TECHNISCHE UNIVERSITÄT DRESDEN

ELECTRICAL AND COMPUTER ENGINEERING DEPARTMENT

SOLID-STATE ELECTRONICS LABORATORY

HEAD: PROF. DR.-ING. HABIL. G. GERLACH

2017 ANNUAL REPORT

Solid-State Electronics Laboratory:

Head:	Prof. Dr.-Ing. habil. Gerald Gerlach
Secretary:	Mrs. Heike Collasch
Postal address:	Technische Universität Dresden Electrical and Computer Engineering Department Solid State Electronics Laboratory 01062 Dresden
Address for visitors:	Mommsenstrasse 15 Günther-Landgraf-Bau, Room 7-E01B
Phone:	+49-351-463 32077
Fax:	+49-351-463 32320
E-mail:	Heike.Collasch@tu-dresden.de
Internet:	http://ife.et.tu-dresden.de

INTRODUCTION

Dear friends and partners of our Solid-State Electronics Laboratory,

This brochure will report on the work, the projects and the results of the previous year. As we look back on the year 2017, we can be pleased with what has been achieved.

The success of the IFE's work can be seen in our figures regarding research results and publications. However, even more important is that our Lab provides an excellent research and working atmosphere where our young scientists and doctoral students have the opportunity to develop. In 2017 again three doctoral students could defend their doctoral theses successfully, further students have almost completed their thesis work. The awards our young researchers could receive in the last year give evidence of the high quality of their achievements.

Similar to last year, we once again have lost a long-time supporting pillar of our Lab. Dr. Bärbel Knöfel is now enjoying her well-deserved retirement after many decades with the IFE. In this time, she has been the coordinator of four (!) DFG-funded Research Training Groups („Sensorics", „LIES – Local Intelligent Energy Systems", „Nano- and Biotechniques for the Packgaging of Electronic Systems" and, finally, „Hydrogel-based Microsystems"). Without Dr. Knöfel, we could not have achieved the success of all of these endeavors. Therefore, we thank her wholeheartedly.

We also would like to offer enormous thanks to all of our partners and companions in other institutes and institutions as well as in our university administration for their efforts in any event. We hope that we can rely on you as a reliable partner at our side again in the next years!

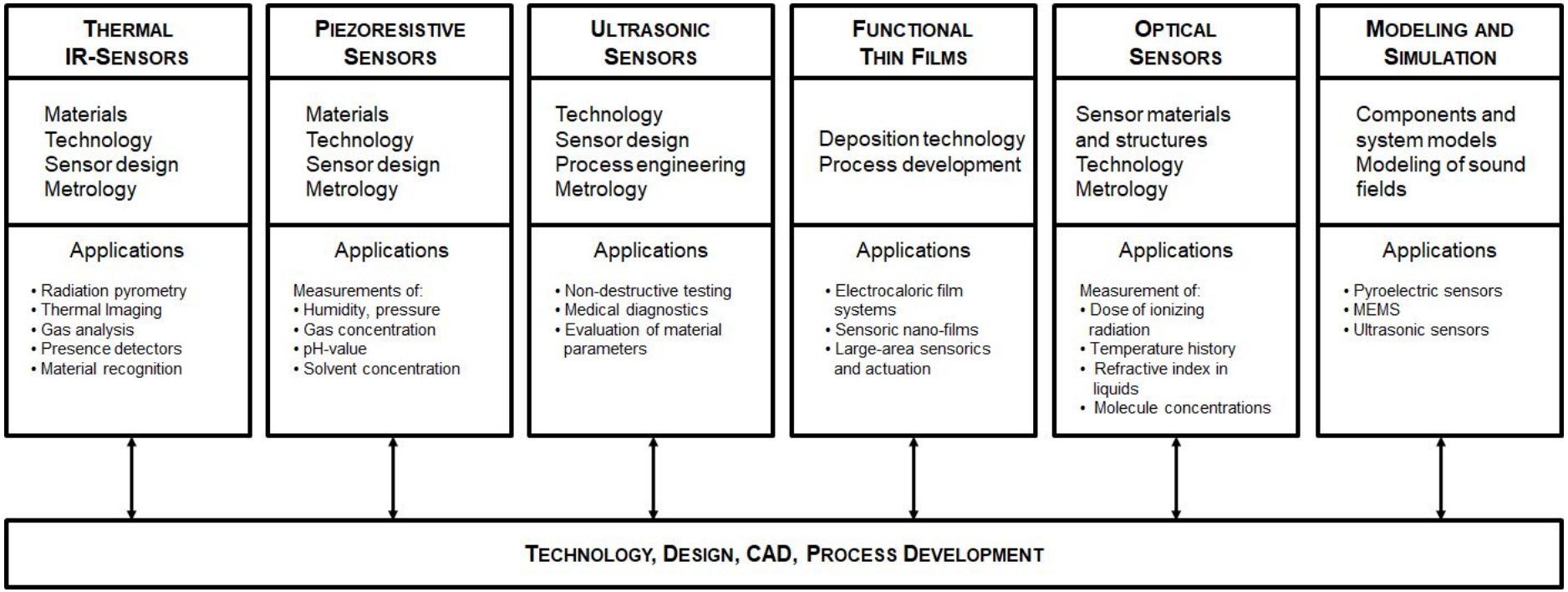
Gerald Gerlach

1. GENERAL

The Solid-State Electronics Laboratory (Institut für Festkörperelektronik - IFE) is one of 12 laboratories of the Electrical and Computer Engineering Department at Technische Universität Dresden. Together with the Semiconductor Technology and Microsystems Lab (IHM) and several chairs of the Circuits and Systems and the Packaging Labs (IAVT), the Solid-State Electronics Laboratory is responsible for the microelectronics specialization in the Electrical Engineering program. Research and teaching field of the Institute for Solid-State Electronics are dedicated to the interaction of physics, electronics and (microelectronics) technology in:

- materials research, technology, and solid-state sensor operational principles,
- application of sensors for special measurement problems,
- design of sensors and sensor systems including the simulation of components as well as of complex systems,
- development of thin films and multilayer stacks for sensor applications,
- application of ultrasound for nondestructive evaluation, medical diagnostics and process measurement technology.

For scientific research modern facilities are available (cf. section 4.3) which are located in the Werner-Hartmann building. This building is operated together with the Electronic Packaging Technology Lab and the Chair of Microsystem Technology at the Semiconductors Technology and Microsystems Lab.


THERMAL IR-SENSORS
Materials
Technology
Sensor design
Metrology
Applications
• Radiation pyrometry
• Thermal Imaging
• Gas analysis
• Presence detectors
• Material recognition
PIEZORESISTIVE SENSORS
Materials
Technology
Sensor design
Metrology
Applications
Measurements of:
• Humidity, pressure
• Gas concentration
• pH-value
• Solvent concentration
ULTRASONIC SENSORS
Technology
Sensor design
Process engineering
Metrology
Applications
• Non-destructive testing
• Medical diagnostics
• Evaluation of material parameters
FUNCTIONAL THIN FILMS
Deposition technology
Process development
Applications
• Electrocaloric film systems
• Sensoric nano-films
• Large-area sensorics and actuation
OPTICAL SENSORS
Sensor materials and structures
Technology
Metrology
Applications
Measurement of:
• Dose of ionizing radiation
• Temperature history
• Refractive index in liquids
• Molecule concentrations
MODELING AND SIMULATION
Components and system models
Modeling of sound fields
Applications
• Pyroelectric sensors
• MEMS
• Ultrasonic sensors
TECHNOLOGY, DESIGN, CAD, PROCESS DEVELOPMENT

Chair for Solid-State Electronics:

Prof. Dr.-Ing. habil. Gerald Gerlach		Professor and Chair	
Bellmann, Christian	Dipl.-Ing.	Research assistant	(until 09/17)
Binder, Simon	Dipl.-Ing.	Research assistant	
Budzier, Helmut	Dr.-Ing.	Senior researcher	
Burkhardt, Anke	Dr. rer. medic.	Research assistant	(since 05/17)
Collasch, Heike		Secretary	
Delan, Annekatrin	Dipl.-Phys.	Research assistant	
Deng, Kanfa	M.Sc.	Research assistant	(until 09/17)
Erfkamp Jan	M.Sc.	Research assistant	
Eydam, Agnes	Dipl.-Ing.	Research assistant	
Franke, Daniela	Dr. rer. nat.	Postdoc	
Gulnizkij, Nikolai	Dipl.-Phys.	Research assistant	
Günther, Margarita	PD Dr.-Ing. habil.	Research assistant	
Härtling, Thomas	PD Dr.rer.nat. et Ing. habil.	Research assistant[1]	
Hecker, Dominic	Dr.-Ing.	Research assistant	
Henke, Markus	Dr.-Ing.	Postdoc	
Herbst, Sabine		Laboratory assistant	
Hildisch, Jan	M.Sc.	Research assistant	
Jorsch, Carola	M.Sc.	Research assistant	
Juhrig, André	Dipl.-Ing.	Research assistant	
Junker, Steffen	Dipl.-Ing.	Research assistant	
Kleiner, Anja	Dipl.-Ing.	Research assistant	
Knöfel, Bärbel	Dr.-Ing.	Research assistant	
Kostka, Siegfried	Dipl.-Ing.	Engineer	
Krause, Volker	Dipl.-Ing.	Engineer	
Kroh, Christoph	M.Sc.	Research assistant	
Kühnicke, Elfgard	extraord. Prof.Dr.rer.nat. et Ing.habil.	Lecturer	
Kümmritz, Sebastian	Dipl.-Ing.	Research assistant	
Kuß, Julia	Dr.-Ing.	Research assistant /Course advisor	
Lehmann, Ulrike		Laboratory assistant	
Liebschner, Rocco	M.Sc.	Research assistant	
Nizard, Harry	Dr. rer. nat.	Research assistant	
Norkus, Christian		Laboratory assistant	
Norkus, Volkmar	Dr.-Ing.	Senior researcher	
Ott, Tobias	Dipl.-Ing.	Research assistant	
Rath, Katharina	B.A.	Technical employee	
Rio, Marisa	M.Sc.	PhD student	(until 08/17)
Sandmann, Tobias	Dipl.-Phys.	Research assistant	(until 03/17)
Schattling Maike		Clerical worker	(until 06/17)
Schmidt, Ulrike	Dipl.-Ing.	Research assistant	
Schossig, Marco	Dipl.-Ing.	Research assistant	
Schröter, Anna	Dipl.-Ing.	Research assistant	(until 06/17)
Suchaneck, Gunnar	Dr. rer. nat.	Senior researcher	

[1] Head of the Junior Research Group for optical nanosensorics at Fraunhofer IKTS Dresden

Timmermann, Lukas	Dipl.-Ing.	Research assistant	
Wolf, Carmen	Dr. rer. nat.	Research assistant	(until 08/17)
Wolf, Mario	Dipl.-Ing.	Research assistant	

Guest scientists:

07.08. – 15.08.2017
MSc Uliana Yakhnevych, TU Lemberg (Ukraine)

3. TEACHING AND ADVANCED TRAINING

Most of the study courses offered at TU Dresden in enginerring sciences are still diploma study courses. At the Department of Electrical and Computer Enginnering, this concerns the graduate study courses Electrical Engineering, Information Systems Technology, Mechatronics and Regenerative Energy Systems. Additionally, master courses are offered to facilitate advanced training of Bachelor graduates from other universities and foreign countries at TU Dresden.

Four semesters of basic studies in Electrical Engineering, that are completed with the so-called “Vordiplom” (Preliminary Diploma), are followed by the main studies of a freely selected branch of study, a course work and a diploma thesis at one of the chairs. As a rule, a total of 10 semesters is necessary to obtain the German academic degree „Diplom-Ingenieur“.

The Chair for Solid-State Electronics is mainly focused on the teaching of design and fabrication technology of electronic components and devices based on solid-state effects. Regarding the basic studies of Electrical Engineering, the Solid-State Electronics Laboratory is involved in lectures related to physical basics of electronics (Solid-State Electronics, Nanotechnology and Nanoelectronics) and their use in devices (Sensorics), and to manufacture and application of electronic components and devices (Plasma Technology, Infrared Measurement Technology, Biochemical Sensors). In the areas of ultrasonic sensorics and measurement technology subject-specific lectures are offered to the students.

The huge demand of economy on graduates in engineering sciences, especially in electrical engineering, motivates to provide a more intensive mentoring of in “Fundamentals in Electrical Engineering” freshmen. In order to reduce the dropout without dimishing education requirements, exercise classes are offered in small groups by experienced mentors taking care in rapid formation of an efficient learning style by our new students. Besides the complete mentoring of three lab works for all students of our department and complete mentoring of the course on “Dynamic Networks” for the students of the Information Systems Technology and Industrial Engineering programs, five freshmen exercise classes were supervised in the summer term 2016 and one in the winter term 2016/2017 by IFE personnel.

In particular, the following courses were given during the 2016 summer term and the 2016/2017 winter term:

Training course	Lecturer Lecture/ exercise/ laboratory work (Double hours per week)	User
Introduction to Sensorics (Sensorics I)	Prof. Gerlach, PD Dr. Günther Dr. Landgraf 2/1/0	(2, 3) Compulsory course, (1, 6, 7, 8) Optional course, PhD students
Sensorics II	Prof. Gerlach, PD Dr. Günther, PD Dr. Härtling 2/0/0	(2) Optional course, PhD students
Sensorics - Laboratory work	DI Binder, DI Krause, MSc Kroh, Dr. Norkus, Dr. Suchaneck 0/0/1	(2, 6, 8) Optional course
Biochemical Sensors	PD Dr. Günther 2/1/0	(2) Optional course
Infrared Measurement Technology	PD Dr. Budzier, Dr. Norkus (2/0/1)	(2) Optional course
Solid-State Electronics	Prof. Gerlach; Dr. Suchaneck 2/1/0	(2) Optional course
Nanotechnology and Nanoelectronics	PD Dr. Härtling 2/1/0	(2) Optional course
Plasma Technology	Dr. Frach, Prof. Gerlach 4/2/0	(2) Optional course
Lab work supervision of Computer Engineering II course	PD Dr. Budzier, Dr. Suchaneck 0/0/2	(1) Compulsory course
Lab work supervision of EE course 1	DI Juhrig, DI Junker, DI Kostka Dr. Norkus, DI Ott, 0/0/2	(1, 5, 6, 7, 8) Compulsory course
Lab work supervision of EE course 2	DI Bellmann, DI Kostka, DI Krause, MSc Liebschner, Dr. Norkus, DI Ott, DI Sandmann 0/0/2	(1, 5, 6, 7, 8) Compulsory course
Tutor of Basics of Electrical Engineering	DI Krause, Dr. Suchaneck (0/2/0) in winter term 2016/17	(1, 6) Compulsory course
Tutor of Electrical and Magnetic Fields	Dr. Suchaneck (0/2/0) in summer term 2016	(1) Compulsory course
Tutor of Dynamic Networks course exercises	Prof. Gerlach, PD Dr. Budzier 0/2/0	(5, 8) Compulsory course
Fundamentals of Ultrasound	extraord. Prof. Kühnicke 2/1/0	(2, 3, 4) Optional course, PhD students
Utrasound Sensors and Measurement Techniques	extraord. Prof. Kühnicke 2/0/0	(2, 3, 4) Optional course, PhD students

(1) General study course, Electrical Engineering program; (2) Graduate study course, Microelectronics program; (3) Graduate study course, Precision, Micro- and Medical Engineering program; (4) Graduate study course, Computer Engineering program; (5) Graduate study course, Information Systems Technology program; (6) Graduate Study course, Mechatronics program; (7) General study course, Renewable Energy Systems program(8) General study course, Industrial Engineering program
.

3.2. Advanced Training Course Noncontact Temperature Measurement and Thermal Imaging

Date: October 18st, 2018

Scientific Chairman: Prof. Dr. Gerald Gerlach, TU Dresden
Lecturer: PD Dr.-Ing. Helmut Budzier, TU Dresden
Dr.-Ing. Matthias Krauß, Infratec GmbH, Dresden

Employees in research, development, manufactoring, and in knowlegde-based customer consulting, including also practitioners developing or using IR technologies or planning to apply this innovative technology, decision-makers and customer consultants intending to get an overview on the capabilities and the limits of IR technology.

Required qualification:
Basic knowlegde of physics and electrical engineering acquired by academic studies of natural or engineering sciences or engineering technician qualification including perennial professional experience in measurement technology and sensorics.

Topics:

Introduction and goal
- Infrared measurement techniques: History and future
- Advantages of IR radiation

Radiometric Fundamentals
- Radiation measurement and radiation laws
- IR properties of solids: Emission, absorption, transmission and reflection
- Fundamental law of photometry

Sensors
- Specific parameters
- Thermal sensors
  - Radiation thermocouples
  - Pyroelectric sensors
  - Bolometers
  - Thermal IR imagers
- Photonic sensors
  - Photoconductors
  - Photodiodes
  - Quantum-well sensors
  - Photonic imagers
  - Cooling
- Comparison of thermal and photonic sensors

Applications
- Thermal imagers
- Pyrometer

Cf.: www.ama-weiterbildung.de

4. RESEARCH TOPICS

4.1. Main research topics

A general scheme of the Laboratory including the main research topics is shown in section 1. Main subjects are:

Infrared detectors and infrared measurement technology, pyroelectric infrared sensors:

- Sensor simulation and design
- Sensor technology and material characterization
- Measurement technology for IR single- and multi-element detectors
- Sensor applications in radiation pyrometry, thermal imaging, gas analysis and presence detection
- Radiation-absorbing layers
- IR-emitters

Piezoresistive sensors:

- Fabrication and characterization of pH-value-, solvent- and glucose-sensitive hydrogel films
- Sensor simulation and sensor design
- Measurement technology
- Application to measurement of pH-value, solvent and glucose concentration as well as for protein detection
- Powerless sensor switches (BIZEPS – Bistable Zero-Power Sensors)

Sensoric Polymers:

- Hydrogels with pH-, temperature-, ion- and concentration-dependent swelling behavior
- Imprint and replica plating
- Biocompatibility

Ultrasound Technology:

- Simulation of sound fields with complex geometry
- Transducer optimization
- Development of ultrasound measurement techniques using information from the sound field (non-scanning curvature measurement, simultaneous measurements of velocity and distance, enhancement of resolution)
- Array technology

Functional thin films:

- Electrocaloric layer stacks
- Piezoelectric sensor and actuator layers
- Deposition technology and process development

Modeling and simulation:

- Component and system models
- Network modeling, finite element and finite network modeling
- Coupled simulation
- Application to sensorics

Optical Measurement Technology:

- Sensoric properties of optical nanostructures and nanomaterials
- Sensoric properties of ceramic phosphors
- Opto-electronic microsystems for sensor readout

Large-area deposition of nanocomposites with defined properties:

- Fabrication of nanoparticles by means of gas phase condensation
- Embedding of nanoparticles into thin films by combination of gas phase condensation with other deposition techniques: RF-PECVD, reactive magnetron sputtering
- Nanoparticle materials consisting of metals, alloys and their reactive compounds in matrix materials of inorganic compounds (oxides, nitrides) or functional plasma polymer coatings
- Applications: Optical absorbers, antibacterial coatings of filtration membranes, electrically conducting percolation networks of nanoparticles for sensoric coatings

The chair is involved in the following major projects of the German Research Foundation (Deutsche Forschungsgemeinschaft - DFG):

- Collaborative Research Center/Transregio TRR 39: “High-volume Production-compatible Production Technologies for Light Metal- and Fiber Composite-based Components with Integrated Piezo Sensors and Actuators“ (PT-PIESA), Project C8: “Polarization Determination of Integrated Piezoceramics as Part of Process Control and Non-destructive Device Evaluation” (07/2010 – 06/2018).

- Research Training Group (Graduiertenkolleg) 1865 „Hydrogel-based Microsystems“ (since 10/2013).

- Priority Programme SPP 1599: „Caloric Effects in Ferroic Materials: New Concepts for Cooling“, Project “Electrocaloric Multilayer and Radial Cooling Device Concepts” (10/2012 – 09/2018).

4.2. Research projects

In the following, a short summary of objectives and results of our Laboratory´s research projects are presented. For theses and related references, more comprehensive data is given in Chapters 5 and 6.

Research Training Group 1865/1 "Hydrogel-based microsystems"

Spokesman:	Prof. Dr.-Ing. habil. Gerald Gerlach
Project leaders:	PD Dr.-Ing. habil. Margarita Günther
	Prof. Dr.-Ing. habil. Gerald Gerlach
PhD Students at IFE:	Dipl.-Ing. Christian Bellmann
	Dipl.-Ing. Simon Binder
	M.Sc. Kangfa Deng
	M.Sc. Jan Erfkamp
	Dipl.-Phys. Nikolai Gulnizkij
	M.Sc. Carola Jorsch
	M.Sc. Christoph Kroh
	Dipl.-Ing. Ulrike Schmidt
Postdoc	Dr. rer. nat. Daniela Franke
Funded by:	DFG (German Research Foundation)
Funding period:	01.10.2013 – 31.03.2018

Topics at IFE:

- Zero-power sensor switch. Hydrogels are used as a material for the switching element in energy-autonomous systems. Therefore, the switching hysteresis and the kinetics of the hydrogel are important (Dipl.-Ing. Christian Bellmann, Dipl.-Phys. Nikolai Gulnizkij).
- Force-compensated pH-sensors: A thermally controlled hydrogel actuator generates a counterforce that compensates the swelling pressure of the hydrogel. By this way, relaxation and drift effects are avoided (M.Sc. Kangfa Deng, Dipl.-Ing. Simon Binder).
- Biochemical sensor. Development of a hydrogel-based biochemical sensor with a biocompatible and hermetic encapsulation for in-line process monitoring and detection of specific analyte molecules based on hydrogels with high detection sensitivity (Dipl.-Ing. Ulrike Schmidt).
- Implantable miniaturized sensors for biomedical diagnostics. (M.Sc. Carola Jorsch).
- Development of a piezoresistive bioaffinity sensor based on aptamer-hydrogels for the detection of biomolecules. The detection of the blood coagulation factor thrombin is very important for medical diagnostics and therapies. Therefore, biosensors should be developed based on aptamer-hydrogels which bind to thrombin highly specifically and reversibly (M.Sc. Jan Erfkamp).

- Plasmonic-based fluid sensor with hydrogel transducer. Implementation of parallel, optical measurement of temperature, pH and ethanol content in one sensor head with corresponding sensitive hydrogels, immobilized on a plasmonic sensor surface. For this, fundamental principles of the optical readout of hydrogel-based sensors for the application in the food industry has to be researched (M.Sc. Christoph Kroh).
- Porous hydrogels with improved response time for application in microsystems (Dr. rer. nat. Daniela Franke).

Objectives:
Stimuli-responsive hydrogels, whose reversible swelling process in an aqueous solution depends on the structure and design of the crosslinked polymer, are characterized by a large spectrum of different physical (e.g. temperature, electrical voltage, magnetic field) and chemical parameters (e.g. *pH*-value, analyte concentration in solution). They are promising both for sensor as well as for actuator applications, especially since it has been shown that hydrogels can be integrated for corresponding applications in microsystems. Thus, integrated hydrogel-based sensors and actuators enable cost-effective microsystem solutions with a great functional potential. The aim of the Research Training Group is to further investigate the use of hydrogels for sensor and actuator functions in microsystems based on the fundamental knowledge of the synthesis and physicochemical properties and, thus, to lay the scientific basics for future microsystem applications. For this purpose, within the framework of the interdisciplinary research program of the Research Training Group, special materials and procedures based on the requirements of such applications (relevant functionality, high sensitivity, selectivity and long-term stability, short response times) will be developed and investigated. On the other hand, selected microsystems comprising these materials and methods are being investigated (e.g. long-term stable pressure-compensated *pH* sensors, biochemical sensors, implantable miniaturized sensor systems, powerless sensor switches, chemical transistors, microfluidic synthesis processors).
Related references: [DISS 1-3], [SA 3-4], [3], [5-6], [9], [22-23], [28], [36-37], [69]

DFG Priority Program SPP 1599: Caloric effects in ferroic materials: New concepts for cooling

Project: Electrocaloric multilayer and radial cooling device concepts

Project leader:	Prof. Dr.-Ing. habil. Gerald Gerlach, Dr. rer. nat. Gunnar Suchaneck
Co-workers at IFE:	Dipl.-Ing. Anja Kleiner, M.Sc. Rocco Liebschner
Collaboration:	TU Darmstadt, Institute of Materials Science; University of Duisburg-Essen, Institute for Materials Science; Fraunhofer-Institute for Ceramic Technologies and Systems (IKTS), Dresden; Leibnitz University Hannover, Institute of Assembly Technology
Funded by:	DFG (German Research Foundation)
Funding period:	11/2012 – 10/2018

Objectives/results:

- Development of a technology for the fabrication of multilayer electrocaloric elements by means of reactive sputtering of high-resistive, electrocaloric $(Ba,Ca)(Zr,Ti)O_3$ thin films.
- Evaluation of the expected electrocaloric properties based on determination of the temperature coefficient of the dielectric constant above the Curie temperature.
- Investigation of the electrical breakdown behaviour and degradation in large electric fields.
- Pyroelectric calorimetry of the enthalphy-time dependence during electrical biasing.
- Fabrication and evaluation of the performance of cooling device demonstrators.

Related references: [1], [14-17], [51], [61-62]

Collaborative Research Center/Transregio 39
Production technologies for light metal- and fiber-reinforced composite-based components with integrated piezoceramic sensors and actuators (PT-PIESA)

Project Part C8: Polarization determination of integrated piezoceramics as part of process control and non-destructive device evaluation

Project leader:	Prof. Dr.-Ing. habil. Gerald Gerlach,
Co-workers at IFE:	Dr. rer. nat. Gunnar Suchaneck Dipl.-Ing. Agnes Eydam Dipl.-Ing. Volker Krause
Funded by:	DFG (German Research Foundation)
Funding period:	07/2010 – 06/2018

Objectives/results:
- Design and assembly of a laser pulse measurement set-up for structural compounds comprising integrated piezoceramics.
- Determination of thermal and thermo-mechanical material properties (thermal conductivity, specific heat, thermal expansion coefficient).
- Reconstruction of the polarization profile taking into account noisy signals and uncertainties of material properties.

Related references: [7-8], [24-27], [33], [40], [63]

DFG-Project: Non-invasive, spatial and time-resolved measurement of sound velocities for process control

Project leader:	apl. Prof. Dr. rer. nat. et Ing. habil. Elfgard Kühnicke
Co-workers at IFE:	Dipl.-Ing. Lukas Timmermann
	Dipl.-Ing. Mario Wolf
Funded by:	DFG (German Research Foundation)
Funding period:	11/2013 – 10/2017

Objectives/results:
- Goal: Developement of a non-invasive method for monitioring mixing processes by spatial and time-resolved measurements of the sound velocity using ultrasound without reflectors at known positions.
- Approach: Measurement of time of flight to the focal position from the echo of moving scattering particles.
- Determination of the sound velocity and the focal position by time of flight and a transducer-specific calibration curve.
- Spatially resolved measurement by shifting the focal position of an array, whose elements are exitated with time delays.
- Modelling of sound propagation in media with continuously changing properities, application of integral transforms and of the high-frequency approximation.
- Study of influence of concentration and density of the scattering particles and study of attenuation influence.
- Investigation of the time resolution attainable during spatially resolved measurements.

Related references: [45-46], [65-68]

DFG-Project: Monitoring of temperature and denaturation during hyperthermia treatment using non-invasive, locally and time-resolved ultrasonics

Project leader:	apl. Prof. Dr. rer. nat. et Ing. habil. Elfgard Kühnicke
Co-workers at IFE:	Dipl.-Ing. Lukas Timmermann
	Dipl.-Ing. Mario Wolf
	Dr. rer. nat. Carmen Wolf
	Dr. rer. medic. Anke Burkhardt
Funded by:	DFG (German Research Foundation)
Funding period:	02/2015 – 01/2018

Objectives/results:

- Goal: Development of a non-invasive procedure for space- and time-resolved monitoring of the temperature and the denaturation using both longitudinal and shear waves.
- Concept: Development of a method for monitoring the sound velocity of longitudinal waves evaluating echoes of non-moving scattering particles.
- Additional determination of the shear wave velocity to separate the effect of temperature and denaturation on the sound velocities, quantitative modeling of the denaturation.
- First experiments to determine longitudinal wave velocity using echoes of stationary scattering particles (investigations on tissues).
- First experiments on denaturation of protein, work on phantom fabrication.

Related references: [65]

DFG-Project: Development of advanced imaging techniques and novel segmented high-frequency ultrasound transducers for scanning acoustic microscopes

Project leader:	apl. Prof. Dr. rer. nat. et Ing. habil. Elfgard Kühnicke
	Dr.-Ing. Sylvia Gebhardt, Fraunhofer-IKTS
Co-workers at IFE:	Dipl.-Ing. André Juhrig
	Dipl.-Ing. Sebastian Kümmritz
	Dipl.-Ing. Mario Wolf
	Dr. rer. medic. Anke Burkhardt
Collaboration:	Fraunhofer Institute for Ceramic Technologies and Systems (IKTS)
Funded by:	DFG (German Research Foundation)
Funding period:	03/2016 – 02/2019

Objectives/results:

- Improvement of ultrasound imaging in layered structures with variable and unknown sound velocity.
- Expansion of test scenarios (examination under inclined planes and curved structures).
- Simultaneous inspection in multiple depth (determination of inclination angle of surfaces and interfaces).
- Development of a novel multichannel scanning acoustic microscopy system.

- Development of segmented annular array transducers with a frequency of 40 MHz and a better resolution compared to conventional transducers.
- Providing novel measurement methods and techniques as well as specially structured ultrasound transducers for focussing the sound field and steering the ultrasound beam.
- Improvement of the soft-mold technique for fabrication of small-scaled, spherically curved PZT-polymer composits with an operating frequency of 40MHz.

Related references: [38], [45-46], [55-56], [65-68]

DFG-Project: Noninvasive, simultaneous determination of thicknesses and sound velocities by ultrasound

Project leader:	apl. Prof. Dr. rer. nat. et Ing. habil. Elfgard Kühnicke
Co-workers at IFE:	Dipl.-Ing. Lukas Timmermann Dipl.-Ing. André Juhrig Dipl.-Ing. Mario Wolf Dipl.-Ing. Ulrike Schmidt, Dr. rer. medic. Anke Burkhardt
Collaboration:	Fraunhofer Institute for Ceramic Technologies and Systems (IKTS)
Funded by:	DFG (German Research Foundation)
Funding period:	07/2017 – 07/2020

Objectives/results:

- Goal: Providing a robust measuring technique to determine simultaneously sound velocities and thicknesses of layered structures.
- Simultaneous evaluation of material quality and geometry of the specimen.
- Use of single arrays without additional reflectors for examining specimen accessible only on one side.
- Significant improvement of the accuracy especially for structures with three or more layers.
- Development and qualification of fast simulation algorithms.

Related references: [45-46], [65-68]

DFG-Project: Nanostructured absorber and emitter layers for thermal infrared sensors and radiators (ABSISIS)

Project leader:	Prof. Dr.-Ing. habil. Gerald Gerlach
Co-workers at IFE:	Dr.-Ing. Marco Schossig
	Dipl.-Ing. Tobias Ott
Funded by:	DFG (German Research Foundation)
Funding period:	08/2015 – 07/2018

Objectives/results:

- Deposition of nanostructured absorber and emitter thin films.
- Investigation of the physical (optical, electrical, mechanical, thermal) properties of thin films and, particularly, determination of the layer porosity in dependence on the layer thickness.
- Modeling and simulation of the layer and device properties.
- Fabrication and characterization of infrared sensors with nanostructured absorber layers.
- Fabrication and characterization of thermal infrared emitters with nanostructured emitter layers.

Related references: [39]

DFG-Project: Mesoporous hydrogels from microemulsions and related structures for hydrogel-based piezoresistive sensors (MESOPOR)

Project leader:	Prof. Dr.-Ing. habil. Gerald Gerlach
Co-workers at IFE:	Dr. rer. nat. Daniela Franke
Funded by:	DFG (German Research Foundation)
Funding period:	01/2018 – 12/2019

Objectives/results:

- Fabrication of porous hydrogel layers to improve the response behavior of hydrogel-based sensors.
- Synthesis of porous, pH-sensitive hydrogels.
- Deposition of pH-sensitive polymer surfactant structures.
- Characterization of the porosity by means of different imaging methods.
- Characterization of the swelling behavior during free swelling.
- Fabrication of hydrogel-based piezoresistive sensors and their characterization.

Related references: [9]

Cooperation project: High-performance Center „Functional integration for micro-/nanoelectronics“

Project part: Black-coating absorbers and emitters

Project leader:	Prof. Dr.-Ing. habil. Gerald Gerlach
Co-workers at IFE:	Dr.-Ing. Volkmar Norkus, Dipl.-Ing. Sebastian Kümmritz, Dipl.-Ing. Volker Krause, Ulrike Lehmann, Sabine Herbst
Collaboration:	Fraunhofer-IPMS Dresden
Funded by:	SAB (Development Bank of Saxony)
Funding period:	02/2016 – 12/2017

Objectives/results:

- Development of a CMOS-compatible absorption layer for IR-detectors and IR-emitters.
- Measurement of optical properties of the absorbing layers.
- Layer deposition on 6”-Si-wafers.
- Examination of the influence of technological parameters on the layer properties.
- Examination of layer homogeneity.
- Investigation of absorption layer patterning.

Cooperation project: Development of basics for a fast thermography camera with few pixels (IR-Simple Cam)

Project leader:	Dr.-Ing. Volkmar Norkus
Co-workers at IFE:	Dipl.-Ing. Steffen Junker, Dr.-Ing. Marco Schossig, Dipl.-Ing. Volker Krause, Ulrike Lehmann
Collaboration:	Institute of Electronic Packaging Technology (IAVT) at TU Dresden
Funded by:	SAB (Development Bank of Saxony)
Funding period:	05/2016 – 04/2018

Objectives/results:

- Design and realization of a measurement device for the contactless measurement of the surface temperature on a Si-die.
- Fabrication of special Si-dies.
- Examinations for thermal activation of Si-die and for measurement of the thermal time behavior.
- Specification for the sensors to be developed.
- Metrological characterization of the infrared sensors.

Growth Core project: Biological sensor-actuator systems based on functionalized microorganisms (BioSAM)

Cooperation project 01: High integrated whole-cell sensors for the environment or medical technology (HIGS)

Project part: Investigation and modeling of a whole-cell sensor

Project leader at IFE:	Prof. Dr.-Ing. habil. Gerald Gerlach
Co-workers at IFE:	PD Dr.-Ing. habil. Margarita Günther
Collaboration:	Institute of Genetics (IfG), TU Dresden; Institute for Materials Science (IfWW), TU Dresden; Institute for Technology and Environmental Law (ITUR), TU Dresden; Kurt-Schwabe Institute for Measuring and Sensor Technology e.V., Meinsberg; CiS Research Institute for Micro Sensors GmbH, Erfurt; UMEX GmbH Dresden
Funded by:	BMBF (Federal Ministry of Education and Research)
Funding period:	01/2015 – 12/2017

Objectives/results:

The goal is to investigate and model a whole-cell sensor for the environment or medical technology based on living yeast cells with a controlled morphology change. To reach this goal, the following tasks have to be performed:

- Development of an experimental set-up for the characterization of sensor components.
- Investigation of impacts of the cell immobilization and of the S1-compatible packaging on cell morphology, vitality, expression ability, common radiation characteristics, and change of electrical properties.
- Design of a physical model describing the optical path and the electrical properties of sensor components.
- Derivation of design guidelines for the packaging, excitation, detection, impedimetric electrode structures as well as for the signal processing based on a sensor model.

The concept of a sensor module based on the technological hybrid integration of fluorescence and impedance sensors as well as of components of the S1-compatible packaging for genetically modified yeast cells and their validation in real media will be researched.

Related references: [29], [42], [52]

Cooperation project: Smart infrared measurement and identification systems (SmartIR)

Project part: **Development and calibration of new uncooled IR cameras**

Project leader: Dr.-Ing. habil. Helmut Budzier
Co-workers at IFE: Dr.-Ing. Volkmar Norkus, Dipl.-Ing. Volker Krause, Dipl.-Phys. Tobias Sandmann, Dipl.-Ing. Siegfried Kostka, Christian Norkus
Funded by: SAB
Funding period: 12/2015 – 07/2018

Objectives/results:

- New microbolometer-based systems for the mid infrared radiation range.
- Digital signal processing for microbolometers.
- Calibration of uncooled thermography systems.
- Durable vacuum housing for detectors.

Related references: [19-20], [47]

Cooperation project: Development of miniaturized textile-based sensors for continuous monitoring of chronic wounds (textile-based sensors for wound monitoring)

Project leader: Dr.-Ing. Andreas Nocke (ITM)
Prof. Dr.-Ing. habil. Gerald Gerlach (IFE)
Dipl.-Ing. Sibylle Hanus (TITV)
Project leader at IFE: Prof. Dr.-Ing. habil. Gerald Gerlach
Co-workers at IFE: Dipl.-Ing. Anna Schröter
Collaboration: TU Dresden / Institute of Textile Maschinery and High-Performance Material Technology (ITM); Thüringen-Vogtland Institute for Textile Research e. V. (TITV)
Funded by: AiF (German Federation of Industrial Research Associations)
Funding period: 06/2013 – 02/2017

Objectives/results:

- Development of a textile-based wound monitoring sensor for determining parameters specific to wound healing (e.g. pH value, amount of exudate, concentration of NETs, amount of lactate) as a multi-layer fiber sensor.
- Investigation of sensor properties of impedimetric, platinized and resistive fiber sensors in liquid media compared to thin-film solutions.
- Investigation of stability, biocompatibility and long-term behaviour of sensors for wound monitoring.
- Metrological characterization and modeling of textile-based sensors.
- Development of technological solutions for evaluation of wound data and of a data acquisition system meeting the requirements.

Related references: [59]

Cooperation project: Miniaturized plasmonic sensor system, integration and validation for on-site water analytics concerning anthropogenic pollutants (ANTHROPLAS)

Project part: **Functional coating of nanostructured plasmonic sensor substrates**

Project leader: PD Dr. habil. Thomas Härtling
Collaboration: Fraunhofer-Institute for Ceramic Technologies and Systems (IKTS)
Funded by: BMBF (Federal Ministry of Education and Research)
Funding period: 10/2015 – 09/2018

Objectives/results:

- Development and testing of an on-site water analytics system to be used at water cleaning and sewage plants.
- Transfer of the lab-based surface plasmon resonance (SPR) spectroscopy towards a robust and miniaturized system for field use.
- Demonstration of targeted control of the water cleaning process with optimized consumption of energy and cleaning additives.

Related references: [13]

Cooperation project: Submersible refractive index sensor as technology platform for process and environmental monitoring (TauSenT)

Project part: **Transducer development of pH- and ethanol-sensitive hydrogels as sensitive coating for optical transducers**

Project leader: PD Dr. habil. Thomas Härtling
Collaboration: Fraunhofer-Institute for Ceramic Technologies and Systems (IKTS)
Funded by: BMBF (Federal Ministry of Education and Research)
Funding period: 01/2017 – 12/2019

Objectives/results:

- Development of a multi-sensor platform for detecting of parameters in liquids, especially for refractive index, *pH* and ethanol concentration.
- Adaption of the platform to the needs of the brewing industry.
- Proof-of-concept for monitoring the fermentation in large-volume fermenters.

Cooperation project: Fabrication of SmS_x-targets and deposition of sensoric, high-precision and stable SmS_x semiconducting thin films by means of magnetron sputtering (SmS sputtering)

Project part: **Development of a coating technology for SmS_x layer deposition by magnetron sputtering**

Project leader:	Prof. Dr.-Ing. habil. Gerald Gerlach
Co-workers at IFE:	Dipl.-Phys. Annekatrin Delan Dipl.-Ing. Dominic Hecker
Collaboration:	Sindlhauser Materials GmbH
Funded by:	BMWi (Federal Ministry for Economic Affairs and Energy)/ ZIM cooperation projects
Funding period:	3/2016 – 2/2018

Objectives/results:

- Aim: Development of a manufacturing technology for high-purity, homogeneous targets of SmS_x.
- Deposition of adherent and chemically stable SmSx thin films by magnetron sputtering.
- Improvement of the coating sensitivity and increase of the temperature range of SmS_x coatings by using high-purity materials as well as a vacuum deposition technology.
- Application of SmS films for sensors, e. g. strain gauges.

Cooperation project: Integrated sensorics for power transmission elements in wind power stations (BiSWind)

Project part: **Energie-harvesting by means of piezoelectric thin films**

Project leader:	Prof. Dr.-Ing. habil. Gerald Gerlach
Co-workers at IFE:	Dipl.-Ing. Dominic Hecker Dipl.-Phys. Annekatrin Delan
Collaboration:	Schaeffler Technologies AG & Co. KG, Herzogenaurach; VTD Vakuumtechnik Dresden GmbH, Dresden; Siegert Thinfilm Technology GmbH, Hermsdorf; Schaeffler Engineering GmbH, Werdohl; Micro Systems Engineering GmbH, Berg; Fraunhofer Institute for Organic Electronics, Electron Beam and Plasma Technology (FEP), Dresden; Fraunhofer-Institute for Ceramic Technologies and Systems (IKTS), Dresden; University Bremen, Bremen Institute for Metrology, Automation and Quality Science (BIMAQ); TU Ilmenau, Micromechanical Systems Group; TU Ilmenau, Electronics Technology Group

Funded by: BMWi ((Federal Ministry for Economic Affairs and Energy)
Funding period: 12/2015 - 11/2018

Objectives/results:

- Goal: Development of an autonomous measurement system for condition monitoring based on component-integrated sensors.
- Monitored values: Torque, temperature, vibration and rotation speed.
- Robustness against aging and resistance against (aggressive) media, e.g., cooling agents, lubricants, moisture, de-icing agents.
- Investigation of technologies and concepts to integrate the sensors directly, without adhesive bonds, on the surfaces of the rotational-symmetric components by thin-film and microstructure techniques.
- Focus of this subproject: Development of highly efficient energy harvesters to ensure the power supply of the sensor elements, development of a customized module for energy generation with high stability based on piezoelectric layers, reduction of the defect density of the isolation layers.

ESF-Project: Orientation Platform Research & Practice (OFP)

General Project Manager Prof. Dr.-Ing. habil. Hans-Georg Krauthäuser
Project leader at IFE: Prof. Dr.-Ing. habil. Gerald Gerlach
Co-workers at IFE/Faculty: Dr.-Ing. Julia Kuß
Dipl.-Wirt.-Inf. Daniel Knöfel
Funded by: ESF (European Social Fund)
Funding period: 05/2016 – 04/2018

Objectives/results:

- Increase the intrinsic motivation of students from the first to fourth semester from the participating Departments of Chemistry and Food Chemistry, Electrical and Computer Engineering, Computer Science, Mechanical Engineering and Mathematics to improve study results.
- Provide insights into subject-related research projects during the basic studies.
- Formats at the Department of Electrical and Computer Engineering in 2017:
  - "Firm rally" / Excursions to Wacker AG (18.1.2017), ESG Elektroniksystem- und Logistik-GmbH (24.-25.4.2017; 20.-21.11.2017), PARTZSCH Elektromotoren e.K. (11.5.2017), XENON Automatisierungstechnik GmbH (31.5.2017), Preh Car Connect GmbH (8.11.2017), CLAAS and T-Systems Multimedia Solutions GmbH (8.12.2017)
  - BeING Inside – Interdisciplinary engineering practise (together with the Department of Chemistry and BASF Schwarzheide, 6.-12.6.2017).
  - Workshop “Rookie becomes engineer” (30.8.2017) with BASF Schwarzheide, Cascade Microtech, DAS Environmental Experts, Leadec Industrial Services, Rail Power Systems, SMT Elektronik, Splu Experts, USK Karl Utz Sondermaschinen, and XENON Automatisierungstechnik.
  - Practice Invasion - Application of theoretical foundations for the solution of everyday problems of practice partners (1.12.2017).

Further information: https://tu-dresden.de/deinstudienerfolg/ofp

ESF-Project: Development of online self-assessments (OSA) for selected study programs of the TU Dresden with a special focus on STEM

General project managers:	Prof. Dr.-Ing. habil. Gerald Gerlach, Prof. Dr. Thomas Köhler (Media Centre) apl. Prof. Dr. Carmen Hagemeister (Psychology Department)
Co-workers at IFE/Faculty:	Dr.-Ing. Julia Kuß Dr. rer. medic Anja Abdel-Haq
Funded by:	ESF (European Social Fund)
Funding period:	09/2016 – 08/2018

Objectives/results:

- Developing online self-assessment tests for the Electrical Engineering study program at TU Dresden.
- Accompanying information and counseling offers.
- Matching the individual competencies, interests and expectations of the study-interested and first-year students with the requirements and actual contents of the study program.
- Promote a conscious choice of study branch in order to increase the success of the study and to prevent dropouts.
- Testing of prior technical knowledge and expertise on the basis of problem-oriented tasks.
- The first version of the OSA prototype was created and evaluated with first-year students.

Further information: https://tu-dresden.de/deinstudienerfolg/osa

Marie Curie action: Autonomous soft robots without electronics - ANSWER

Project leader:	Prof. Dr.-Ing. habil. Gerald Gerlach
Co-worker at IFE:	Dr.-Ing. Markus Henke
Funded by:	European Commission
Funding period:	06/2016 – 08/2018

Objectives/results:

- Development of multifunctional dielectric elastomers (DEs) for bionic robots.
- Modeling and simulation of DE actuators, sensors, logic circuits and oscillators.
- Development of bionic robots.

Related references: [11], [31-32]

4.3 Facilities and Equipment

The Solid-State Electronics Labratory is equipped with process facilities which allow us to deal with sophisticated scientific tasks and projects. In detail, the following facilities are available in our laboratories:

Sensor technology laboratory:
- Precision crystal treatment by sawing (Struers), grinding, lapping, and polishing (PM2A, Struers)
- Photolithography
- Wire bonding (type 1419 and 4126, K&S)

Vacuum engineering laboratory:
- Multi-target sputtering system (LS703S, von Ardenne Anlagentechnik)
- Sputter equipment
- Ion beam etching equipment (Microetch 301 A, Veeco)
- PECVD/RIE double chamber tool (*Plasmalab*^{80Plus}, Oxford Plasma Technology)

Plasma technology laboratory:
- Vacuum system for fabrication of nanoparticles and nanocomposite layers
- 60 MHz plasma source for deposition of plasma polymers and inorganic composite layers
- Gas flow sputter source for creation of anorganic nanoparticles
- Vacuum deposition system Pfeiffer PLS570 comprising puls sputtering
- RF-Sputter system Perkin Elmer 2400
- Plasma cleaner (RF and microwave) Plasma Electronics MR300D

Process measurement instruments:
- Scanning surface profile measuring system (Profiler Dektak)
- FT-IR spectrometer (Spectrum 2000, Perkin Elmer)
- Laser interferometer (SP 120, SIOS)
- Dual-beam laser vibrometer (Polytec)
- Ellipsometer Plasmos SD2000,
- Optical contact angle instrumentation DataPhysics OCA20/6

PC-controlled measurement equipment:
- Dielectric and pyroelectric properties of ferroelectric materials
- LIMM (Laser intensity modulation method) setup for the depth-resolved non-invasive determination of polarization in piezo-, pyro- and ferroelectrics
- Characteristic parameters of infrared detectors (single-element and line detectors, focal plane arrays)
- Sample response to pressure changes
- Sample response to humidity and temperature changes
- High-temperature system (Novotherm HT1200) for characterization of electrical properties
- Measurement of amplitude and frequency for resonance frequency determination
- Evaluation of the dynamic behavior of MEMS devices
- Analysis of the thermal and temporal influence on sensors
- Measurement set-up for gas sensor evaluation

IR applications laboratory:

- Blackbody radiators (Mikron M300, DIAS, HGH RCN 300)
- Pyrometers (Heimann, infra sensor, Raytek)
- Line scanner and 2D infrared cameras (DIAS GmbH)
- Thermal vision camera (Inframetrics)
- Climatic exposure test cabinet (mytron WB80KH)

Ultrasound technology:

- Scanning ultrasonic microscope D6000 (10 to 230 MHz)
- One-channel ultrasonic test instrument for non-destructive examination
- Ultrasound field measuring station with x-y-z positioning system
- 8-channel ultrasonic sending-receiving system comprising ADC (125 MS/s sampling rate per channel) for signal analysis
- 10-channel ultrasonic sending-receiving system comprising ADC (500 MS/s sampling rate per channel) for microscopy application (up to 200 MHz)
- Measuring set-up for sound velocity determination in fluids without reference reflectors (one-channel, x-y positioning system, thermostat)
- Ultrasonic annular arrays (3...19 MHz), focussing transducers (8...100 MHz)

CAE laboratory:

- Software: ANSYS, PSpice, Matlab, LabView, Testpoint

5.1. State doctorates

[Habil 1] Melinda Varga: **Wireless Flexible Electrodes for Intraoperative Neuromonitoring**
TU Dresden, Electrical and Computer Engineering Department
Mentor: Prof. Dr.-Ing. habil. Gerald Gerlach

Day of defense: September 18, 2017

An exciting area of future growth in the electronics industry is represented by the development of biomedical electronic systems, devices and instruments that restore health or support emerging biotechnologies. Aging populations as well as constantly increasing healthcare costs raise needs for efficient and reliable biomedical electronic systems in order to treat neurological disorders, replace limbs or complement patient's vital functions.
Neuro-prosthetic devices are electronic devices that can provide input and links to the nervous system and by sending electrical impulses. They can restore various functions such as hearing or vision.
Neural electrodes are an important part of neuro-prosthetic devices as they are capable of interfacing with the nervous system at the cellular level by transducing ionic biological signals to electronic signals. They can be used to localize nerve fibers and to test the function and intact structure of these during surgeries.

5.2. PhD theses

In 2015, 15 doctoral students (including 5 external ones) were supervised by the Chair of Solid-State Electronics. The following PhD theses were successfully defended:

[DISS 1] Markus Klemm: **Acoustic Simulation and Characterization of Capacitive Micromachined Ultrasonic Transducers**
TU Dresden, Electrical and Computer Engineering Department
Supervisor: Prof. Dr.-Ing. habil. Gerald Gerlach

Day of defense: April 10, 2017

The aim of this thesis is the development of simulation and characterization methods for capacitive ultrasonic transducers (CMUT). A nonlinear simulation model for CMUT cells is implemented, which allows to find the best CMUT design by a genetic optimization procedure. For the verification of fabricated CMUTs against simulation results and specification sheets, acoustic measurement procedures for the characterization of CMUT cell designs are developed. They are based on decoupling

the sound field from the individual cell characteristics to measure the send- and receive sensitivity of CMUTs. Another possibility to assess the acoustic characteristics is electrical impedance measurement. A nonlinear analytical model for the electrical impedance of CMUT is introduced for design evaluation. A wafer level test procedure for an end-of-line quality assurance based on electrical impedance measurements closes the loop from simulation to fabricated CMUT. The thesis finishes with ideas for further improving the CMUT technology and measurement procedures.

Publication:
M. Klemm: Acoustic simulation and characterization of capacitive micromachined ultrasonic transducers. Dresdner Beiträge zur Sensorik, Band 66, Dresden: TUDpress 2017.

[DISS 2] Carola Jorsch: **Implantable Hydrogel-based Sensors**
TU Dresden, Faculty of Chemistry and Food Chemistry
Supervisors: Prof. Dr. rer. nat. habil. Brigitte Voit
PD Dr.-Ing. habil. Margarita Günther
Prof. Dr.-Ing. habil. Gerald Gerlach

Day of defense: May 12, 2017

In this work a new class of implantable biochemical sensors with a high sensitivity at physiological *pH* (*pH* 7.4) and glucose (2 – 20 mM) ranges were developed and tested. The glucose-sensitive hydrogel was made of acrylamide and N,N′-methylene-bis(acrylamide) as a crosslinker (AAm/APB/BIS, 80/20/0,75 mol%). The swelling mechanism is based on the reversible interaction of sugar molecules and the boronic acid groups in the hydrogel. Also a *pH* sensitive hydrogel made of 2-(dimethylamino) ethyl methacrylate (DMAEMA), hydroxypropyl-methacrylat (HPMA) and the crosslinker tetraethylene glycol dimethacrylate (TEGDMA) with different molar ratios and geometries was characterized.
The swelling kinetics as well as the diffusion processes of different hydrogels were studied to advance sensitivity, selectivity, reproducibility and response time with respect to physiological parameters (*pH*, pCO_2, glucose). pCO_2 sensors showed promising short response times of about 4 min whereas glucose and *pH* sensors displayed longer response times of several hours in phosphate-buffered saline solution.
The combination of piezoresistive pressure sensors and stimuli-sensitive hydrogels enables a great diversity of detecting analytes as well as miniaturized and implantable sensors for continuous measuremas of physiological parameters. However, to implant the sensors, an encapsulation strategy is needed that secures the electronics as well as ensures the biocompatibility without loss of functionality and flexibility. For this, the devices were coated with parylene C and an additional layer of blockcopolymers composed of polyaminoacid (PAA) and polyethyleneglycol (PEG) blocks synthesized via ring-opening polymerization. The functionalization units are carried out by the PEG blocks whereas the PAA blocks perform as linker molecules onto the activated parylene C surface. After covalent coupling of block

copolymers to the inert polymer the surface characteristics changed and, hence, the cell and blood compatibility was improved. Furthermore, the stealth effect of the outward PEG chains was utilized to reduce the adsorption of proteins like fibronectin or fibrinogen. These proteins play a major role in inflammatory processes, cell adhesion and blood coagulation. The results gave proof that the encapsulation leads to decisively reduced physiological reactions.

[DISS 3] Kangfa Deng: **Force-compensated Hydrogel-based pH Sensors**
TU Dresden, Electrical and Computer Engineering Department

Supervisor: Prof. Dr.-Ing. habil. Gerald Gerlach

Day of defense: August 7, 2017

For conventional open-loop hydrogel-based pH sensors, the sensor performance, like response time and long-term stability, is often limited by the slow cooperative diffusion process of hydrogels. In contrast, sensors using the force compensation approach (called closed-loop sensors) exhibit a faster dynamic response. This sensor concept capitalizes on the fact that a compensation pressure arising from an actuator can suppress the hydrogel's swelling, accelerate the hydrogel's diffusion process and, eventually, improve the sensor's dynamic behaviour. However, this sensor is hard to miniaturize due to the macro-scale pressure actuator. The design rules are not completely clear yet, such as the influence of the controller's parameters and the components' characteristic dimensions on the sensor performance.
To meet these above-mentioned challenges and to further improve the sensor performance, a miniaturized closed-loop sensor is developed. In particular, a microactuator with a high energy density is applied to replace the previous macroscopic actuator; most of the sensor components are manufactured by the microfabrication technology.
To achieve a deep understanding of the force compensation method on hydrogel-based sensors, a system-level simulation, a thermal simulation and a mechanical simulation are conducted, respectively. Those simulation results provide detailed guidelines for the sensor design, such as the key control parameters to ensure system stability and to accelerate the sensor's transient response, the crucial component sizes to obtain the improved temperature homogeneity of hydrogels, the key factors to alleviate the packaging-induced residual stress, etc.
Miniaturized sensor prototypes were tested by considering the transient response, the reproducibility and the transfer characteristics. These sensors exhibit a wide operating *pH* range of 4…10, a maximum sensitivity of -4.4 K/pH, and a maximum reduction of 77% in response time compared to conventional open-loop sensors. Both the simulation and experimental results demonstrate that the sensor performance of such miniaturized sensors can be improved by means of the force compensation approach. The versatility of this approach can be further applied to other bending-plate-based chemical sensors and biosensors.

Publication:
K. Deng: Force-compensated hydrogel-based pH sensors. Dresdner Beiträge zur Sensorik, Band 67, Dresden: TUDpress 2017.

[DISS 4] Christian Bellmann: **Powerless Humidity Threshold Switches**
TU Dresden, Electrical and Computer Engineering Department

Supervisor: Prof. Dr.-Ing. habil. Gerald Gerlach

Day of defense: September 1, 2017

This thesis describes the approach, the dimensioning and the realisation of a zero-power humidity-sensitive threshold switch, which is based on the binary zero-power sensor (BIZEPS) concept. Here, the humidity of the ambient air leads to a swelling of a humidity-sensitive hydrogel as the detection element. In contrast to existing solutions, this swelling provides the energy to trigger mechanically an electrical contact by using the bimorph effect. As long as a defined threshold is not reached, the electrical microcontact remains open. Only after passing the threshold value the switch will be triggered and, hence, the contacts will be closed without any electrical power supply. The threshold can be adjusted by varying the distance of the electrical contacts.
This work was focussed on the realisation of such sensors using the bimorph effect, the proof of concept as well as the investigation of essential parameters influencing the sensor performance. For this, theoretical calculations and experiments were used.
For the humidity-sensitive layer, the hydrogel system poly(vinyl alcohol)/poly(acrylic acid) (PVA/PAA) was chosen. To achieve a sufficiently large and properly directed displacement, the hydrogel layer on top of the silicon plate has to be structured. The related parameters, in particular shape and coverage ratio, have been determined by means of finite element analysis (FEA). For the PVA/PAA layer, the water loading, the glass transition temperature and the complex Young's modulus were determined as a function of the humidity by using a dynamical water vapour analyser and a dynamical mechanical analyser. With this data, the swelling hysteresis and sensitivity were characterised.
The transducer was realised by a mechanically deformable silicon boss structure partially coated with the hydrogel layer. Demonstrators were fabricated, which were used to investigate the response behaviour of the switching process and the interactions between the humidity-sensitive layer and the mechanical silicon system. These experimental results were used to validate the finite element model.

Publication:
C. Bellmann: Leistungslose Feuchteschwellwertschalter. Dresdner Beiträge zur Sensorik, Band 68, Dresden: TUDpress 2017.

5.2. Diploma theses

(Supervisors in brackets)

[DA 1] Daniel Seidel:
Berührungslose Temperaturmessung an miniaturisierten Infrarotstrahlungsquellen hoher Temperatur (Non-contact temperature measurement on miniaturized infrared radiation sources of high temperature)
(Prof. Dr.-Ing. habil. G. Gerlach / PD Dr.-Ing. habil. H. Budzier, Dipl.-Ing. T. Ott)

[DA 2] Hans Liebscher:
Design und Umsetzung einer Messelektronik für die frequenzmodulierte Auswertung eines plasmonischen Fluidsensors (Design and implementation of measuring electronics for the frequency-modulated evaluation of a plasmonic fluid sensor)
(Prof. Dr.-Ing. habil. G. Gerlach / PD Dr. rer. nat. et Ing. habil. T. Härtling)

5.3. Master theses

[MA 1] Meenu Selvaraj:
Electrospray ionization (ESI) deposition of carbon nanotubes (CNTs) under vacuum conditions
(Prof. Dr.-Ing. habil. G. Gerlach / Dr.rer.nat. G. Suchaneck, Dipl.-Ing. D. Hecker)

[MA 2] Panpan Bao:
Entwicklung und Charakterisierung eines geschlossenen mikrophysiologischen Systems für zirkulierende Zellen (Development and characterization of a closed microphysiological system for circulating cells)
(Prof. Dr.-Ing. habil. G. Gerlach / PD Dr.-Ing. habil. M. Günther, Dipl.-Ing. M. Busek [Fraunhofer IWS, Dresden])

[MA 3] Varun Kumar Katepally:
Automatically controlled high-precision heat source
(Prof. Dr.-Ing. habil. G. Gerlach / Dr. M. Seilmayer [HZDR, Rossendorf])

5.4. Study Projects

[SA 1] Silvio Dickert:
Entwurf und Aufbau einer steuerbaren Dosiereinrichtung (Design and assambly of a controllable dosing device)
(apl. Prof. Dr. rer. nat. et Ing. habil. Kühnicke, Dipl.-Ing. A. Juhrig)

[SA 2] Panpan Bao:
Optimierung der Pumpgeometrie von pneumatisch betriebenen Mikropumpen zur Mikroperfusion von adhärenten Zellen (Optimization of the pump geometry of pneumatically operated micropumps for microperfusion of adherent cells)
(Prof. Dr.-Ing. habil. G. Gerlach, Dipl.-Ing. M. Busek [Fraunhofer IWS, Dresden])

[SA 3] Linda Felsberg:
Thermische Regelung eines Drucksensors auf MEMS-Basis (Thermal control of a MEMS-based pressure sensor)
(Prof. Dr.-Ing. habil. G. Gerlach, Dipl.-Ing. S. Binder)

[SA 4] Marcel Gehringer:
Entwicklung eines automatisierten Messplatzes zur Charakterisierung chemischer Sensoren (Development of an automated measuring set-up for the characterization of chemical sensors)
(Prof. Dr.-Ing. habil. G. Gerlach, Dipl.-Ing. S. Binder)

6. PUBLICATIONS

6.1. Book series: Dresden Contributions to Sensorics

The book series „Dresdner Beiträge zur Sensorik“ was founded in 1996 and is edited by G. GERLACH. The aim of this series is to publish outstanding scientific contributions of TU Dresden, especially of those from the Solid-State Electronics Laboratory, to sensor technology. The 64 volumes published so far were continued by four new ones in 2017.

Alexander Tempelhahn: Verschlusslose mikrobolometerbasierte radiometrische Infrarotkameras. (Shutter-less microbolometer-based radiometric IR cameras). Dresdner Beiträge zur Sensorik, vol. 65. Dresden: TUDpress 2017.

Markus Klemm: Acoustic simulation and characterization of capacitive micromachined ultrasonic transducers. Dresdner Beiträge zur Sensorik, vol. 66, Dresden: TUDpress 2017.

Kanfa Deng: Force-compensated hydrogel-based pH sensors. Dresdner Beiträge zur Sensorik, vol. 67, Dresden: TUDpress 2017.

Christian Bellmann: Leistungslose Feuchteschwellwertschalter (Powerless humidity threshold switches). Dresdner Beiträge zur Sensorik, vol. 68, Dresden: TUDpress 2017.

6.2. Book chapters

1. G. Suchaneck, O. Pakhomov, G. Gerlach: Electrocaloric cooling. In: O. Ekren (Ed.): Refrigeration. Chapter 2. Rijeka: InTech 2017. 19-43.

6.3. Papers in journals

2. H. Balke, G. Suchaneck: On the linear coupling of mechanical and magnetic fields in magnetoelectrical composites. AIP Advances 7 (2017) 060901.

3. S. Binder, A. T. Krause, B. Voit, G. Gerlach: Bisensitive hydrogel with volume compensation properties for force compensation sensors. IEEE Sensor Letters 1 (2017) 6, 4501004.

4. C. Cherif, R. Hickmann, A. Nocke, M. Schäfer, K. Röbenack, S. Wießner, G. Gerlach: Development and testing of controlled adaptive fiber-reinforced elastomer composites. Textile Research Journal 88 (2018) 3, 345 - 353.

5. K. Deng, G. Mu, M. Guenther, G. Gerlach: Control of a hydrogel-based thermal actuator in closed-loop configuration. Procedia Engineering 168 (2016), 1504-1508.

6. K. Deng, C. Bellmann, Y. Fu, M. Rohn, M. Guenther, G. Gerlach: Miniaturized force-compensated hydrogel-based pH sensors. Sensors and Actuators B 255 (2018) 3, 3495-3504.

7. A. Eydam, G. Suchaneck, G. Gerlach: Thermal pulse method for non-destructive characterization of integrated piezoelectric transducers. Procedia Engneering 168 (2017) 848-851.

8. A. Eydam, G. Suchaneck, G. Gerlach: Polarisationsbestimmung integrierter Piezokeramiken mittels Wärmeschwingungen und Wärmepulsen. Technisches Messen 84 (2017) S1, S81-S87.

9. D. Franke, S. Binder, G. Gerlach: Performance of fast-responsive, porous cross-linked poly(*N*-isopropylacrylamide) in a piezoresistive microsensor. IEEE Sensor Letters 1 (2017) 6, 1500904.

10. G. Gerlach, R. Tutsch: 18. GMA/ITG-Fachtagung Sensoren und Messsysteme 2016. Editorial and Guest Editorship. Technisches Messen 84 (2017) 6, 371-372.

11. E.-F. M. Henke, S. Schlatter, I. A. Anderson: Soft dielectric elastomer oscillators driving bioinspired robots. Soft Robotics 4 (2017) 4, 353 – 366.

12. M. Rio, S. Bola, R. H. W. Funk, G. Gerlach: Microfluidic biochip for studying cellular response to nonhomogeneous DC electric fields. Procedia Technology 27 (2017), 250-251.

13. N. Steinke, M. Rio, R. Wuchrer, C. Schuster, E. Ljasenko, D. Knopp, G. Gerlach, T. Härtling: Detection of diclofenac molecules by planar and nanostructured plasmonic sensor substrates. Sensors and Actuators B 254 (2017), 749-754.

14. G. Suchaneck, A. S. Starkov, I. A. Starkov, A. I. Dedyk, G. Gerlach: Hysteresis phenomena in relaxor ferroelectrics: consideration of polar nanoregions. Physica Status Solidi B (2017), 1700245.

15. G. Suchaneck, E. Chernova, A. Kleiner, R. Liebschner, L. Jastrabík, D. C. Meyer, G. Gerlach, A. Dejneka: Vacuum-ultraviolet ellipsometry spectra and optical properties of $Ba(Zr,Ti)O_3$ thin films. Thin Solid Films 621 (2017), 58-62.

16. G. Suchaneck, G. Gerlach: Adapting $BaTiO_3$-based relaxor ferroelectrics for electrocaloric application. Ferroelectrics 515 (2017), 1-7.

17. G. Suchaneck, G. Gerlach: The impact of the *P-E* hysteresis on the performance of electrocaloric cooling. Ferroelectrics 516 (2017), 1-7.

6.3. Conference and Workshop Contributions

18. S. Binder, G. Gerlach: Reduktion der Ansprechzeit Hydrogel-basierter Sensoren. In: 13. Dresdner Sensor-Symposium, Dresden, 04.-06.12.2017, DOI 10.5162/13dss2017/P3.05 (http://www.ama-science.org/proceedings/listing/2698).

19. H. Budzier, G. Gerlach: Grenzen der thermischen, räumlichen und zeitlichen Auflösung ungekühlter Thermografiekameras. Temperatur 2017, Berlin, 17./18.05.2017.

20. H. Budzier, G. Gerlach: Grenzen der thermischen, räumlichen und zeitlichen Auflösung ungekühlter Thermografiekameras. Thermographie-Kolloquium 2017, Berlin, 28./29.05.2017.

21. A. Delan, R. Ngoumeni, K. Vondkar, D. Glöß, G. Gerlach: Eigenschaften von Samariumsulfidschichten für Sensoranwendungen. In: 13. Dresdner Sensor-Symposium, Dresden, 04.-06.12.2017, DOI 10.5162/13dss2017/P3.03 (http://www.ama-science.org/proceedings/listing/2698).

22. J. Erfkamp, M. Günther, G. Gerlach: Entwicklung von piezoresistiven Hydrogelsensoren zum Nachweis von Ethanol. In: 13. Dresdner Sensor-Symposium, Dresden, 04.-06.12.2017, DOI 10.5162/13dss2017/P2.04 (http://www.ama-science.org/proceedings/listing/2698).

23. J. Erfkamp, M. Günther, G. Gerlach: Entwicklung eines piezoresistiven Bioaffinitätssensors auf Aptamer-Hydrogel-Basis zum Nachweis von Thrombin. Infotag Aptamere 2017, Frankfurt am Main, 3. April 2017, Abstracts, p.17.

24. A. Eydam, G. Suchaneck, G. Gerlach: Evaluation of integrated piezoelectric transducers by a thermal pulse method. AMEC-2016, the 10th Asian Meeting on Electroceramics, Dec. 04-07, 2016, Taipei (Taiwan), Program and Abstract book, p. 109.

25. A. Eydam, G. Suchaneck, G.Gerlach: Thermal wave and thermal pulse studies of the impact of manufacturing technology on the polarization of piezofiber composites. In: AMA Conferences 2017 with SENSOR and IRS². Nuremberg Exhibition Centre, Germany, 30.05.–01.06.2017. Wunstorf: AMA Service GmbH, 420-423.

26. A. Eydam, G. Suchaneck, G. Gerlach: Influence of the measurement system on the nondestructive pyroelectric evaluation of embedded piezoelectric transducers. IEEE International Symposium on Applications of Ferroelectrics (ISAF), International Workshop on Acoustic Transduction Materials and Devices (IWATMD), Piezoresponse Force Microscopy Workshop (PFM), 7-11 May, 2017, Atlanta, USA, Electronic abstract P76.

27. A. Eydam, G. Suchaneck, G. Gerlach: Polarisationsbestimmung integrierter Piezokeramiken mittels thermischer Wellen und Pulse. AHMT 2017 - 31. Messtechnisches Symposium des Arbeitskreises der Hochschullehrer für Messtechnik, 21.09.-23.09.2017, Clausthal-Zellerfeld.

28. N. Gulnizkij, C. Bellmann, G. Gerlach: Hydrogel-basierte Sensorschalter mit Schalthysterese. In: 13. Dresdner Sensor-Symposium, Dresden, 04.-06.12.2017, DOI 10.5162/13dss2017/1.10 (http://www.ama-science.org/proceedings/listing/2698).

29. M. Günther, G. Gerlach, C. Schirmer, J. Posseckardt, W. Fichtner, M. Mertig, F. Altenkirch, K. Ostermann, A. Schuller, G. Rödel, A. T. Winzer, I. Tobehn-Steinhäuser, M. Schröder, W. Scharff, P. Zimmermann: Kombinierter optisch-impedimetrischer Ganzzellbiosensor. In: 13. Dresdner Sensor-Symposium, Dresden, 04.-06.12.2017, DOI 10.5162/13dss2017/3.7 (http://www.ama-science.org/proceedings/listing/2698).

30. S. Haefner, P. Frank, E. Langer, D. Gruner, U. Schmidt, M. Elstner, G.Gerlach, A. Richter: Chemically controlled micro-pores and nanofilters for separation tasks in 2D and 3D microfluidic systems. RSC Advances 7 (2017). 49279 - 49289.

31. E.-F. M. Henke, K. E. Wilson, I. A. Anderson, Y. Bar-Cohen (Ed.): Entirely soft dielectric elastomer robots. Proceedings of SPIE, 2017, 10163, 101631N.

32. P. K. Illenberger, K. E. Wilson, E.-F. M. Henke, U. K. Madawala, I. A. Anderson: A mathematical model for an integrated self priming dielectric elastomer generator. In: Y. Bar-Cohen (Ed.): Proceedings of SPIE, 2017, 10163, 101630H.

33. K. Hohlfeld, S. Eßlinger, A. Eydam, A. Winkler, T. Weber, M. Gude, N. Modler, G. Gerlach, G. Suchaneck, A. Michaelis, A. Schönecker, S. Gebhardt, P. Neumeister: Effect of the integration of piezoceramic composites into structural components on their poling Condition and polarizability. In: 8th ECCOMAS Thematic Conference on Smart Structures and the 6th International Conference on Smart Materials and Nanotechnology in Engineering – SMN2017, June 5-8, 2017, Madrid (Spain), Electronic abstracts, 349-358.

34. S. Junker, V. Norkus, M. Schaulin, G. Gerlach: In situ-Dianostik der Kontaktstelle ungehäuster Silizium-Leistungshalbleiter mittels Pyrometrie. In: 13. Dresdner Sensor-Symposium, Dresden, 04.-06.12.2017, DOI 10.5162/13dss2017/2.3 (http://www.ama-science.org/proceedings/listing/2698).

35. R. Köhler, D. Wassilew, V. Norkus, M. Schossig, G. Hofmann: Enhanced pyroelectric linear arrays for infrared spectroscopy. In: AMA Conferences 2017 with Sensor and IRS^2, Nuremberg, 30.05.-01.06.2017, Proceedings, AMA Service GmbH 2017. 754-759.

36. C. Kroh, M. Günther, G. Gerlach, T. Härtling: Entwicklung von optisch aktiven Hydrogelsensorelementen zum Nachweis von pH-Wertänderung. In: 13. Dresdner Sensor-Symposium, Dresden, 04.-06.12.2017, DOI 10.5162/13dss2017/P2.02 (http://www.ama-science.org/proceedings/listing/2698).

37. C. Kroh, R. Wuchrer, M. Günther, G. Gerlach, T. Härtling: Hydrogel-based plasmonic sensor system. Nanophotonics and MicroNano Optics 2017, Barcelona, 13.-15.09.2017.

38. S. Kümmritz, A. Juhrig, L. Timmermann, E. Kühnicke: Novel measurement techniques with annular arrays for scanning acoustic microscopy. In: AMA Conferences 2017 with SENSOR and IRS². Nuremberg Exhibition Centre, Germany, 30.05. - 01.06.2017. Wunstorf: AMA Service GmbH, 329-333.

39. T. Ott, M. Schossig, G. Gerlach: Thermal modulation behavior of infrared emitters with cantilevered heating elements. In: AMA Conferences 2017 with SENSOR and IRS². Nuremberg Exhibition Centre, Germany, 30.05. - 01.06.2017. Wunstorf: AMA Service GmbH, 774-778.

40. G. Suchaneck: Thermal wave and thermal pulse methods for the evaluation of embedded piezoceramics. XIth Conference of the Polish Ceramic Society, September 13-17, 2017, Zakopane (Poland), Plenary talk, Book of Abstracts, 17-19.

41. M. Schaulin, S. Junker, V. Norkus, T. Zerna: Beiträge zur in-situ Sensorik für die Inspektion von Kontaktstellen an Leistungshalbleitern. MikroSystemTechnik Kongress, München, 23-25.10.2017, 480 – 482.

42. M. Schröder, C. Schirmer, J. Posseckardt, W. Fichtner, M. Mertig, I. Tobehn-Steinhäuser, S. Herbst, M. Schädel, H. Wünscher, T. Ortlepp, A. Winzer, M. Günther, F.Altenkirch, A. Schuller, G. Rödel, K. Ostermann, U. Soltmann, A. Meyer: Hochintegrierte Ganzzellsensoren für die Umwelt- und Medizintechnik, 13. Dresdner Sensor-Symposium, Dresden, 04.-06.12.2017.

43. A. Tempelhahn, D. Wassililew, H. Budzier, G. Gerlach: Messunsicherheit radiometrischer Infrarotkameras bei shutterloser und shutterbasierter Korrektur. Temperatur 2017, Berlin, 17./18.05.2017.

44. K. E. Wilson, E.-F. M. Henke, G. A. Slipher, I. A. Anderson: Rubbery computing. In: Y. Bar-Cohen (Ed.): Electroactive Polymer Actuators and Devices (EAPAD), Proceedings of SPIE, vol. 10163, 2017. 101632H.

45. M. Wolf, E. Kühnicke: Novel simulation algorithms for developing measuring techniques for multichannel ultrasonic microscopy. In: AMA Conferences 2017 with SENSOR and IRS². Nuremberg Exhibition Centre, Germany, 30.05. – 01.06.2017. Wunstorf: AMA Service GmbH, 579-584.

46. M. Wolf: Transiente Green'sche Funktionen bei ringförmiger Anregung zur verbesserten Modellierung für die Entwicklung neuer Ultraschallmessverfahren. 43. Jahrestagung für Akustik - DAGA 2017, 06.-09.03.2017, Kiel, Proceedings, 987-990.

6.5. Guest lectures (if not included in section 6.3)

47. H. Budzier, G. Gerlach: Grenzen der thermischen, räumlichen und zeitlichen Auflösung ungekühlter Thermografiekameras. Thermografie–Kolloquium 2017, Berlin, 28.-29.09.2017, DGZfP, Kurzfassungen, p. 22.

48. G. Gerlach: Hydrogel-based chemical and biochemical MEMS sensors. King Abdullah University of Science and Technology, Saudi-Arabien, Computer, Electrical and Mathematical Science and Engineering Division, 13.03.2017.

49. G. Gerlach: Hydrogel-based chemical and biochemical MEMS sensors. University of Auckland, New Zealand, Auckland Bioengineering Institute, 04.04.2017.

50. G. Gerlach: Schreiben eines DFG-Forschungsantrags. VDI-Doktorandentag 2017, 19.05.2017, BTU Cottbus.

51. G. Gerlach: Thin film devices for electrocaloric cooling. International Conference on Thin Films (ICTF-17), 13.-17.11.2017, New Delhi (India), Invited talk.

52. M. Günther: Sensormodul basierend auf integrierter Fluoreszenz- und Impedanz-Sensorik. Workshop HIGS, Dresden, 19.05.2017.

53. M. Günther: Untersuchung und Modellierung eines Ganzzellsensors, Workshop HIGS, Erfurt, 20.09.2017.

54. T. Härtling, E. Ljasenko, J. Katzmann, M. Reitzig, C. Schuster, G. Gerlach: Optical measurement of ionizing radiation dose for quality assurance in electron beam sterilization. AMA Conferences 2017 with SENSOR and IRS². Nuremberg Exhibition Centre, Germany, 30.05.–01.06.2017.

55. S. Kümmritz: Schallfeldbasierte Messverfahren. Workshop des Fachausschusses Ultraschall der DEGA e.V. „Schallfeldbasierte Messverfahren - vom Transducer bis zur praktischen Anwendung“, 10.-12.07.2017, Drübeck.

56. S. Kümmritz: Mehrkanalige Ultraschallmikroskopie. 3. Doktorandentreffen “Elektrische Messtechnik”, 27.-29.09.2017, Horn-Bad Meinberg.

57. V. Norkus, V. Krause: Sensoren – Schlüssel zur Umwelt. UNI LIVE, Dresden, 12.01.2017.

58. M. Schossig: Miniaturisierte Infrarotstrahler. Workshop „Mikro- und Nanotechnologien für die angewandte Spektroskopie“. Dresden, 17.10.2017.

59. A. Schröter, G. Gerlach: Impedanzsensoren für das Wundmonitoring. Workshop „Mikrosystemtechniken für medizinische Anwendungen“. 10.05.2017, CiS Forschungsinstitut für Mikrosensorik, Erfurt.

60. A.S. Starkov, I.A. Starkov, O.V. Pakhomov, I.L. Mylnikov, A.I. Dedyk, G. Suchaneck, G. Gerlach: Hysteresis phenomena in relaxor ferroelectrics: consideration of polar nano-regions. International Workshop on Hysteresis in Magnetocaloric, Electrocaloric and Elastocaloric Refrigeration, 07.-10.02.2017, Dresden, Germany, Electronic Abstracts, p. 32.

61. G. Suchaneck: Electrocaloric refrigerators – physical fundamentals, theoretical limits, device prototypes. ITMO National Research University (ITMO University), St. Petersburg (Russia), 13.03.2017.

62. G. Suchaneck: A new application of relaxor ferroelectrics: Electrocaloric cooling. International Conference on Oxide Materials for Electronics Engineering – Fabrication, Properties and Application – OMEE 2017, 29.05.-02.06.2017, Lviv (Ukraine), Electronic Abstracts, p.194.

63. G. Suchaneck, A. Eydam, G. Gerlach: Application of the thermal pulse method for nondestructive evaluation of embedded piezoelectric transducers. International Conference on Oxide Materials for Electronics Engineering – Fabrication, Properties and Application – OMEE 2017, 29.05.-02.06.2017, Lviv (Ukraine), Electronics Abstracts, p.122.

64. A. Tempelhahn, D. Wassilew, H. Budzier, G. Gerlach: Limitations of shutter-less compensation for microbolometer-based infrared cameras. AMA Conferences 2017 with SENSOR and IRS². Nuremberg Exhibition Centre, Germany, 30.05.–01.06.2017.

65. L. Timmermann: Hochflexibles, mehrkanaliges Ultraschall-Messsystem. Workshop des Fachausschusses Ultraschall der DEGA e.V. „Schallfeldbasierte Messverfahren - vom Transducer bis zur praktischen Anwendung“, 10.-12.07.2017, Drübeck.

66. L. Timmermann: Highly flexible multichannel measuring system for piezocomposite annular-arrays. International Symposium on Piezocomposite Applications ISPA 2017, 13.-15.09.2017, Dresden.

67. M. Wolf: Gleichzeitige Messung von Schallgeschwindigkeiten und Abständen zur Charakterisierung von Fluiden und Festkörpern. 23. DEGA-Workshop „Physikalische Akustik“ 19.-20.10.2017, Bad Honnef.

68. M. Wolf: Transiente Green'sche Funktionen bei ringförmiger Anregung in mehrschichtigen Medien zur verbesserten Modellierung für die Entwicklung neuer Ultraschallmessverfahren. Workshop des Fachausschusses Ultraschall der DEGA e.V. „Schallfeldbasierte Messverfahren - vom Transducer bis zur praktischen Anwendung“, 10.-12.07.2017, Drübeck.

6.6. Patents

69. S. Binder, G. Gerlach: Sensor zur Messung der Konzentration von Komponenten in einer Flüssigkeit nach dem Kraftkompensationsprinzip mit vereinfachtem Aufbau (Sensor for measuring the concentration of components in a liquid by means of the force compensation principle with a simplified construction). Patent application 2017.

70. M. Schossig, T. Ott: Mikroheizleiter (Micro-heating conductor). PCT application PCT/EP2017/068942, 2017.

71. J. Hildisch: Verfahren und Einrichtung zur Herstellung einer Fluor-dotierten SiO_2-Schicht mittels reaktiv geregelten Magnetron-Pulssputterns (Method and device for producing a fluorine-doped SiO_2 layer by means of reactively controlled magnetron pulse sputtering). Patent application, 2017.

7. GUEST LECTURES

Also in the last year we could welcome numerous guest speakers at our Laboratory. For that, significant financial assistance was provided by the Research Training Group „Hydrogel-based microsystems“ (GRK 1865) enabling in most cases the financement of the travel costs and lectures.

18.05.2017	Dr. Matthias Meier (IMTEK Freiburg)	Microfluidic and biological engineering for stem cell research
11.06. - 15.06.2017	Prof. Dirk Kuckling (University of Paderborn)	Synthesis of hydrogels with tailored properties
11.06. - 15.06.2017	Dr. Thomas Härtling (Fraunhofer-Institute for Ceramic Technologies and Systems)	Hydrogel-based sensors with plasmonic transducer
11.06. - 15.06.2017	Frank Bunge (University of Bremen)	Porous hydrogel membranes used in mikrofluidics
11.06. - 15.06.2017	Prof. Thomas Hellweg (University of Bielefeld)	Intelligent micro- und nanogels at surfaces
11.06. - 15.06.2017	Prof. Walter Richtering (RWTH Aachen)	Functional microgels
11.06. - 15.06.2017	Prof. Mathias Ulbricht (University of Duisburg-Essen)	Polymer-based membranes with stimuli-responsive barrier and surface properties
16.06.2017	Prof. Iain Anderson (Auckland Bioengineering Institute, New Zealand)	Making sensors, robots and generators soft
10.08.2017	MSc Uliana Yakhnevych TU Lemberg (Ukraine)	Diffusion of dopants in piezoelectric $LiNbO_3$ crystal during high-temperature treatment in the presence of metal ions
18.09.2017	Dr. Julia Körner (University of Utah, USA)	Coupled oscillators as a novel sensor for cantilever-magnetometry

Dipl.-Ing. Martin Schmidt:
Diploma Thesis Award 2016 of the Solid-State Elctronics Laboratory, jountliy donated by DIAS Infrared GmbH Dresden and HEIMANN Sensor GmbH Dresden, for his diploma thesis „Modernization and enhancement of an electron-beam precision welding machine“.

Dr.-Ing. Julia Körner:
„AHMT Award 2016” donated by the Working Group of University Professors for Measurement Technology e.V., for her PhD thesis „Coupled oscillators as a novel sensor for cantilever magnetometry“.

Dipl.-Ing. Simon Binder:
Scholarship holder of the German Academic Scholarship Foundation.

M.Sc. Kangfa Deng:
2016 Chinese Government Award for Outstanding Self-financed Students Abroad, China Scholarship Council.

Daniel Knöfel, Gerald Gerlach, Rainer Jordan:
Teaching Recognition Award 2017 for the introduction of the interdisciplinary project week „**BE**ING **Inside**“ as a joint activity of the Faculty of Chemistry and the Faculty of Electrical and Computer Engineering for a realistic simulation of an industrial project in order to improve the students skills for practical implementation of theoretically acquired knowledge.

Dr.-Ing. Marco Schossig, Dipl.-Ing. Tobias Ott, Dipl.-Ing. Anja Kleiner; Dipl.-Wirt.-Ing. Benjamin Buchbach:
IQ Innovation Award Central Germany 2017: 2nd place in the Cluster Energy/ Environment/ Solar Economy.

Dr.-Ing. Marco Schossig, Dipl.-Ing. Tobias Ott, Dipl.-Ing. Anja Kleiner; Dipl.-Wirt.-Ing. Benjamin Buchbach:
Science4Life Venture Cup 2017: 6th place in the business plan phase.

Dr.-Ing. E.-F. Markus Henke:
3rd price in the “EAP in action” session at the SPIE Smart Structures and Devices/NDE Conference 2017, Portland, Oregon, USA.

Prof. Dr.-Ing. habil. G. Gerlach:

- Member of the DFG Senate and the DFG Steering Committee (until 07/2017).
- Member of the DFG Senate Committee and Granting Committee for Collaborative Research Centers (until 12/2017).
- Member of the Department Council of the Electrical and Computer Engineering Department.
- Dean of Educational Affairs of the Electrical and Computer Engineering Department.
- Member of the Executive Board of the Graduate Academy at TU Dresden.
- Chairman of the DTV – the German Association of Technical-Scientific Societies.
- Member of the Advisory Board of the Deutscher Zukunftspreis Award headed by the German Federal President (until 2017).
- Member of the VDE Committee „VDE Ring of Honor“.
- Associated Editor-in-Chief, IEEE Sensors Journal.
- Chief Editor, JSSS Journal of Sensors and Sensor Systems.
- Member of the Scientific Board of the Journal „Technisches Messen“.
- Member of the Scientific Board of the Journal „Pomiary Automatyka Kontrola”, Poland.
- Member of the Advisory Board of the Fraunhofer Institutes for Electron Beam and Plasma Technology (FEP) and for Photonic Microsystems (IPMS), Dresden.
- Member of the Advisory Board of the High-performance Center for Functional Integration of Micro- and Nanoelectronics in Dresden and Chemnitz.
- Member of the Advisory Board of the Kurt-Schwabe-Institute for Measuring and Sensor Technology e.V., Meinsberg.
- Member of the Advisory Board of the Kurt-Schwabe Foundation.
- Member of the Scientific Advisory Board of the CiS Research Institute for Microsensorics, Erfurt.
- Chairman of the Working Group “Microelectronics”, VDE Dresden Branch.
- Member of the Executive Board of the fair SENSOR+TEST-Messtechnikmesse Nuremberg.
- Godfather of TU Dresden at the Martin-Andersen-Nexö Secondary School (MANOS), Dresden.

apl. Prof. Dr. rer. nat. et Ing.habil. E. Kühnicke

- Member of IEEE, German Society for Non-Destructive Testing (DGZfP), Technology in Medicine and Health Care (TIMUG), German Acoustical Society (DEGA), and the German Association of University Professors.
- Vice-chairman of the Working Group “University Professors” of the DGZfP.
- Member of the Working Group “Ultrasound” of the DGZfP, Member of the sub-committtees "Models and Theories for Ultrasound Testing" and "Phased Array".
- Referee of the scientific journals “Journal of the Acoustical Society of America (JASA)” and “Journal of Wave Motion”.
- Referee of the Alexander von Humboldt Foundation and the German Research Foundation (DFG).

PD Dr.-Ing. habil. H. Budzier
- Person-in-charge for literature of the IFE.
- Network administrator of the IFE.
- Referee of the scientific journals „IEEE Sensors Journal“ and „Journal of Sensors and Sensor Systems (JSSS)“.

PD Dr.-Ing. Margarita Günther:

- Member of the Executive Board of the Research Training Group “Hydrogel-based Microsystems”.

Dr.-Ing. Thomas Härtling:

- Member of the AMA Science Board.
- Permanent guest of the Working Group of University Professors for Measurement Technology (AHMT).

Dr. rer. nat. G. Suchaneck

- Member of the Center of Applied Photonics at the Institute of Applied Photophysics at TU Dresden.
- Member of the Working Group “Plasma Technology” of the Association of German Engineers (VDI), http://www.akplasma.org.
- Project referee of the Horizon 2020 program of the European Union.
- Project referee of the Southeast European Research Area Network (SEE-ERA.NET).
- Project referee for the subject "Thin film technology" of the Grant Agency, Academy of Science of the Czech Republic.
- Referee of the scientific journals “Applied Physics Letters”, “Advanced Functional Materials”, “Advanced Science”, “Journal of Materials Chemistry C”, “Journal Vacuum Science and Technology B”, “Applied Ceramic Technology”, “Acta Physica Polonia”, “Chemical Science”, “Journal Alloys and Compounds”.
- Deputy member of the Employee Committee of the TU Dresden.

10.1. IRS² 2017, 15th International Conference on Infrared Sensors & Systems

Place: Nuremberg, Exhibition Centre, Germany

Date: May 30-31, 2017

Chairman: G. Gerlach, TU Dresden

Conference Committee:

G. Hofmann	DIAS Infrared GmbH, Dresden
J. Hollandt	Physikalisch-Technische Bundesanstalt, Berlin
U. Kienitz	Optris GmbH, Berlin
W. Minkina	University of Technology Czestochowa, Poland
F.-H. Möllmann	FH Brandenburg
R. Riesenberg	Institut für Photonische Technologien e. V., Jena
J. Schieferdecker	Heimann Sensor GmbH, Dresden
H. Schlemmer	Airbus DS Optronics GmbH, Oberkochen
M. Tacke	Fraunhofer-Institut IOSB, Ettlingen
M. Walther	Fraunhofer-Institut IAF, Freiburg
J. Wendler	AIM Infrarot Module GmbH, Heilbronn

Topics:

- Infrared Sensors and Arrays
- Spectroscopy and Gas Analysis
- Thermal Imaging
- Recent Developments in IR Industry
- Poster Session

Further information: www.ama-science.org

10.2. SENSOR 2017

Place: Nuremberg, Exhibition Centre, Germany

Date: May 30 – June 1, 2017

Chairmen: R. Lerch, University of Erlangen-Nürnberg
G. Gerlach, TU Dresden

Topics:

A Sensor principles
A1 Mechanical sensors
A2 Flow sensors
A3 Dimensional measurement
A4 Ultrasonic sensors
A5 Microacoustic sensors
A6 Magnetic sensors
A7 Impedance sensors
A8 Gas sensors
A9 Temperature and humidity sensors
A10 Chemosensors
A11 Biosensors
A12 Embedded sensors
A13 Sensor-actuator systems
A14 Optical sensors

B Sensor technology
B1 Sensor design
B2 Numerical simulation of sensors
B3 Sensor materials
B4 MEMS-technology
B5 Micro-Nano-Integration
B6 Packaging
B7 Materials
B8 Thin films
B9 Sensor production
B10 Sensor reliability
B11 Calibration and testing

C Sensor electronics and communication
C1 Sensor electronics
C2 Sensor networks
C3 Wireless sensors
C4 Sensor communication
C5 Energy harvesting
C6 Measuring systems
C7 Embedded systems
C8 Self-monitoring and diagnosis

D Application
D1 Medical measuring technology
D2 Ambient-assisted living
D3 Process-measuring technology
D4 Automotive
D5 Sensors in energy technology
D6 Production technology
D7 Security technology
D8 Smart home
D9 Household technology

Further information: www.ama-science.org

10.3. 13. Dresdner Sensor-Symposium

Place: Hotel Elbflorenz Dresden

Date: 04.-06. Dezember 2017

Organization: DECHEMA e. V.

Topics:
- Sensor technology I, II
- Process measurement
- Environmental sensorics
- Biomedical sensorics

Further information: www.dechema.de/DSS13.html; www.ama-science.org

11. CONFERENCES 2018

11.1. Focus session „Smart Hydrogels and Hydrogel-based Devices“ at the DFG Spring Meeting 2018

Place: Berlin

Date: March 11-16, 2018

Organisation: Prof. Thomas Hellweg (University of Bielefeld)
Prof. Walter Richtering (RTWH Aachen)
Prof. Gerald Gerlach (TU Dresden)

11.2. Sensors & Measuring Systems 2018

Place: Congress Center Nuremberg-West, Germany

Date: June, 26-27, 2018

Chairmen: L. Reindl, University of Freiburg
J. Wöllenstein, Fraunhofer IPM

Organization: Information Technology Society (ITG)

Sessions:

Topics:

A	**Sensors**
A1	Sensors for mechanical values, force, pressure and inertial sensors
A2	Temperature sensors
A3	Magnetic sensors
A4	Optical and infrared sensors
A5	Microwave, terahertz and radar sensors
A6	Acoustic and resonant sensors
A7	Chemical and biosensors
A8	MEMS and nanosensors
A9	Sensors for extreme environmental conditions
A10	Sensory-active materials
A11	Polymer and elastic sensor materials

B Measurement systems

B1 Measurement uncertainty
B2 Modelling, simulation and condition monitoring
B3 Networked digital measuring systems, sensor data fusion, signal processing
B4 Self-X-concepts (self-validation, self-calibration, etc.) and reliability
B5 Micro- and nano-measuring systems
B6 Wireless sensor systems and networks, self-powered sensors
B7 Sensors for smart grids
B8 Bioanalytical measuring systems
B9 Imaging / tomographic techniques
B10 Optical measurement techniques and laser measuring systems
B11 Impedance spectroscopy
B12 3D printed sensors

C: Applications

C1 Sensors for the internet of things
C2 Industrial engineering, manufactoring engineering
C3 Power engineering and renewable energies
C4 Process engineering, process automation
C5 Environmental measuring technology
C6 Materials testing and –characterization
C7 Structural monitoring
C8 Safety engineering, safety und security
C9 Agriculture and forestry
C10 Autonomous systems, robotics
C11 Automotive and rail engineering
C12 Aerospace engineering
C13 Transport and product logistics

Further information: www.ama-science.org

12. VDE WORKING GROUP MICROELECTRONICS

12.1. Mission

Since 2003 the Working Group “Microelectronics” has been providing a panel of experience exchange focused on the area of microelectronics to engineers, technical staff, scientists and students.

The settlement of world-leading suppliers of computer processors, random access memories, silicon wafers and MEMS-devices in the Dresden as well as the success of traditional and new companies manufacturing microelectronics devices and silicon sensors made Saxony with its center Dresden to Europe’s capitol in microelectronics.

The Working Group meetings are arranged mostly directly at enterprises or research institutes. Thereby, the objectives of the working group are:

- to establish a panel of free-of-charge education by interesting presentations which mirror new developments in all areas of microelectronics,
- to open possibilities to get to know colleagues and enterprises of the Dresden microelectronics environment,
- to arrange contacts between companies, universities and research institutions and their students.

The topics of the Working Group are spread over all areas of microelectronics:

- Wafer fabrication,
- Technology,
- Installation engineering,
- Electronic devices and their design,
- Applications (e. g. sensorics, automotive, biotech, medical engineering).

Prof. Dr.-Ing. habil. G. Gerlach has been chairman of the Working Group since the beginning.

12.2. Meetings 2017

January 11, 2017	„Organic photovoltaics at Heliatek GmbH Dresden“ Heliatek GmbH, Dresden
August 09, 2017	„Vakuum coating technologies at CREVATC – Creative Vakuumbeschichtung GmbH“ CREVATC GmbH, Dresden

The planned meetings are available in the communications of the VDE Dresden Branch at www.vde-dresden.de.