in Freiberg, Germany, was honored with the "E-MRS Symposium W Graduate Student Award". He was able to demonstrate that with certain structural properties of multicrystalline silicon wafers, only 1% of the wafer surface contained so-called dislocation clusters. In the case of multicrystalline standard wafers, though, the percentage of area with these harmful crystal defects is more than 10%. With his research results, Mr. Lehmann provides important insights regarding the direction in which the industrial manufacturing process for multicrystalline silicon wafers should develop in the future. With such an optimized silicon material, solar cells can be manufactured with even higher efficiencies, and the costs for producing photovoltaic current can be reduced further.

Nowadays, photovoltaic current is mostly generated with silicon solar cells. The basis of the solar cells are silicon wafers that are manufactured from large silicon crystals. The silicon crystals are industrially produced from a silicon melt according to the principle of directional solidification. As a result of the process, a microstructure with differently sized and variously oriented grains forms in the crystals. In addition, structural crystal defects develop in the form of so-called dislocation clusters in the silicon. The dislocation clusters reduce the carrier lifetime within the individual crystal grains and thus limit the efficiency of the solar cells produced from the wafers. Until now, however, there has been no statistically verifiable connection between the occurrence of dislocation clusters and the structural properties of the multicrystalline wafers.

At Fraunhofer THM in Freiberg, Mr. Lehmann investigated the grain sizes in industrially produced multicrystalline silicon wafers with a so-called grain detector. An X-ray-based metrology device that he helped to develop, a so-called Laue scanner, made it possible to determine the grain orientation in the crystal material. Using an optical photoluminescence scanner, Mr. Lehmann was then able to detect the dislocation clusters on the wafer surface and correlate their occurrence one-to-one with the grain orientation.

The systematic investigations revealed a clear relationship between the occurrence of specific grain orientations and the percentage of area with dislocation clusters on a wafer. The harmful dislocation clusters are thus more likely to appear in <111>- and <112>-oriented crystal grains, since an especially large number of glide planes can be activated here. However, the size of the grains does not play a role. When the above-mentioned orientations do not occur, wafers with small grain sizes as well as wafers with larger grains have relatively few dislocation clusters.

"For this excellent scientific work, we have presented Mr. Lehmann from the Fraunhofer THM with the E-MRS Symposium W Graduate Student Award at the symposium W 'Crystals for energy conversion and storage' at the E-MRS spring meeting, which had 2800 participants," explained Prof. Jeff Derby from the University of Minnesota, USA, who organized the symposium together with colleagues from Japan and Germany.

1 *Toni Lehmann investigates multicrystalline Silicon wafers.*
© Fraunhofer IISB

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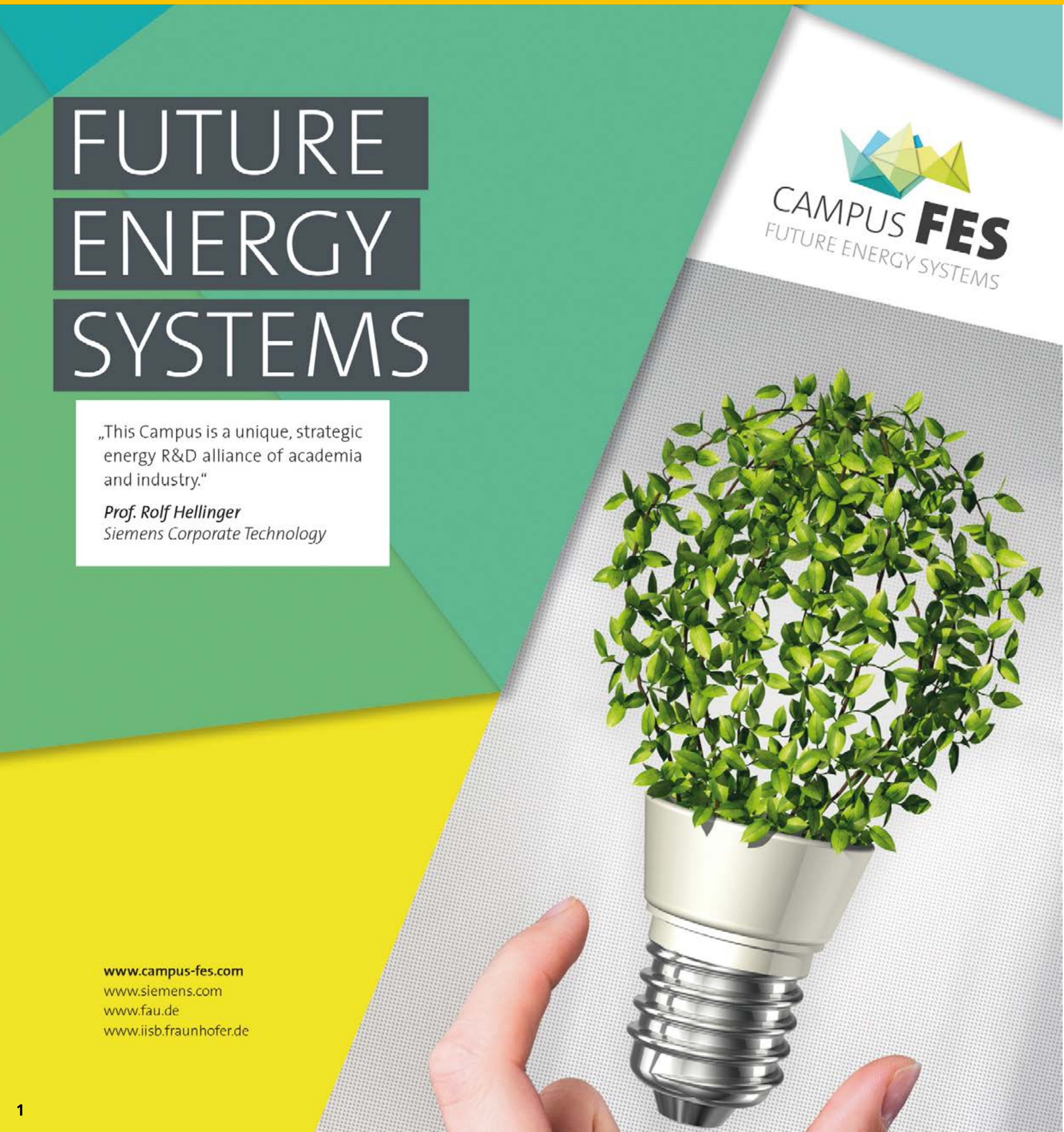

Electronics for Energy Supply – Strategic Cooperation between Siemens and IISB

Siemens and Fraunhofer IISB work together in the field of electrical energy supply. Together they develop new solutions for energy conversion in the low- and medium-voltage range using multi-level technology. The research cooperation expands the Campus Future Energy Systems in Erlangen and underlines the importance of the location as a national center of excellence for electronic systems.

In late July 2014, representatives of Siemens Corporate Technology and the Fraunhofer-Gesellschaft signed a strategic cooperation agreement. In the framework of a close, long-term cooperation in the area of multi-level technology, Siemens AG has awarded research assignments to Fraunhofer IISB, which are defined in a joint roadmapping process as part of the new Campus Future Energy Systems (Campus FES). This specifically advances multi-level technology and develops further application possibilities in energy technology as well as in industrial environments. Siemens and Fraunhofer IISB contribute their comprehensive competences and experience in the development of power electronic systems for energy supply.

Inverters on the basis of state-of-the-art multi-level technologies help to make the conversion of electrical energy between AC and DC voltage that is required at many points in the power grid more efficient and reliable. Simply put, multi-level approaches in switching make it possible to replace a few transistors for high voltages with many smaller ones. As a result, desired voltage curves – such as, e.g., a sinusoidal shape – can be almost ideally approximated in small steps. This leads to a greatly improved voltage quality and eliminates feedback disturbances in the power grid or in connected consumers. Inverters equipped with earlier technologies can also be improved further as a consequence. One example of the use of this technology is the high-voltage DC current transport of electrical energy over long paths, under the ground or through water – such as from an offshore wind park to land. The DC voltage used here must be converted into AC voltage again in order to be fed into the standard high-voltage network. Another use is the coupling of AC current networks that work with different frequencies. For example, the connection between the public 50 Hz high-voltage network and the 16 $^{2/3}$ Hz railway network is made via a DC link. In this case, the respective AC voltage is first converted into a DC voltage and then into an AC voltage again with the frequency required in the other network. In addition to network-connected systems, application fields are in large-scale drives in industry or in shipping.

Siemens AG and Fraunhofer IISB have been working together very successfully in the area of modular multi-level technologies on the project level for many years. This partnership has been further intensified by the deeper strategic cooperation.

1 *Campus Future Energy Systems – a strategic R & D alliance of academia and industry.*
© Campus FES

2 *Contract was signed on 25 July 2014 (from left to right) Dr. Wolfgang Heuring (Siemens CT RTC), Prof. Lothar Frey, Professor Martin März (both Fraunhofer IISB), Prof. Rolf Hellinger (Siemens CT RTC PET) and Thomas Jacob (Siemens Corporate Technology Intellectual Property)*
© Siemens AG

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Fraunhofer Results Press Conference 2014 with Examples from Power Electronics

1 *Prof. Lothar Frey, director of Fraunhofer IISB, presents the latest research results of the institute on power electronics for energy supply.*
© M. Müller / Fraunhofer

At the annual results press conference of the Fraunhofer-Gesellschaft in Munich, the focus was on current developments in power electronics – in addition to financial figures and securing the future. This year, Prof. Lothar Frey, Director of the Fraunhofer IISB, presented the topic of power electronics for energy supply to the public. According to its motto "From the material to the system", the IISB presented numerous research highlights along the entire valued added chain in an accompanying presentation.

At the results press conference, CFO Prof. Alfred Gossner reported on the key figures for 2013. For the first time, the finance volume of the Fraunhofer-Gesellschaft was above the mark of 2 billion euros. The project earnings in contract research increased more, at 1.2 billion euros, than the finance volume. The project earnings from the private sector reached a new high of 578 million euros. The Fraunhofer-Gesellschaft continued to invest strongly in the infrastructure of its research facilities, with a total of 235 million euros. President Prof. Reimund Neugebauer explained how Fraunhofer is preparing for future challenges. A basic funding that is in relation to the earnings is the prerequisite for staying "a half a step ahead" in the future as well. The interdisciplinary cooperation beyond subject boundaries and sectors is ensured on the only hand through support programs, including lead projects, and on the other through the group structure. In addition, concepts result such as the national centers of excellence, which are now to be included in the profile locations. These are planned as an instrument of the next high-tech strategy of the BMBF.

As an example of current research projects, Prof. Lothar Frey, Director of the Fraunhofer IISB, mentioned electronic systems for the grids of tomorrow. "Changes are coming on several levels, from the large European power grids to the distribution networks up to industrial companies, houses and electric vehicles." Frey explained how direct current supply can make especially the operation of office and hi-fi equipment more efficient: "Almost every one of these devices has its own power supply unit, which generates the DC voltage needed by the device from the 230 V AC voltage." In addition, these power supply units have a relatively low degree of efficiency. For example, the power supply unit of each device produces 40 to 80 percent more power loss through the supply with AC voltage than in the case of direct supply with direct current. Researchers of Fraunhofer IISB have developed a converter the size of a pack of cards that can supply an entire living room and a direct current network manager that could supply an entire office complex or several single-family houses. The converter has an efficiency of 98.5 percent and is qualitatively much better than the usual power supply units today. In the Bavarian SEEDs project, the IISB is currently developing a holistic solution for its own institute building, in which

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power peaks and energy losses are broken down and secondary forms of energy such as coldness, warmth and process gases are included in the supply. In this way, the institute becomes a research and demonstration platform for efficient energy management.

Prof. Alexander Verl, Fraunhofer Board Member for Technology Marketing and Business Models, added that Fraunhofer is doing far more development work in the energy sector, such as in the area of energy management or in power-to-gas or power-to-product technologies.

1 *The IISB deputy director Prof. Martin März (right) informed Secretary of State Stefan Müller about the efficiency of modern power electronic converters. © Fraunhofer IISB*

BMBF State Secretary Stefan Müller Learns about Electronic Systems for Energy Supply

Stefan Müller, Parliamentary State Secretary of the Federal Minister for Education and Research, learned about the latest research developments in power electronic systems during a visit to the Fraunhofer IISB in Erlangen, Germany, on 15 May 2014. These systems are an essential technical component for the energy supply restructuring.

Whether grid restructuring, an increased and decentralized supply of regenerative energies or energy savings in residential houses, office buildings and industrial plants – the demanding objectives in the restructuring of the energy supply cannot be technically realized without modern power electronics. Power electronic components and systems ensure the distribution and conversion of electrical energy and thus its supply in the required form. At the same time, maximum energy efficiency, reliability and cost-effectiveness are decisive for feasibility and market success. This results in corresponding challenges for research and development.

During his visit in Erlangen, Stefan Müller learned about the latest developments at Fraunhofer IISB, including those in the areas of direct current systems and low-loss, compact power converters. With IISB director Prof. Dr. Lothar Frey and his deputy Prof. Dr. Martin März, he discussed the application possibilities and potentials of power electronic components, for example for energy management in building complexes, as well as for use in electric vehicles and the infrastructure that they require.

As a member of the German parliament for the federal electoral district of Erlangen, Stefan Müller also showed great interest in the future development of the research location during his visit. Erlangen contains an important research landscape for electronics systems, with two Fraunhofer institutes, the Faculty of Engineering of the University of Erlangen-Nuremberg and a dense regional concentration of prominent industry.

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Guest Scientists

Liehr, S.C.
May 31, 2014 – August 15, 2014
USA
Rochester Institute of Technology

Malassi, K.
April 22, 2014 – June 28, 2014
France
CEA-Leti

Montoliu Alvaro, Carles
March 20, 2014 – July 17, 2014
Spain
Universitat Politecnica di Valencia
Etch Model Implementation using the Level Set Method

Portier, B.
April 22, 2014 – June 28, 2014
France
CEA-Leti

Soalca, S.
April 22, 2014 – June 28, 2014
France
CEA-Leti

Xia, C.
October 20, 2013 – October 10, 2014
China
Shanghai University
Modellierung von SiC-Leistungshalbleiterbauelementen

Patents

Azizi, M.; Reimann, C.; Friedrich, J.; Blankenburg, H.J.; Colditz, R.:
Verfahren zur Behandlung und/oder Recycling von Säge-Slurries
DE 10 2012 017 183; A1: 20120830

Azizi, M.; Reimann, C.; Friedrich, J.; Blankenburg, H.J.; Colditz, R.; Gruß, D.:
Method for the treatment and/or recycling of sawing slurries
WO 2014/033243 A3

Burenkov, A.:
Strahlungsquelle und Verfahren zu deren Betrieb
DE 10 2013 202 220; A1: 20130212

Forman, C.; Gootz, M.; Herrmann, M.; Mehner, E.; Meyer, B.; Meyer, D.C.; Muritala, I.; Pardemann, R.; Scheithauer, D.; Schulze, O.; Leisegang, T.:
Vorrichtung und Verfahren zur Energie- und Stoffwandlung mittels pyroelektrischer Materialien zur Herstellung von Spaltprodukten
DE 10 2014 003815.7

Friedrich, J.; Blankenburg, H.J.; Colditz, R.; Azizi, M.; Reimann, C.; Gruß, D.:
Verfahren zur Behandlung und/oder Recycling von Säge-Slurries
DE 10 2012 017 183

Friedrich, F.; Reimann, C.; Wunderwald, U.:
Verfahren und Vorrichtung zur Bestimmung der Schmelzhöhe und zur Regulation der Erstarrung und Schmelzung einer Schmelze im Tiegel
DE 10 2013 002 471.

Mono, T.; Schneider, V.; Martin, R.; Reimann, C.; Friedrich, J.:
Wiederverwendbarer Tiegel aus einer Siliziumnitrid-Keramik sowie dessen Verwendung bei der Herstellung eines mono- oder multikristallinen Halbmetallkörpers aus einer Schmelze
DE 10 2012 101 214

Reimann, C.; Obermeier, S.; Trempa, M.; Schneider, V.; Friedrich, J.:
Verfahren zur Herstellung einer diffusionshemmenden Beschichtung, Tiegel zum Schmelzen und/oder Kristallisieren von Nicht-Eisen Metallen sowie Verwendungszwecke
DE 10 2012 019 519

Zeltner, S.; Endres, S.:
Leistungselektronische Schaltung und System mit derselben
DE 10 2013 205 706; A1: 20130328

Participation in Committees

Bauer, A.J.
- Koordinator der VDE / VDI – Fachgruppe 1.2.4 „Heißprozesse"

Erlbacher, T.
- VDE-GMM FG 1.3.6 „Materialien für Nichtflüchtige Speicherzellen"

Frey, L.
- Mitglied der Studienkommission Elektrotechnik, Elektronik und Informationstechnik
- Mitglied der Deutschen Physikalischen Gesellschaft
- Mitglied der Böhmischen Physikalischen Gesellschaft
- Member of the Excellence Cluster „Engineering of Advanced Materials" (EAM) der Universität Erlangen-Nürnberg
- Mitglied der Erlangen Graduate School in Advanced Optical Technologies (SAOT)
- Mitglied des wissenschaftlichen Beirats des Leibnitz-Instituts für Innovative Mikroelektronik IHP Frankfurt/Oder

Content

Continuation: Participation in Committees

- Member of the Evaluation Panel (NT-L) of the Swedish Research Council
- Representative of the Fraunhofer Gesellschaft / Microelectronics Alliance at the European Semiconductor Industry Association (ESIA)
- Nationale Plattform Elektromobilität, AG1
- Wissenschaftlicher Beirat der NaMLab GmbH in Dresden
- Advisory Board, Res. Inst. for Tech. Phys. and Matl. Sci. (MFA), Budapest, HUN
- Kerngutachter in der Auswahlkommission „Kooperative Projekte" der Fraunhofer Gesellschaft mit dem Max-Planck-Institut
- Wissenschaftlicher Beirat der Gesellschaft für Mikro- und Nanoelektronik GMe, Vienna, AUT

Friedrich, J.

- President der Deutschen Gesellschaft für Kristallwachstum und Kristallzüchtung e.V. (DGKK)
- Mitvorsitzender des DGKK-Arbeitskreises „Herstellung und Charakterisierung massiver Halbleiter"
- Councilor in the Executive Committee of the International Organization of Crystal Growth (IOCG)
- Program Co-Chair of the „International Conference on Crystal Growing" (ICCG-17), Warsaw, POL
- Advisory Committee of International Workshop on Crystalline Silicon for Solar Cells
- Advisory Committee of International Workshop on Modeling of Crystal Growth
- Reviewer for Journal of Crystal Growth, Applied Physical Letters
- Co-Chair of Symposium W "Crystals for Energy Conversion and Storage" of E-MRS Spring Meeting, Lille, FRA

Giegerich, M.; Lorentz, V.

- Mitarbeit im IEEE Industrial Electronics Society Technical Committee "Energy Storage"

Häublein, V.

- Mitglied der GMM-Fachgrppe 1.2.2
- Mitglied der ITG-Fachgruppe 8.1.1 „Ionenimplantation"

Jank, M.P.M.

- Working group on nanomaterials – European Semiconductor Industry Association (ESIA)
- VDE GMM Fachausschuss Gesamtprozesse (1.3) – Schwerpunkt Materialien für nichtflüchtige Speicher (1.3.6)
- Exzellenzcluster Engineering of Advanced Materials an der FAU Erlangen-Nürnberg
- Gutachter im Peer-Review-Verfahren für IEEE Electron Device Letters, Materials Chemistry and Physics, Miecroelectronic Engineering
- Mitglied Prüfungskommittee in einem Promotionsverfahren an der Universität Dunarea de Jos, Galati, ROM

Kallinger, B.

- Reviewer for Journal of Crystal Growth, Materials Science in Semiconductor Processing

Lorenz, J.

- Chairman of the Modeling and Simulation International Working Group (ITWG) of the ITRS (International Technology Roadmap for Semiconductors)
- Member of the Electrochemical Society
- Member of the Institute of Electrical and Electronics Engineers (IEEE)

März, M.

- Wissenschaftlicher Beirat „Bayerisches Cluster Leistungselektronik"
- Wissenschaftlicher Beirat „Conference on Integrated Power Systems" (CIPS)
- Wissenschaftlicher Beirat „Conference on Power Conversion and Intelligent Motion" (PCIM)
- Fachbeirat im „Forum Elektromobilität e.V."
- DRIVE-E Akademie, Gutachterkreis und Programmkomitee

Meißner, E.

- Member of the International Steering Committee „International Workshop on Bulk Nitride Semiconductors"
- Member of the Publication Committee of the International Workshop on Bulk Nitride Semiconductors
- Guest-Editor of Journal of Crystal Growth 403 (Proceedings of 8th International Workshop on Bulk Nitrides Semiconductors (IWBNS VIII))
- Reviewer for Journal of Crystal Growth and Materials Chemistry and Physics

Pfeffer, M.

- Member of the „Factory Integration Working Group" (FITWG) of the „International Technology Roadmap for Semiconductors" (ITRS)
- Member of Semicon Europe Semiconductor Technology Programs Committee (STC)

Pfitzner, L.

- Honorarprofessor an der Universität Erlangen-Nürnberg, Fachbereich Elektrotechnik
- Chairman of the „Yield Enhancement Working Group" (ITWG) of the ITRS (International Technology Roadmap for Semiconductors) Conference 2014, Bad Nauheim, GER, April 6 – 9, 2014
- Chair of International Planning Working Group of Nanoelectronics (IPWGN)
- Chair of the Executive Committee and of the 6th International Conference on "450 mm - Status and Overview", Grenoble, FRA, October 7 – 9, 2014
- Member of the Program Committee of the 6th International Conference on "450 mm - Status and Overview", Grenoble, FRA, October 7 – 9, 2014
- Member of the Program Committee ISSM 2014, Tokyo, JPN, December 2 – 3, 2014
- Member of the Program Committee of the FCMA, International Conference on "Frontiers of Characterization and Metrology for Nanoelectronics", Dresden, GER
- Mitglied der VDE/VDI-Gesellschaft für Mikroelektronik, Mikro- und Feinwerktechnik, Fachbereich „Halbleitertechnologie und Halbleiterfertigung", Leiter des Fachausschusses „Produktion und Fertigungsgeräte"

Content

Continuation: Participation in Committees

- Mitglied der VDE/VDI-Gesellschaft für Mikroelektronik, Mikro- und Feinwerktechnik, Fachbereich „Halbleitertechnologie und Halbleiterfertigung", Leiter des Fachausschusses 1.1 „Geräte und Materialien"
- Co-Chair of the SEMI Task Force „Environmental Contamination Control"
- Co-Chair of the Standardization Committee „Equipment Automation Standards Committee" of SEMI
- Member of the „Global Coordination Committee" of SEMI
- Member of the „European Planning Group for 450 mm Technology" (EEMI450)
- Mitglied des Strategischen Beirats des österreichischen Bundesministeriums für Verkehr, Innovation und Technologie (BMVIT) für die Initiative „Intelligente Produktion"

Pichler, P.
- Board of Delegates der European Materials Research Society

Reimann, C.
- Co-Chair of International Workshop on Crystalline Silicon for Solar Cells (CSSC-8)
- Reviewer for Journal of Crystal Growth, Crystal Research and Technology, Progress in Photovoltaics: Research and Applications, and Journal of Photovoltaics

Roeder, G.
- Koordinator der VDE/VDI-GMM-Fachgruppe 1.2.3 „Abscheide- und Ätzverfahren"

Rommel, M.
- Koordinator der VDE/VDI-GMM-Fachgruppe 1.2.6 „Prozesskontrolle, Inspektion & Analytik"

Ryssel, H.
- International Committee of the Conference „Ion Implantation Technology" (IIT), the conference takes place biannually alternatingly in Europe, the USA, and East Asia
- Mitglied der Informationstechnischen Gesellschaft (ITG): Leiter des Fachausschusses 8.1 „Festkörpertechnologie"
- Mitglied der VDE/VDI Gesellschaft für Mikroelektronik, Mikro- und Feinwerktechnik (GMM)
- Leiter des Fachbereichs 1, „Mikro- und Nanoelektronik-Herstellung", Leiter der Fachgruppe 1.2.2 „Ionenimplantation"
- Mitglied des Beirats der Bayerischen Kooperationsinitiative Elektronik / Mikrotechnologie (Bayerisches Staatsministerium für Wirtschaft, Verkehr und Technologie)
- Mitglied der Böhmischen Physikalischen Gesellschaft
- Life Fellow of the Institute of Electrical and Electronics Engineers (IEEE)
- Editorial Board of „Radiation Effects and Defects in Solids" Taylor & Francis Ltd., Abingdon, U.K.
- Member of the European SEMI Award Committee

Schellenberger, M.
- Leiter der europäischen SEMI PCS-Taskforce
- Mitglied im Programmkomitee der europäischen APCM-Konferenz
- Member of the Technical Programme Committee of the ESSCIRC-ESSDERC Conference

Smazinka, T.
- Mitarbeit im Normungsgremium der DKE / UK 767.3 – Hochfrequente Störgrößen
- Mitarbeit im Normungsgremium der DKE / GAK 767.13.18 – Elektromagnetische Verträglichkeit, Fahrzeuge – EMV Elektromobilität
- Mitglied im Arbeitskreis Elektromagnetische Verträglichkeit EMV des VDE-Bezirksverein Nordbayern e.V.

Trempa, M.
- Reviewer for Journal of Crystal Growth

Conferences, Workshops, Fairs, and Exhibitions

5th Electronics System-Integration Technology Conference
Helsinki, FIN, September 16 – 18, 2014

12th Fraunhofer IISB Lithography Simulation Workshop
Hersbruck, GER, September 11 – 13, 2014

41. Tagung des DVM Arbeitskreises Betriebsfestigkeit
Ingolstadt, GER, October 8 – 9, 2014

Alternative Lithographic Technologies Conference
San Jose, USA, February 24 – 27, 2014

APEC Workshop on Smart DC Power
ChiangMai, THA, November 10 – 11, 2014

CENCON 2014
Johor Bahru, MAS, October 13 – 14, 2014

CIPS 2014
Nuremberg, GER, February 25 – 27, 2014

Cluster-Seminar „LV DC-Grids"
Erlangen, GER, October 16 – 17, 2014

CoFat 2014
Munich, GER, March 17 – 18, 2014

CONTACT 2014
Erlangen, GER, November 27, 2014

contactING 2014
Nuremberg, GER, November 13, 2014

CSNDSP 2014
Manchester, UK, July 23 – 25, 2014

Deutscher Verband für Materialforschung und -prüfung
Berlin, GER, May 8 – 9, 2014

DGKK Arbeitskreis „Industrielle Kristallzüchtung"
Freiberg, GER, November 3 – 4, 2014

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Conferences, Workshops, Fairs, and Exhibitions

DGKK Arbeitskreis „Massive Halbleiterkristalle“
Freiberg, GER, October 8 – 9, 2014

DGKK Meeting
Halle, GER, March 11 – 12, 2014

eCarTec 2014
Munich, GER, October 21 – 23, 2014

ECPE / Cluster Tutorial „Thermal Engineering“
Nuremberg, GER, October 14 – 15, 2014

ECPE Workshop „Intelligent Reliability Testing“
Nuremberg, GER, December 2 – 3, 2014

ECPE Workshop „Quality Inspection“
Ismaning, GER, March 26 - 27, 2014

ECSCRM 2014
Grenoble, FRA, September 21 – 25, 2014

ECTC 2014
Orlando, USA, May 27 – 30, 2014

EDPC 2014
Nuremberg, GER, September 30 – October 1, 2014

Electronica 2014
Munich, GER, November 14, 2014

Elektronische Baugruppen und Leiterplatten (EBL)
Fellbach, GER, February 11 – 12, 2014

Energietechnik im Wandel – bayer. Energieforschungsprojekte
Nuremberg, GER, October 27, 2014

EPE-ECCE Europe 2014
Lappeenranta, FIN, August 26 – 28 August, 2014

Ergebnis-Pressekonferenz der Fraunhofer-Gesellschaft
Munich, GER, April 29, 2014

ESSDERC 2014
Venice, ITA, September 22 – 26, 2014

EU PVSEC 2014
Amsterdam, NED, September 22 – 26, 2014

EuroSimE 2014
Ghent, BEL, April 7 – 9, 2014

Extreme Ultraviolet (EUV) Lithography Conference
San Jose, USA, February 24 – 27, 2014

GMM-Nutzergruppentreffen „PVD, PECVD und Ätzen“
Erlangen, GER, November 26, 2014

GMM-Nutzertreffen „Prozesskontrolle, Inspektion, Analytik“
Frankfurt/Oder, GER, March 9, 2014

GMM-Workshop „Abscheide- und Ätzverfahren“
Erlangen, GER, November 27, 2014

High Purity and High Mobility Semiconductor Symposium
Cancun, MEX, October 5 – 9, 2014

IECON 2014
Dallas, USA, October 29 – November 1, 2014

IISB-Jahrestagung 2014 „Niederspannungs-Gleichstromnetze“
Erlangen, GER, October 17, 2014

IIT 2014
Portland, USA, June 26 – July 4, 2014

INTELEC 2014
Vancouver, CAN, September 28 – October 2, 2014

ISGT 2014
Washington, USA, February 19 – 22, 2014

ITG-GMM-Nutzergruppentreffen „Heißprozesse und RTP“
Erlangen, GER, April 2, 2014

ITG-GMM-Nutzergruppentreffen „Heißprozesse und RTP“
Dresden, GER, November 12, 2014

ITG-GMM-Nutzergruppentreffen „Ionenimplantation“
Dresden, GER, November 13, 2014

ITG-GMM-Nutzergruppentreffen „Ionenimplantation“
Erlangen, GER, April 3, 2014

ISIE 2014
Istanbul, TUR, June 1 – 4, 2014

Kolloquium zur Halbleitertechnologie und Messtechnik
Erlangen, GER, 2014

MNE 2014
Lausanne, SUI, September 22 – 26, 2014

NESEM 2014
Erlangen, GER, September 24 – 25, 2014

OTTI-FAchforum „Getaktete Stromversorgungen“
Regensburg, GER, October 20 – 22

PCIM Europe 2014
Nuremberg, GER, May 20 – 22, 2014

realize your visions!
Nuremberg, GER, February 13, 2014

SEMICON Europa 2014
Grenoble, FRA, October 6 – 9, 2014

SISPAD 2014
Yokohama, JPN, September 9 – 11, 2014

SPIE 2014
San Jose, USA, February 23 – 27, 2014

Symposium W of E-MRS Spring Meeting
Lille, FRA, May 26 – 30, 2014

THERMINIC 2014
Greenwich, ENG, September 24 – 26, 2014

ULIS 2014
Stockholm, SWE, April 7 – 9, 2014

VDE Kongress „Smart Cities“
Frankfurt, GER, October 20 – 21, 2014

Vortragsreihe des Fraunhofer-Innovationsclusters
Erlangen, GER, 2014

Wissenschaftstag der Europäischen Metropolregion Nürnberg
Nuremberg, GER, July 25, 2014

WODIM 2014
Kinsale, IRL, June 9 – 11, 2014

SCIENTIFIC PUBLICATIONS

Content

Publications

Aarik, J.; Bauer, A.J.; Dobročka, E.; Frey, L.; Fröhlich, K.; Han, J.H.; Hudec, B.; Hušeková, K.; Hwang, C.S.; Kasikov, A.; Lee, W.; Murakami, K.; Paskaleva, A.; Rammula, R.; Rommel, M.; Rosová, A.; Song, S.J.:
Nanoscale characterization of TiO2 films grown by atomic layer deposition on RuO2 electrodes
ACS applied materials & interfaces 6, 4, 2486-2492; 2014
DOI: 10.1021/am4049139

Agocs, E.; Fodor, B.; Pollakowski, B.; Beckhoff, B.; Nutsch, A.; Jank, M.; Petrik, P.:
Approaches to calculate the dielectric function of ZnO around the band gap
Thin solid films 571, Pt.3, S.684-688, 2014
DOI: 10.1016/j.tsf.2014.03.028

Agudelo, V.; Führer, T.; Erdmann, A.; Evanschitzky, P.:
Application of artificial neural networks to compact mask models in optical lithography simulation
Journal of micro/nanolithography, MEMS and MOEMS 13, Nr.1, Art.011002, 2014
DOI: 10.1117/1.JMM.13.1.011002

v. Ammon, W.; Friedrich, J.; Müller, G:
Czochralski Growth of Silicon Crystals
Handbook of Crystal Growth 2nd Edition (Eds: T. Nishinaga, P. Rudolph, T. Kuech), Elsevier (2014) 45-104; ISBN: 978-0-444-63303-3

Azizi, M.:
Eisenverunreinigungen in multikristallinem Silizium: Gerichtete Erstarrung und Analyse der strukturellen und elektrischen Eigenschaften
Stuttgart: Fraunhofer Verlag, 2014, XIV, 182 S.; ISBN: 978-3-8396-0689-6

Badr, E.; Pichler, P.; Schmidt, G.:
Deep energy levels of platinum-hydrogen complexes in silicon
Murphy, J.D.: Gettering and Defect Engineering in Semiconductor Technology XV, GADEST 2013 : Selected papers from the 15th Gettering and Defect Engineering in Semiconductor Technology Conference (GADEST 2013), September 22 – 27, 2013, Oxford, UK; Durnten-Zurich: TTP, 2014 (Solid state phenomena 205-206); S.260-264
DOI: 10.4028/www.scientific.net/SSP.205-206.260

Badr, E.; Pichler, P.; Schmidt, G.:
Modeling platinum diffusion in silicon
Journal of applied physics 116, Nr.13, Art. 133508, 7 S., 2014
DOI: 10.1063/1.4896909

Baer, E.; Burenkov, A.; Erdmann, A.; Evanschitzky, P.; Lorenz, J.K.; Pichler, P.:
Challenges and opportunities for process modeling in the nanotechnology era
Journal of computational electronics 13, 1, 3-17, 2014
DOI: 10.1007/s10825-013-0477-4

Banzhaf, C.T.; Grieb, M.; Trautmann, A.; Bauer, A.J.; Frey, L.:
Influence of diverse post-trench processes on the electrical performance of 4H-SiC MOS structures
Okumura, H.: Silicon Carbide and Related Materials 2013. Vol.1 : Selected, peer reviewed papers from the 15th International Conference on Silicon Carbide and Related Materials, (ICSCRM 2013), September 29 – October 4, 2013, Miyazaki, Japan; Dürnten: Trans Tech Publications, 2014 (Materials Science Forum 778-780); S.595-598
DOI: 10.4028/www.scientific.net/MSF.778-780.595

Banzhaf, C.T.; Grieb, M.; Trautmann, A.; Bauer, A.J.; Frey, L.:
Investigation of trenched and high temperature annealed 4H-SiC
Okumura, H.: Silicon carbide and related materials 2013. Vol.2: Selected, peer reviewed papers from the 15th International Conference on Silicon Carbide and Related Materials 2013, (ICSCRM 2013), September 29 – October 4, 2013, Miyazaki, Japan; Durnten-Zurich: Trans Tech Publications, 2014 (Materials Science Forum 778-780); S.742-745
DOI: 10.4028/www.scientific.net/MSF.778-780.742

Beier, M.; Trempa, M.; Seebeck, J.; Reimann, C.; Wellmann, P.; Gründig-Wendrock, B.; Friedrich, J.; Dadzis, K.; Sylla, L.; Richter, T.:
Feedstock recharging during directional solidification of silicon ingots for PV applications
Proceedings of 29th European Photovoltaic Solar Energy Conference and Exhibition (EU PVSEC 2014), Amsterdam, September 22 – 26, 2014 (2014) 717-721
DOI: 10.4229/EUPVSEC20142014-2AV.1.11

Brockerhoff, P.; Burkhardt, Y.; Egger, K.; Rauh, H.:
Highly integrated drivetrain solution: Integration of motor, inverter and gearing
4th International Electric Drives Production Conference, EDPC 2014 – Proceedings
DOI: 10.1109/EDPC.2014.6984412

Burenkov, A.; Lorenz, J.; Spiegel, Y.; Torregrosa, F.:
Simulation of AsH3 plasma immersion ion implantation into silicon
Institute of Electrical and Electronics Engineers -IEEE-: 20th International Conference on Ion Implantation Technology, IIT 2014. Proceedings : June 26 – July 4, 2014, Portland, Oregon; Piscataway, NJ: IEEE, 2014; 4 S.
DOI: 10.1109/IIT.2014.6940004

Content

Continuation: Publications

Burenkov, A.; Bär, E.; Boianceanu, C.:
Thermal properties of interconnects in power MOSFETs
Institute of Electrical and Electronics Engineers -IEEE-: 20th International Workshop on Thermal Investigations of ICs and Systems, THERMINIC 2014 : September 24 – 26, 2014, Greenwich, London; Piscataway, NJ: IEEE, 2014; 6 S.
DOI: 10.1109/THERMINIC.2014.6972518

Carl, E.R.; Danilewsky, A.; Meissner, E.; Geiger, T.:
Large and small angle grain boundaries in multi-crystalline silicon and implications for the evolution of grain boundaries during crystal growth
Journal of Applied Crystallography 47, S.1958-1965, 2014
DOI: 10.1107/S1600576714023061

Cristiano, F.; Pichler, P.; Tavernier, C.; Windl, W.:
Advanced extra functionality CMOS-based devices
Physica status solidi. C 11, Nr.1, S.7-8, 2014
DOI: 10.1002/pssc.201470035

Ditze, S.:
Steady-State Analysis of the Bidirectional CLLLC Resonant Converter in Time Domain
INTELEC, Vancouver 2014
DOI: 10.1109/INTLEC.2014.6972179

Endres, S.; Zeltner, S.:
Controlling of power electronic modules by a 2-wire-connection with combined signal and power transfer
CIPS, Nürnberg 2014; ISBN: 978-3-8007-3578-5 ; S.1-5

Erdmann, A.; Liang, R.G.; Sezginer, A.; Smith, B.:
Advances in lithography: Introduction to the feature. Editorial
Applied optics 53, Nr.34, S.L1-L2, 2014
DOI: 10.1364/AO.53.000LI1

Erlbacher, T.:
Lateral Power Transistors in Integrated Circuits
Springer, 2014, ISBN 978-3-319-00499-0

Erlbacher, T.; Schwarzmann, H.; Krach, F.; Bauer, A.J.; Berberich, S.E.; Kasko, I.; Frey, L.:
Reliability of monolithic RC-snubbers in MOS-based power modules
Proceedings of the 5th Electronics System-Integration Technology Conference 2014", Helsinki, FIN, September 16 – 18, 2014
DOI: 10.1109/ESTC.2014.6962794

Erlekampf, J.; Seebeck, J.; Savva, P.; Meissner, E.; Friedrich, J.; Alt, N.S.A.; Schlücker, E.; Frey, L.:
Numerical time-dependent 3D simulation of flow pattern and heat distribution in an ammonothermal system with various baffle shapes
Freitas, J.A.: 8th International Workshop on Bulk Nitrides Semiconductors, IWBNS 2013 (Seeon, GER, September 30 – October 5, 2013); Amsterdam: Elsevier, 2014 (Journal of crystal growth 403.2014), S.96-104
DOI: 10.1016/j.jcrysgro.2014.06.007

Essa, Z.; Cristiano, F.; Spiegel, Y.; Qiu, Y.; Boulenc, P.; Quillec, M.; Taleb, N.; Zographos, N.; Bedel-Pereira, E.; Mortet, V.; Burenkov, A.; Hackenberg, M.; Torregrosa, F.; Tavernier, C.:
Large boron-interstitial cluster modelling in BF3 plasma implanted silicon
Physica status solidi. C 11, Nr.1, S.117-120, 2014
DOI: 10.1002/pssc.201300165

Filipovic, L.; Rudolf, F.; Bär, E.; Evanschitzky, P.; Lorenz, J.; Roger, F.; Singulani, A.; Minixhofer, R.; Selberherr, S.:
Three-dimensional simulation for the reliability and electrical performance of through-silicon vias
Japan Society of Applied Physics -JSAP-; IEEE Electron Devices Society; Institute of Electrical and Electronics Engineers -IEEE-: International Conference on Simulation of Semiconductor Processes and Devices, SISPAD 2014. Proceedings : September 9 – 11, 2014, Yokohama, Japan; Piscataway, NJ: IEEE, 2014; S.341-344
DOI: 10.1109/SISPAD.2014.6931633

Frankeser, S.; Hiller, S.; Jutz, J.; Domes, K.:
Proportional Driver for SiC BJT's in electric vehicle inverter application
PCIM, Nürnberg, 2014; S.1-8; Print ISBN: 978-3-8007-3603-4

Freitas, J.A.; Meissner, E.; Paskova, T.; Miyake, H.:
Preface. 8th International Workshop on Bulk Nitrides Semiconductors, IWBNS 2013
Freitas, J.A.: 8th International Workshop on Bulk Nitrides Semiconductors, IWBNS 2013 (Seeon, GER, September 30 – October 5, 2013); Amsterdam: Elsevier, 2014 (Journal of crystal growth 403.2014); S.1-2
DOI: 10.1016/j.jcrysgro.2014.07.001

Fuegl, M.; Mackh, G.; Meissner, E.; Frey, L.:
Analytical stress characterization after different chip separation methods
Microelectronics Reliability 54 (2014) 1735-1740
DOI: 10.1016/j.microrel.2014.07.086

Content

Continuation: Publications

Führer, T.; Welling, U.; Müller, M.; Erdmann, A.:
Rigorous simulation and optimization of the lithography/directed self-assembly co-process
Lai, K. ; Society of Photo-Optical Instrumentation Engineers -SPIE-, Bellingham/Wash.: Optical microlithography XXVII : 25 – 27 February 2014, San Jose, California, United States; Selected papers presented at the 27th Optical Microlithography Conference (OM XXVII) held as part of the SPIE Advanced Lithography Symposium 2014; Bellingham, WA: SPIE, 2014 (Proceedings of SPIE 9052); Paper 90521C, 12 S.
DOI: 10.1117/12.2047381

Gustafsson, T.; Nord, S.; Andersson, D.; Brinkfeldt, K.; Hilpert, F.:
COSIVU – compact, smart and reliable drive train unit for commercial electric vehicles
AMAA, Berlin 2014
DOI: 10.1007/978-3-319-08087-1_18

Hackenberg, M.; Huet, K.; Negru, R.; Fisicaro, G.; La Magna, A.; Taleb, N.; Quillec, M.; Pichler, P.:
Simulation of the boron build-up formation during melting laser thermal annealing
Physica status solidi. C 11, Nr.1, S.89-92, 2014
DOI: 10.1002/pssc.201300156

Häublein, V.; Birnbaum, E.; Grimm, W.; Ryssel, H.; Frey, L.:
Modification of Polypropylene Films for Thin Film Capacitors by Ion Implantation
20th International Conference on Ion Implantation Technology (IIT), IEEE, 2014.
DOI: 10.1109/IIT.2014.6939968

Hanzig, J.; Zschornak, M.; Nentwich, M.; Hanzig, F.; Gemming, S.; Leisegang, T.; Meyer, D.C.:
Strontium titanate: An all-in-one rechargeable energy storage material
Journal of power sources 267, S.700-705, 2014
DOI: 10.1016/j.jpowsour.2014.05.095

Hilpert, F.; Brinkfeldt, K.; Arenz, S.:
Modular integration of a 1200 v SiC inverter in a commercial vehicle wheel-hub drivetrain
4th International Electric Drives Production Conference, EDPC 2014 – Proceedings
DOI: 10.1109/EDPC.2014.6984400

Hirtz, E.M.; Käsgen, J.; Krause, I.; Pleteit, H.; Eckardt, B.; Möller, R.:
Auslegungs- und Absicherungsprozess im Fokus der Elektromobilität – Herausforderungen der Betriebsfestigkeit
Brune, M. ; Deutscher Verband für Materialforschung und -prüfung e.V. -DVM-, Arbeitskreis Betriebsfestigkeit: Von der Lastannahme bis zur Absicherung - Betriebsfestigkeit entlang der Prozesskette : 41. Tagung des DVM-Arbeitskreises Betriebsfestigkeit, Ingolstadt; Berlin, October 8 – 9, 2014; DVM (DVM-Bericht 141)

Hürner, A.; Mitlehner, H.; Erlbacher, T.; Bauer, A.J.; Frey, L.:
Experimental analysis of bipolar SiC-devices for future energy distribution systems
16th European Conference on Power Electronics and Applications, EPE-ECCE Europe 2014
DOI: 10.1109/EPE.2014.6910847

Hürner, A.; Bonse, C.; Clemmer, G.; Kallinger, B.; Heckel, T.; Erlbacher, T.; Mitlehner, H.; Häublein, V.; Bauer, A.J.; Frey, L.:
Temperature and electrical field dependence of the ambipolar mobility in n-doped 4H-SiC
Materials Science Forums 778-780 (2014) 487-490
DOI: 10.4028/www.scientific.net/MSF.778-780.487

Hutzler, A.; Tokarski, A.; Kraft, S.; Zischler, S.; Schletz, A.:
Increasing the lifetime of electronic packaging by higher temperatures: Solders vs. silver sintering
Institute of Electrical and Electronics Engineers -IEEE-: IEEE 64th Electronic Components and Technology Conference, ECTC 2014, 27 – 30 May 2014, Orlando, Florida, USA; Piscataway, NJ: IEEE, 2014; S.1700-1706
DOI: 10.1109/ECTC.2014.6897526

Hutzler, A.; Tokarski, A.; Schletz, A.:
Modellierung von Ermüdungsausfällen durch aktive Lastwechseltests
Lang, K.-D. ; VDE/VDI-Gesellschaft Mikroelektronik, Mikro- und Feinwerktechnik -GMM-; Deutscher Verband für Schweißen und Verwandte Verfahren e.V. -DVS-: Elektronische Baugruppen und Leiterplatten, EBL 2014: Von Hochstrom bis Hochintegration; Vorträge der 7. DVS/GMM-Tagung in Fellbach am 11. und 12. Februar 2014; Düsseldorf: DVS Media, 2014 (DVS-Berichte 301); S.141-147

Hutzler, A.; Zeyss, F.; Vater, S.; Tokarski, A.; Schletz, A.; März, M.:
Power cycling community 1995-2014 - an overview of test results over the last 20 years
Bodo's power systems, ISSN: 1863-5598, Nr.05-14, S.78-81, 2014

Jelinek, M.; Laven, J.G.; Rommel, M.; Schustereder, W.; Schulze, H.J.; Frey, L.; Job, R.:
Deep-level defects in high-dose proton implanted and high-temperature annealed silicon
Simoen, E. ; Electrochemical Society -ECS-: High Purity and High Mobility Semiconductors 13: ECS and SMEQ Joint International Meeting, October 5 – 9, 2014, Cancun, Mexico; Pennington, NJ: ECS, 2014 (ECS transactions 64.2014, Nr.11); S.173-185
DOI: 10.1149/06411.0173ecst

Content

Continuation: Publications

Jelinek, M.; Schustereder, W.; Kirnstoetter, S.; Laven, J.G.; Schulze, H.J.; Rommel, M.; Frey, L.:
MeV-proton channeling in crystalline silicon
Institute of Electrical and Electronics Engineers -IEEE-: 20th International Conference on Ion Implantation Technology, IIT 2014. Proceedings: June 26 – July 4, 2014, Portland, Oregon; Piscataway, NJ: IEEE, 2014; 4 S.
DOI: 10.1109/IIT.2014.6940059

Jelinek, M.; Laven, J.G.; Job, R.; Schustereder, W.; Schulze, H.J.; Rommel, M.; Frey, L.:
A new method to increase the doping efficiency of proton implantation in a high-dose regime
Simoen, E.; Electrochemical Society -ECS-: High Purity and High Mobility Semiconductors 13: ECS and SMEQ Joint International Meeting, October 5 – 9, 2014, Cancun, Mexico; Pennington, NJ: ECS, 2014 (ECS transactions 64.2014, Nr.11); S.199-208
DOI: 10.1149/06411.0199ecst

Kallinger, B.; Ehlers, C.; Berwian, P.; Friedrich, J.; Rommel, M.:
Silicon carbide in power electronics: Overcoming the obstacle of bipolar degradation
Clausthal-Zellerfeld: Trans Tech Publications (Materials Science Forum 778-780), 2014
DOI: 10.4028/www.scientific.net/MSF.778-780.210

Kallinger, B.; Ehlers, C.; Berwian, P.; Rommel, M.; Friedrich, J.:
HCl assisted growth of thick 4H-SiC epilayers for bipolar devices
Materials Science Forum Vols. 778-780 (2014) 210-213
DOI: 10.4028/www.scientific.net/MSF.778-780.210

Kallinger, B.; Rommel, M.; Lilja, L.; Hassan, J.U.; Booker, I.; Janzen, E.; Bergman, P.:
Comparison of carrier lifetime measurements and mapping in 4H SiC using time resolved photoluminescence and μ-PCD
Clausthal-Zellerfeld: Trans Tech Publications, Materials Science Forum 778-780
DOI: 10.4028/www.scientific.net/MSF.778-780.301

Kilian, D.; Polster, S.; Vogeler, I.; et al.:
Pulsed Direct Flame Deposition and Thermal Annealing of Transparent Amorphous Indium Zinc Oxide Films As Active Layers in Field Effect Transistors
ACS APPLIED MATERIALS & INTERFACES Volume: 6, Issue: 15, Pages: 12245-12251, Published: AUG 13 2014

Koffel, S.; Burenkov, A.; Sekowski, M.; Pichler, P.; Giubertoni, D.; Bersani, M.; Knaipp, M.; Wachmann, E.; Schrems, M.; Yamamoto, Y.; Bolze, D.:
On an improved boron segregation calibration from a particularly sensitive power MOS process
Physica status solidi. C 11, Nr.1, S.12-15, 2014
DOI: 10.1002/pssc.201300152

Kreutzer, O. et al.:
Unidirectional fast switching non-isolated 100 kW fuel cell boost converter
European Conference on Power Electronics and Applications, Lappeenranta, EPE, 2014
DOI: 10.1109/EPE.2014.6910797

Krukowski, S.; Fornari, R.; Zytkiewicz, Z.R.; Friedrich, J.:
Editorial - Chairpersons' preface
Journal of Crystal Growth 401 (2014) 1–3

Landwehr, J.; Fader, R.; Rumler, M.; Rommel, M.; Bauer, A.J.; Frey, L.; Simon, B.; Fodor, B.; Petrik, P.; Schiener, A.; Winter, B.; Spiecker, E.:
Optical polymers with tunable refractive index for nanoimprint technologies
Nanotechnology 25, Nr.50, Art. 505301, 10 S., 2014
DOI: 10.1088/0957-4484/25/50/505301

Laven, J.G.; Jelinek, M.; Job, R.; Schustereder, W.; Schulze, H.J.; Rommel, M.; Frey, L.:
DLTS characterization of proton-implanted silicon under varying annealing conditions
Physica status solidi. B 251, Nr.11, S.2189-2192, 2014
DOI: 10.1002/pssb.201400028

Lehmann, T.; Trempa, M.; Meissner, E.; Zschorsch, M.; Reimann, C.; Friedrich, J.:
Laue scanner: A new method for determination of grain orientations and grain boundary types of multicrystalline silicon on a full wafer scale
Acta Materialia 69, S.1–8, 2014
DOI: 10.1016/j.actamat.2014.01.050

Lewke, D.; Koitzsch, M.; Dohnke, K.O.; Schellenberger, M.; Zuehlke, H.U.; Rupp, R.; Pfitzner, L.; Ryssel, H.:
High quality and high speed cutting of 4H-SiC JFET wafers including PCM structures by using Thermal Laser Separation
MRS Proceedings, Volume 1693, 2014
DOI: 10.1557/opl.2014.566

Li, S.; Wang, X.; Yang, J.; Tang, F.; Yan, G.; Erdmann, A.:
A defocus measurement method for an in situ aberration measurement method using a phase-shift ring mask
Lai, K. ; Society of Photo-Optical Instrumentation Engineers -SPIE-, Bellingham/Wash.: Optical microlithography XXVII : 25 - 27 February 2014, San Jose, California, USA; Selected papers presented at the 27th Optical Microlithography Conference (OM XXVII) held as part of the SPIE Advanced Lithography Symposium 2014; Bellingham, WA: SPIE, 2014 (Proceedings of SPIE 9052); Paper 90521L, 9 S.
DOI: 10.1117/12.2046649

Content

Continuation: Publications

Liu, X.; Wang, X.; Li, S.; Yan, G.; Erdmann, A.:
Fast rigorous model for mask spectrum simulation and analysis of mask shadowing effects in EUV lithography
Wood, O.R. ; Society of Photo-Optical Instrumentation Engineers -SPIE-, Bellingham/Wash.: Extreme ultraviolet (EUV) lithography V. Vol.2 : 24 – 27 February 2014, San Jose, California, USA, at the 2014 SPIE Advanced Lithography Symposium; Bellingham, WA: SPIE, 2014 (Proceedings of SPIE 9048); Paper 90483E, 10 S.
DOI: 10.1117/12.2046333

Lorenz, J.K.; Baer, E.; Burenkov, A.; Erdmann, A.; Evanschitzky, P.; Pichler, P.:
Challenges and opportunities for process modeling in the nanotechnology era
Journal of computational electronics 13, Nr.1, S.3-17, 2014
DOI: 10.1007/s10825-013-0477-4

Lorenz, J.; Bär, E.; Burenkov, A.; Evanschitzky, P.; Asenov, A.; Wang, L.; Wang, X.; Brown, A.; Millar, C.; Reid, D.:
Simultaneous simulation of systematic and stochastic process variations
Japan Society of Applied Physics -JSAP-; IEEE Electron Devices Society; Institute of Electrical and Electronics Engineers -IEEE-: International Conference on Simulation of Semiconductor Processes and Devices, SISPAD 2014, Proceedings: September 9 – 11, 2014, Yokohama, Japan; Piscataway, NJ: IEEE, 2014, S.289-292
DOI: 10.1109/SISPAD.2014.6931620

Maier, R.; Häublein, V.; Ryssel, H.:
Out-Diffusion of Cesium and Rubidium from Amorphized Silicon during Solid-Phase Epitaxial Regrowth
20th International Conference on Ion Implantation Technology (IIT), IEEE, 2014.
DOI: 10.1109/IIT.2014.6939974

Meyer, D.C.; Leisegang, T.:
Preface: 1st International Freiberg Conference on Electrochemical Storage Materials
June 3 – 4, 2013 in Freiberg, Germany; AIP Conference Proceedings 1597 (2014) 1–2
DOI: 10.1063/1.4878475

Moyne, J.; Schellenberger, M.; Pfitzner, L.:
The Factory Integration Roadmap in Semiconductor Manufacturing
in Proc. of 44th European Solid-State Device Research Conference (ESSDERC), IEEE Catalog Number: CFP14543-POD, pp. 154-156, ISBN: 978-1-4799-4375-3, 2014
DOI: 10.1109/ESSDERC.2014.6948781

Murakami, K.; Rommel, M.; Hudec, B.; Rosová, A.; Hušeková, K.; Dobročka, E.; Rammula, R.; Kasikov, A.; Han, J.H.; Lee, W.; Song, S.J.; Paskaleva, A.; Bauer, A.J.; Frey, L.; Fröhlich, K.; Aarik, J.; Hwang, C.S.:
Nanoscale characterization of TiO2 films grown by atomic layer deposition on RuO2 electrodes
ACS applied materials & interfaces 6, 4, 2486-2492, 2014
DOI: 10.1021/am4049139

Nagy, R., Burenkov, A., Lorenz, J.:
Numerical evaluation of the ITRS transistor scaling
Journal of Computational Electronics, 2014
DOI: 10.1007/s10825-014-0638-0

Nestler, T.; Schmid, R.; Munchgesang, W.; Bazhenov, V.; Schilm, J.; Leisegang, T.; Meyer, D.C.:
Separators-Technology-Review:Ceramic based Separators for Secondary-Batteries
AIP Conference Proceedings 1597, 2014, 155-184
DOI: 10.1063/1.4878486

Niedermeier, M.T.; Wenger, M.M.; Filimon, R.; Sedlacek, V.O.; Lorentz, V.R.H.; Fort, C.; März, M.; Ferrieux, J.P.; Frey, L.:
Galvanically isolated differential data transmission using capacitive coupling and a modified Manchester algorithm for smart power converters
Industrial Electronics (ISIE), 2014 IEEE 23rd International Symposium on, vol., no., pp.2596,2600, June 1 – 4, 2014
DOI: 10.1109/ISIE.2014.6865029

Noll, S.; Rambach, M.; Grieb, M.; Scholten, D.; Bauer, A.J.; Frey, L.:
Effect of shallow n-doping on field effect mobility in p-doped channels of 4H-SiC MOS field effect transistors
Okumura, H.: Silicon carbide and related materials 2013. Vol.2 : Selected, peer reviewed papers from the 15th International Conference on Silicon Carbide and Related Materials 2013, (ICSCRM 2013), September 29 – October 4, 2013, Miyazaki, Japan; Durnten-Zurich: Trans Tech Publications, 2014 (Materials Science Forum 778-780); S.702-705
DOI: 10.4028/www.scientific.net/MSF.778-780.702

Oertel, S.; Jank, M.P.M.; Teuber, E.; Bauer, A.J.; Frey, L.:
High-mobility metal-oxide thin-film transistors by spray deposition of environmentally friendly precursors
European Materials Research Society (E-MRS) Spring Meeting 2013 : Symposium O „Synthesis, Processing and Characterization of Nanoscale Multi Functional Oxide Films IV" (Strasbourg, FRA, May 27 – 31, 2013); Amsterdam: Elsevier, 2014 (Thin solid films 553.2014), S.114-117
DOI: 10.1016/j.tsf.2013.11.061

Content

Continuation: Publications

Ortiz, G.; Mortet, V.; Strenger, C.; Uhnevionak, V.; Burenkov, A.; Bauer, A.J.; Pichler, P.; Cristiano, F.; Bedel-Pereira, E.:
Impact of fabrication process on electrical properties and on interfacial density of states in 4H-SiC n-MOSFETs studied by hall effect
Zielinski, Marcin: HeteroSiC & WASMPE 2013 : Selected, peer reviewed papers from the 5th Edition of International Workshop on Silicon Carbide Hetero-Epitaxy and Workshop on Advanced Semiconductor Materials and Devices for Power Electronics Applications (HeteroSiC-WASMPE 2013), June 17 – 19, 2013, Nice, France; Dürnten: Trans Tech Publications, 2014 (Materials Science Forum 806); S.127-132
DOI: 10.4028/www.scientific.net/MSF.806.127

Ott, L.; Wunder, B.; Han, Y.; Kaiser, J.; März, M.:
Leistungselektronik für Niederspannungs-Gleichstromnetze in kommerziell genutzten Gebäuden
VDE Kongress 2014, Smart Cities, 6 S., ISBN 978-3-8007-3641-6

Rauh, H.; Sueltrop, C.; März, M.; Frey, L.:
Energy optimized implementation of climatisation systems in electric vehicles with integrated drive components
CoFAT, München, 2014
DOI: 10.13140/RG.2.1.5015.1528

Roeder, G.; Winzer, S.; Schellenberger, M.; Jank, S.; Pfitzner, L.:
Feasibility Evaluation of Virtual Metrology for the Example of a Trench Etch Process
Semiconductor Manufacturing, IEEE Transactions on, vol. 27, pp. 327-334, 2014
DOI: 10.1109/TSM.2014.2321192

Rommel, M.; Beuer, S.; Haas, A.; Rumler, M.:
Nano-patterning silicon carbide by Ga+ resistless lithography and subsequent reactive ion etching
Process News 0614, A Newsletter from Oxford Instruments Plasma Technology (OIPT), 4-5 (2014)

Roßkopf, A.; Joffe, C.; Bär, E.:
Calculation of ohmic losses in litz wires by coupling analytical and numerical methods
Institute of Electrical and Electronics Engineers -IEEE-; Verband Deutscher Maschinen- und Anlagenbau e.V. -VDMA-, Frankfurt/Main: 4th International Electric Drives Production Conference (EDPC), Nuremberg, GER, September 30 - October 1, 2014; Piscataway, NJ: IEEE, 2014; ISBN: 978-1-4799-5008-9; ISBN: 978-1-4799-5009-6; ISBN: 978-1-4799-5010-2; S.385-390
DOI: 10.1109/EDPC.2014.6984423

Roßkopf, A.; Bär, E.; Joffe, C.:
Influence of inner skin- and proximity effects on conduction in litz wires
IEEE transactions on power electronics 29, Nr.10, S.5454-5461, 2014
DOI: 10.1109/TPEL.2013.2293847

Rosu, D.; Petrik, P.; Rattmann, G.; Schellenberger, M.; Beck, U.; Hertwig, A.:
Optical characterization of patterned thin films
Thin solid films 571, Part 3, S.601-604, 2014
DOI: 10.1016/j.tsf.2013.11.052

Rykov, K.; Duarte, J.L.; Szpek, M.; Olsson, J.; Zeltner, S.; Ott, L.:
Converter impedance characterization for stability analysis of low-voltage DC-grids
Institute of Electrical and Electronics Engineers -IEEE-; Institute of Electrical and Electronics Engineers -IEEE-, Power & Energy Society -PES-: IEEE PES Innovative Smart Grid Technologies Conference, ISGT 2014: Washington, DC, USA, February 19 – 22, 2014; Piscataway, NJ: IEEE, 2014; S.81-85
DOI: 10.1109/ISGT.2014.6816385

Rykov, K; Ott, L; Duarte, J.L.; Lomonova; E.:
Modelling of Aggregated Operation of Power Modules in Low-Voltage DC Grids
Conference Paper: Proceedings of the 16th European Conference on Power Electronics and Applications (EPE'14-ECCE Europe), Lappeenranta, Finland, 26 – 28 August 2014, (pp. 1-9). Piscataway: IEEE Service Center

Scharin, M.; Rommel, M.; Dirnecker, T.; Marhenke, J.; Herrmann, B.; Rumler, M.; Fader, R.; Frey, L.; Herrmann, M.:
Bioactivation of plane and patterned PDMS thin films by wettability engineering
BioNanoScience 4, Nr.3, S.251-262, 2014
DOI: 10.1007/s12668-014-0145-6

Schmenger, J., Endres, S., Zeltner, S., März, M.:
A 22 kW on-board charger for automotive applications based on a modular design
2014 IEEE Conference on Energy Conversion, CENCON 2014
DOI: 10.1109/CENCON.2014.6967467

Seliger, B.; Popov, J.; Eckardt, B.; März, M.:
Galvanic isolated auxiliary power supply with high power density and efficiency
INTELEC, Vancouver 2014
DOI: 10.1109/INTLEC.2014.6972188

Content

Continuation: Publications

Sintonen, S.; Rudziski, M.; Suihkonen, S.; Jussila, H.; Knetzger, M.; Meissner, E.; Danilewsky, A.; Tuomi, T.O.; Lipsanen, H.:
Synchrotron radiation x-ray topography and defect selective etching analysis of threading dislocations in GaN
Journal of Applied Physics 116 (2014) 083504
DOI: 10.1063/1.4893901

Stockmeier, L.; Müller, G.; Seidl, A.; Lehmann, T.; Reimann, C.; Friedrich, J.:
Preferred Grain Orientations in Silicon Ribbons Grown by the String Ribbon and the Edge-defined Film-fed Growth Methods
Journal of Crystal Growth 395 (2014) 74–79
DOI: 10.1016/j.jcrysgro.2014.03.005

Strenger, C.; Uhnevionak, V.; Mortet, V.; Ortiz, G.; Erlbacher, T.; Burenkov, A.; Bauer, A.J.; Cristiano, F.; Bedel-Pereira, E.; Pichler, P.; Ryssel, H.; Frey, L.:
Systematic analysis of the high-and low-field channel mobility in lateral 4H-SiC MOSFETs
Materials Science Forums 778-780 (2014) 583-586
DOI: 10.4028/www.scientific.net/MSF.778-780.583

Thesen, M.; Rumler, M.; Schlachter, F.; Grützner, S.; Moormann, C.; Rommel, M.; Nees, D.; Ruttloff, S.; Pfirrmann, S.; Vogler, M.; Schleunitz, A.; Grützner, G.:
Enabling large area and high throughput roll-to-roll NIL by novel inkjetable and photo-curable NIL-resists
Resnick, D.J. ; Society of Photo-Optical Instrumentation Engineers -SPIE-, Bellingham/Wash.: Alternative Lithographic Technologies VI : February 2014, San Jose, California; Bellingham, WA: SPIE, 2014 (Proceedings of SPIE 9049) ISBN: 978-0-8194-9972-1; Paper 90490H
DOI: 10.1117/12.2046279

Thesen, M.W.; Nees, D.; Ruttloff, S.; Rumler, Maximilian; Rommel, Mathias; Schlachter, F.; Grützner, S.; Vogler, M.; Schleunitz, A.; Grützner, G.:
Inkjetable and photo-curable resists for large-area and high-throughput roll-to-roll nanoimprint lithography
Journal of micro/nanolithography, MEMS and MOEMS 13, Nr.4, Art. 043003, 2014
DOI: 10.1117/1.JMM.13.4.043003

Trapnauskas, J.; Rommel, M.; Bauer, A.J.; Frey, L.:
Thickness mapping of high-k dielectrics at the nanoscale
Applied Physics Letters 104, 5, Art. 052907, 5 S., 2014
DOI: 10.1063/1.4863947

Trempa, M.; Reimann, C.; Friedrich, J.; Müller, G.; Krause, A.; Sylla, L.; Richter, T.:
Defect formation induced by seed-joints during directional solidification of quasi-mono-crystalline silicon ingots
Journal of Crystal Growth 405 (2014) 131–141
DOI: 10.1016/j.jcrysgro.2014.08.002

Trempa, M.:
Gerichtete Erstarrung von einkristallinen Siliciumkristallen nach dem VGF-Verfahren für die Anwendung in der Photovoltaik
Stuttgart: Fraunhofer Verlag, 2014, III, 205 S.; ISBN: 978-3-8396-0695-7

Tröger, B.; Mühlig, A.; Fries, T.; Bauer, S.; Wihr, H.; Riedel, F.; Lewke, D.; Schellenberger, M.:
Automated tool for measuring nanotopography of 300 mm wafers at early stages of wafer production
Schmitt, R.: Measurement technology and intelligent instruments IX : Selected, peer reviewed papers from the 11th International Symposium on Measurement Technology and Intelligent Instrument (ISMTII-2013), July 1 – 3, 2013, Aachen, GER; Durnten-Zurich: Trans Tech Publications, 2014 (Key engineering materials 613); ISBN: 978-3-03835-112-2; S.87-93
DOI: 10.4028/www.scientific.net/KEM.613.87

Uhnevionak, U.; Burenkov, A.; Strenger, C.; Mortet, V.; Bedel-Peireira, E.; Cristiano, F.; Bauer, A.J.; Pichler, P.:
Hall factor calculation for the characterization of transport properties in n-channel 4H-SiC MOSFETs
Okumura, H.: Silicon Carbide and Related Materials 2013. Vol.1 : Selected, peer reviewed papers from the 15th International Conference on Silicon Carbide and Related Materials, (ICSCRM 2013), September 29 – October 4, 2013, Miyazaki, JPN; Dürnten: Trans Tech Publications, 2014 (Materials Science Forum 778-780); S.483-486
DOI: 10.4028/www.scientific.net/MSF.778-780.483

Valcu (Herbei), E.E.; Musat, V.; Oertel, S.; Jank, M.:
Sol-gel preparartion of ZrO2-PMMA for thin film transistors
Revista de Chimie 65 (2014) 574-577

Voelkel, R.; Vogler, U.; Bramati, A.; Erdmann, A.; Ünal, N.; Hofmann, U.; Hennemeyer, M.; Zoberbier, R.; Nguyen, D.; Brugger, J.:
Lithographic process window optimization for mask aligner proximity lithography
Lai, K. ; Society of Photo-Optical Instrumentation Engineers -SPIE-, Bellingham/Wash.: Optical microlithography XXVII : 25 – 27 February 2014, San Jose, California, USA; Selected papers presented at the 27th Optical Microlithography Conference (OM XXVII) held as part of the SPIE Advanced Lithography Symposium 2014; Bellingham, WA: SPIE, 2014 (Proceedings of SPIE 9052); Paper 90520G, 11 S.
DOI: 10.1117/12.2046332

Content

Continuation: Publications

Voronkov, V.V.; Falster, R.; Pichler, P.:
Relaxation of vacancy depth profiles in silicon wafers: A low apparent diffusivity of vacancy species
Applied Physics Letters 104, Nr.3, Art. 032106, 5 S., 2014
DOI: 10.1063/1.4863225

Waltrich, U.; Malipaard, D.; Schletz, A.:
Novel design concept for modular multilevel converter power modules
PCIM Europe Conference Proceedings, 2014; ISBN: 978-380073603-4; Pages 1063-1068

Wang, X.; Li, S.; Yang, J.; Tang, F.; Yan, G.; Erdmann, A.:
In situ aberration measurement method using a phase-shift ring mask
Lai, K.: Society of Photo-Optical Instrumentation Engineers -SPIE-, Bellingham/Wash.: Optical microlithography XXVII : 25 – 27 February 2014, San Jose, California, USA; Selected papers presented at the 27th Optical Microlithography Conference (OM XXVII) held as part of the SPIE Advanced Lithography Symposium 2014; Bellingham, WA: SPIE, 2014 (Proceedings of SPIE 9052); Paper 90521J, 9 S.
DOI: 10.1117/12.2046257

Wang, L.; Brown, A.R.; Millar, C.; Burenkov, A.; Wang, X.; Asenov, A.; Lorenz, J.:
Simulation for statistical variability in realistic 20nm MOSFET
Institute of Electrical and Electronics Engineers -IEEE-: 15th International Conference on Ultimate Integration on Silicon, ULIS 2014 : 7 – 9 April 2014, Stockholm, SWE; Piscataway, NJ: IEEE, 2014; S.5-8
DOI: 10.1109/ULIS.2014.6813892

Wang, X.; Reid, D.; Wang, L.; Burenkov, A.; Millar, C.; Cheng, B.; Lange, A.; Lorenz, J.; Bär, E.; Asenov, A.:
Variability-aware compact model strategy for 20-nm bulk MOSFETs
Japan Society of Applied Physics -JSAP-; IEEE Electron Devices Society; Institute of Electrical and Electronics Engineers -IEEE-: International Conference on Simulation of Semiconductor Processes and Devices, SISPAD 2014. Proceedings: September 9 – 11, 2014, Yokohama, JPN; Piscataway, NJ: IEEE, 2014; ISBN: 978-1-4799-5288-5; S.293-296
DOI: 10.1109/SISPAD.2014.6931621

Wenger, M.M.; Filimon, R.; Lorentz, V.R.H.; März, M.:
A robust contactless capacitive communication link for high power battery systems
Industrial Electronics (ISIE), 2014 IEEE 23rd International Symposium on, vol., no., pp.1766,1772, 1 – 4 June 2014
DOI: 10.1109/ISIE.2014.6864882

Wenger, M.; Waller, R.; Lorentz, V.R.H.; März, M.; Herold, M.:
Investigation of gas sensing in large lithium-ion battery systems for early fault detection and safety improvement
Industrial Electronics Society, IECON 2014 - 40th Annual Conference of the IEEE, vol., no., pp.5654,5659, October 29 – November 1, 2014
DOI: 10.1109/IECON.2014.7049366

Widenmeyer, M.; Meissner, E.; Senyshyn, A. Y.; Niewa, R.:
On the Formation Mechanism of Chromium Nitrides: An in situ Study
Zeitschrift für anorganische und allgemeine Chemie Volume 640, Issue 14 (2014), 2801–2808
DOI: 10.1002/zaac.201400246

Widenmeyer, M.; Hansen, T. C.; Meissner, E.; Niewa, R.:
Formation and Decomposition of Iron Nitrides Observed by in situ Powder Neutron Diffraction and Thermal Analysis
Z. Anorg. Allg. Chem. 640, (7) (2014), 1265–1274
DOI: 10.1002/zaac.201300676

Wolf, F.A.; Martinez-Limia, A.; Stichtenoth, D.; Pichler, P.:
Modeling the annealing of dislocation loops in implanted c-Si solar cells
IEEE Journal of Photovoltaics 4, Nr.3, S.851-858, 2014
DOI: 10.1109/JPHOTOV.2014.2312103

Wright, A.; Hutzler, A.; Schletz, A.; Pichler, P.:
Thermo-mechanical simulation of plastic deformation during temperature cycling of bond wires for power electronic modules
Institute of Electrical and Electronics Engineers -IEEE-: 15th International Conference on Thermal, Mechanical and Multi-Physics Simulation and Experiments in Microelectronics and Microsystems, EuroSimE 2014: April 7 – 9, 2014, Ghent , BEL; Piscataway, NJ: IEEE, 2014; S.278-282
DOI: 10.1109/EuroSimE.2014.6813813

Wunder, B.; Ott, L.; Szpek, M.; Boeke, U.; Weiß, R.:
Energy Efficient DC-Grids for Commercial Buildings
INTELEC 2014
DOI: 10.1109/INTLEC.2014.6972215

Wysokowski, M.; Motylenko, M.; Walter, J.; Lota, G.; Wojciechowski, J.; Stocker, H.; Galli, R.; Stelling, A. L.; Himcinschi, C.; Niederschlag, E.; Langer, E.; Bazhenov, V. V.; Szatkowski, T.; Zdarta, J.; Pertenko, I.; Kljajic, Z.; Leisegang, T.; Molodtsov, S. L.; Meyer, D. C.; Jesionowskia, T.; Ehrlich, H.:
Synthesis of nanostructured chitin-hematite composites under extreme biomimetic conditions
RSC Advances 4, Nr.106, S.61743-61752, 2014
DOI: 10.1039/c4ra10017d

Content

Continuation: Publications

Xu, D.B.; Fühner, T.; Erdmann, A.:
Pixel-based defect detection from high-NA optical projection images
Applied optics 53, Nr.18, S.3866-3874, 2014
DOI: 10.1364/AO.53.003866

Yan, G.; Wang, X.; Li, S.; Yang, J.; Xu, D.:
Aberration measurement based on principal component analysis of aerial images of optimized marks
Optics communications 329, S.63-68, 2014
DOI: 10.1016/j.optcom.2014.05.003

Yan, G.; Wang, X.; Li, S.; Yang, J.; Xu, D.; Erdmann, A.:
Aberration measurement technique based on an analytical linear model of a through-focus aerial image
Optics Express 22, Nr.5, S.5623-5634, 2014
DOI: 10.1364/OE.22.005623

Zeltner, S.; Endres, S.:
Power Electronics for Smart Micro and Nano Grids Controlled by a Novel Two-Wire Interface with Integrated Power and Signal Transfer
CSNDSP, Manchester 2014
DOI: 10.1109/CSNDSP.2014.6923950

Presentations

Azizi, M.; Reimann, C.; Cröll, A.; Friedrich, J.:
PARSIWAL - one small step for improving photovoltaics; TEXUS - one giant leap for basic research in crystal growth
Invited, TEXUS 50: 35 Years of Research in Microgravity
Speyer, GER, March 6 – 7, 2014

Bayer, C.; Bär, E.; Kallinger, B.; Berwian, P.:
Thermal Simulation of Paralleled SiC PiN Diodes in a Module Designed for 6.5 kV/1 kA
Poster Presentation, 10th European Conference on Silicon Carbide and Related Materials (ECSCRM)
Grenoble, FRA, September 21 – 25, 2014

Beier, M.; Trempa, M.; Gründig-Wendrock, B.; Reimann, C.; Friedrich, J.; Dadzis, K.; Sylla, L.; Richter, T.:
Quasi continuous recharging during directional solidification of silicon ingots for PV applications
E-MRS 2014 Spring Meeting
Lille, FRA, May 26 – 30, 2014

Beier, M.; Trempa, M.; Seebeck, J.; Reimann, C.; Wellmann, P.; Gründig-Wendrock, B.; Friedrich, J.; Dadzis, K.; Sylla, L.; Richter, T.:
Feedstock recharging during directional solidification of silicon ingots for PV applications
Poster, 29th European Photovoltaic Solar Energy Conference and Exhibition (EU PVSEC 2014)
Amsterdam, NL, September 22 – 26, 2014

Berwian, P.; Kallinger, B.; Friedrich, J.:
Quality Assurance in the Epitaxy of SiC and its Relevance for Device Reliability
6th International Workshop on Crystal Growth Technology (IWCGT-6)
Berlin, GER, June 15 – 19, 2014

Brockerhoff, P.; Burkhardt, Y.; Egger, K.; Rauh, H.:
Highly integrated drivetrain solution: Integration of motor, inverter and gearing
EDPC
Nürnberg, GER, September 30 – October 1, 2014

Burkhardt Y., Rauh, H.:
Integrierte E-Antriebsstränge durch intelligente Einzelzähne
Leistungselektronik Kolloquium
Erlangen, GER, October 20, 2014

Endres, S.; Zeltner, S.:
Controlling of power electronic modules by a 2-wire-connection with combined signal and power transfer
CIPS
Nürnberg, GER, February 25 – 27, 2014

Erlbacher, T.:
Prospects of Monolithic Capacitors for Power Electronic Applications
CMOS Emerging Technologies Research 2014
Grenoble, FRA, June 6 – 8, 2014

Content

Continuation: Presentations

Erlbacher, T.; Schwarzmann, H.; Bauer, A.J.; Frey, L.; Döhler, G.; Scheivogel, M.; Lutz, T.; Guillén, F.H.; Graf, J.; Fix, R.:
Modeling of ion drift in SiC MOSFET-based chemical sensors
Workshop on Dielectrics in Microelectronics 2014
Cork, IR, June 9 – 11, 2014

Erlbacher, T.; Schwarzmann, H.; Krach, F.; Bauer, A.J.; Berberich, S.E.; Kasko, I.; Frey, L.:
Reliability of monolithic RC-snubbers in MOS-based power modules
5th Electronics System-Integration Technology Conference
Helsinki, FIN, September 16 – 18, 2014

Erlekampf, J.; Seebeck, J.; Meissner, E.; Savva, P.; Friedrich, J.; Frey, L.:
Numerical view on the relevance of the baffle design in an ammonothermal system
Poster Presentation, International Workshop on Nitride Semiconductors (IWN 2014)
Wroclaw, POL, August 24 – 29, 2014

Erlekampf, J.; Seebeck, J.; Meissner, E.; Savva, P.; Friedrich, J.; Frey, L.:
Numerical time-dependent 3D simulation of flow pattern and heat distribution in an ammonothermal system
4th International Solvothermal and Hydrothermal Association Conference – ISHA 2014,
Bordeaux, FRA, October 26 – 29, 2014

Fader, R.; Landwehr, J.; Rumler, M.; Förthner, M.; Rommel, M.; Bauer, A.J.; Frey, L.; Simon, B.; Fodor, B.; Petrik, P.; Winter, B.; Spiecker, E.:
Optical polymers with tunable refractive index for nanoimprint technologies
Poster Presentation, 40th International Conference on Micro and Nano Engineering (MNE)
Lausanne, CHE, September 22 – 26, 2014

Fader, R.; Landwehr, J.; Rumler, M.; Rommel, M.; Bauer, A.J.; Frey, L.; Simon, B.; Fodor, B.; Petrik, P.; Schiener, A.; Winter, B.; Spiecker, E.:
Optical polymers with tunable refractive index for nanoimprint technologies
Poster Presentation, 13th International Conference on Nanoimprint and Nanoprint Technology (NNT)
Kyoto, JPN, October 22 – 24, 2014

Fader, R.; Rumler, M.; Scharin, M.; Förthner, M.; Rommel, M.:
Process development for nanoimprint at Fraunhofer IISB
SUSS Technology Forum Nanoimprint
Grenoble, FRA, June 24, 2014

Fader, R.; Förthner, M.; Rumler, M.; Rommel, M.; Bauer, A.J.; Frey, L.; Verschuuren, M.; Butschke, J.; Irmscher, M.; Storace, E.; Ji, R.; Schömbs, U.:
Structure placement accuracy of wafer level stamps for substrate conformal imprint lithography
Poster Presentation, 13th International Conference on Nanoimprint and Nanoprint Technology (NNT)
Kyoto, JPN, October 22 – 24, 2014

Frankeser, S.; Hiller, S.; Jutz, J.; Domes, K.:
Proportional Driver for SiC BJT's in electric vehicle inverter application
PCIM
Nürnberg, GER, May 20 – 22, 2014

Friedrich, J.; Kallinger, B.; Ehlers, C.; Berwian, P.:
Silicon carbide in power electronics: Overcoming the obstacle of bipolar degradation
Deutsche Kristallzüchtungstagung (DKT)
Halle, GER, March 12 – 14, 2014

Friedrich, J.:
Kristalle – Wunderwerkstoffe für unsere Gesellschaft
4. P/W Schülerkongress
Nuremberg, GER, February 11, 2014

Friedrich, J.; Miller, W.; Azizi, M.:
The crystal growers of Freiburg
50 Jahre Kristallographie
Freiburg, GER, October 31, 2014

Förthner, M.; Fader, R.; Rumler, M.; Rommel, M.; Frey, L.; Girschikofsky, M.; Belle, S.; Hellmann, R.; Klein, J.J.:
Large area fabrication of hybrid polymer waveguides for planar Bragg grating sensors using UV-enhanced Substrate Conformal Imprint Lithography (UV-SCIL)
Poster Presentation, 13th International Conference on Nanoimprint and Nanoprint Technology (NNT)
Kyoto, JPN, October 22 – 24, 2014

Fuegl, M.; Meissner, E.; Frey, L.:
Analytical stress-characterization after different chip separation methods
Poster Presentation, 25th European Symposium on Reliability of Electron Devices, Failure Physics and Analysis (ESREF)
Berlin, GER, September 29 – October 2, 2014

Content

Continuation: Presentations

Gustafsson,T.; Nord, S.; Andersson, D.; Brinkfeldt, K.; Hilpert, F.:
COSIVU – compact, smart and reliable drive train unit for commercial electric vehicles
AMAA
Berlin, GER, June 23 – 24, 2014

Häublein, V.:
Ionenimplantation in Kondensatorfilme
ITG 8.1.1/GMM 1.2.2-Nutzertreffen Ionenimplantation
Erlangen, GER, April 3, 2014

Häublein, V.:
Modification of Polypropylene Films for Thin Film Capacitors by Ion Implantation
20th International Conference on Ion Implantation Technology (IIT)
Portland, Oregon, USA, June 29 – July 4, 2014

Häublein, V.:
Out-Diffusion of Cesium and Rubidium from Amorphized Silicon during Solid-Phase Epitaxial Regrowth
20th International Conference on Ion Implantation Technology (IIT)
Portland, Oregon, USA, June 29 – July 4, 2014

Häublein, V.:
Out-Diffusion of Cesium and Rubidium from Amorphized Silicon during Solid-Phase Epitaxial Regrowth
ITG 8.1.1/GMM 1.2.2-Nutzertreffen Ionenimplantation
Dresden, GER, November 13, 2014

Hilpert, F.:
Modularer 1200V SiC Umrichter für Nutzfahrzeug-Radnabenmotoren
Leistungselektronik Kolloquium
Erlangen, GER, October 20, 2014

Hilpert, F.; Arenz, S.; Brinkfeldt, K.:
Modular integration of a 1200V SiC inverter in a commercial vehicle drivetrain
EDPC
Nürnberg, GER, September 30 – October 1, 2014

Hofmann, P.; Röder, C.; Habel, F.; Leibiger, G.; Beyer, F.; Krupinski, M.; Schröter, C.; Weinert, B.; Mikolajick, T.; Eichler, S.:
Silizium Dotierung von bulk-HVPE GaN Material
DGKK-Arbeitskreis „Herstellung und Charakterisierung von massiven Halbleiterkristallen"
Freiberg, GER, October 8 – 9, 2014

Hubenthal, L.; Trempa, M.; Reimann, C.; Wellmann, P.; Friedrich, J.:
Entwicklung der Gefügestruktur während der gerichteten Erstarrung von multikristallinem (mc) Photovoltaik-Silizium
Poster Presentation, jDGKK Meeting
Halle, GER, March 11 – 12, 2014

Hürner, A.; Ehlers, C.; Kallinger, B.; Mitlehner, H.; Erlbacher, T.; Häublein, V.; Bauer, A. J.; Frey, L.:
Electrical Characterization of n-doped 4H-SiC Epitaxial Layers grown with Hydrogenchloride Addition
Poster Presentation, 10th European Conference on Silicon Carbide and Related Materials (ECSCRM)
Grenoble, FRA, September 21 – 25, 2014

Hutzler, A.; Tokarski, A.; Kraft, S.; Zischler, S.; Schletz, A.:
Increasing the lifetime of electronic packaging by higher temperatures: solders vs. silver sintering
ECTC Conference
Orlando, USA, May 27 – 30, 2014

Hutzler, A.; Wright, A.; Schletz, A.:
Increasing the lifetime of power modules by smaller bond wire diameters
IMAPS Wire Bonding Workshop
San Jose, California, USA, January 21 – 22, 2014

Hutzler, A.; Schletz, A.:
Hohe Lebensdauer durch hohe Temperatur, Cluster Leistungselektronik, Kolloquium
Erlangen, GER, March 2014

Hutzler, A.; Tokarski, A.; Schletz, A.:
Modellierung von Ermüdungsausfällen durch aktive Lastwechseltests
EBL Konferenz
Fellbach, GER, February 11 – 12, 2014

Hutzler, A.; Noreik, B.; Schletz, A.; Schimanek, E.:
Statistische Lebensdauer- und Zuverlässigkeitsanalyse. Cluster Leistungselektronik
Nürnberg, GER, June 25 – 26, 2014

Content

Continuation: Presentations

Hutzler, A.; Noreik, B.; Schletz, A.; Schimanek, E.; Erlbacher, T.:
Statistische Lebensdauer- und Zuverlässigkeitsanalyse. Cluster Leistungselektronik
Nürnberg, GER, 21 – 22 October, 2014

Jauß, T.; Sorgenfrei, T.; Cröll, A.; Azizi, M.; Reimann, C.; Friedrich, J.; Volz, M.:
Behavior of particle depots in molten silicon during float-zone growth in strong static magnetic fields
Poster Presentation, DKT 2014
Halle, GER, March 12 – 14, 2014

Jelinek, M.; Laven, J.G.; Kirnstoetter, S.; Schustereder, W.; Schulze, H.J.; Rommel, M.; Frey, L.:
A DLTS study of hydrogen doped Czochralski-grown silicon
Poster Presentation, 19th International Conference on Ion Beam Modification of Materials (IBMM)
Leuven, BEL, September 14 – 19, 2014

Kallinger, B.; Ehlers, C.; Berwian, P.; Friedrich, J.; Möller, H.; Schütz, M.:
Silicon Carbide in Power Electronics: Overcoming the Obstacle of Bipolar Degradation
DKT 2014
Halle, GER, March 12 – 14, 2014

Kallinger, B.; Ehlers, C.; Berwian, P.; Friedrich, J.; Rommel, M.:
Silicon Carbide in Power Electronics: Overcoming the Obstacle of Bipolar Degradation
TMS Annual Meeting 2014 (The Minerals, Metals and Material Society)
San Diego, USA, February 16 – 20, 2014

Kallinger, B.; Kaminzky, D.; Berwian, P.; Oppel, S.; Schütz, M.; Schneider, A.; Krieger, M.; Weber, J.; Friedrich, J.:
New Defect Luminescence Scanner for Inline Control of Material Quality
Poster Presentation, European Conference on Silicon Carbide and Related Materials (ECSCRM)
Grenoble, FRA, September 21 – 25, 2014

Kallinger, B.; Berwian, P.; Friedrich, J.; Oppel, S.; Schütz, M.; Weber, J.; Krieger, M.:
Defect Luminescence Scanner: Towards Inline Monitoring of SiC Material Quality
Poster Presentation, 10th European Conference on Silicon Carbide and Related Materials (ECSCRM)
Grenoble, FRA, September 21 – 25, 2014

Kaminzky, D.; Kallinger, B.; Berwian, P.; Oppel, S.; Schütz, M.; Friedrich, J.:
Defektlumineszenz in 4H-SiC
DGKK-Arbeitskreis „Herstellung und Charakterisierung von massiven Halbleiterkristallen"
Freiberg, GER, October 8 – 9, 2014

Koffel, S.; Giegerich, M.; Filimon, R.; Grosch, J.L.; Führer, T.; Wenger, M.M.; Gepp, M.; Lorentz, V.R.H:
Model Order Reduction for Electrothermal Modelling of Battery Cells and Systems, ANSYS Conference & 32. CADFEM Users' Meeting (CADFEM Users' Meeting, über MOR)
Nuremberg, GER, June 4 – 6 2014

Knetzger, M.; Meissner, E.; Leibiger, G.; Habel, F.; Friedrich, J.; Weinert, B.:
Makroskopische Defekte in GaN-Volumenkristallen: Einfluss der Mikrostruktur am Keim auf das weitere Kristallwachstum
DKT 2014
Halle, GER, March 12 – 14, 2014

Kupka, I.; Reimann, C.; Friedrich, J.; Kropfgans, F.; Sylla, L.:
Influence of grain growth behaviour through varying the nucleation conditions and shape of the phase boundary
Poster Presentation, DKT 2014
Halle, GER, March 12 – 14, 2014

Kupka, I.; Reimann, C.; Lehmann, T.; Friedrich, J.; Gerlach, N.; Kropfgans, F.; Sylla, L.:
Influencing the initial grain structure of multicrystalline (mc) silicon ingots through a Al2O3 coating at the crucible bottom
Poster Presentation, 29th European Photovoltaic Solar Energy Conference and Exhibition (EU PVSEC 2014)
Amsterdam, NL, September 22 – 26, 2014

Kupka, I.; Reimann, C.; Lehmann, T.; Friedrich, J.; Gerlach, N.; Kropfgans, F.; Sylla, L.:
Influencing the initial grain structure of multicrystalline (mc) silicon ingots through a Al2O3-coating at the crucible bottom
DGKK-Arbeitskreis „Herstellung und Charakterisierung von massiven Halbleiterkristallen"
Freiberg, GER, October 8 – 9, 2014

Lehmann, T.; Meissner, E.; Reimann, C.; Friedrich, J.:
Understanding the performance of fine grained vs. conventional mc-Si, based on grain orientation and –boundary type distribution
Poster Presentation, jDGKK Meeting
Halle, GER, March 11 – 12, 2014

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Lehmann, T.; Meissner, E.; Reimann, C.; Friedrich, J.:
Understanding the performance of fine grained vs. conventional mc-Si, based on grain orientation and –boundary type distribution
Poster Presentation, 29th European Photovoltaic Solar Energy Conference and Exhibition (EU PVSEC 2014)
Amsterdam, NL, September 22 – 26, 2014

Lehmann, T.; Meissner, E.; Reimann, C.; Friedrich, J.:
Understanding the performance of fine grained vs. conventional mc-Silicon based on grain orientation and boundary type analysis
DGKK-Arbeitskreis „Herstellung und Charakterisierung von massiven Halbleiterkristallen"
Freiberg, GER, October 8 – 9, 2014

Lehmann, T.; Meissner, E.; Reimann, C.; Friedrich, J.:
Understanding the performance of fine grained vs. conventional mc-Si, based on grain orientation and –boundary type distribution
DKT 2014
Halle, GER, March 12 – 14, 2014

Lehmann, T.; Meissner, E.; Reimann, C.; Friedrich, J.:
Understanding the performance of fine grained vs. conventional mc-Si, based on grain orientation and –boundary type distribution
E-MRS 2014 Spring Meeting
Lille, FRA, May 26 – 30, 2014

S. Li, S.; Wang, X.; Yang, J.; Tang, F.; Yan, G.; Erdmann, A.:
A defocus measurement method for an in situ aberration measurement method using a phase-shift ring mask
Poster Presentation, SPIE Advanced Lithography
San Jose, USA, February 2014

Liu, X.; Wang, X.; Li, S.; Yan, G.; Erdmann, A.:
Fast rigorous model for mask spectrum simulation and analysis of mask shadowing effects in EUV lithography
Poster Presentation, SPIE Advanced Lithography
San Jose, USA, February 2014

März, M.:
DC MicroGrids – Challenges and Perspectives
ISPS Conference 2014, DC Workshop,
Prague, CZE, August 26, 2014

Matlok, S., Eckardt, B.:
DC/DC Wandler – Neue Perspektiven durch SiC und GaN Leistungshalbleiter
IISB Jahrestagung & Cluster-Seminar LV-Gleichstromnetze
Erlangen, GER, October 17, 2014

Matlok, S.:
Luftgekühlte Leistungselektronik mit Multilevel DC/DC Wandler für Elektrofahrzeuge
Forum-Elektromobilität Roadshow
Darmstadt, GER, April 29, 2014

Meisner, P.; Breite, M.; Wunderwald, U.; Stöcker, H.; Mehner, E.; Leisegang, T.; Meyer, D. C.; Friedrich, J.:
Synthesis of tetragonal BaTiO3 nanoparticles for new energy conversion concepts
Poster Presentation, E-MRS 2014 Fall Meeting
Warsaw, POL, September 15 – 19, 2014

Meissner, E.; Knetzger, M.; Friedrich, J.:
Thorough study of the evolution of the microstructure of thick GaN crystals for homoepitaxial processing of GaN devices
7th Wide Band Gap Semiconductor and Components Workshop, ESA-ESRIN
Frascati, IT, September 11 – 12, 2014

Meissner, E.; Knetzger, M.; Friedrich, J.:
Thorough study of the evolution of the microstructure of thick GaN crystals as substrate material for homoepitaxial processing of GaN devices
3rd Collaborative Conference on Crystal Growth (3CG)
Phuket, THAI, November 4 – 7, 2014

Öchsner, R.:
Erfassung und Analyse von Ressourcenverbräuchen als Basis von Optimierungsprozessen im Betrieb
RunderTisch green.economy.nürnberg
Nürnberg, GER, February 18, 2014

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Öchsner, R.:
Vorstellung von SEEDs
Rauschert GmbH
Erlangen, GER, March 21, 2014

Öchsner, R.:
Automation für Smart Building: Vorstellung Fraunhofer IISB
Kooperationsforum Automation Valley
Nürnberg, GER, May 16, 2014

Öchsner, R.:
Vorstellung von SEEDs
Schäffler AG
Herzogenaurach, GER, July 22, 2014

Öchsner, R.:
Vorstellung von SEEDs
Schmalz GmbH
Erlangen, GER, July 28, 2014

Öchsner, R.:
PV-Anlage zur Eigenstromnutzung
Kolloquium Leistungselektronik
Erlangen, GER, September 22, 2014

Öchsner, R.:
Project SEEDs: Path to the industrial "Energiewende"
Besuch der argentinischen Delegation
Erlangen, GER, September 25, 2014

Öchsner, R.:
Energy Efficiency in Semiconductor Manufacturing – Tool and Fab Aspects
Semicon 2014
Grenoble, FRA, October 7, 2014

Öchsner, R.:
ITRS - Yield Enhancement Working Group Update
Semicon 2014
Grenoble, FRA, October 7, 2014

Öchsner, R.:
Energieeffizienz und Energiemanagement für Industrieanlagen
Kooperationsforum Smart Metering und Smart Building Applications
Nuremberg, GER, November 11, 2014

Öchsner, R.; Pfitzner, L.:
ITRS - Yield Enhancement Working Group Update
ITRS Conference in Grenoble, France,
Grenoble, FRA, October 7, 2014

Oertel, S.; Jank, M.; Butterworth, S; Crawshaw, C.; Gooden, P.:
Large volume continuous synthesis of IZO nanoparticles and processing into semiconducting thin films
Poster Presentation, European- Material Research Society (E-MRS)
Lille, FRA, May 27 – 28, 2014

Oertel, S.; Jank, M.; Butterworth, S; Crawshaw, C.; Gooden, P.:
Large volume continuous synthesis of IZO nanoparticles and processing into semiconducting thin films
Poster Presentation, International Exhibition and Conference for the Printed Electronics Industry (LOPE-C)
Munich, GER, May 26 – 28, 2014

Oertel, S.; Jank, M.; Bauer, A.; Frey, L.:
Metal oxide thin-film transistors by spray pyrolysis from aqueous precursor: Process integration
Poster Presentation, 5th International Symposium on Transparent Conductive Materials
Chania, GR, October 12 – 17, 2014

Pfeffer, M.; Roeder, G.:
Overview and R&D results of the European Semiconductor Equipment Assessment Project
SEA4KET, 17. Workshop der GMM – Fachgruppe 1.2.3 Abscheide- und Ätzverfahren
Erlangen, GER, November 27, 2014

Pfitzner, L.:
Yield Enhancement Activities towards ITRS 2.0
ITRS Spring Meeting
Bad Nauheim, GER, April 6 – 9, 2014

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Continuation: Presentations

Pfitzner, L.:
ITRS – Yield Enhancement Working Group Update
ITRS Conference
San Francisco, USA, July 8, 2014

Pfitzner, L.:
SEA – Semiconductor Equipment Assessment for Thin Films, their Metrology and Implementation into Manufacturing
SATF 2014 Conference
Izmir, TUR, September 17, 2014

Pfitzner, L.:
Roadmap to Innovative Equipment
ILaCoS Asia 2014
Shanghai, CHN, October 16, 2014

Pfitzner, L.:
ITRS - Yield Enhancement Working Group Update
ITRS Conference
Ilsan, KOR, October 12 – 15, 2014

Pfitzner, L.; Schellenberger, M.; Pfeffer, M.:
450 mm / beyond 14nm Metrology Challenges
More than Metro: Enabling 450mm Silicon Wafer Metrology , The Israeli 450mm Metrology Consortium's Annual Conference
Haifa, IL, January 23, 2014

Pfitzner, L.; Schellenberger, M.:
The Factory Integration Roadmap in Semiconductor Manufacturing
ESSDERC 2014, 44th European Solid-State Device Conference
Venice, IT, September 22 – 26, 2014

Puls, P.:
Effizienzsteigerung in Kälteversorgungssystemen
IHK Nürnberg für Mittelfranken, Energieeffiziente Kältetechnik
Nuremberg, GER, October 6, 2014

Puls, P.:
Optimierung von Kälteversorgungssystemen
Schäffler AG, Vorstellung des Forschungsbereichs Effizienzpotenzial in der Kältetechnik
Herzogenaurach, GER, July 22, 2014

Puls, P.:
Energieerzeugung und Sekundärenergienutzung
Rauschert GmbH, Vorstellung der Aktivitäten im Bereich Energieeffizienz in thermischen Versorgungssystemen
Erlangen, GER, March 21, 2014

Rauh, H.; Sueltrop, C.; März, M.; Frey, L.:
Energy optimized implementation of climatisation systems in electric vehicles with integrated drive components
CoFAT
Munich, GER, March 17 – 18, 2014

Reimann, C.:
Challenges in material improvement and cost reduction for crystalline silicon for PV application
DKT 2014
Halle, GER, March 12 – 14, 2014

Reimann, C.:
Kristalle – Wunderwerkstoffe der Gesellschaft
Geowissenschaftlicher Freundeskreis Mainz-Finthen
Mainz-Finthen, GER, September 13, 2014

Roeder, G.; Niess, J.; Schellenberger, M.; Gschwandtner, A.; Pfitzner, L.; Berger, R.; Förg, R.:
Application of Virtual Metrology Techniques to combine Process Information from DOEs and individual Experiments performed during Equipment Assessment
15th European advanced process control and manufacturing (apc|m) Conference
Rome, IT, April 7 – 9, 2014

Rommel, M.:
Nanoscale characterization of high-k dielectrics by electrical SPM methods
Novel High k Applications Workshop
Dresden, GER, March 24, 2014

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Rumler, M.; Fader, R.; Förthner, M.; Haas, A.; Rommel, M.; Bauer, A.J.; Frey, L.:
Large area fabrication of plasmonic color filters using UV-SCIL
40th International Conference on Micro and Nano Engineering (MNE)
Lausanne, CHE, September 22 – 26, 2014

Rumler, M.; Fader, R.; Förthner, M.; Haas, A.; Rommel, M.; Bauer, A.; Frey, L.:
Large area fabrication of plasmonic color filters using UV-SCIL
International Conference on Nanoimprint and Nanoprint Technology (NNT)
Kyoto, JPN, October 22 – 24, 2014

Schellenberger, M.:
Advanced Automation based on Standards – How other industries can profit from automation concepts in semiconductor manufacturing
14th AIS User Conference
Dresden, GER, June 26, 2014

Schellenberger, M.; Moyne, J.; Pfitzner, L.:
The Factory Integration Roadmap in Semiconductor Manufacturing
44th European Solid-State Device Conference
Venice, IT, September 22 – 26, 2014

Schellenberger, M.; Pfeffer, M.; Erdmann, A.; Pfitzner, L.:
450 mm or There and Back Again – How 450 mm innovations will impact 200/300 mm semiconductor manufacturing
11th innovationsforum for automation
Dresden, GER, January 23 – 24, 2014

Schellenberger, M.; Pfeffer, M.; Pfitzner, L.:
Keynote presentation 450 mm or There and Back Again – Synergies of 450 mm Innovations with 200/300 mm Semiconductor Manufacturing
14th European apc|m Conference
Rome, IT, April 7 – 9, 2014

Schmenger, J.; Endres, S.; et al.:
A 22 kW On-board Charger for Automotive Applications Based on a Modular Design
CENCON 2014
Johor Bahru, MYS, October 13 – 14, 2014

Seebeck, J.; Jung, T.; Friedrich, J.:
Growing 1000kg heavy silicon crystals in the computer using OpenFOAM
9th OpenFOAM® Workshop
Zagreb, HRV, June 23 – 26, 2014

Seebeck, J.; Erlekampf, J.; Meissner, E.; Savva, P.; Friedrich, J.; Frey, L.:
Modeling of mineralizer-mediated species transport in an ammonothermal system
Poster Presentation, 4th International Solvothermal and Hydrothermal Association Conference – ISHA 2014
Bordeaux, FRA, October 26 – 29, 2014

Seliger, B.; Popov, J. Eckardt, B.; März, M.:
Galvanic isolated auxiliary power supply with high power density and efficiency
INTELEC
Vancouver, BC, Canada, September 28 – October 22014

Sintonen, S.; Rudziński, M.; Suihkonen, S.; Jussila, H.; Knetzger, M.; Meissner, E.; Danilewsky, A.; Tuomi, T. O.; Lipsanen, H.:
Characterization of threading dislocations in GaN by synchrotron radiation x-ray topography
Poster Presentation, International Workshop on Nitride Semiconductors (IWN 2014)
Wroclaw, POL, August 24 – 29, 2014

Steinberger, M.:
Brennstoffzellen zur Verwertung von wasserstoffhaltigen Gasgemischen
IISB-Kolloquium
Erlangen, GER, December 8, 2014

Stockmeier, L.; Bergmann, C.; Zschorsch, M.; Lehmann, L.; Friedrich, J.:
Point defects in heavily As-doped Czochralski Silicon
Poster Presentation, jDGKK Meeting
Halle, GER, March 11 – 12, 2014

Stockmeier, L.; Bergmann, C.; Zschorsch, M.; Lehmann, L.; Friedrich, J.:
Point defects in heavily As-doped Czochralski Silicon
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Halle, GER, March 12 – 14, 2014

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Stockmeier, L.; Bergmann, C.; Zschorsch, M.; Lehmann, L.; Friedrich, J.:
Point defects in heavily As-doped Czochralski Silicon
49. Treffen des Arbeitskreises „Punktdefekte“
Dresden, GER, April 4 – 5, 2014

Stockmeier, L.; Bergmann, C.; Zschorsch, M.; Lehmann, L.; Friedrich, J.:
Point defects in heavily As-doped Czochralski Silicon
E-MRS 2014 Spring Meeting
Lille, FRA, May 26 – 30, 2014

Stockmeier, L.; Zschorsch, M.; Friedrich, J.:
Versetzungen in hochdotiertem Cz-Silicium
DGKK-Arbeitskreis „Herstellung und Charakterisierung von massiven Halbleiterkristallen“
Freiberg, GER, October 8 – 9, 2014

Stumpf, F.; Rommel, M.; Bauer, A.J.; Frey, L.; Hitzel, F.; Stadelmann, A.:
NanoSPV - SPM Technique for Measuring Minority Charge Carrier Diffusion Lengths with High Spatial Resolution
International Conference on Nanoscience and Technology (INC+T)
Vail, Colorado, July 21 – 25, 2014

Stumpf, F.; Rommel, M.; Bauer, A.; Frey, L.; Hitzel, F.; Stadelmann, A.; Bartel, T.:
NanoSPV - SPM Technique for the Quantitative Measurement of Minority Charge Carrier Diffusion Lengths with High Spatial Resolution
European Photovoltaic Solar Energy Conference and Exhibition (EU PVSEC)
Amsterdam, NLD, September 22 – 26, 2014

Sumiyoshi, H.; Kangawa, Y.; Chichibu, S. F.; Knetzger, M.; Meissner, E.; Nagata, S.; Kakimoto, K.:
CL studies of AlN/AlN(0001) grown by solid source solution growth method
Poster Presentation, International Workshop on Nitride Semiconductors (IWN 2014)
Wroclaw, POL, August 24 – 29, 2014

Tobisch, A.:
Optische Topographiemessung von Si-Wafern
35. Treffen der Nutzergruppe Heißprozesse und RTP
GMM Fachgruppe 1.2.3 „Abscheide- und Ätzverfahren“
Erlangen, GER, April, 2014

Tobisch, A.; Schellenberger, M.; Frey, L.:
Optical metrology for full-field wafer nanotopography inspection
14th European Advanced Process Control and Manufacturing Conference
Rome, IT, April 7 – 9, 2014

Uhnevionak, V.; Burenkov, A.; Strenger, C.; Mortet, V.; Bedel-Pereira, E.; Cristiano, F.; Bauer, A.; Pichler, P.:
Effect of bulk potential engineering on the transport properties of SiC MOSFETs: Characterization and interpretation
Poster Presentation, European Conference on Silicon Carbide & Related Materials (ECSCRM)
Ghent, BEL, April 7 – 9, 2014

Wang, X.; Li, S.; Yang, J.; Tang, F.; Yan, G.; Erdmann, A.:
In situ aberration measurement method using a phase-shift ring mask
Poster Presentation, SPIE Advanced Lithography
San Jose, USA, February 23 – 27, 2014

Wenger, M.:
Gas sensing in large lithium-ion battery systems for early fault detection and safety improvement
Leistungselektronik Kolloquium
Erlangen, GER, November 24, 2014

Wenger, M.; Waller, R.; Lorentz, V.R.H.; März, M.; Herlod, M.:
A robust contactless apacitive communication link for high power battery systems
ISIE 2014
Istanbul, TR, June 1 – 4, 2014

Wenger, M.; Lorentz, V.R.H.:
Der Weg zu leicht skalierbaren Batteriesystemen für elektrifizierte Antriebsstränge
6. Expertenforum Elektrische Fahrzeugantriebe
Wolfsburg, GER, May 15 – 16, 2014

Wright, A.; Hutzler, A.; Schletz,A.; Pichler, P.:
Thermo-mechanical simulation of plastic deformation during temperature cycling of bond wires for power electronic modules
Poster Presentation, EuroSimE Conference
Ghent, BEL, April 7 – 9, 2014

Wunder, B.:
Ladekonzepte für Elektrofahrzeuge
Leistungselektronik Kolloquium
Erlangen, GER, April 28, 2014

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Wunder, B.:
Energieeffiziente Gleichstromnetze in kommerziellen Gebäuden
Leistungselektronik Kolloquium
Erlangen, GER, September 22, 2014

Wunder, B.:
DC Grid Manager – eine universelle Systemlösung für den Betrieb lokaler Gleichspannungsnetze
IISB Jahrestagung & Cluster-Seminar Niederspannungs-Gleichstromnetze
Erlangen, GER, October 17, 2014

Wunder, B.:
Energiemanagement und Kommunikation in einem Gleichstromnetz
Symposium – Energietechnik im Wandel
Nürnberg, GER, October 27, 2014

Wunder, B.:
380V DC in Commercial Buildings and Offices
14 SENAI International Workshop
Jaraguá do Sul, BRA, November 18, 2014

Wunder, B.:
380V DC in Commercial Buildings and Offices
Vicor - High Voltage DC Webinar
February 11, 2014

Wunder, B.:
Sonnenberg BJ: European Union DCC+G (DC Components +Grid) Project Update
Darnell Power Forum
Richmond, USA, September 23, 2014

Wunder, B.:
Commercial and Industrial Buildings in DC Community Power Systems
APEC Workshop on Smart DC Power
ChiangMai, November 10 – 11, 2014

Veerapandian, S.K.P.; Beuer, S.; Rumler, M.; Stumpf, F.; Thomas, K.; Pillatsch, L.; Michler, J.; Frey, L.; Rommel, M.:
Comparison of patterning silicon and silicon carbide using focused ion beam
Poster Presentation, 19th International Conference on Ion Beam Modification of Materials (IBMM)
Leuven, BEL, September 14 – 19, 2014

Zeltner, S.; Endres, S.; Schmenger J.:
Bidirectional isolating AC/DC converter for coupling DC grids with the AC mains based on a modular approach
ISPS Conference 2014, E2SG Workshop
Prague, CZE, August 26, 2014

Zeltner, S.; Endres, S.; Schmenger J.:
Bidirektionaler AC/DC Netzkoppler
IISB Jahrestagung & Cluster-Seminar Niederspannungs-Gleichstromnetze
Erlangen, GER, October 2014

Zeltner, S.; Endres, S.:
Power Electronics for Smart Micro and Nano Grids Controlled by a Novel Two-Wire Interface with Integrated Power and Signal Transfer
CSNDSP
Manchester, UK, July 23 – 25, 2014

Zschorsch, M.; Stockmeier, L.:
Herausforderungen bei der Charakterisierung von hochdotiertem Czochralski-Silizium
EFDS-Workshop „Materialien für die Energiewende, Leistungshalbleiter“
Dresden, GER, June 4, 2014

PhD Theses

Agudelo, V.:
Compact Mask Models for Optical Projection Lithography

Behrens, T.:
Kupfer-Metallisierung für Siliciumcarbid-Leistungshalbleiter zur Steigerung der Lebensdauer

Fader, R.:
Substratkonforme Imprintlithographie für optische Anwendungen

SCIENTIFIC PUBLICATIONS

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Continuation: PhD Theses

Huang, J.:
Zinc Oxide Thin Film Transistors by Radio Frequency Magnetron Sputtering

Niedermeier, M.:
ASIC Based Galvanically Isolated Driver Circuit for the Use in Power Converters for Photovoltaic Applications

Strenger, C.:
Herstellung und Charakterisierung von Metall-Oxid-Halbleiter-Kondensatoren und Feldeffekttransistoren auf 4H-Siliciumcarbid

Wolf, A.:
Modellierung von Ausheilprozessen für ionenimplantierte einkristalline Siliziumsolarzellen

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Dynamische Charakterisierung schnell schaltender pn-Dioden auf der Basis von 4H-SiC

Alexejenko, A.:
Physikalische Modellierung eines Brennstoffzellensystems zur Verwertung von wasserstoffreichen Gasgemischen

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Entwicklung eines Verfahrens zum Nachchargieren bei der gerichteten Erstarrung von kristallinem Silizium

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Charakterisierung von Oberflächendefekten in SiC-MOS-Strukturen

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Entwicklung einer Betriebsstrategie für ein DC-Mikrogrid Testfeld

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Modellbasierte Auslegung eines multifunktionalen Wasserstoffsystems und Entwicklung einer Betriebsstrategie

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Untersuchung eines Maximum Power Tracking Algorithmus für PV-Anlagen und Implementierung auf einen DC/DC-Wandler

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Entwicklung einer optimierten Ansteuerung für ein E-Fahrzeug Kühlsystem

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Entwicklung eines Herstellungsprozesses für plasmonische Filterstrukturen mittels der UV-Nanoimprintlithografie

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Aufbau und Inbetriebnahme eines Kältespeicherdemonstrators mit teillanter Speichertechnologie

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Simulation und Auswertung von Kapazitäts-Spannungskennlinien von MOS-Kapazitätsstrukturen

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Torque Vectoring für ein frontgetriebenes Elektrofahrzeug mit Einzelradantrieb

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Verfahren zur Regelung eines Resonanzwandlers eines induktiven Energieübertragungssystems

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Einfluss verschiedener Wärmeabfuhrbedingungen im Bereich des Tiegelbodens auf die elektrischen Eigenschaften von multikristallinem Silizium bei der gerichteten Erstarrung

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Theoretische Auslegung effizienter Kältenetzwerke auf Basis von thermischen Speichern am Beispiel des IISB

Schalk, J.:
Domänenübergreifende Simulation eines Hybridsportwagens zur Verbrauchs- und Performancebewertung

Schiele, C.:
Untersuchung von Randabschlusskonzepten für Leistungshalbleiterbauelemente auf 4 H-SiC

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Entwicklung eines Modells für die Last- und Einspeiseprognose eines mittelständischen Industriebetriebs

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Entwicklung eines Ansatzes zur optimalen Positionierung von Drehzahlsensoren in einem Planetenautomatikgetriebe

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Optimierung eines PEM-Brennstoffzellensystems zum Dualbetrieb mit Gasgemischen

Bachelor Theses

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Entwicklung einer Tiegelbeschichtung für die gerichtete Erstarrung von Silizium für die Photovoltaik

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Entwurf und Charakterisierung eines thermoelektrischen Generators

Brecht, C.:
Untersuchungen zur Herstellung und Charakterisierung von leitfähigen Schichten auf Si-basierten flexiblen Polymer- Substraten

Dorak, S.:
Energetische Optimierung eines Kälteversorgungssystems durch temperaturdifferenzgeregelte Volumenstromanpassung

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Bestimmung der Kontakteigenschaften von tintenstrahlgedruckten, nanopartikulären Indiumzinnoxidstrukturen auf Zinkoxidschichten

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Temperaturabhängige Assoziation und Dissoziation von themischen Donatoren in Abhängigkeit der Eisenkonzentration in multikristallinem Silizium

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Betrachtung der Belastbarkeit von Impulskondensatoren für hochdynamische Schalthandlungen

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Konzeption und Aufbau einer reinraumtauglichen Schleuder zur gezielten Kontamination von Wafern

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Elektrische Charakterisierung von Kontakten auf Galliumnitrid

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Vergleich von Averaged-Switch- und geschalteten Simulationsmodellen für DC/DC-Wandler in TLSpice

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Fahrzustandserkennung am Motorrad

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Untersuchungen zur Architektur von Hochstrom-Dünnschichttransistoren

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Automatische Messdatenerfassung zur elektrischen Ausgangsprüfung monolithischer Kondensatoren

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Entwicklung eines Steuergeräts mit Firmware für ein Klimagerät mit kooperativem Multitasking

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Energieanalyse an Halbleiterfertigungsgeräten - Bestandsaufnahme und Untersuchung von Einsparpotentialen

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Charakterisierung des Einschaltwiderstands von Leistungshalbleiterschaltern

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Untersuchung von Waferbondverfahren für mikrofluidische Systeme

Schrampfer, S.:
Elektronisches Wartungsbuch einer reinraumtauglichen Schleuder

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Einfluss der Phasengrenzform auf die Kornstruktur bei der gerichteten Erstarrung von mc-Silizium

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Gerätesteuerung und Überwachung einer reinraumtauglichen Schleuder

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Simulation der mechanischen Spannung in 600 V RC-Gliedern

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Energetische Gesamtanalyse eines Druckluftsystems

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Network Building through Technology Marketing - A Partner Analysis

Zipfel, J.:
Untersuchung der Adhäsionseigenschaften von ebenen und strukturierten PDMS-Folien für biomedizinische Anwendung