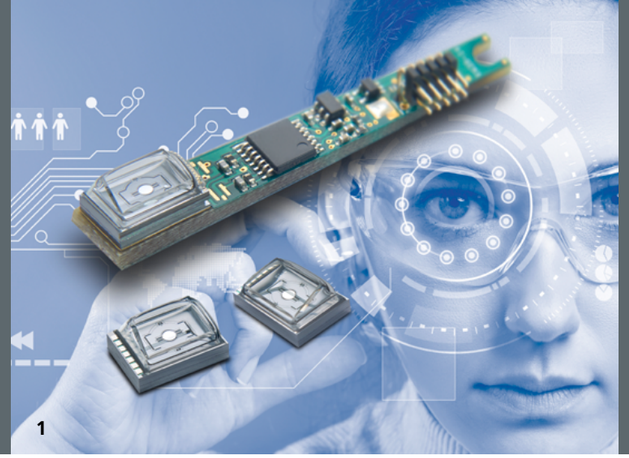
Fraunhofer
ISIT

FRAUNHOFER INSTITUTE FOR SILICON TECHNOLOGY ISIT

ANNUAL REPORT
2020



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ANNUAL REPORT 2020

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PREFACE TO THE 2020 ANNUAL REPORT

1

DEAR BUSINESS PARTNERS, DEAR FRIENDS OF FRAUNHOFER ISIT, DEAR COLLEAGUES,

COVID-19 had a major impact on social life around the world in 2020, and of course on life at our institute as well. We established a crisis management group to rise to the challenges posed by the pandemic and to overcome them. We defined new workflows, implemented hygiene concepts, established new rules for working from home, and integrated new digital collaboration tools into our day-to-day work. The pandemic also had a considerable effect on events. Face-to-face events and trade fairs in which ISIT takes part were only held at the start of the year. Such events included Photonics West in California, Nortec in Hamburg, and the regional promotional day "Mädchen für MINT", an occupational orientation exhibition for girls in mathematics, informatics, natural sciences, and technology. Practically no face-to-face events were possible starting in March. The cancellation of a visit by the Federal Minister of Education and Research Anja Karliczek and Premier Daniel Günther was especially painful for ISIT. ISIT had planned to present current research highlights in cooperation with partner companies at the site, illustrating the social relevance of the research projects.

Nevertheless we did welcome a prominent guest in 2020: Federal Parliament Vice President Wolfgang Kubicki visited our institute during an informational trip through the Steinburg district.

COVID-19 forces digitization

If there is one good thing about the pandemic, it is surely the fact that it gave digitization in the working world, both internally and externally, a major and likely irreversible push forward. Event formats are being tested everywhere, experimentation is ongoing, new ideas are emerging, and experiences are being gathered on what works well and what not so much. These experiences are of tremendous importance for shaping the future.

ISIT also established new communication and event formats, such as a tech blog and specialist webinars, and participated in virtual trade fairs with new videos, virtual exhibits, and virtual clean room tours. Working with online video conferences is just as much part of our everyday life by now as experiencing the exhaustion that can result from this workload compression. Events included the Fraunhofer Solution Days, where numerous Fraunhofer Institutes presented their research projects over four days, the Hamburg Innovation Summit initiated by the Hamburg Science Administration, and the Science Match Future Energy.

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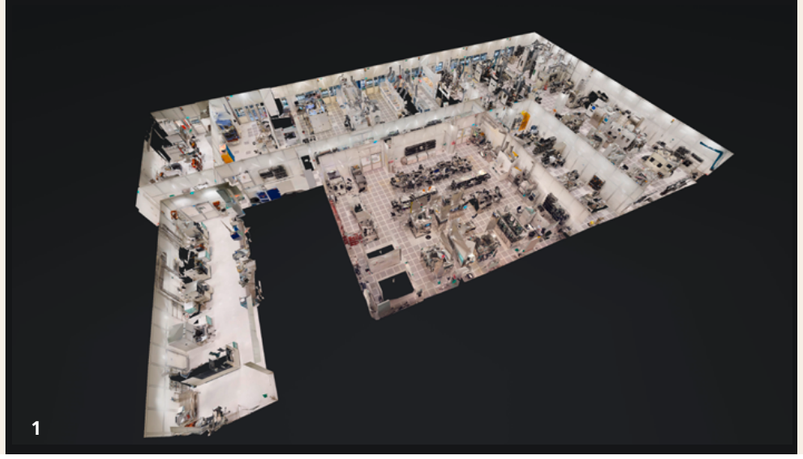
1 *Impression of the virtual ISIT cleanroom tour*

2 **Prof. Dr. Axel Müller-Groeling**
Director of Fraunhofer ISIT



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Not least was GAIN 20 (German Academic International Network), an event where American scientists had the opportunity to inform themselves about employment opportunities in Germany and Schleswig-Holstein. ISIT took part in this trade fair as a member of the Schleswig-Holstein Alliance for Top-Level Research. Aside from ISIT, 13 universities, non-university research institutions, and the Schleswig-Holstein University Hospital (UKSH) are part of the alliance founded in June.

ISIT growth topics

The Battery Group obtained numerous projects during the past year within the framework of the Federal Ministry of Education and Research (BMBF) battery competence cluster and beyond. The group grew considerably and there are concrete plans for the establishment of a dedicated "Research Center for Applied Battery Technology" (FAB.SH) at the Itzehoe site in 2021. Financial support for this project is being provided by the town of Itzehoe, the Steinburg district, the state of Schleswig-Holstein, and the federal government.

Aside from battery technology that is currently in particularly high demand, ISIT is considering additional subject areas for its research activities in the coming year to ensure the institute's profitable growth. These include a novel "micro-additive" manufacturing method and the prospects of the recently discovered ferroelectricity of the material aluminum scandium nitride.

ISIT scientists developed a new technology in recent years for the production of three-dimensional porous microstructures from particles of just about any material on planar substrates. Establishing a dedicated laboratory for this micro-additive "powder technology", now operating under the name "µShapes", began in 2020. The method opens up entirely new innovation possibilities for microsystems engineering components. In particular, the ability to integrate micro-magnetic structures in a clean room compatible process for the first time makes innovative micro-components possible for a wide variety of applications. Examples of initial applications include integrated coils with magnetically soft cores for on-chip DC/DC converters and magnetically excited vibration harvesters. Magnetically actuated micro-valves or micro-pumps, miniaturized linear motors, or electrically switchable filters in micro-fluidics are also conceivable for the future.

The discovery of our employee Dr. Simon Fichtner that aluminum scandium nitride (AlScN) has ferroelectric properties caused a stir in the professional community. We see at least two major fields of application for this material: The first is that AlScN will form the basis for considerably improved piezoelectric micro-actuators used, for example, in micro-scanners or micro-speakers. Secondly, we expect new ferroelectric AlScN components to make an important contribution to next generation computing: neuromorphic electronics, non-volatile memory, and energy efficient power transistors can benefit from the outstanding material properties of AlScN. We are only just beginning to survey the wide variety and full breadth of the new applications that ISIT will be able to develop in cooperation with partners.

Power Electronics Network Schleswig-Holstein

A project of equal importance for both the state and ISIT was successfully concluded in 2020. The Power Electronics Network Schleswig-Holstein set priorities and combined fundamental research, application-oriented research, and industrial implementation in the power electronics field. There were regular workshops, seminars, and trade fair presentations. The network participants bundled their acquisition efforts and prepared new R&D projects, and a video was created about career opportunities in power electronics. Some of the network activities were carried on after the end of the project. ISIT will keep the network members together through further workshops, the website is going to remain as a point of contact, and the promotion of new talent will continue to be supported with online information and newly introduced formats.

Research Fab Microelectronics Germany

Fraunhofer ISIT is part of Research Fab Microelectronics Germany, which was initiated in 2017 by the Federal Ministry of Education and Research (BMBF) as the largest multi-site consortium of research and development institutions for microelectronics and nanoelectronics in Europe. ISIT was able to add to its equipment with the help of this initiative and therefore expand its portfolio regarding new microsystems engineering and power electronics components. Meanwhile ISIT has received nearly all of the planned equipment. Numerous systems have been installed and are currently being used for research projects. The implementation of three important system complexes is almost finished. We expect the installation work to be completed within a few weeks. The final planned tool will then be delivered and installed in Q2 2021.

Establishing a manufacturing execution system (MES) that will operate across all FMD participants to enable production control between multiple sites is planned in parallel. Numerous research and development projects were launched within the FMD framework at ISIT in addition to this work, including one for the further development of GaN components.

1 *Virtual ISIT cleanroom tour: overview*

2 *An electroplating system is brought into the cleanroom*

PREFACE

Prof. Dr. Bernhard Wagner

Scientific papers of Prof. Dr. Bernhard Wagner presented in a different way.

Further development of the ISIT strategy

ISIT has been going through a comprehensive strategy process since 2017. The organization has been adapted to the strategy that was developed, the control of operating processes was improved, and personnel development and the cultural transformation at ISIT were furthered. We have established professional business development and implemented a modern social media strategy within this framework, and customer management has been professionalized. Rather than focusing primarily on internal structural improvements, the time has now come to pay special attention to measures that support the profitable growth of ISIT. Thus our future focus should be on expanding our project activities, both with industry and funding through subsidies.

For ISIT as a research institute, helping to shape the technological future of tomorrow is the elementary challenge. That not only means representing the most recent state of scientific research, but developing innovations and continuously researching new technology fields of application, also in cooperation with universities, technical colleges, and cooperation partners. The stated goal of ISIT is therefore to strengthen the expertise of personnel in all areas and, in particular, to expand competencies in promising innovation fields. An initial foundation for this was laid in 2020 and successes are apparent. ISIT was able to increase the number of employees by around 10 percent in the past year. A positive trend is already developing for ISIT in 2021 as well. Notwithstanding the challenging conditions during the pandemic, we will stand by our growth strategy and support it with conceptual measures, for instance to recruit students and young research fellows, and by creating a personnel development concept as an individual career support tool.

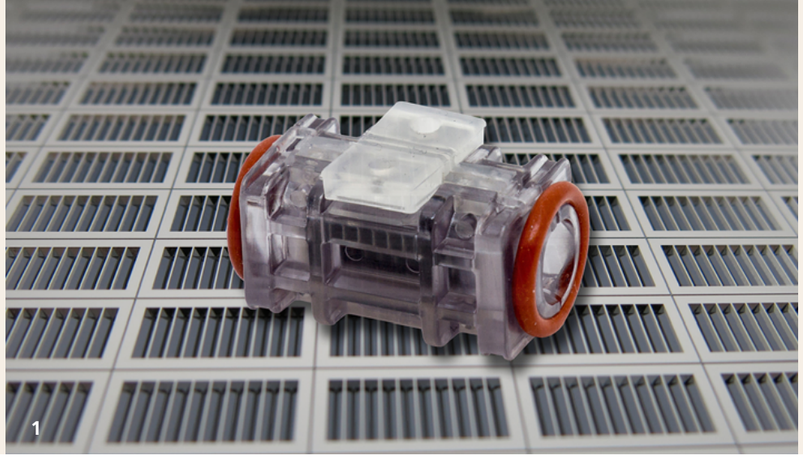
New appointments

There were a number of personnel changes in 2020. Two colleagues who made significant contributions to the institute's establishment and success have retired. Prof. Ralf Dudde was one of the first Fraunhofer employees at the site and a member of the institute's extended management group for many years. He assisted with the successful acquisition of major national and European research projects, contributed to the establishment of industrial enterprises at the site, helped shape relations with Fraunhofer on the west coast, and maintained a variety of contacts with regional and state institutions.

Prof. Dr. Wolfgang Benecke, Dr. Werner Riethmüller, Prof. Dr. Bernhard Wagner, Claus Wacker, Dr. Klaus Reimer (from left to right)

Prof. Ralf Dudde

Prof. Dr. Holger Kapels



Prof. Bernhard Wagner, our deputy director, has also left ISIT after more than 30 years with the Fraunhofer-Gesellschaft and retired in December. He deserves a lot of credit for his contribution to establishing the institute. He helped develop microsystems engineering into a key research topic at the institute and provided technical support for many young scientists in their research. Most of all, he made a key contribution over all these years to the outstanding reputation enjoyed by the institute, both nationally and internationally. We are very thankful to him for these efforts.

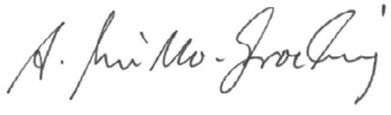
His successor as deputy director is Prof. Dr. Holger Kapels. He has been working at Fraunhofer ISIT since 2014. Over the last few years, he has been the head of the Power Electronics business unit, a position he continues to hold. Prof. Kapels brings a wealth of industry experience to the table in his new position. He worked in research and development at various industrial enterprises for several years, most recently as the head of a development department.

I myself accepted the "Microsystems and Technology Transfer" professorship at the Technical Faculty of Christian-Albrechts University in June of 2020. I intend to intensify the networking of Fraunhofer ISIT and CAU with my professorship. Aside from promoting the ISIT research topics among students, I will contribute to increasing the number of theses – bachelor, master, or doctorate – emerging from the cooperation between CAU and ISIT. For me it is of special importance to familiarize students from the outset with the mindset, means, and methods for implementing applied research results in economic practice.

Conclusion

Unfortunately the pandemic still has us in its clutches. So far we have passed the test very well thanks to the dedication of our employees, and at times also their ability to endure. With this experience and against the background of the many ideas and future topics being promoted at ISIT, we are ready to face the doubtless great challenges of 2021 calmly and with confidence.

ISIT has left the path of economic consolidation and now faces the task of translating its innovativeness into sustainably financed growth. In this spirit, I wish all of us the best of luck and the right touch. I sincerely thank our employees for their dedication, commitment, and willingness to blaze new trails with us.



Prof. Dr. Axel Müller-Groeling

1 *Diamond-coated trench structures in silicon are used as electrodes in miniaturized ozone generators for water disinfection.*

ORGANIZATIONAL CHART

Functional Boards
- Innovation
- Projects
- Sales
- Operations

Leadership
Prof. Dr. Axel Müller-Groeling (Managing Director)
Prof. Dr. Holger Kapels (Deputy Director)

Coordination of Forschungsfabrik Mikroelektronik Deutschland (FMD)
Dr. Mohammad Hejjo Al-Rifai

Management Center
Brigitta Hackmann (HD)
Annette Kramschuster (Dep.HD)

Business Development
Dr. Oliver Schwarzelbach

Administration
Brigitta Hackmann

IT & Processes
Annette Kramschuster

Power Electronics (PE)
Prof. Dr. Holger Kapels (HBU)
Dr. Andreas Würsig (Dep. HBU)
Frank Dietz (DST)

Advanced Power Transistors
Dr. Michael Mensing

Battery Systems for Special Applications
Dr. Andreas Würsig

Micro-Manufacturing Processes
Christian Beckhaus (HBU)
Dr. Jens-Hendrik Zollondz (Dep. HBU)
Dr. Wolfgang Reinert (DST)
Hans-Joachim Quenzer (DST)

Process Integration and Pilot Production
Dr. Vanessa Stenchly
Dr. Jens-Hendrik Zollondz

Module Services
Helge Schimanski
Saskia Schröder

MEMS Applications
Dr. Fabian Lofink (HBU)
Dr. Dirk Kaden (Dep. HBU)
Dr. Simon Fichtner (DST)

Optical Systems
Dr. Shanshan Gu-Stoppel

Acoustic Systems and Micro Actuators
Dr. Fabian Stoppel

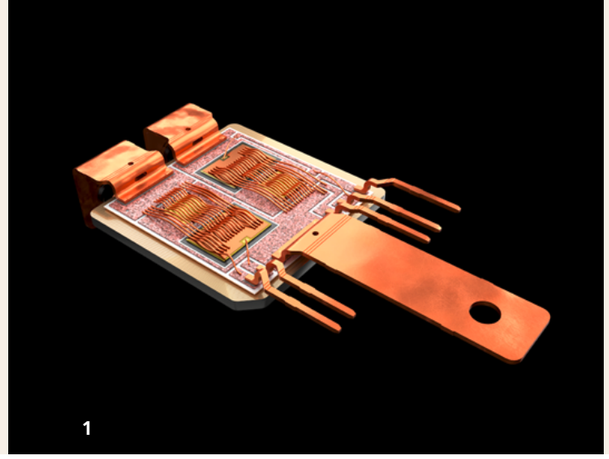
Agglomerated Micro Systems
Dr. Björn Gojdka

Technology Development
Dr. Oliver Schwarzelbach

FAB
Dr. Martin Detje (HD)
Dr. Mohammad Hejjo Al-Rifai (HD)
Maria Claus (Dep. HD)
Björn Jensen (DST)

HD: Head of Department
HBU: Head of Business Unit
DST: Director of Science and Technology

BRIEF PORTRAIT



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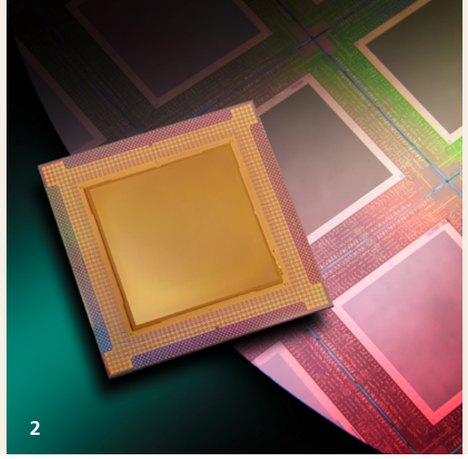

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FRAUNHOFER ISIT RESEARCH, DEVELOPMENT AND PRODUCTION AT ONE LOCATION

Fraunhofer ISIT in Itzehoe is one of Europe's most modern research facilities for microelectronics and microsystems technology. The heart of the institute are the cleanrooms with the capability to operate not only research projects but also to produce the developed microchips in industrial scale. 160 scientists at ISIT develop power electronic components and microsystems, with tiny movable structures for sensors (motion, magnetic field, infrared, etc.) and actuators (micromirrors, loudspeakers etc.) including the necessary electronics. These miniaturized components are used especially in medical, consumer, communication and automotive applications.

Ultra-modern technological equipment based on 200 mm silicon wafer technology and expertise built up over decades put Fraunhofer ISIT and its customers at the forefront in their field of application worldwide. Fraunhofer ISIT supports customers right the way from design and simulation to the production of prototypes, preparation for series production and reliability aspects. The institute deals also with all the important aspects of system integration, packaging and reliability. Fraunhofer ISIT supports also the demanding storage segment by the development of electrical energy storage devices, with a focus on Li-polymer batteries.

What sets Fraunhofer ISIT apart is the speed with which innovative developments are transferred to industrial application and production. For this purpose, Fraunhofer ISIT cooperates with the companies Vishay and X-FAB MEMS Foundry Itzehoe on site for series production of power electronics and MEMS. In addition, ISIT has established close collaborations with several spin-off companies located nearby. ISIT professors have also joined research groups at the Christian-Albrechts-Universität zu Kiel. Furthermore Fraunhofer ISIT is participant of the Forschungsfabrik Mikroelektronik Deutschland (FMD).

The quality management system at Fraunhofer ISIT is qualified according to ISO 9001:2015.

BUSINESS UNITS AT FRAUNHOFER ISIT

The ISIT activities are implemented in three business units.

Business Unit Power Electronics

The business unit Power Electronics develops and manufactures innovative active and passive power semiconductor components based on silicon and gallium nitride. Power electronic systems are manufactured from these and the scientists at ISIT integrate them with powerful battery storage devices for special applications to form high-performance energy storage systems.

The advanced power transistors and diodes from Fraunhofer ISIT support applications in a wide voltage range from a few 10 V to 1200 V. The development portfolio includes silicon-based IGBTs, diodes and MOSFETs as well as diodes and transistors for the highest switching frequencies in the MHz range based on gallium nitride in state-of-the-art 8" manufacturing environments.

The topic of energy storage has been for a long time one of the key research areas at Fraunhofer ISIT. The ISIT develops batteries and battery systems for a wide variety of applications with its specific requirements, e.g. a particularly high energy density for a long range in electric vehicles or a high power density to charge and discharge batteries quickly.

Business Unit Micro-Manufacturing Processes

This business unit deals with processes, methods and services which are on the one hand an indispensable prerequisite for the research and development in the business unit MEMS-Applications, and on the other hand also represent a direct service offer of ISIT to the market.

Important offerings at ISIT are wafer-level packaging (WLP) and various individual processes at wafer level. Here the focus is on the packaging of microsystems on wafer, but also the further processing of pre-structured wafers. The technology basis at ISIT is excellent: front-end processes of the business unit power electronics and the own back-end clean room line with equipment for MEMS-specific manufacturing processes can be used.

After all, Fraunhofer ISIT offers a number of services at the module level to internal and external customers as module services. In assembly and interconnection technology, ISIT specializes in the implementation of innovative processes and technologies in direct cooperation with manufacturers of assemblies, equipment, and materials.

1 *IGBT power module for automotive applications. IGBTs: 200 A, 1200 V.*

2 *IMEMS deflection array plate system with driving electronics for electron multibeam mask writing. A fanned out electron beam is split by the perforated plate in 262 144 single beams. Each beam can be switched individually.*

ISIT has 20 years of experience with the assessment of quality, reliability, and robustness. Focal points are on the assessment of manufacturing quality, reliability testing, lifetime prediction and failure analysis, and the development of electronics as well as assembly and interconnect concepts, from the chip to the system.

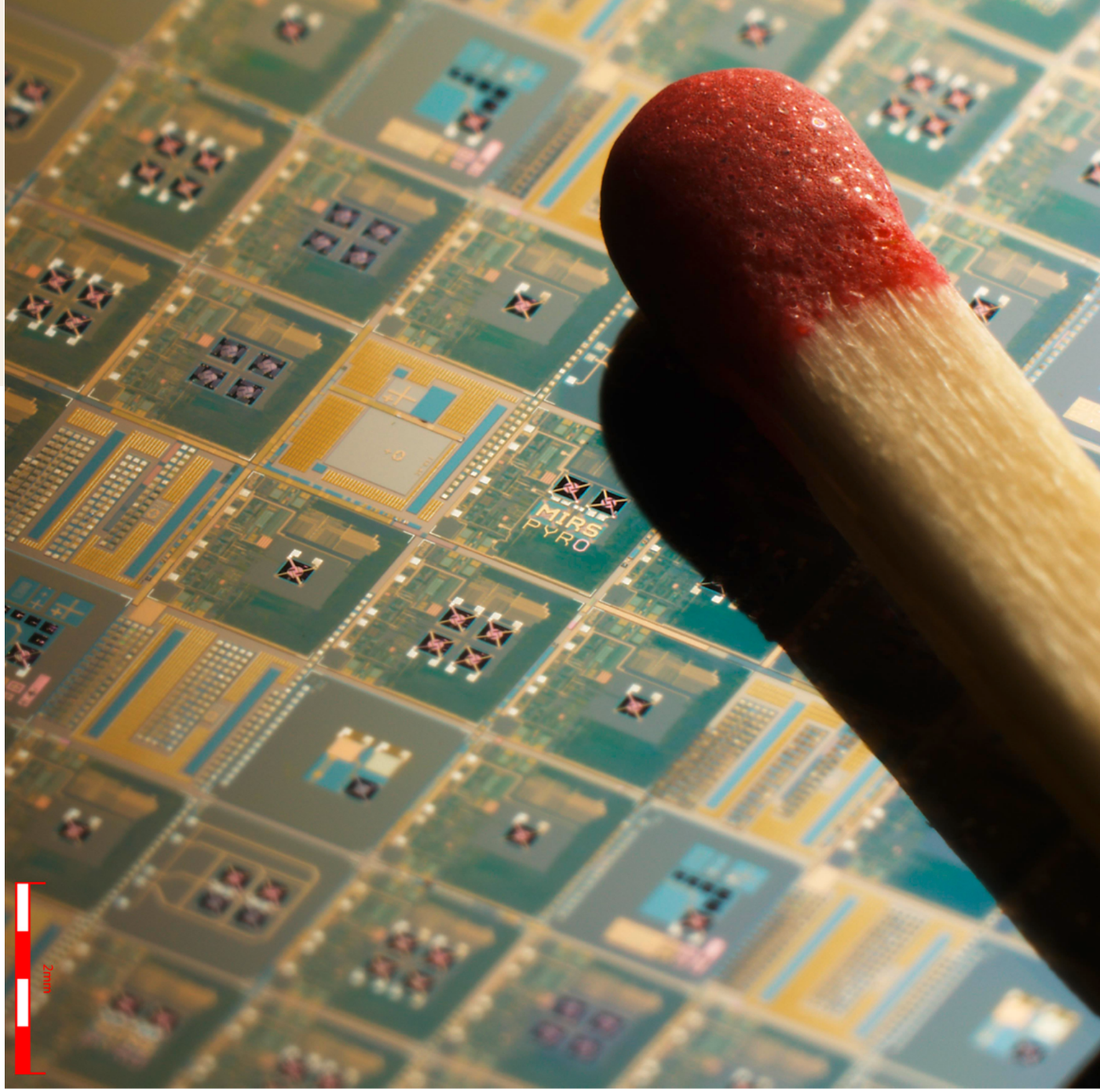
Business Unit MEMS Applications

The MEMS Applications team provides consultancy, ideas, technology development, process integration and prototyping in the early stage of MEMS product development. Our core competencies on device level are actuators for optical and acoustic applications such as micromirrors and miniaturised acoustic transducers. From a technological point of view, our advanced Piezo MEMS technology often forms the centrepiece for our solutions. Next to this, we are currently pushing the development of a brand new ISIT technology for the monolithic integration of porous 3D micro-structures in MEMS devices (Powder MEMS), as we expect this to provide a variety of new and disruptive solutions.

The optical group develops vector scanners and resonant MEMS scanners including control and readout electronics for various types of laser projection displays, for optical measurement and detection systems (e.g. LIDAR), for applications with high laser power in the field of material processing and generative manufacturing as well as for the use in optical telecommunications.

In the fast-growing field of acoustic microsystems, we are international pioneers in research into innovative, highly miniaturised loudspeakers for applications in wearables, hearing aids, AR/VR, wireless headphones and smartphones. Our MEMS loudspeakers can compete in sound with conventional electrodynamic counterparts, can be made significantly smaller, more reproducible and more cost-effective, and also offer a high degree of flexibility in the design of the lateral form factor.

Another fascinating application for our acoustic transducers are ultrasonic microsystems, e.g. for 3D distance measurements and haptic man-machine interfaces. For that purpose, we develop ultrasound transducers with centre frequencies from a few kHz to several hundred MHz.

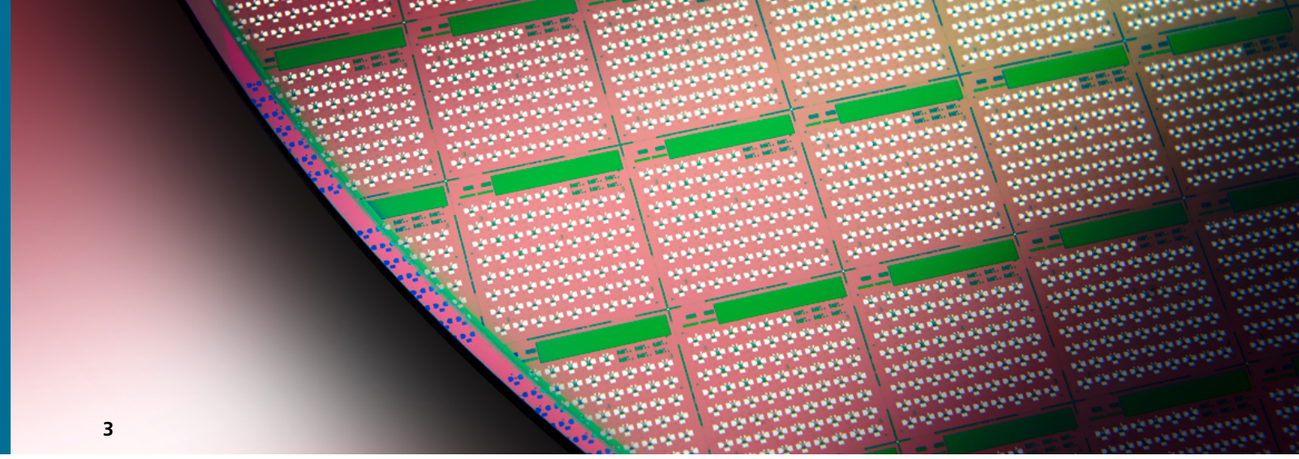


Based on our new Powder MEMS technology, the Agglomerated Microsystems group develops innovative and disruptive solutions for advanced microcomponents. The technology opens up numerous degrees of freedom for the realization of novel 3D micro-structures with superior functionalities. The type of materials as well as the geometry, porosity and inner surface of the agglomerated structures are used to set the desired properties. First promising applications are microsystems with integrated magnets, energy harvesters or microfluidic microsystems for cooling or lab-on-chip applications.

1 *On CMOS integration of pyroelectric sensors made of AlScN in the BMBF project MIRS*

ISIT FLAGSHIP PROJECTS 2020

POWER ELECTRONICS

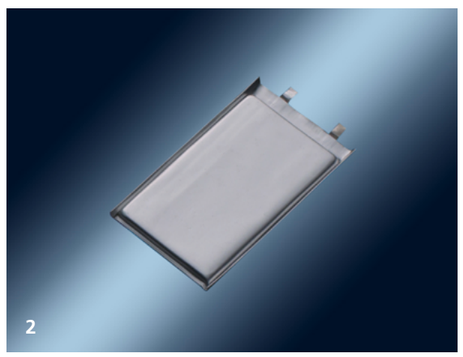


CARBAT – CALCIUM RECHARGEABLE BATTERIES

Batteries have an immense importance for our daily life and the number of potential and increasingly specific applications is constantly growing. Lithium Ion Batteries (LIB) are today the most developed accumulator systems. They are used for a very wide range of applications from cell phones to electric cars.

However, in some areas a viable scenario stays out of reach due to the high material costs and still too low energy density of LIB as rechargeable battery storage. Multivalent cell chemistries based on calcium or magnesium metal electrodes are considered promising, as they are superior to LIBs both in terms of the specific capacities of anode materials and their availability, and could replace LIBs in certain application areas (e.g. stationary storage) in future. Within the framework of Horizon 2020, the EU is funding research on rechargeable calcium ion batteries (CIB), in which ISIT and its partners (CISC, Chalmers University) are also participating with the CARBAT project.

The goal of CARBAT is to research and develop new cathode materials and electrolytes that enable reversible storage of $Ca2^{+}$ ions in cells. In doing so, ISIT explores the possibilities of integrating these novel materials into a pilot fabrication. Within the frame of CARBAT, ISIT was able to produce the world's first calcium ion cell in pouch technology and thus demonstrate the suitability in principle of a Ca cell chemistry for the entire manufacturing process.



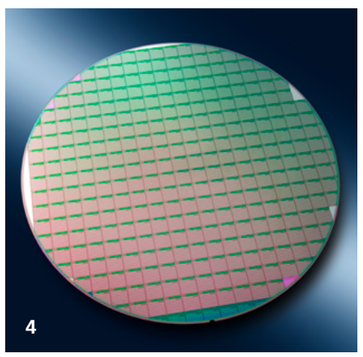
1 *Demonstration of the world's first calcium ion cell in pouch technology*

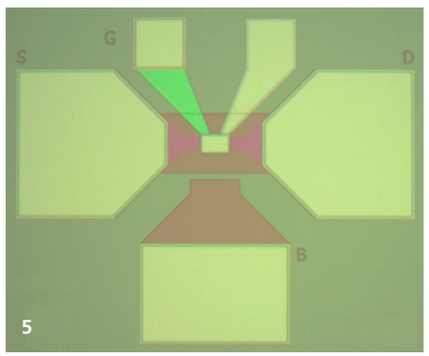
2 *Calcium ion cell*

FIRST AlScN-BASED FERROELECTRIC-GATE FIELD EFFECT TRANSISTORS

With the aim of creating technological conditions for increasing the efficiency of power transistors for power conversion, e-mobility and communication applications, the innovative material AlScN was successfully validated for its use in NMOS-transistors. As such, the deliberate polarization switching of the ferroelectric AlScN in silicon-based transistors was demonstrated. This achievement represents an important proof of concept and underpins the potential of the novel approach by bridging the gap between materials research and first devices. For this purpose and based on process and device simulations, various transistor designs were tailored to the needs and strengths of the material system, whose ferroelectric properties were recently discovered by the MEMS applications business unit at the Fraunhofer ISIT.

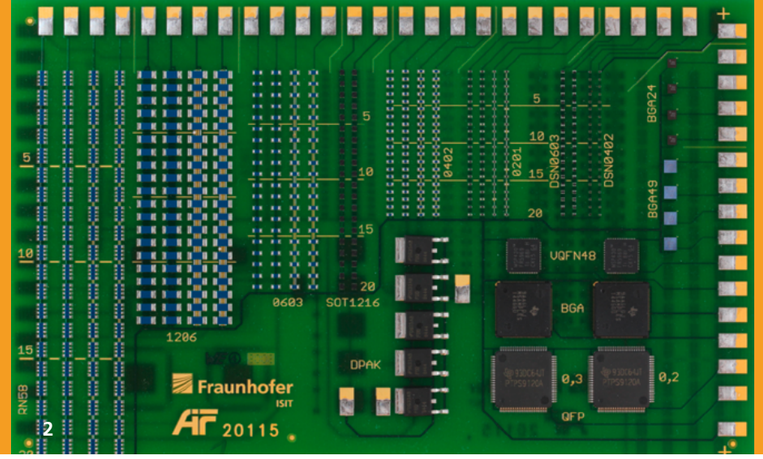
The designs were combined into a unified processing flow and fabricated in first iteration. The comprehensive electrical characterization of these unique devices is ongoing. However, based on the initial results the path to further improvements of the devices architecture has already been revealed. Besides the continuous integration in silicon-based transistors, a sophisticated roadmap has been laid out to tightly incorporate AlScN in the recently added GaN technology platform.





3;4 *Image of a fully processed 8"-wafer.*

5 *Optical microscopy image of an exemplary transistor layout.*



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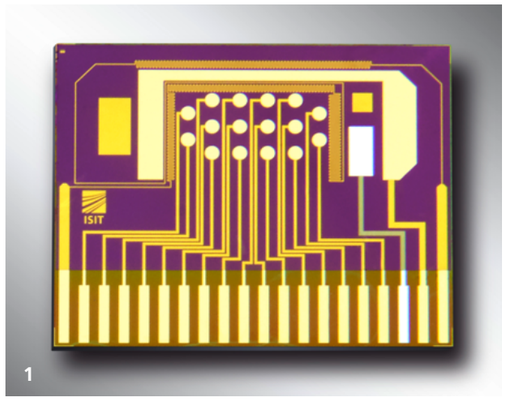
FAST PCR TESTING FOR COVID-19

In the CoVMoTe project, several Fraunhofer institutes (IME-MB, CSB, IME-TMP, IBMT, ENAS, ISIT, EMFT) and their partners (e.g. Campton Diagnostics GmbH) are working together on the implementation of a mass producible rapid PCR assay that can be used in a small mobile unit. In the current pandemic situation, a scalable mobile test system would be of great advantage in areas requiring special protection. The project focus lies primarily on domestic care for elderly persons, but also on nursing homes and hospitals. Such a test system could constantly screen both patients and nursing staff in order to suppress the spread of the virus in an early stage. In addition, a use in any entity, such as schools, workplaces, flight groups, travel companies etc. is conceivable and could contribute to re-opening social life after a lock-down.

The project started in September 2020. The task of ISIT is to transfer an existing readout chip into a near-series production. The current status is that the manufacturing flow is largely set up. Missing links in the production chain have been identified as work packages for process development and are being worked on. Wafer material is being processed in the ISIT clean room for this purpose.

The goal is to hand over the manufactured and tested chips to the project consortium in cooperation with our partner Campton Diagnostics GmbH. There, it will be fit into a cartridge designed and developed in a parallel activity for use in the targeted PCR test. The consortium also aims to establish a novel PCR test procedure (neo-LAMP) to guarantee a test execution within 30 minutes.



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1 *Bio Chip used in the project*

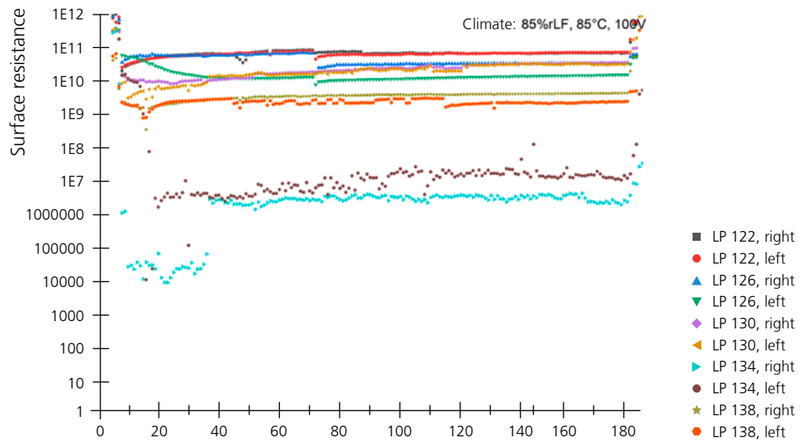
SURFACE INSULATION RESISTANCE (SIR) TEST UNDER 1500 V APPLIED VOLTAGE

In the research project „Investigation of the effect of ionic contamination in thin gaps on realistic electronic assemblies with new miniaturized components“, an industry-relevant question is being investigated within the framework of a publicly funded project of joint industrial research.

Ionic contamination can lead to electrochemical migration (ECM) in the presence of potential difference under the influence of humidity and thus ultimately to the failure of the electronics. In particular, the application of higher voltages in the field of power electronics and also increasingly in the automotive sector places high demands on system quality and reliability. In order to provide a further building block for reliability assessment, a test set-up is being created at ISIT with which the surface insulation resistance (SIR) can be measured under applied voltages of up to 1500 V. 80 devices can be tested simultaneously, each with a different voltage.

This high-voltage SIR test will be put into operation in 2021 and will then also be available for testing industrially manufactured assemblies as well as power modules.

SIR test measurement using the example of a Quad Flat Package (QFP)



2 *IGF-Testboard*

QUASISTATIC MIRRORS WITH LARGE APERTURES

Excellent accuracy laser projection for high quality optical sensing and measurement tasks

Fraunhofer ISIT has developed 1D and 2D quasistatic scanning mirrors with piezoelectric AlN and AlScN based actuation. While commonly used piezoelectric materials like PZT show pronounced non-linear behavior like hysteresis, the non-ferroelectric nitride-based actuators ensure high linearity and large tilting angles. A special rose-leaf shaped actuator designs allows fast and powerful mirror actuation. Compared to electrostatic actuation, pull-in effect and limited actuation range are avoided by using a piezoelectric bimorph. Moreover, mirror plates with different sizes and optical coatings can be used on top of this actuation platform for flexible design and manufacturing of piezoelectric MEMS mirrors. Combined with our advanced multiple-wafer glass-frit bonding technique for hermetic sealing, high mechanical robustness and protection against particles and humidity are achieved.

Technical specifications

Mirror apertures:	2 mm, 5 mm, (10 mm)
Resonant frequencies:	~ 1200 Hz, ~ 250 Hz
Driving voltage (piezoelectric):	Up to ~150 V
Field of view (@80V):	16°, 20°

Unique advantages and possibilities

- Fast and robust AlN/AlScN-based quasistatic mirror actuation for ROI and arbitrary laser projection, e.g. for LIDAR applications in automotive and robotics
- Various combinations of mirror apertures and frequencies, e.g. for far field laser scanning > 250 m
- Highly linear mirror movement
- Optical wafer level packaging with inert gas
- HR (mirror) and AR (package) coatings for wavelength selection and stray light suppression

Fabricated mirrors with 2 mm and 5 mm apertures.

SURFACE ACOUSTIC WAVE SENSORS

Motivation

Sensors based on the modulation of surface acoustic waves (SAW) can be utilized to measure different physical phenomena: In addition to mass absorption, elastic, viscoelastic or electrical effects can be exploited. Dedicated functional coatings enable a wide range of applications comprising pressure, humidity, electric field, vibration, gas, bio or magnetic field sensors.
A special feature common to all SAW sensors is that they are suitable for measuring both static and rapidly changing states. Based on the SAW-technology platform, ISIT is currently developing a high-performance current sensor with a dynamic range of 6 orders of magnitude and a bandwidth of up to 20 MHz in cooperation with the Christian-Albrechts-Universität zu Kiel and the Fraunhofer Institute for Applied Solid State Physics. This sensor is designed to precisely measure the very fast switching processes (~kA/ns) of modern switch-mode power supplies and thus enable highly efficient power conversion. The functional layer of this sensor consists of a magnetostrictive layer that causes a field-dependent modulation of the SAW wave by changing the elastic modulus.

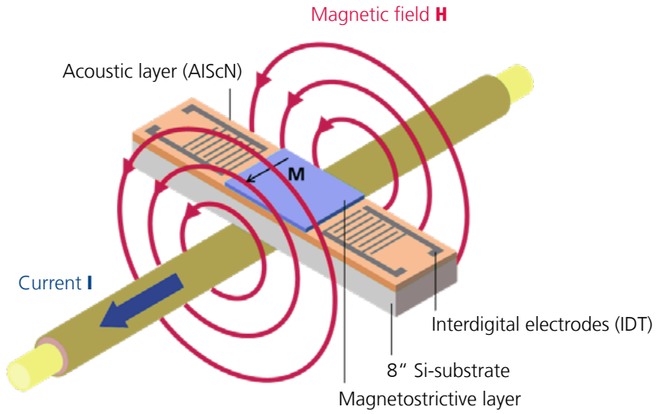
Technology

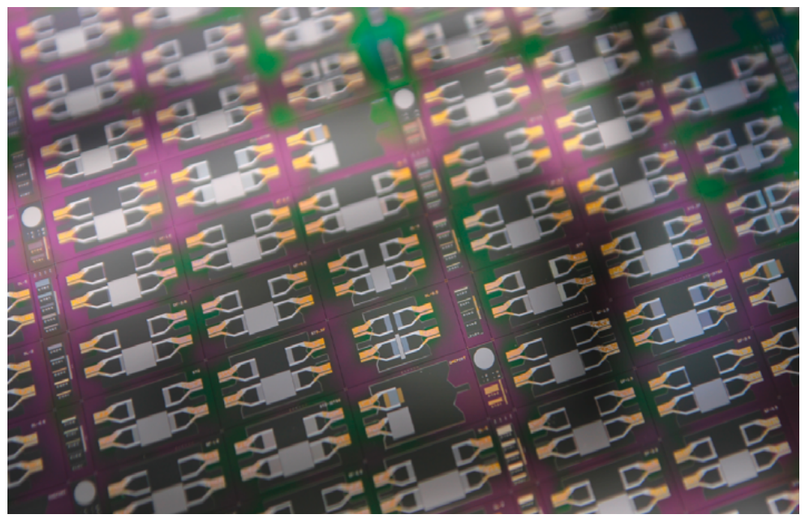
The distinctive aspect of the SAW sensor technology at ISIT is that it does not rely on volume crystals such as quartz. Instead, ISIT's SAW sensor elements are entirely fabricated in CMOS- and MEMS-compatible silicon technology. This is only made possible by the use of the high-performance piezoelectric thin-film material AlScN. In addition to the high technology compatibility, further advantages are higher process flexibility with regard to the integration of functional layers, a reduced chip size as well as the possibility to fuse different sensors on one chip.

Applications

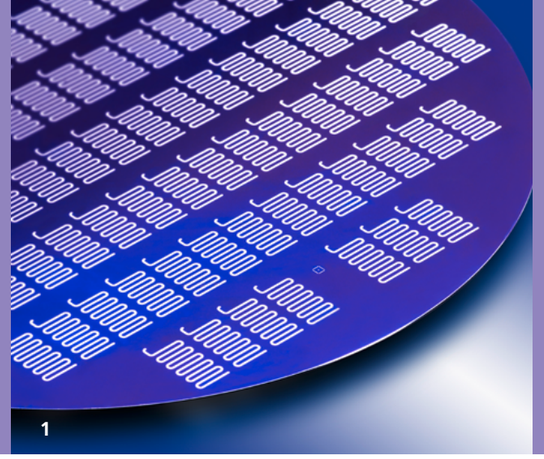
- Efficient energy conversion for electro mobility, renewable energies and lighting
- Data centre monitoring
- Feedback and control for home, motors and industry

Function scheme of a surface acoustic wave sensor

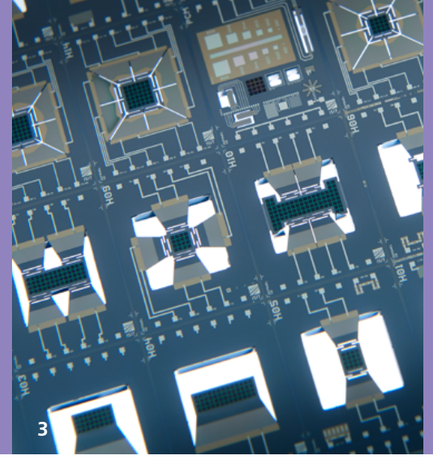




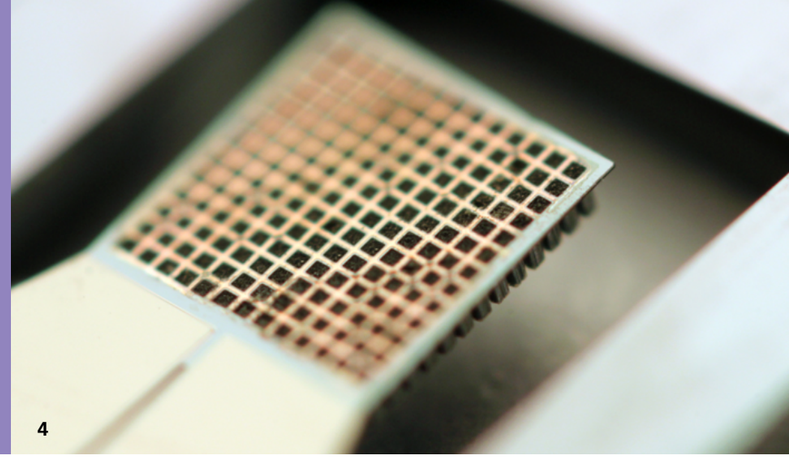
Variety of SAW magnetic field sensors on an 8-inch Si wafer.



1



3



4

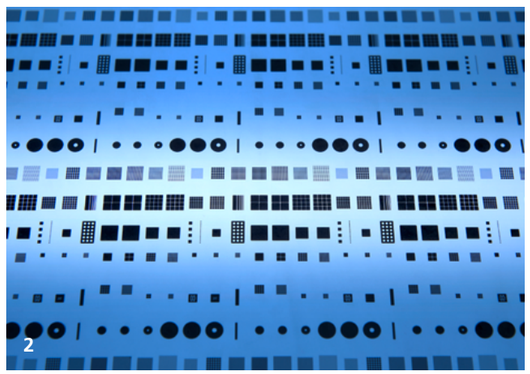
POWDERMEMS TECHNOLOGY: 3D MICRO-COMPONENTS FOR INNOVATIVE MICROSYSTEMS

Wafer-based technologies have limited means to create three-dimensional microstructures. Fraunhofer ISIT has added a new building block for microsystems engineers, using a low-temperature powder agglomeration technique based on atomic layer deposition. A vast choice of materials enables the integration of micromagnets, porous microfluidic channels, thermal insulation and numerous other features for next-generation microsystems. PowderMEMS access the third dimension for the design of microsystems with significant advantages compared to other techniques like sintering or polymeric binding. Various parameters can be taken advantage of, such as the choice of powder material, the creation of three-dimensional shapes and the ability to pre- and post-process with established clean room techniques.

A dedicated laboratory with an area of 100 m² is currently being set up at ISIT for the production of PowderMEMS components. The Lab3D project, funded by the state of Schleswig-Holstein, will enable the development and production of PowderMEMS structures with industry-oriented equipment for 200 mm wafers and other substrates from mid-2021.

As a fundamental technology for microsystems technology, PowderMEMS opens up great innovation potential in a variety of application fields. The possibility of creating porous three-dimensional structures at substrate level is of particular interest for microfluidic applications. Integrated hard and soft magnetic components enable innovative solutions for MEMS sensors and actuators as well as the miniaturization of electronic components such as coils and power supplies.

1 *Silicon wafer with on-chip porous SiO_2 separation columns for micro chromatography.*
The intrinsic porosity of PowderMEMS structures opens up great innovation potential for microfluidic applications.



2

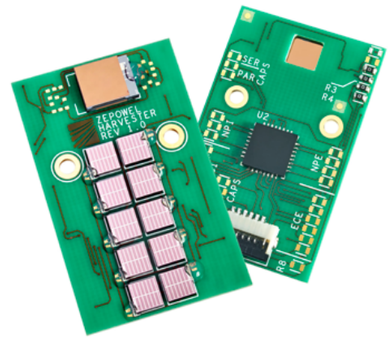
2 *Porous and magnetic micro components can be integrated at the substrate level with PowderMEMS, such as these hard magnetic structures made of NdFeB.*

ENERGY HARVESTER SYSTEM WITH INTEGRATED MAGNETS

Within the Fraunhofer lighthouse project "Toward Zero Power Electronics-ZePowEl", Fraunhofer ISIT developed a novel MEMS magnetomechanical energy harvester. The unique wafer-level integration of NdFeB micromagnets, enabled by ISIT's patented PowderMEMS technology, allows contactless energy harvesting in various excitation schemes. The harvested energy is transduced by high quality AlN or AlScN piezoelectric layers. The device allows for the mechanical and/or magnetic exploitation of linear and rotational motion, electromagnetic waves and shock-like accelerations. In resonance, high power output > 100 µW is achieved. Low frequency pulse-like excitations lead to outputs sufficient to realize near-zero power wake-up functionality.

Examples of Application

- Energy autonomous sensor nodes
- Magnetic field sensor
- Zero-power wake-up device
- Low-power tachometer
- Transducer for power transmission (e.g. active implants)



5

Technical specifications

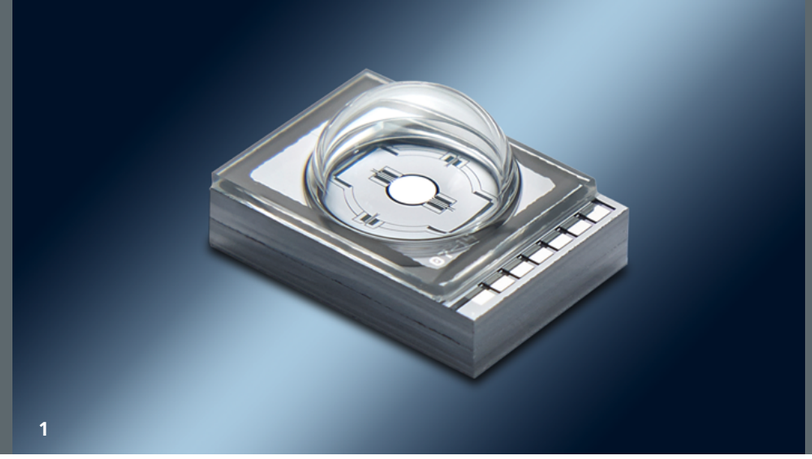
Harvester Dimensions:	6.0 x 8.0 mm²
Power output in resonance:	> 100 µW
Open-circuit voltage in resonance:	> 4 V
Resonance frequency range:	1 – 4 kHz
Power output at 30-50 Hz (pulse-like excitation):	> 5 µW
Open circuit voltage at 30-50 Hz (pulse-like excitation):	> 3 V
Vacuum packaging:	available

3 *Magnetoelectric energy-harvesters with integrated 3D-micromagnets*

4 *Top view of energy harvester with integrated 3D-micromagnets*

5 *Integrated harvesting and storage module*

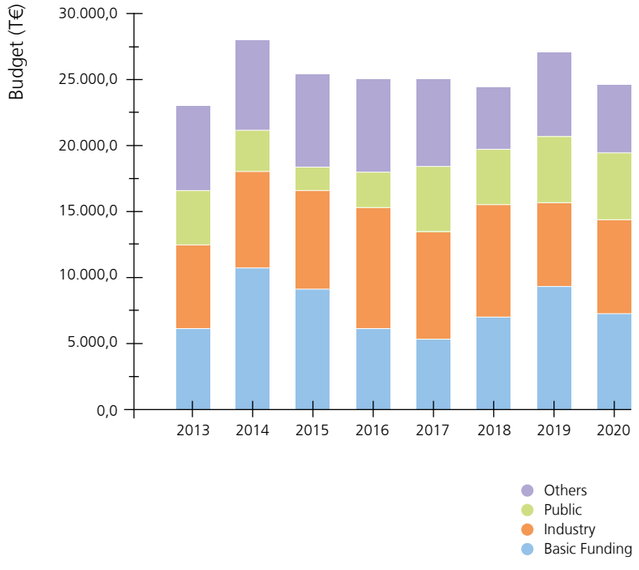
REPRESENTATIVE FIGURES



INCOME OF FRAUNHOFER ISIT FROM 2013 UP TO 2020

The budget 2020 was financed by proceeds of projects of industry/industrial federations/small and medium sized companies amounting to 7.246,4 T€, of government/project sponsors/ federal states amounting to 4.954,4 T€ and of others amounting to 5.273,7 T€. Furthermore, there were FhG-projects and basic funding with 7.483,2 T€.

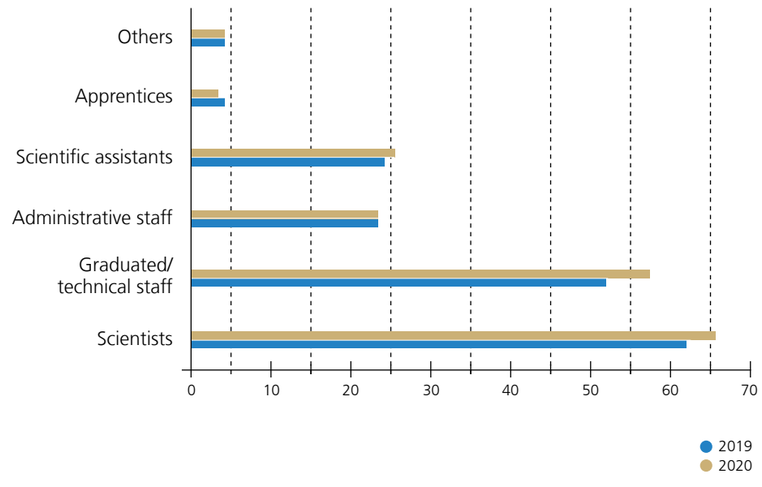
Budget of Fraunhofer ISIT from 2013 up to 2020



STAFF DEVELOPMENT

At the end of 2020, the staff consisted of 148 employees. 66 were employed as scientific personnel, 58 as graduated/technical personnel and 24 worked within organisation and administration. The employees were assisted through 26 scientific assistants, 3 apprentices and 4 others.

Staff Development



1 *Glass domes are fabricated at ISIT on wafer level and connected to MEMS wafers.*

THE FRAUNHOFER-GESELLSCHAFT

The Fraunhofer-Gesellschaft is the world's leading applied research organization. With its focus on developing key technologies that are vital for the future and enabling the commercial exploitation of this work by business and industry, Fraunhofer plays a central role in the innovation process. Based in Germany, Fraunhofer is an innovator and catalyst for groundbreaking developments and a model of scientific excellence. By generating inspirational ideas and spearheading sustainable scientific and technological solutions, Fraunhofer provides science and industry with a vital base and helps shape society now and in the future.

At the Fraunhofer-Gesellschaft, interdisciplinary research teams work together with partners from industry and government in order to transform novel ideas into innovative technologies, to coordinate and realize key research projects with a systematic relevance, and to strengthen the German and the European economy with a commitment to creating value that is based on human values. International collaboration with outstanding research partners and companies from around the world brings Fraunhofer into direct contact with the key regions that drive scientific progress and economic development.

Founded in 1949, the Fraunhofer-Gesellschaft currently operates 75 institutes and research institutions. The majority of our 29,000 staff are qualified scientists and engineers who work with an annual research budget of 2.8 billion euros. Of this sum, 2.4 billion euros are generated through contract research. Around two thirds of Fraunhofer's contract research revenue is derived from contracts with industry and publicly funded research projects. The remaining third comes from the German federal and state governments in the form of base funding. This enables the institutes to work on solutions to problems that are likely to become crucial for industry and society within the not-too-distant future.

Applied research also has a knock-on effect that is felt way beyond the direct benefits experienced by the customer: Our institutes boost industry's performance and efficiency, promote the acceptance of new technologies within society and help train the future generation of scientists and engineers that the economy so urgently requires.

Our highly motivated staff, working at the cutting edge of research, are the key factor in our success as a scientific organization. Fraunhofer offers researchers the opportunity for independent, creative and, at the same time, targeted work. We therefore provide our employees with the chance to develop the professional and personal skills that will enable them to take up positions of responsibility at Fraunhofer, at universities, in industry and within society. Students who work on projects at Fraunhofer Institutes have excellent career prospects in industry by virtue of the practical training they enjoy and the early experience they acquire of dealing with contract partners.

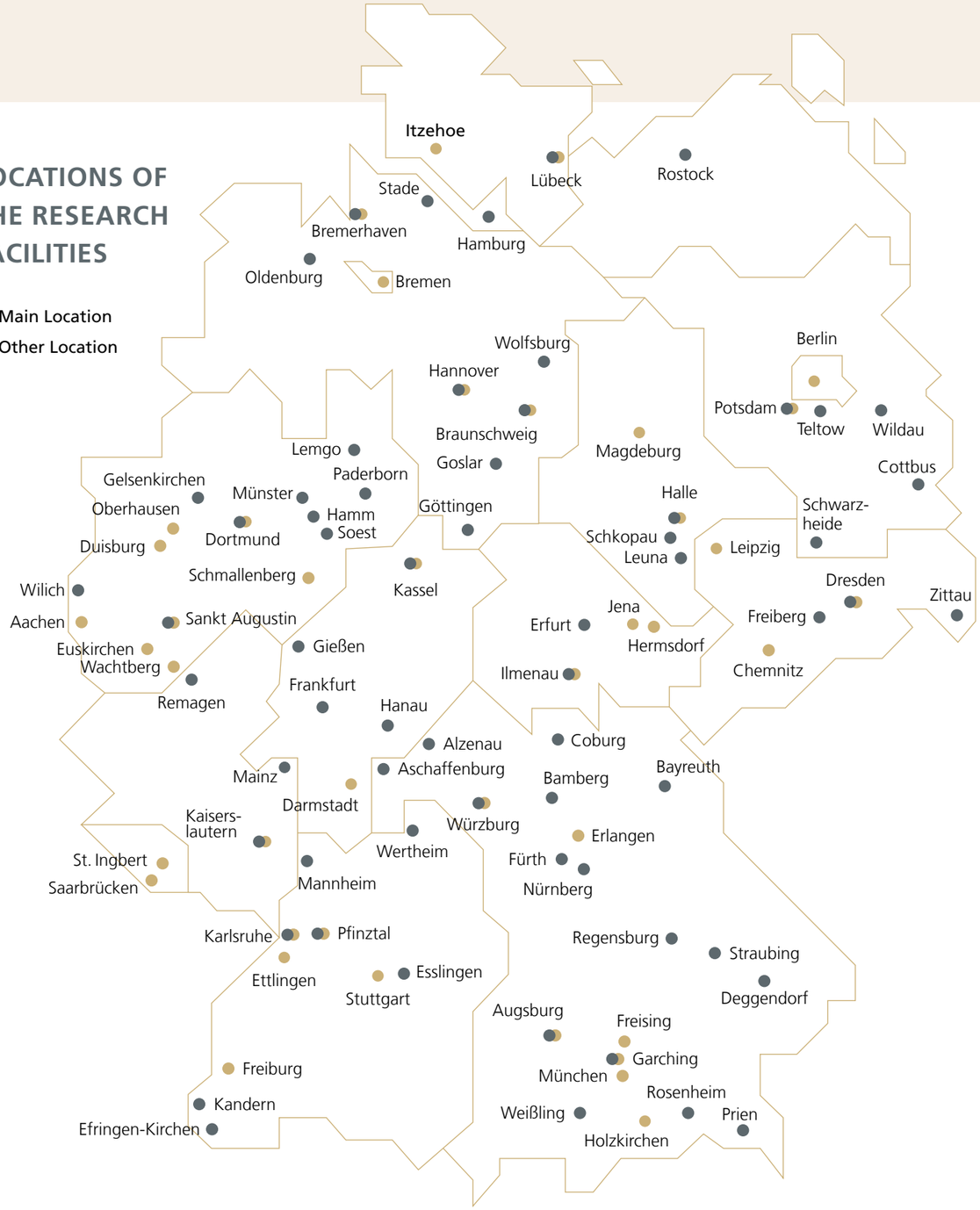
The Fraunhofer-Gesellschaft is a recognized non-profit organization that takes its name from Joseph von Fraunhofer (1787–1826), the illustrious Munich researcher, inventor and entrepreneur.

www.fraunhofer.de

Last updated: January 2021

LOCATIONS OF THE RESEARCH FACILITIES

- Main Location
- Other Location



FORSCHUNGSFABRIK MIKROELEKTRONIK DEUTSCHLAND

ONE-STOP-SHOP: FROM BASIC RESEARCH TO CUSTOMER-SPECIFIC PRODUCT DEVELOPMENT

Since April 2017, Fraunhofer ISIT and 12 other member institutes have formed the cross-site collaboration Research Fab Microelectronics Germany (FMD). With over 2000 scientists from the Fraunhofer Group for Microelectronics and the Leibniz institutes FBH and IHP, this research association is the largest and world-leading R&D group for applications and systems in micro- and nanoelectronics.

Consolidating the FMD

The FMD, with the aim to conduct research and development in Germany across several locations, was in its inauguration phase until 2020, supported by the Federal Ministry of Education and Research (BMBF) with around 350 million euros. This mainly involved modernising the research equipment of the 13 participating institutes of the Fraunhofer-Gesellschaft and the Leibniz Association. With a new concept for sustainable operation, the FMD is now entering the productive phase after the initial project period.

Versatile cooperation opportunities

In addition to the range of services for its customers from industry, FMD also offers a wide variety of cooperation opportunities for its partners in science. Among the highlights are services that aim directly at processing research questions cooperatively, for example through collaborative work in joint projects and the operation of so-called Joint Labs. In addition, it is possible to commission FMD institutes to test basic research concepts in the institutes' facilities with regard to their suitability in more application-oriented environments. Good examples of cooperation between FMD and universities as well as other institutions of higher education include the ASCENT+ project, the „iCampus" research collaboration and the SmartBeam-Lab Joint Lab in Duisburg.

Fraunhofer ISIT
is participant of the

Forschungsfabrik Mikroelektronik Deutschland

IMPORTANT NAMES, DATA, EVENTS

LECTURING ASSIGNMENTS AT UNIVERSITIES

R. Dudde
Mikrotechnologien (8168), Fachbereich Technik, *FH Westküste, Heide*

S. Gu-Stoppel
Mikrotechnologie und Entwurf von Mikrosystemen, *FH Westküste, Heide*

F. Haase
Professor für Leistungselektronik und Grundlagen der Elektrotechnik, Department Informations- und Elektrotechnik, *HAW Hamburg*

H. Kapels
Professur Halbleiterbauelemente der Leistungselektronik, Technische Fakultät, *Christian-Albrechts-Universität zu Kiel*

F. Lofink
Prozesse und Materialien der Nanosystemtechnik, Micro- and Nanosystem Technology, Technische Fakultät, *Christian-Albrechts-Universität zu Kiel*

G. Pangalos
Advanced Control Systems: Simulation and Optimization Tools, *Lehrauftrag an der HAW Hamburg*

A. Müller-Groeling
Professur Mikrosysteme und Technologietransfer, Technische Fakultät, *Christian-Albrechts-Universität zu Kiel*

O. Schwarzelbach
Mikroelektromechanische Systeme (MEMS), Institut für elektrische Messtechnik und Mess-Signalverarbeitung, *Technische Universität Graz, Austria*

B. Wagner
Lehrstuhl Prozesse und Materialien der Nanosystemtechnik, Micro- and Nanosystem Technology, Technische Fakultät, *Christian-Albrechts-Universität zu Kiel*

TRADE FAIRS AND EXHIBITIONS

Nortech 2020
January 21 – 24, 2020, Hamburg

SPIE 2020
Photonics West Exhibition, February 04 – 06, 2020, San Francisco, USA

Battery Japan 2020
International Rechargeable Battery Expo, February 25 – 27, 2020, Japan

MISCELLANEOUS EVENTS / WEBINARS

ISIT Presentation in Framework of „Macht mit bei MINT – Zukunftsberufe für Frauen“
Information Day for Schoolgirls, initiated by Volkshochschulen Kreis Steinburg, February 25, 2020, Fraunhofer ISIT, Itzehoe

ISIT Presentation at EBL (Elektronische Baugruppen und Leiterplatten) 2020
February 18 – 19, 2020, Fellbach

ISIT Participation at Parentum.online 2020, Unterelbe Westküste
Event for Education and Study, June 9, 2020

ISIT Participation at GAIN 2020 (German Academic International Network) goes virtual
August 28 – 29, 2020

Megatrends in Leistungselektronik - Chancen und Perspektiven aus Norddeutschland
ISIT Webinar, September 16, 2020

Pulverbasierte Mikrokomponenten - Innovations-bausteine der Mikrosystemtechnik
ISIT Webinar, September 23, 2020

ISIT Participation at “Hamburg Innovation Summit - goes virtual”
September 24, 2020

Anwendungen und Use Cases der Pulvertechnologie
ISIT Webinar, October 21, 2020

ISIT Presentation in Framework of ProZell-Industrietag - Digital
“Wissensbausteine für Batteriezellen Made in Germany“ October 27, 2020

Fraunhofer Solution Days 2020, Digital Event
October 26 – 29, 2020

Rapid Prototyping: How To Satisfy Your Customer in 24h
ISIT Webinar, October 28, 2020

Workshop “Energiewende in der Praxis”
organized by “Netzwerk Leistungselektronik Schleswig-Holstein”, November 22, 2020, Fraunhofer ISIT, Itzehoe

Modulation and control of modular power converters for high-power applications
ISIT Webinar, November 11, 2020

ISIT Participation at EEHH Web Seminar: “Wechselrichter als Enabler der Energiewende”
November 26, 2020

ISIT Presentation in Framework of Science-Match – Future Energies 2020, Digital Edition
December 01, 2020

Niederinduktive Aufbaukonzepte und Kondensatoren in der Leistungselektronik
ISIT Webinar, December 02, 2020

High-Power Cells: From Development to Industrialization
ISIT Webinar, December 09, 2020

SCIENTIFIC PUBLICATIONS

JOURNAL PAPERS AND CONTRIBUTIONS TO CONFERENCES

H.-G. Bremes
ISIT TechBlog: Maßgeschneiderte Zelle made by ISIT. *September 28, 2020, Itzehoe*

C. Cateriano Yáñez, G. Lichtenberg, G. Pangalos, J. Sanchis
An Approach to State Signal Shaping by Limit Cycle Model Predictive Control. *21st IFAC World Congress, 2020, Berlin*

C. A. B. Costa, D. Grazhdan, J. Fiutowski, E. Nebling, L. Blohm, F. Lofink, H.-G. Rubahn, R. de Oliveira Hansen
Meat and Fish Freshness Evaluation by Functionalized Cantilever-Based Biosensors. *Microsystem Technologies 26, p. 867-871, 2020*

J. Franz, F. Röben
Market Response for Real-Time Energy Balancing - Simulation using Field Test Data. 17th International Conference on the European Energy Market, *September 2020, Stockholm, Sweden*

B. Gojdka & S. Grünzig
ISIT TechBlog: Energie ernten für grüne Mikroelektronik. *November 27, 2020, Itzehoe*

B. Gojdka
ISIT TechBlog: Disruptive Technologie für die nächste Generation von Mikrosystemen. *June 09, 2020, Itzehoe*

M. Grasenack, L. Jürgens, A. C. Meißner, K. Knorr, A. Dreher, M. Vogt, P. Giron
Design and Evaluation of a Last-Minute Electricity Market Considering Local Grid Limitations. *17th European Energy Market Conference, 2020, Stockholm, Sweden*

S. Grünzig & T. Giese
ISIT TechBlog: Elektrische Ansteuerung von MEMS-Lautsprechern. *November 13, 2020, Itzehoe*

S. Gu-Stoppel, T. Lisec, S. Fichtner, N. Funck, M. Claus, B. Wagner, F. Lofink
AlScN Based MEMS Quasi-Static Mirror Matrix with Large Tilting Angle and High Linearity. *Sensors and Actuators A312, 112107, 2020*

S. Gu-Stoppel, T. Lisec, M. Claus, N. Funck, S. Fichtner, S. Schröder, B. Wagner, F. Lofink
A Triple-Wafer-Bonded AlScN Driven Quasi-Static MEMS Mirror with High Linearity and Large Tilt Angles. Conference *„MOEMS and Miniaturized Systems, February 28, 2020, San Francisco/California*

F. Heinrich & J. Lingner
ISIT TechBlog: Zuverlässiger Wafer Bondprozess. *October 28, 2020, Itzehoe*

C. Kaufmann, C. Cateriano Yáñez, G. Pangalos
Power System Frequency Estimation Method to Provide Synthetic Inertia by Energy Storage Systems. *11th International Symposium on Power Electronics for Distributed Generation Systems, September 2020, Dubrovnik, Croatia*

A. Kittmann, C. Müller, P. Durdaut, L. Thormählen, V. Schell, F. Niekiel, F. Lofink, D. Meyners, R. Knöchel, M. Höft, J. McCord, E. Quandt
Sensitivity and Noise Analysis of SAW Magnetic Field Sensors with Varied Magnetostrictive Layer Thicknesses. Sensors and Actuators. *A 311, Art.111998, 2020*

M. Kontek
ISIT TechBlog: 12“ Dünndrahtbonder am ISIT installiert. *May 05, 2020, Itzehoe*

J. Lähn
ISIT TechBlog: Herausforderungen bei der Bestückung von kleinsten Bauteilen im SMD-Prozess. *July 13, 2020, Itzehoe*

N. Laske & A. Kulkarni
ISIT TechBlog: Technologien für miniaturisierte Infrarot-Sensorsysteme. *October 30, 2020, Itzehoe*

A. Müller-Groeling
ISIT TechBlog: Interview mit dem Leiter des Fraunhofer ISIT - Prof. Dr. Axel Müller-Groeling. *July 31, 2020, Itzehoe*

E. Nebling
ISIT TechBlog: Elektrische Biochips aus dem ISIT für Coronadiagnostik. *August 13, 2020, Itzehoe*

M. Paesler, T. Lisec and H. Kapels
Novel Back-End-of-Line Compatible Method for Integration of Inductances with Magnetic Core on Silicon. *CIPS 2020; 11th International Conference on Integrated Power Electronics Systems, pp. 1-6, 2020, Berlin*

M. Paesler, T. Lisec and H. Kapels
Novel Integrated BEOL Compatible Inductances for Power Converter Applications. *IEEE Applied Power Electronics Conference and Exposition (APEC), pp. 2647-2652, 2020, New Orleans, LA, USA*

M. Paesler, T. Lisec, H. Kapels
Novel Integrated BEOL Compatible Inductances for Power Converter Applications. Institute of Electrical and Electronics Engineers -IEEE-: *35th Annual IEEE Applied Power Electronics Conference and Exposition, APEC 2020: March 15-19, 2020, New Orleans, Louisiana*

M. Paesler, T. Lisec and H. Kapels
Novel Integrated BEOL Compatible Inductances for Power Converter Applications. *APEC 2020; Applied Power Electronics Conference and Exposition, March 15-19, 2020*

M. Paesler, T. Lisec and H. Kapels
CIPS 2020; 11th International Conference on Integrated Power Electronics Systems. Novel back-end-of-line compatible method for integration of inductances with magnetic core on silicon, *March 26, 2020*

Sebastian Puls
ISIT TechBlog: Dehnungsmessstreifen zur Qualitätssicherung in der Elektronik. *May 19, 2020, Itzehoe*

L. Ratzmann & J. Albers
ISIT TechBlog: Von der Skizze zum Demonstrator. *November 20, 2020, Itzehoe*

W. Reinert, P. Malaurie
Development of a Small RGB-laser Light Engine. Components and Packaging for Laser Systems VI: *February 3-5, 2020, San Francisco, California*

K. Reiter
Anfertigung von Flächenschliffen zur Beurteilung von Verbindungsflächen bei elektronischen Aufbauten und Komponenten. *October 26, 2020, Itzehoe*

M. Reiter
ISIT TechBlog: Bewertung von Einpressverbindungen. *August 19, 2020, Itzehoe*

F. Röben
Smart Balancing of Electrical Power - Matching Market Rules with System Requirements for Cost-Efficient Power Balancing. *Journal „Energy Policy“, March, 2020*

SCIENTIFIC PUBLICATIONS

F. Röben, A. Meißner
Market Response for Real-Time Energy Balancing with Fuzzy Logic. *17th International Conference on the European Energy Market, September 2020, Stockholm, Sweden*

V. Schell, C. Müller, P. Durdaut, A. Kittmann, L. Thormählen, F. Lofink, D. Meyners, M. Höft, J. McCord, E. Quandt
Magnetic Anisotropy Controlled FeCoSiB Thin Films for Surface Acoustic Wave Magnetic Field Sensors. *Applied Physics Letters 116, Nr.7, Art. 073503, p. 6, 2020*

H. Schimanski
Sichere Verarbeitung von Bottom Termination Components am Beispiel von 01005 Dioden.
GMM-Fb. 94: EBL 2020 – Elektronische Baugruppen und Leiterplatten, p. 131 - 134, Technologische Plattform für die digitale Transformation, Vorträge der 10. DVS/GMM-Tagung, ISBN 978-3-8007-5185-3, *February 18–19, 2020, Fellbach*

T. Schmitz-Kempen, S. Tappertzhofen, S. Bette, S. Tiedke, S. Fichtner, S. Bröker, B. Wagner, M. G. Cain
LIMM Analysis of Novel Lead-free Pyroelectric Materials for IR Array Detectors.
IEEE IFCS-ISAF 2020, *International Frequency Control Symposium and International Symposium on Applications of Ferroelectrics*

F. Schwarz, F. Senger, J. Albers, P. Malaurie, C. Janicke, L. Pohl, F. Heinrich, D. Kaden, H.-J. Quenzer, F. Lofink, A. Bahr, T. von Wantoch, U. Hofmann
Resonant 1D MEMS Mirror with a Total Optical Scan Angle of 180° for Automotive LiDAR.
Piyawattanametha, W. ; Society of Photo-Optical Instrumentation Engineers -SPIE-, Bellingham/Wash.: MOEMS and Miniaturized Systems XIX : *February 1-3, 2020, San Francisco, California*

S. Schröder & H. Schimanski
ISIT TechBlog: Fortschrittliche Fehleranalyse als Grundlage für zuverlässige Elektronik. *October 23, 2020, Itzehoe*

S. Schröder
ISIT TechBlog: Women Leaders in Science and Technology - Ein Interview mit Mikrotechnologin Saskia Schröder. *March 05, 2020, Itzehoe*

F. Senger, J. Albers, U. Hofmann, G. Piechotta, T. Giese, F. Heinrich, T. von Wantoch, S. Gu-Stoppel
A Bi-Axial Vacuum-Packaged Piezoelectric MEMS Mirror for Smart Headlights.
Conference „MOEMS and Miniaturized Systems, *February 28, 2020, San Francisco/ California*

V. Stenchly
Optische Gehäuse zur Verpackung von Bauelementen auf Waferebene. *Mikroelektronik Nachrichten 78*

V. Stenchly
3D Opto-Gehäuse für Bauelemente auf Waferebene.
IVAM Fachmagazin, *25. Jahrgang, Nr. 75, Frühjahr 2020*

V. Stenchly
ISIT TechBlog: 3D Opto-Gehäuse zur Verpackung von Bauelementen auf Waferebene.
October 16, 2020, Itzehoe

F. Stoppel, A. Männchen, F. Niekiel, D. Beer, B. Wagner
Integrated Piezoelectric MEMS Loudspeakers for In-Ear Applications.
Forum Acusticum, December 10, 2020, Lyon, France

N. Stuchynska, F. Röben
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S. A. Wiljes
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TALKS AND PRESENTATIONS

H. Schimanski
Fortschrittliche Fehleranalyse als Grundlage für zuverlässige Elektronik.
NORTEC Auditorium Elektronikfertigung, January 21, 2020, Hamburg

F. Röben, H. Schäfers, A Meißner, J. de Haan
Smart Balancing - Kann Transparenz Kosten reduzieren und neue Geschäftsmodelle ermöglichen?
Tagung Zukünftige Stromnetze, January 30, 2020, Berlin

H. Schimanski
Sichere Verarbeitung von Bottom Termination Components am Beispiel von 01005 Dioden.
EBL 2020, 10. DVS/GMM-Tagung, February 18-19, 2020, Fellbach

A. Würsig
Polymer and Oxide Solid Electrolytes.
2 ALL SOLID STATE HANDS-ON BATTERY SEMINAR, February 19-20, 2020, Itzehoe

H. Schimanski
Bleifrei Handlöten. Inhouse-Schulung „Manuelles Löten von SMD- und THT-Bauelementen auch mit bleifreien Loten", *February 26, 2020, TWK, Wedel*

H. Schimanski
Baugruppen- und Fehlerbewertung. Inhouse-Schulung „Manuelles Löten von SMD- und THT-Bauelementen auch mit bleifreien Loten", *February 26, 2020, TWK, Wedel*

H. Schimanski
Qualifizierte Reworkprozesse – Von der Anforderung zum sicheren und dokumentierten Prozess.
Webinar der FED RG Hamburg, June 03, 2030, Itzehoe

H. Schimanski
Korrosion und elektrochemische Migration (ECM) auf elektronischen Baugruppen.
3. Technologietage Leiterplatte & Baugruppe, Vogel Verlag, Würzburg, July, 21-22, 2020

K. Reiter
Anfertigung von Flächenschliffen zur Beurteilung von Verbindungsflächen bei elektronischen Aufbauten und Komponenten.
54. Metallographie-Tagungung, September 16-18, 2020, Sankt Augustin

H. Schimanski
Fortschrittliche Fehleranalyse als Grundlage für zuverlässige Elektronik.
16. Technologieseminar bei Firma Wolf, October 07, 2020, Freudenstadt

M. Päsler
Anwendungen und Use Cases der Pulvertechnologie.
ISIT - Webinare, October, 21, 2020

F. Stoppel
Lecture on MEMS Based Audio Transducers for New Generations of In-Ear Headphones.
Deep Dive into Smart Earphones Workshop 2020, November 12, 2020, Tokyo, Japan

A. Kulkarni, N. Laske, A. V. Schulz-Walsemann, A. Ambrosius, J. Hagge, and H. J. Quenzer
Miniaturized Infrared Lenses Realized By Wafer Bonding Technologies.
PRiME 2020 October 4-9, Honolulu, HI (Online),
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DOCTORAL THESES

Fabian Stoppel
Entwicklung hochleistungsfähiger ohmscher MEMS-Schalter auf Basis eines neuartigen Aktorkonzeptes.
Dissertation, Christian-Albrechts-Universität zu Kiel, September 2020

DIPLOMA, MASTER'S AND BACHELOR'S THESES

Neele Borkowsky
Gestaltung eines Investitionsentscheidungsprozesses im Forschungsbereich unter Berücksichtigung mehrerer Entscheidungsträger mit Hilfe des Analytischen Hierarchieprozesses.
Bachelor's Thesis, Technische Universität Clausthal July 2020

Mirco Drews
Stabilitätskriterien für den Einsatz von wide band-gap Leistungshalbleitern in Leistungshalbleitermodulen.
Master's thesis, HAW Hamburg, April 2020

Tom-Niklas Kreutzer
Ferroelectric AlScN Double Layers for Piezoelectric MEMS Actuators.
Master's thesis, Christian-Albrechts-Universität zu Kiel, July 2020

Lara Kreft
Simulationsbasierte Parameterstudie eines Virtual Inertia Controllers für einen Batteriespeicher im elektrischen Verbundnetz bei niedriger Systemträgheit
Master's thesis, HAW Hamburg, April 2020

Artur Neumann
Aufbau eines Messplatzes zur Ermittlung der Grenzen von Leistungstransistoren im Linearbetrieb.
Master's thesis, FH Westküste & HAW Hamburg, May 2020

Simon Rindelaub
Entwicklung eines Werkzeugs zur Temperaturtomographie einer Li-Ionen-Pouchzelle.
Master's thesis, HAW Hamburg, 2020

Divya Singhal
Simulative Study of Inverter Topologies for High Precision and Low Frequency Applications
Master's thesis, Brandenburgische Technische Universität Cottbus, August 2020

Moonhyeok Song
Quality Increase in the Lithium-Ion Battery.
Master's thesis, Christian-Albrechts-Universität zu Kiel, December 2020

PATENTS

SUPPLEMENT 2019

U. Hofmann, T. v. Wantoch, C. Mallas, F. Senger
Appliance and method for detecting objects in a detection region
US 10,436,880 B2

T. Lisec, F. Lofink
Verfahren zum Herstellen einer magnetischen Struktur und Vorrichtung
DE 102016215616 B4
CN ZL201710717498.7

G. Piechotta, H.-J. Quenzer
Auf Waferebene hergestellter Chip für Flüssigchromatographie sowie Verfahren für seine Herstellung
EP 2496938 B1

SUPPLEMENT 2020

T. Lisec, F. Lofink
Method of producing a cavity having a porous structure
CN ZL201710713589.3

J. Janes, U. Hofmann
Einrichtung zur Projektion eines Laserstrahls zur Erzeugung eines Bildes auf der Netzhaut eines Auges und Brilleneinrichtung mit zwei derartigen Einrichtungen
DE 102018209886 B4

U. Hofmann, H.-J. Quenzer, T. Lisec, T. von Wantoch
Converter for generating a secondary light from a primary light, light-emitting elements which contains such a converter, and method for producing the converter and the light-emitting elements
US 10,647,915 B2

S. Gu-Stoppel, H.-J. Quenzer, U. Hofmann
Vorrichtung mit einer Feder und einem daran aufgehängten Element und Verfahren zum Herstellen desselben
EP 3312136 B1

M. F. Niekiel, F. Stoppel, T. Lisec
MEMS-Schallwandler
DE 102019201755 B4

A. Ebberg, U. Hofmann, W. Schernus, F. Senger
Antenna device
US 10,665, 938 B2

T. Knieling, E. Nebling, L. Blohm
Mundstück mit einem Kanal
DE 10 2016 226 210 B4

U. Hofmann, F. Senger, T. von Wantoch, C. Mallas, J. Janes, M. Weiß
Verfahren zum Ansteuern einer Ablenkeinrichtung für eine Projektionsvorrichtung, Ablenkeinrichtung für eine Projektionsvorrichtung und Projektionsvorrichtung
DE 10 2014 220 115 B4

F. Stoppel, B. Wagner
Micromechanical piezoelectric actuators for implementing large forces and deflections
CA 2 960 072

GENERAL VIEW ON PROJECTS

POWER ELECTRONICS

Advanced Power Transistors

- Trusted Resource Aware ICT – TRAICT
- Vertikale GaN-Transistoren für effiziente Leistungselektronik im Niederspannungsbereich – VERTIGO
- Lagerschild integrierte Silizium-Carbid Leistungselektronik – LASIC
- Netzwerk Leistungselektronik - Netzwerk LE
- Norddeutsche Energiewende 4.0 - NEW 4.0
- Schaufenster intelligente Energie, Systemdienstleistungen mit Speichern - NEW 4.0, SDL
- Schaufenster intelligente Energie, Algorithmen-Entwicklung – NEW 4.0, ALG
- Schaufenster intelligente Energie, Modellbildung und Simulation zur Systemintegration - NEW 4.0, SYS

Battery Systems for Special Applications

- Cell for High Temperature/ Shock - AIF-CHiTS
- Hochstromfähiges Lithium-Batteriemodul, Entwicklung einer Hochleistungs-Lithiumbatterie - HostBM
- Calcium Rechargable Battery Technology – CARBAT
- CObalt-free Batteries for FutuRe Automotive Applications – COBRA
- Forschungsfertigung Batteriezelle Deutschland FFB – FoFeBat
- 2nd Use Green Battery-GreenBAT²Use - Green Battery
- Umweltfreundliche Hoch-Energie-NCM 622-Kathoden mit optimierter Speicherkapazität – HiLo
- Lithium-Ionen-Zellen zur Integration mit erweiterter Sensorik – LImeSI
- Optimierung von Magnesium-Schwefel Batterien durch innovative Materialentwicklung – MagSiMal
- Verbundvorhaben: Neuartige Untersuchungsmethoden zur Batteriesicherheit; Teilvorhaben: Aufklärung von Schadensprozessen mittels zellinterner Sensorik – NUBase
- Ökologisch schonende Trockenbeschichtung von Batterie-Elektroden mit optimierter Elektrodenstruktur – ÖkoTroP
- Hochleistungsladesystem mit integriertem Pufferspeicher - Power400
- Kostensenkung und Qualitätssteigerung bei der Lithium-Ionen-Batterie-Elektrodenfertigung durch quantitative, optische inline-Messtechnik - Q-LIB

MICRO-MANUFACTURING PROCESSES

Process Integration and Pilot Production

- Voll Integrierte, ungekühlte Wafer-Level FIR-Kamera für Wärmestrahlung
- MEMS Mirror Based 3D-Camera Module feasibility study project
- Herstellung und Transfer eines MEMS 3D-Gyro
- Herstellung von Wafern mit MEMS-Elektroden für einen Mikro-Ozon-Generator
- Innovatives mobiles Testsystem zur nachhaltigen Beschleunigung des SARS-COV2 Virusnachweis und des Nachweises bestehender Immunität
- Entwicklung eines Prozessablaufs zur Herstellung eines Dehnungsmessstreifen
- Elektrische Array-Chips für biotechnische Anwendungen
- Herstellung von Aerosol Verdampfer-Chips
- Mirrorless resonant transmission scanner for mixed reality applications
- Miniaturisierte IR-basierte Sensorsysteme (MIRS) - Optische Waferlevel-Integration von FIR-Sensoren und innovativen pyroelektrischen Sensormaterialien
- Multifunktionale Sensorintegration auf anwenderspezifischen ICs
- Entwicklung einer Plattform für funktionelle Glasgehäuse für die Integration mikrooptischer und -mechanischer Systeme auf Waferebene (PRISMA)
- Transfer of fabrication process for switchable e-beam mask
- Entwicklung eines CMP-Prozesses für TEOS-Oxid mit Stopp auf Epi-Poly

Module Services

- Adhesive reliability and feasibility testing for print head dies
- Untersuchung der Auswirkung ionischer Verunreinigungen in dünnen Spalten an realitätsnahen Aufbauten mit neuen miniaturisierten Bauelementen
- Wafer dicing and build up of pre-selected print head dies
- Lebensdauerprüfung an Elektrolytkondensatoren
- Qualifizierung eines SnAgBi-Lötprozesses

MEMS APPLICATIONS

Optical Systems

- 3D Gyro- Design- and process-development for a 3D MEMS gyro - 3D-Gyro MF
- Cluster of Excellence Advanced Photon Sources – CAPS
- Entwicklung eines Schnelltest-Systems zur frühen und versorgungsrelevanten Detektion immun-vermittelter muskoskelettaler Erkrankungen – CIMD
- Industrietaugliche UKP-Laserquellen und systemweite Produktivitätssteigerungen für hochdynamische Bohr- und Schneidanwendungen – InBus
- Aufbau eines LIDAR-Demonstrators - LIDAR-Demonstrator
- Compressed Sensing unterstütztes LiDAR mit kohärenter Detektion bei augensicheren Wellenlängen für autonomes Fahren – MELINDA
- Pilot Line for Micro-Transfer-Printing of functional components on wafer level – MICROPRINCE
- Entwicklung und Herstellung eines sensorgesteuerten Ozongenerators – MIKROOZON
- Miniaturisierte IR-basierte Sensorsysteme-Teilvorhaben: Optische Waferlevel-Integration von FIR-Sensoren und innovativen pyroelektrischen Sensormaterialien - MIRS-PENTA – MEMS
- Optoelektronisch-mikrofluidisches System zur Detektion von fluoreszenzmarkierten Nukleinsäuren – OPTOCHIP
- Piezo-MEMS basierte hermetisch gekapselte Spiegel-Bauelemente mit 4,3 mm hohem kuppelförmigem Glasdeckel - OQmented Spiegel-Bauelemente
- Fertigung eines passiven MEMS-Spiegels mit kuppelförmigem Deckel - OQmented MEMS-Spiegel
- Fertigung eines aktiven MEMS-Spiegels mit/oder ohne kuppelförmigen Decke - OQmented MEMS-Spiegel
- Funktionale Mikrospiegel mit kundenspezifischem Design - Sacher MEMS-Spiegel
- MEMS-Scanner basiertes Laserprojektionssystem für Maritime Augmented Reality - Smart Window
- Entwicklung einer adaptierbaren, modularen Strategie zur Qualitätskontrolle zellbasierter Therapien - ZellTherQC

Acoustic Systems and Micro Actuators

- Generative Herstellung effizienter Piezo-MEMS für die Mikroaktorik - Auslegung und Herstellung gedruckter Mehrlagen-Piezoaktuatoren-Generator
- Extrem breitbandiger Stromsensor mit höchster Dynamik für hocheffiziente Leistungswandlung – mAgnes
- Ferroelektrizität in ScAlN: Von der Entdeckung des Effekts zu disruptiven Bauelementen – SALSA
- Sensor Edge Cloud for Distributed Learning - SEC-Learn TAKE-OFF
- SFB 1261-A3, Resonant magnetoelectric sensors -SFB 1261-A3
- SFB 1261-A9, Surface Acoustic Wave Magnetic Field Sensors - SFB 1261-A9
- SFB 1261-Z1, MEMS magnetoelectric sensor fabrication - SFB 1261-Z1
- MEMS-Speakerentwicklung – SPKR
- Feasibility of non-CMOS substrates for Printhead - X-FAB Printhead
- Towards Zero Power Electronics – ZePowEl

Agglomerated Microsystems

- Labor zur Integration poröser 3D-Hochleistungswerkstoffe in Bauelemente der Mikrosystemtechnik und Leistungselektronik - LAB 3D
- Entwicklung dreidimensionaler Mikrostrukturen aus Niedertemperaturverfestigten porösen Pulverpackungen - MiniPack

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Studio 2038, Hamburg
www.studio2038.com
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