TECHNISCHE UNIVERSITÄT DRESDEN

ELECTRICAL AND COMPUTER ENGINEERING DEPARTMENT

SOLID-STATE ELECTRONICS LABORATORY

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

2020 ANNUAL REPORT

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Solid-State Electronics Laboratory:

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Dear friends and partners of our Institute,

The year 2020 was certainly one of the most eventful years in the history of our Institute.
In March, the COVID-19 virus presented IFE with a particular challenge when the entire research and attendance lecture program at TU Dresden had to be halted. We were relieved when we were able to resume laboratory operations in April, albeit with severe restrictions. On the one hand, this made it possible to continue working on our research projects, and on the other hand, our doctoral students were finally able to pursue their doctoral projects again.

Due to the circumstances, we have made our teaching offerings virtual for the most part in the summer semester 2020. Only some lab experiments could be conducted in presence again in early summer. As expected, the efforts for the conception, preparation and implementation of the digital courses were enormous, but we were nevertheless able to offer the complete range of courses. We were very pleased that the results in the summer semester exams were as good as in previous years. Fortunately, in the beginning of the current winter semester it was possible that some of our courses could be offered in presence again.

A second major change then occurred in August, when the Institute's long-time director, Prof. Gerald Gerlach, took over as Vice-Rector Academic Affairs at the TU Dresden. Since this is a full-time position, he is now on leave from his previous position for the five-year term. Nevertheless, he will remain spokesman for the Research Training Group "Hydrogel-based Microsystems" until the end of the funding in 2022 and will also continue to supervise the current doctoral students.

The duties of the Professorship for Solid-state Electronics have now been taken over by PD Dr. Helmut Budzier. In the coming year, the professorship will be filled again with a slightly different dedication for "Biomedical Sensor Technology". In addition, we hope that the Professorship for "Coating Technologies in Electronics" will soon be filled at IFE, with which the position as Director of the Fraunhofer Institute for Organic Electronics, Electron Beam and Plasma Technology (FEP) is also associated.

Due to the special conditions of 2020, the number of conference visits and publications in this report is, as expected, extraordinarily small. On the other hand, in 2020 at IFE a total of six young PhD students from our Institute (Simon Binder, Jan Erfkamp, Agnes Eydam, Sebastian Kümmritz, Tobias Ott) or external PhD students (Markus Krenkel/Fraunhofer IPMS) were able to successfully defend their dissertations - a record number in the history of IFE. We are pleased that our IFE continues to offer our young scientists a good environment for their scientific work and qualification.

Once again, we would like to take this opportunity to emphasize that all of our results would not have been possible without our IFE staff. Many thanks for that! However, much is also based on the close cooperation with our partners and colleagues from other institutes and institutions and on the support of the staff of our university administration and the funding institutions. We thank them all just as much!

PD Dr.-Ing. habil. Helmut Budzier

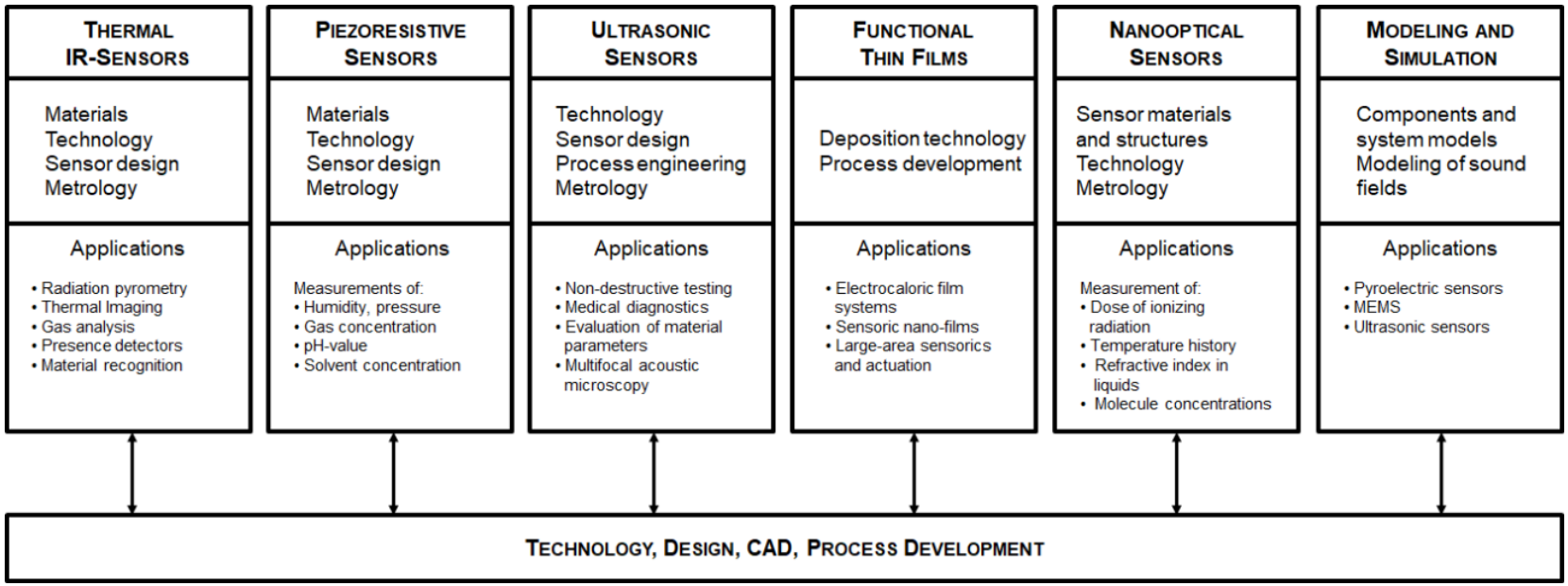
Prof. Dr.-Ing. habil. Gerald Gerlach

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 and several chairs of the Institute of Circuits and Systems, 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 and other functionalities,
- 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 inaugurated in 2013 is operated together with the Institute of Electronic Packaging Technology (IAVT), the Centre for Microtechnical Manufacturing (ZmP) and the Chair of Microsystems at the Institute of Semiconductors and Microsystems (IHM).


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
• Multifocal acoustic microscopy
FUNCTIONAL THIN FILMS
Deposition technology
Process development
Applications
• Electrocaloric film systems
• Sensoric nano-films
• Large-area sensorics and actuation
NANOOPTICAL 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

2. STAFF

Chair for Solid-State Electronics:

PD Dr.-Ing. habil. Helmut Budzier		Acting Head (since 08/20)
Prof. Dr.-Ing. habil. Gerald Gerlach		Professor (on leave since 08/20)
Beyer, Julia	Dipl.-Ing.	Research assistant
Binder, Simon	Dipl.-Ing.	Research assistant (until 06/20)
Collasch, Heike		Secretary
Delan, Annekatrin	Dipl.-Phys.	Research assistant
Eydam, Agnes	Dipl.-Ing.	Research assistant
Franke, Daniela	Dr. rer. nat.	Postdoc
Gulnizkij, Nikolai	Dipl.-Phys.	Research assistant (until 04/20)
Günther, Margarita	PD Dr.-Ing.	Research assistant
Härtling, Thomas	PD Dr.rer.nat. et Ing. habil.	Research assistant[1]
Herbst, Sabine		Laboratory assistant
Kostka, Siegfried	Dipl.-Ing.	Engineer
Krause, Volker	Dipl.-Ing.	Engineer for teaching/research
Kühnicke, Elfgard	Prof. Dr.rer.nat. et Ing.habil.	Lecturer
Kupsch, Christian	Dr.-Ing.	Research assistant (since 04/20)
Kuß, Julia	Dr.-Ing.	Research assistant /Course advisor
Lehmann, Ulrike		Laboratory assistant
Liebscher, Hans	Dipl.-Ing.	Research assistant (since 01/20)
Leipner, Emanuel	Dipl.-Ing.	Research assistant (since 08/20)
Malberg, Insa	Dipl.-Jur.	Program coordinator
Mieting, Alice	M.Sc.	Research assistant
Nizard, Harry	Dr. rer. nat.	Research assistant
Norkus, Christian		Laboratory assistant
Norkus, Volkmar	Dr.-Ing.	Senior researcher
Pfeil, Sascha	Dipl.-Ing.	Research assistant
Rath, Katharina	B.A.	Technical employee
Schreiber, Stefan, Marco	Dipl.-Ing.	Research assistant
Suchaneck, Gunnar	Dr. rer. nat.	Senior researcher
Wang, Sitao	Dipl.-Ing.	Research assistant
Wolf, Mario	Dipl.-Ing.	Research assistant

Guest Scientists:

Nikolay Kalanda	14.02. - 02.04.2020
Alexander Petrov	14.02. - 02.04.2020

[1] Head of the Research Group for Optical Nanosensors at Fraunhofer IKTS Dresden

3. TEACHING AND ADVANCED TRAINING

Most of the study courses offered at TU Dresden in enginerring sciences are still diploma study programs. At the department of Electrical Enginnering and Information technology, this concerns the graduate study programs Electrical Engineering, Information Systems Technology, Mechatronics and Regenerative Energy Systems. Additionally, master programs 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 and their use in devices (Sensorics), manufacture and application of electronic components and devices (Microtechnology, and Infrared Measurement Technology). In the area of ultrasonic sensorics and measurement technology subject-specific lectures are offered to the students.

The huge demand of industry on graduates in engineering sciences, especially in electrical engineering, motivates our Department to provide a more intensive mentoring of “Fundamentals in Electrical Engineering” freshmen. In order to reduce the dropout without dimishing education requirements, exercise classes are carried out in small groups by experienced mentors taking care in rapid formation of an efficient learning style by our new students. Besides the complete supervision of two lab experiments for all students of our Department and the complete supervision of “Dynamic networks” for the students for the courses Information Systems Technology and Industrial Engineering, two freshman exercise classes were supervised in summer term 2020 and one class in the winter term 2020/2021 by IFE personnel.

In particular, the following courses were given during the 2020 summer term and the 2020/2021 winter term:

Training course	Lecturer Lecture/ exercise/ laboratory work (Double hours per week)	Required/elective course
Introduction to Sensorics (Sensorics I)	Prof. Gerlach 2/1/0	(2, 3) Required course (1, 6, 7, 8), elective Optional course, PhD students
Sensorics-laboratory work	DI Schreiber, DI Krause, DI Beyer, Dr. Norkus, Dr. Suchaneck 0/0/1	(2, 6, 8) Elective course
Solid State Electronics	Prof. Gerlach; Dr. Suchaneck 2/1/0	(2) Elective course
Nanotechnology and Nanoelectronics	Prof. Härtling 2/1/0	(2) Elective course
Lab work supervision of Computer Engineering II course	PD Dr. Budzier, Dr. Suchaneck 0/0/2	(1) Required course
Lab work supervision of Circuitry course 1	DI Kostka, Dr. Eydam, DI Liebscher Dr. Norkus 0/0/2	(1, 5, 6, 7, 8) Required course
Lab work supervision of Circuitry course 2	DI Kostka, Dr. Eydam, DI Liebscher DI Pfeil 0/0/2	(1, 5, 6, 7, 8) Required course
Tutor of Basics of Electrical Engineering	Dr. Kuß (0/2/0)	(6) Required course
Tutor of Electrical and magnetic fields	Dr. Suchaneck, DI Krause (0/2/0)	(1, 6) Required course
Tutor of Dynamic Networks course exercises	PD Dr. Budzier 0/2/0	(5) Required course
Fundamentals of Ultrasound	Prof. Kühnicke 2/1/0	(3, 4) Elective course, PhD students
Utrasound Sensors and Measurement Techniques	Prof. Kühnicke 2/0/0	(3, 4) Elective course, PhD students

(1) General study course, Electrical Engineering program; (2) Graduate study course, Microelectronics program; (3) Graduate study course, Equipment, Micro- and Medical Technology 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 (8) General study course, Industrial Engineering.

4. RESEARCH TOPICS

4.1. Main research topics

A general scheme of the Laboratory including the main research topics is shown in section 1. Here, the following topics are in the focus:

Infrared detectors and infrared measurement technology, pyroelectric infrared sensors:

- Sensor technology and material characterization
- Sensor simulation and design
- 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-emitter

Piezoresistive sensors:

- Fabrication and characterization of pH-value-, glucose-, ammonia-, ethanol- and urea -sensitive hydrogel films
- Sensor simulation and sensor design
- Measurement technology
- 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

Elastomer-based actuators:

- Soft robotics
- Fiber-elastomer composites
- Electroactive Polymers (EAP)
- Function generation by means of integrated textile materials
- Textile EAPs

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
- Multifocal acoustic microscopy

Functional thin films

- Electrocaloric layer stacks
- Ferromagnetic thin films
- 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 was and is involved in the following major projects of the German Research Foundation (Deutsche Forschungsgemeinschaft - DFG):

- Research Training Group (Graduiertenkolleg) 1865 „Hydrogel-based micro-systems“ (10/2013-09/2022).

- Research Training Group (Graduiertenkolleg) 2430 „Interactive fiber-elastomer-composites“ (since 11/2018)

4.2. Research projects

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

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

Spokesman:	Prof. Dr.-Ing. habil. Gerald Gerlach
Principal investigators:	PD Dr.-Ing. habil. Margarita Günther Prof. Dr.-Ing. habil. Gerald Gerlach
PhD students at IFE:	Dipl.-Ing. Julia Beyer Dipl.-Ing. Simon Binder M.Sc. Jan Erfkamp Dipl.-Phys. Nikolai Gulnizkij M.Sc. Alice Mieting Dipl-Ing. Stefan Schreiber Dipl.-Ing. Sitao Wang
Postdoc	Dr. rer. nat. Daniela Franke
Funded by:	DFG (German Research Foundation)
Funding period:	01.04.2018 – 30.09.2022
Topics at IFE:	- Zero-power sensor switch. Hydrogels are used as a material for the switching element in self-sufficient energy systems. Therefore, the switching hysteresis and the kinetics of the hydrogel are important. (Dipl.-Phys. Nikolai Gulnizkij) - Force-compensated pH-sensors: A bisensitive hydrogel combines sensory and actuator properties. The thermally controllable actuator function compensates the source pressure of the gel after a change in the measured variable. This prevents relaxation and drift effects and shortens the response time. (Dipl.-Ing. Simon Binder, Dipl-Ing. Stefan Schreiber) - Plasmonic-based fluid sensor with hydrogel-transducer: Application of different stimuli-responsive hydrogels in an optical sensor system for the simultaneous detection of different fluid parameters (e.g. ethanol or glucose concentration, pH value, etc.). (Dipl.-Ing. Julia Beyer) - Hydrogel composites for the detection of heavy metals in aquatic systems: Hydrogels are specifically functionalized with iron oxide particles and tested in piezoresistive sensors. The characterization of the magnetic and electrical properties of the hydrogel composites enables their application for other sensor and actuator principles. (M.Sc. Alice Mieting)

- Smart hydrogels for analyte detection in gases: Investigation of the gas absorption capabilities of different hydrogels. Modification of hydrogels with additional nanofillers, e.g. graphene oxide and Mxene to further improve the gas absorption ability. This also includes the development of a suitable detection option for the swelling degree of the hydrogel, so that finally there is a complete sensor concept for the analyte detection in gases.
  (Dipl.-Ing. Sitao Wang).
- 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), 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 sensory and actoric 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 numerically and experimentally. 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 3], [DISS 5], [4], [7], [9-10], [20]

Research Training Group 2430/1 “I-FEV Interactive Fiber-Elastomer-Composites”

Spokesman:	Prof. Dr.-Ing. habil. Dipl.-Wirt.-Ing. Chokri Cherif
Principal investigator at IFE:	Prof. Dr.-Ing. habil. Gerald Gerlach
PhD Students at IFE:	Dipl.-Ing. Sascha Pfeil Dipl.-Ing. Johannes Mersch
Funded by:	DFG (German Research Foundation)
Funding period:	01.11.2018 – 31.04.2023
Topics at IFE:	- TP7: Modeling and metrological evaluation of adaptive components in I-FRCs using electro-mechanical network models. - TP8: Electro-mechanical modeling and metrological evaluation of I-FRCs with material-integrated sensors.

Objectives:

This Research Training Group (RTG) mainly focusses on interactive fiber-rubber composites (I-FRC), including structurally integrated smart actuator and sensor networks

- to specifically adjust component stiffness, and
- to achieve steplessly adjustable, complex deformation patterns with almost unlimited freedom of deformation, long deformation paths, and high actuating power with sensorial feedback,
- as well as on in-depth scientific analyses of structural and material behavior on multiple scales.

Due to their high intrinsic deformation capacity, I-FRC have become a promising approach to generate controllably deformable components with specifically adjustable properties. As actutors they can respond to changes in their environment (e.g. temperature and magnetic fields) and ensure precise as well as long-term stable functionalities by means of regulation and control circuits that are based on and linked to sensorial condition monitoring. However, these functionalities require innovative component designs and cross-scale modelling, simulation, integration into system conceptions, experimental research, and material developments. These I-FRC are a new class of materials offering new properties. For example, the development of I-FRC allows for the reversible and contactless adjustment of geometric degrees of deformation for mechanical components; thus, various environmental requirements can be met in a quick and precise manner. This advantage makes them suitable for numerous fields of application, such as mechanical engineering, vehicle construction, robotics, architecture, orthotics, and prosthetics. Potential applications include their use in systems for precise gripping and transportation processes, such as hand prostheses, automated lids, seals, shapeable membranes, and adaptive flaps for rotor blades of wind turbines as well as trim tabs for ground- and watercraft to effectively reduce flow separation.

The objective of the Research Training Group is the simulation-based development of smart material combinations and gradations for self-sufficient I-FRC with structurally integrated actuator and sensor networks to actively and locally adjust component stiffness. I-FRC are also suitable to achieve controlled complex deformation patterns. Of particular interest will be characteristics in terms of large deformation capabilities,

high frequencies, and large actuating powers due to sensorial feedback in consideration of thermal and mechanical stress, while simultaneously reducing weight and enhancing compactness.
Related references: [11], [13-14]

DFG-Project: Development of Advanced Imaging Techniques and Novel Segmented High-frequency Ultrasound Transducers for Scanning Acoustic Microscopes

Principal investigators:	Prof. Dr. rer. nat. et Ing. habil. Elfgard Kühnicke Dr.-Ing. Sylvia Gebhardt, Fraunhofer IKTS
Co-worker at IFE:	Dipl.-Ing. Mario Wolf
Collaboration:	Fraunhofer Institute for Ceramic Technologies and Systems (IKTS)
Funded by:	DFG (German Research Foundation)
Funding period:	03/2016 – 01/2020

Objectives/results:

- Completion of the project
- Further development of the 16-channel ultrasonic microscopy system: motorized positioning system; quasi-simultaneous, phase-delayed generation of pulses on each of the 16 channels as well as reception, amplification and filtering separately for each channel; delay times from 0 to 1.6 µs with a step size of 0.25 ns; 100 MHz bandwidth, script-based surface for controlling the positioning system, the pulser and the measurement cards, more flexible selection of the scan area and an adaptation of the parameters of the pulser and measurement card to the measurement situation.
- Further development of the soft-mold process for the production of 1-3 piezoelectric composites, so that ultrasonic transducers with frequencies up to at least 40 MHz can be produced, downsizing of the rod layout and significant shifting of interfering resonances to higher frequencies.
  Functionality of the developed transducers: after electrical contacting, application of a damping body and housing. The desired center frequencies of around 20 MHz or 40 MHz have signal shapes and bandwidths comparable to conventionally manufactured PZT transducers.

DFG-Project: Noninvasive, Simultaneous Determination of Thicknesses and Sound Velocities by means of Ultrasound

Principal investigator:	Prof. Dr. rer. nat. et Ing. habil. Elfgard Kühnicke
Co-workers at IFE:	Dipl.-Ing. Emanuel Leipner, Dr.-Ing. Christian Kupsch, Dipl.-Ing. Mario Wolf
Funded by:	DFG (German Research Foundation)
Funding period:	07/2017 – 07/2021

Objectives/results:

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

Related references: [Diss 4]

DFG-Project: Simultaneous Determination of Layer Thickness and Sound Velocity for Multifocal Ultrasonic Microscopy

Principal investigators:	Prof. Dr. rer. nat. et Ing. habil. Elfgard Kühnicke
	Dr. Peter Czurratis
Co-workers at IFE:	Dipl.-Ing. Emanuel Leipner, Dr.-Ing. Christian Kupsch, Dipl.-Ing. Mario Wolf
Collaboration:	PVA TePla Analytical Systems GmbH (PVA), Westhausen
Funded by:	DFG (German Research Foundation)
Funding period:	05/2020 – 04/2023

Objectives/results:

- Provision of a multifocal ultrasound microscopy system for simultaneous examination at different depths for analysis frequencies from 100 to approx. 250 MHz
- Sound field-based design of the system consisting of an annular array and an aspherical lens
- Development of high-precision focusing electronics
- Provision of algorithms for processing high-frequency signals
- Software for the provision of high-resolution quasi-3D images

Related references: [Diss 4]

DFG-Project: Mesoporous Hydrogels from Microemulsions and Related Structures for Hydrogel-based Piezoresistive Sensors (MESOPOR)

Principal investigator: Prof. Dr.-Ing. habil. Gerald Gerlach
Co-worker at IFE: Dr. rer. nat. Daniela Franke
Funded by: DFG (German Research Foundation)
Funding period: 01/2018 – 03/2021

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: [8]

DFG-Project: Quartz Oscillator Sensors for High-resolution Detection of Infrared Radiation

Principal investigators: Prof. Dr.-Ing. habil. Gerald Gerlach
Dr.-Ing. Volkmar Norkus
Co-workers at IFE: Dr.-Ing. Agnes Eydam, Dipl.-Ing. Siegfried Kostka, Dipl.-Ing. Volker Krause, Sabine Herbst, Christian Norkus, Ulrike Lehmann
Funded by: DFG (German Research Foundation)
Funding period: 10/2020 – 09/2023

Objectives/results:

- Sensor concept and draft of the basic sensor layout.
- Modeling and simulation of the sensor geometry.
- Damping behavior of the structured quartz wafers.
- Thermal model of the sensor.
- Thinning of quartz crystal wafers by ion beam etching.

EU Project: Physical Principles of the Creation of Novel SPINtronic Materials on the Base of MULTIlayered Metal-Oxide FILMs for Magnetic Sensors and MRAM (SPINMULTIFILM)

Principal investigator at IFE:	Prof. Dr.-Ing. habil. Gerald Gerlach
Co-worker at IFE:	Dr. rer. nat. Gunnar Suchaneck
Collaboration:	University Aveiro, Department of Physics (Portugal); Vrije Universiteit Brussel, Department MACH "Materials in Chemistry" (Belgium); Kaunas University of Technology; Institute of Materials Science (Lithuania); SSPA Scientific and Practical Materials Research Center of NAS of Belarus, Division of Cryogenic Research (Belarus); Institute of Magnetism of the National Academy of Science of Ukraine and the Ministry of Education and Science of Ukraine, Laboratory of Nanocrystalline Structures (Ukraine); WMT Wire Machine Technology (Israel)
Funded by:	EU (Horizon 2020) - Marie Skłodowska-Curie Research and Innovation Staff Exchange (MSCA-RISE)
Funding period:	01/2018 – 12/2021

Objectives/results:

- Synthesis of metal-oxide compounds on the base of Sr_2FeMoO_6.
- Creation of nanoheterostructures with dielectric interlayers.
- Characterization and simulation of nanoheterostructures.
- Prototyping of spintronic devices.
- Knowledge exchange and outreach activities.

Related references: [3], [6], [18-19], [22-23], [26-27]

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**

Principal investigator:	Hon.-Prof. 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 detection of parameters in liquids, especially refractive index, *pH* and ethanol concentration.
- Adaption of the platform to the needs of the brewing industry.
- Proof-of-concept for monitoring of fermentation in large volume fermenters.

Cooperation project: High-frequency Adjustable, Textile-based Actuator Structures for Complex Fiber-Plastic Composite Kinematics with High Degrees of Deformation (HoTexA)

Principal investigators:	Prof. Dr.-Ing. habil. Dipl.-Wirt. Ing. Chokri Cherif (ITM) Dr.-Ing. Sven Wießner (IPF) Prof. Dr.-Ing. habil. Gerald Gerlach (IFE)
Co-worker at IFE:	Dipl.-Ing. Hans Liebscher
Collaboration:	Institute of Textile Machinery and High Performance Materials (ITM), TU Dresden; Leibniz Institute of Polymer Research Dresden e. V. (IPF);
Funded by:	AiF (German Federation of Industrial Research Associations), Forschungskuratorium Textil e.V. (Confederation of the German Textile and Fashion Industry)
Funding period:	10/2019 – 03/2022

Objectives/results:

- Development of functionalized, textile reinforcement structures with structure-integrated, textile-based, high-frequency actuators for geometrically complex fiber-plastic composite applications with fast adaptive adjustment potential.
- Targeted design, development and testing of new textile actuators based on dielectric elastomers.
- Implementation as coaxial conductor in hybrid construction with highly stretchable, long-term stable, textile-based internal and external electrodes.
- Automated actuator integration in the area forming process (e.g. through weaving or knitting).

Cooperation project: Advanced Free-form Coating of Flat and 3-dimensional Substrates (3D-FF)

Project part: Model Development for Simulation, Calculation and Layer Property Optimization in Free-form Coating

Principal investigator:	Prof. Dr.-Ing. habil. Gerald Gerlach
Co-worker at IFE:	Dipl.-Phys. Annekatrin Delan
Collaboration:	Fraunhofer Institute for Organic Electronics, Electron Beam and Plasma Technolog (FEP); AIS Automation Dresden GmbH; LSA GmbH; Von Ardenne GmbH; SeeReal Technologies GmbH; TU Dresden, Institute of Numerical Mathematics (INM)
Funded by:	SAB (Development Bank of Saxony)
Funding period:	08/2019 - 02/2022

Objectives/results:

- Goal: high-precision free-form coating of large substrates, i.e. realization of very defined layer thickness profiles on 3D surfaces.
- Functional coatings in efficient, automated coating processes.
- Combination of new concepts for coating systems and innovative substrate motion modules, a highly productive precision coating technology and a software platform that provides a continuous data chain from the layer thickness simulation to the coating process and automatic system control.
- Model development for simulation, calculation and optimization of the layer properties in the free-form coating.

Cooperation project: Development of an Inline Sensor for Permanent Control and Assessment of the Training and Development of Biofilms in Water-bearing Piping Systems (Inline Biofilm Sensor)

Project part: **Development of the Sensor Head and Deposition of the Sensor Layers**

Principal investigator:	Prof. Dr.-Ing. habil. Gerald Gerlach
Co-workers at IFE:	PD Dr.-Ing. habil. Margarita Günther Dipl.-Phys. Annekatrin Delan Dr.-Ing. Harry Nizard
Collaboration:	-4H- Jena engineering GmbH; 3Faktur GmbH, Jena; Institute for Bioprocessing and Analytical Measurement Techniques e.V., Heiligenstadt
Funded by:	Project of the Central Innovation Programme for small and medium-sized enterprises (SMEs) by BMWi (Federal Ministry for Economic Affairs and Energy) and AiF (German Federation of Industrial Research Associations)
Funding period:	11/2019 – 10/2021

Objectives/results:

- Goal: Development of an inline biofilm sensor for the detection of bacterial contamination in water-bearing systems for drinking water supply and technical water circuits by means of impedance measurement.
- Enrichment and detection of biofilms on substrate traps.
- Definition of threshold values for the indication of in tolerable bacterial contamination at an early stage.

Cooperation project: Spectral Multi-channel Pyroelectric High-detectivity Sensors in SMD Housing (PYRO-SMD)

Principal investigator:	Dr.-Ing. Volkmar Norkus
Co-workers at IFE:	Dipl.-Ing. Agnes Eydam, Dipl.-Ing. Siegfried Kostka, Dipl.-Ing. Volker Krause, Sabine Herbst, Ulrike Lehmann, Christian Norkus
Collaboration:	DIAS Infrared GmbH, Dresden
Funded by:	AiF
Funding period:	10/2018 – 09/2020

Objectives/results:

- Concept, sensor layout and design.
- Fabrication of pyroelectric $LiTaO_3$ chips.
- Assembly of functional models and metrological characterization of the spectrally multi-channel sensors,
- Design and implementation of a measuring station for noise measurement and spike detection.
- Noise measurements on JFETs.

Cooperation project: Pilot Line for the Next Generation of Highly Integrated Microelectronics (PIN3S)

Principal investigator:	Prof. Dr.-Ing. habil. Gerald Gerlach
Co-workers at IFE:	Dr. rer. nat. Gunnar Suchaneck Dipl.-Ing. Simon Binder
Collaboration and funding:	Fraunhofer Institute for Organic Electronics, Electron Beam and Plasma Technolog (FEP), Dresden
Funding period:	10/2019 - 12/2020

Objectives/results:

- Fabrication of piezoelectric thin films on pre-terated glass substrates.

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

General Project Manager	M.A. Christiane Einmahl, ZiLL (Center for Interdisciplinary Learning and Teaching)
Principal investigator 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 – 12/2023

Objectives/results:

- Increase the intrinsic motivation of students from the first to fourth semester from the participating faculties Chemistry and Food Chemistry, Electrical Engineering

and Information Technology, Computer Science, Mechanical Engineering and Mathematics to improve study results.
- Provide insights into subject-related research projects during the basic studies.
- Formats at the Faculty of Electrical and Computer Engineering: 2019:
  - "Firm rallye": Excursion for students to CERN (1.-4.3.2020).
  - Agile Meets Lego, Department of Computer Science, 24.01.2020
  - BeING Inside – Interdisciplinary engineering practise (together with the Faculty of Business and Economics) for TUD students and eleventh grade students (12.-16.10.2020).
  - Workshop: profi.com Security (15.01.2020).
  - Workshop: Career prospects at FRoSTA (21.10.2020).

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

ESF-Project: Development of Online Self-assessments (OSA) for the Mechatronics Study Program and OPA optimization for the Electrical Engineering Study Program at TU Dresden.

General Project Manager:	Dr. phil. Christiane Einmahl, ZiLL (Center for Interdisciplinary Learning and Teaching)
Principal investigators:	Prof. Dr.-Ing. habil. Gerald Gerlach, Prof. Dr. Thomas Köhler (Media Centre) Prof. Dr. Petra Kemter-Hofmann (Faculty of Psychology)
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 – 12/2021

Objectives/results:
- Developing online self-assessment tests for the study program in Electrical Engineering at TU Dresden.
- Matching the individual competencies, interests and expectations of the study-interested and first-year students with the requirements and actual content of the study program.
- Promote a conscious choice of study branch in order to increase the success of the study and to prevent drop-outs.
- Testing prior technical knowledge and expertise on the basis of problem-oriented specialized tasks.
- The OSA prototype is available in OPAL (Online platform for academic teaching and learning) and was evaluated with first-year students.

Further information: https://tu-dresden.de/deinstudienerfolg/osa
Related references: [1]

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 (scia Mill 150, scia Systems GmbH, Microetch 301A, 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 compo-site 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)
- Pyrometer (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. PhD theses

In 2020, 14 doctoral students (including 6 external ones) were supervised by the Chair of Solid-State Electronics. The following PhD theses were successfully defended:

[DISS 1] Marcel Krenkel: **Mechanically Coupled Microelectromechanical Ultrasonic Transducers**

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

Day of defence: March 16, 2020

This thesis investigates a novel air-coupled capacitive micromachined ultrasonic transducer (CMUT) theoretically and experimentally. These transducers can be used for air-coupled medical, industrial and end consumer applications, e.g. distance measurements, gesture recognition and gas flow measurements.
Former CMUTs have a limited sound pressure transmitted and restrictions regarding the geometrical parameters for transducers with resonance frequencies below 1 MHz. The CMUT concept presented separates the acoustically transmitting and receiving surface from the electrostatic transducer. A larger deflection of transducers based on a sacrificial release technology with resonance frequencies below 1 MHz and increased design freedom is desired with the objective of an improved transmit and receive sensitivity.
The theoretical investigations were performed with numerical and analytical simulation models. Both a macroscopic demonstrator and micromechanical structures were utilized to validate the device concept. Therefore, the devices were characterized by means of electrical impedance and optical vibrometer measurements.
Results of the theoretical analyses are design rules, a numerical substructure model and a multiphysical equivalent-circuit model, which help designing these CMUTs with mechanically coupled plate actuators. Experimental results show that calculated and measured eigenfrequencies of small geometrical structures are in good agreement. For large lateral dimensions, deviations are not negligible due to unconsidered physical effects. Similarly, the bandwidth of a transducer calculated with the developed models is too small in comparison to measured bandwidths.
The impedance measurements as well as the vibrometer measurements verify mechanical vibrations of the transducers with resonance frequencies from 400 kHz to 900 kHz. Furthermore, the vibrometer results show an improvement of the fill factor and, thus, a potential increase of transmit and receive sensitivity.

Publication:
M. Krenkel: Mechanisch gekoppelte mikroelektromechanische Ultraschallwandler. Dresdner Beiträge zur Sensorik, Band 76. Dresden: TUDpress 2020.
ISBN: 978-3-95908-204-4.

[DISS 2] Tobias Ott: **High-performance Infrared Emitters with Glancing-angle Vapor-deposited Emission Layers**

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

Day of defence: April 22, 2020

Human progress is inconceivable without the use of gases or gas mixtures, e.g. for energy generation in gas-fired power plants or as anaesthetic gases in medicine. Such and other gases, however, are usually not perceptible to the human senses and can be very harmful to health or the environment. For these reasons, gas sensors are needed to monitor our environment and ensure safety in our daily life. Small, long-lasting and energy-saving gas sensors that accurately detect flammable, toxic or environmentally harmful gases are essential for widespread use.
A frequently used method for measuring gases and gas mixtures is based on the principle of the absorption of infrared radiation. The resolution of the infrared detector and the intensity of the radiation generated by the radiation source are decisive for the gas concentration that a gas sensor can resolve. Therefore, high demands are placed on the performance of infrared radiation sources.
In the present work, an infrared emitter is designed which achieves high radiant power through the use of high-melting metals and the glancing angle deposition (GLAD) of porous films on heating conductors.
The concept for the design of the infrared emitter comprises a self-supporting, planar heating element made of a thin tantalum foil, which ensures a high operating temperature and a defined radiation characteristic. A two-dimensional heating conductor improves the energy efficiency without impairing the mechanical stability of the heating element too much. The radiation output is greatly increased by depositing porous tantalum thin films on the heating element using the GLAD process. For this purpose, the influence of the deposition parameters of the GLAD process on the optical properties of these porous layers is investigated.
The novel tantalum emitter is compared to commercially available thin film emitters, which are used as the standard radiation sources in gas measuring devices. The tantalum emitter is superior to these radiation sources in the important parameters of operating temperature, radiant power and radiant energy efficiency. The greatest advantage of thin film emitters is their high modulation capability, which is essential for fast measurements with small measurement deviations. In terms of this characteristic value, the tantalum emitter can be regarded as equivalent to the thin-film emitters.
Due to the excellent scalability of the heating element area, miniaturized, cost-effective and powerful infrared emitters based on the new concept can be developed in a further step, opening up a wide field of new potential applications in mobile gas and substance analysis.

Publication:
T. Ott: Leistungsstarke Infrarotemitter mit schrägwinkelbedampften Emissionsschichten. Dresdner Beiträge zur Sensorik, Band 77. Dresden: TUDpress 2020.
ISBN: 978-3-95908-211-2.

[DISS 3] Jan Erfkamp: **Development of Piezoresistive Chemo- and Biosensors Based on Stimuli-responsive Hydrogels**

Supervisors: Prof. Dr.-Ing. habil. Gerald Gerlach
PD Dr.-Ing. habil. Margarita Günther

Day of defence: May 22, 2020

Without reliable chemical and biosensors, the monitoring of process parameters in the chemical and biotechnological industry, the detection of lowest analyte concentrations in biomedical analysis or the trace analysis of pollutants would be inconceivable. New sensor materials such as stimuli-responsive hydrogels are becoming increasingly important in the development of new chemical and biochemical sensors. Hydrogels are „intelligent“ hydrophilic polymer networks that can swell and deswell depending on certain stimuli. In combination with piezoresistive pressure sensors, the resulting swelling pressure is then transformed into a measurable output voltage.
In this work, novel stimuli-responsive hydrogels for the detection of ethanol in alcoholic beverages as well as for the detection of dissolved ammonia and urea for biotechnological processes are presented. After the controlled synthesis and functionalization of the gels, the swelling properties in free swelling will be investigated. The focus of the characterization is on sensor-relevant parameters such as the swelling behaviour in dependence on the given stimulus. In the next step, piezoresistive hydrogel sensors are synthesized and measured. Important sensor properties such as the sensitive measuring range, detection limits or cross-sensitivities are to be investigated in detail and the sensor concepts evaluated with regard to their application potential.

Publication:
J. Erfkamp: Entwicklung von piezoresistiven Chemo- und Biosensoren auf der Basis von stimuliresponsiven Hydrogelen. Dresdner Beiträge zur Sensorik, Band 78. Dresden: TUDpress 2020. ISBN: 978-3-95908-212-9.

[DISS 4] Sebastian Kümmritz: **Ultrasonic Measuring Method with Annular Arrays for Improved Determination of Material Properties and Characterization of Inclusions**

Supervisor: Prof. Dr. rer. nat. et Ing. habil. Elfgard Kühnicke

Day of defence: June 25, 2020

Ultrasound annular arrays provide a wide variety of application possibilities for the nondestructive evaluation. They enable, for example, a point-like focusing along the acoustic axis of the array. In comparison to line or matrix arrays only a few elements are needed for good focusing. In addition, the element patterning of the array enables the evaluation of the sound pressure distribution on the transducer surface. This opens up opportunities for the development of novel measurement techniques for a better imaging, for material characterization or for the characterization of inclusions.

This thesis presents two novel measurement techniques as well as further approaches based on ultrasound annular arrays. The first method enables the simultaneous determination of thicknesses and sound velocities in layered structures. For that the effect is used, that the amplitude of a sound echo depends on the location of the reflecting interface in the sound field of the probe. The amplitude gets maximal, if the interface is located in the focus. The time-delayed excitation of the elements of an annular array allows to vary the focus position. A geometric model is used to calculate the delay times required for focusing. The sound velocity and the thickness of the considered layer are variable parameters in this model. The amplitude of the focused signal is evaluated while these parameters are varied systematically. The set of parameters where the amplitude of the focused signal is highest, leads to the correct sound velocity and thickness in the layer.
The second technique developed in this thesis allows the classification of inclusions. The idea is to evaluate the sound pressure distribution of the echo signals on the transducer surface. The shape of the sound field of a wave reflected from an inclusion depends on the shape and size of the inclusion. A sphere reflects an incident pressure wave omnidirectionally, whereby the reflection on a circular disk is very directed. The evaluation of the sound pressure distribution on the array thus enables the inclusion to be classified as curved or flat.
Such a classification is necessary for the selection of a suitable method for size estimation. Methods established for flat reflectors like the half-value-method or the DSG-method can be used. However, applying these methods on spherical inclusions leads to strongly faulty results. Therefore, several approaches for the size determination of spherical inclusions are discussed.
A novel approach for the sizing of spherical inclusions, which is presented in this thesis, is based on the evaluation of the reflected sound field. The shape of the reflected sound field is nearly independent of the sphere size, provided that the vertex of the sphere is located in the acoustic axis of the transducer. However, a small displacement of the acoustic axis beside the vertex of the sphere leads to noticeably differences in the reflected sound field of spheres depending on the sphere size. This effect can be used for the development of a technique for sphere size determination.

Publication:
S. Kümmritz: Ultraschallmessverfahren mit Annular Arrays zur verbesserten Bestimmung von Materialeigenschaften und Charakterisierung von Einschlüssen. Dresdner Beiträge zur Sensorik, Band 79. Dresden: TUDpress 2020.
ISBN: 978-3-95908-218-1.

[DISS 5] Simon Binder: **Force-compensated Chemical Sensors Based on Bisensitive Hydrogels**

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

Day of defence: September 9, 2020

The measurement of substances in aqueous solutions using piezoresistive hydrogel sensors offers huge potential for chemical measurement and sensor technology. The operating principle, consisting of the stimulus-responsive polymer as a sensor element and a pressure sensor as a swelling pressure transducer, allows the detection of a wide variety of species, such as pH value, ion concentration or glucose molecules, cost-effectively and easily.
Although these sensors exhibit good sensitivity and reversibility behavior, the viscoelastic properties of the swellable polymer limit the dynamic sensor response. Once the measuring solution has been applied, the tedious diffusion processes result in response times in the range of minutes to hours.
In the present work, the measuring procedure of intramolecular force compensation to improve these properties is introduced, implemented in an actual sensor setup and investigated. The compensation concept is based on the utilization of a bisensitive hydrogel, which has a further sensitivity to temperature in addition to the actual analyte sensitivity. Embedded in a closed-loop control, the temperature controller is intended to keep the system continuously in a state of equilibrium and thus suppress the swelling processes of the gel.
The present work shows that this type of compensation enables a significant shortening of the transient response by up to 70% and at the same time a considerably simplified and miniaturized sensor setup compared to other compensation principles.

[DISS 6] Agnes Eydam: **Polarization Determination of Integrated Piezoceramics for Process Control and Non-destructive Component Testing**

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

Day of defence: October 8, 2020

Piezoelectric sensors and actuators are integrated into lightweight structures to create smart structural components. They are able to respond to changing environmental and operating conditions or to monitor the condition of a component permanently. Thermal and mechanical loads during the integration process can lead to a partial depolarization of the piezoceramics. Therefore, this work investigates the non-destructive evaluation of the polarization state of integrated piezoelectric modules for quality control and to optimize the manufacturing technology.
Thermal measurement methods based on the pyroelectric effect are applied for this purpose. In the case of the laser intensity modulation method (LIMM), the sample is irradiated with a periodically modulated laser beam and the spectrum of the pyroelectric current is determined in frequency domain. The thermal pulse method uses short laser pulses and the signal is recorded in time domain. A measurement and

evaluation method for integrated piezceramics has to take into account the multi-layer design and it should be fast and simple for application in large-scale production.
The measured frequency spectrum of the pyroelectric current is described by an analytical model which considers a harmonically heated piezoelectric plate exhibiting heat losses to the environment. The heat transfer is characterized by a single thermal relaxation time or a continuous distribution of relaxation times. Similar to the Debye model and advanced models like the Havriliak-Negami function for dielectric relaxation, the thermal relaxation was modeled. But the amplitude of the pyroelectric response increases with higher frequencies due to decreased thermal losses. A homogeneous polarization distribution was determined for most samples.
The thermal pulse signals are described only partially by models in time domain. The frequency spectra are determined by a Fourier transform and corrected with the transfer function of the measurement set-up. Up to 100 Hz an undistorted spectrum was obtained which is in good agreement with the respective LIMM spectrum.
The measurement in time domain is much faster than in frequency domain, but leads to greater measurement uncertainties.
Both measurement methods, LIMM and the thermal pulse method, confirmed the slight decrease of the remanent polarization of piezofiber composites after integration in structural components.

Publication:
A. Eydam: Polarisationsbestimmung integrierter Piezokeramiken für die Prozesskontrolle und zerstörungsfreie Bauteilprüfung. Dresdner Beiträge zur Sensorik, Band 80. Dresden: TUDpress 2020. ISBN: 978-3-95908-421-5.

5.2. Diploma theses

(Supervisors in brackets)

[DA 1] Aaron Vogel
Kombination von optischer Messtechnik und Wirbelstrommesstechnik zur Charakterisierung von Carbonfasergarn (Combination of optical and eddy current measurement techniques to characterize carbon fiber yarn).
(Prof. Dr.-Ing. habil. G. Gerlach / Dr.-Ing. V. Norkus, Dipl.-Ing. M. Drobisch [SURAGUS GmbH])

[DA 2] Gerrit Bücken:
Numerische und analytische Modellierung des (nichtlinearen) Schwingungsverhaltens von ko-resonant gekoppelten Cantilever-Systemen (Numerical and analytical modeling of the (non-linear) vibration behavior of co-resonantly coupled cantilever systems).
(Prof. Dr.-Ing. habil. G. Gerlach / Prof. Dr.-Ing. Uwe Marschner, Prof. Dr.-Ing. J. Körner)

5.3. Study Projects

[SA 1] Victoria Constance Köst:
Untersuchung zum Denaturierungsverhalten von PAA-Eiweiß-Phantomen (Investigation of the denaturing behavior of PAA protein phantoms)
(apl. Prof. Dr. rer. nat. et Ing. habil. Kühnicke, Dipl.-Ing. M. Wolf)

6. PUBLICATIONS

6.1. Book series: Dresden Sensorics Contributions

Since 1996 the book series „Dresdner Beiträge zur Sensorik“ edited by G. GERLACH has been published. The aim of this series is the publication of outstanding scientific contributions of TU Dresden, especially of those made at the Solid-State Electronics Laboratory. The 73 volumes published so far were continued by six new ones in 2020.

A. Schröter: Impedimetrischer Sensor für das Wundmonitoring. Dresdner Beiträge zur Sensorik (Impedimetric Sensor for the Monitoring of Wounds), Band 74. Dresden: TUDpress 2020. ISBN: 978-3-95908-187-0.

C. Kroh: Hydrogel-basierter plasmonischer Sensor zur Inline-Überwachung von Flüssigkeitsparametern (Hydrogel-based Plasmonic Sensors for the Inline Monitoring of Fluid Parameters). Dresdner Beiträge zur Sensorik, Band 75. Dresden: TUDpress 2020. ISBN: 978-3-95908-198-6.

M. Krenkel: Mechanisch gekoppelte mikroelektromechanische Ultraschallwandler (Mechanically Coupled Microelectromechanical Ultrasonic Transducers). Dresdner Beiträge zur Sensorik, Band 76. Dresden: TUDpress 2020.
ISBN: 978-3-95908-204-4.

T. Ott: Leistungsstarke Infrarotemitter mit schrägwinkelbedampften Emissionsschichten (High-performance Infrared Emitters with Glancing-angle Vapor-deposited Emission Layers). Dresdner Beiträge zur Sensorik, Band 77. Dresden: TUDpress 2020.
ISBN: 978-3-95908-211-2.

J. Erfkamp: Entwicklung von piezoresistiven Chemo- und Biosensoren auf der Basis von stimuliresponsiven Hydrogelen (Development of Piezoresistive Chemo- and Biosensors Based on Stimuli-responsive Hydrogels). Dresdner Beiträge zur Sensorik, Band 78. Dresden: TUDpress 2020.
ISBN: 978-3-95908-212-9.

S. Kümmritz: Ultraschallmessverfahren mit Annular Arrays zur verbesserten Bestimmung von Materialeigenschaften und Charakterisierung von Einschlüssen (Ultrasonic Measuring Method with Annular Arrays for Improved Determination of Material Properties and Characterization of Inclusions). Dresdner Beiträge zur Sensorik, Band 79. Dresden: TUDpress 2020.
ISBN: 978-3-95908-218-1.

A. Eydam: Polarisationsbestimmung integrierter Piezokeramiken für die Prozesskontrolle und zerstörungsfreie Bauteilprüfung. (Polarization Determination of Integrated Piezoceramics for Process Control and Non-destructive Component Testing). Dresdner Beiträge zur Sensorik, Band 80. Dresden: TUDpress 2020. ISBN: 978-3-95908-421-5.

6.2. Book chapters

1. J. Kuß, A. Abdel-Haq, A. Jacob, T. Zimmermann: Entwicklung von Online-Self-Assessments für Studiengänge der Ingenieurwissenschaften an der TU Dresden (Development of online self-assessments for engineering study programs at the TU Dresden). In: F. Schulze-Stocker, C. Schäfer-Hock, H. Greulich (Hrsg.): Wege zu Studienerfolg. Analysen, Maßnahmen und Perspektiven an der Technischen Universität Dresden 2016-2020 (Ways to Academic Success. Analyses, Measures and Perspectives at the Technische Universität Dresden 2016-2020). Dresden: TUDpress 2020. 241-268.

2. G. Suchaneck, G. Gerlach: Thin films for electrocaloric cooling devices. In: S. Kumar, D. K. Aswal (Eds.): Recent Advances in Thin Films. Singapore: Springer 2020. Chapter 12, 369-388. ISBN 978-981-15-6115-3.

6.3. Guest editorals

3. N. A. Sobolev, M. M. Krupa, G. Suchaneck, S. Tamulevičius: Advanced Magnetic Oxides. Physica Status Solidi B 257 (2020) 2000058.

4. Micromachines: Special Issue "Selected papers from the APMM 2019 – Active Polymeric Materials and Microsystems Conference"
   Special Issue Editor: G. Gerlach

5. Sensors: Special Issue “MEMS Actuators and Sensors 2020”
   Guest Editors: T: Sandner, G. Gerlach, J. Mehner

6.4. Papers in journals

6. E. Artsiukh, G. Suchaneck: Evaluation of crystallographic ordering degree of magnetically active ions in $Sr_2FeMoO_{6-\delta}$ by means of the (101) X-ray peak intensity. Modern Electronic Materials 5(4) (2019) 151-157. Russian version: Izvestiya Vysshikh Uchebnykh Zavedenii. Materialy Elektronnoi Tekhniki (Materials of Electronics Engineering, Moscow) 22(2) (2020) 134-141. Doi: 10.17073/1609-3577-2019-2-135-142.

7. A. Ehrenhofer, S. Binder, G. Gerlach, T. Wallmerperger: Multisensitive swelling of hydrogels for sensor and actuator design. Advanced Engineering Materials (2020), 2000004 (12 pages).

8. D. Franke, G. Gerlach: Swelling studies of porous and nonporous semi-IPN hydrogels for sensor and actuator applications. Micromachines 11 (2020), 425 (14 pages).

9. N. Gulnizkij, G. Gerlach: Modelling and model verification of an autonomous threshold sensor for humidity measurements. Journal of Sensors and Sensor Systems 9 (2020), 1-6.

10. N. Gulnizkij, G. Gerlach: Bistable threshold humidity sensor switch with rectangular bimorph bending plate. Micromachines 11 (2020) 6, 569 (22 pages).

11. J. Mersch, H. Winger, A. Nocke, C. Cherif, G. Gerlach: Experimental investigation and modeling of the dynamic resistance response of carbon particle-filled polymers. Macromolecular Materials and Engineering 305 (2020) 10, 2000361.

12. T. Ott, G. Gerlach: Morphological characterization and porosity profiles of tantalum GLAD thin films for infrared radiation-absorbing layers. Journal of Sensors and Sensor Systems 9 (2020), 79-87.

13. S. Pfeil, E.-F.M. Henke, K. Katzer, M. Zimmermann, G. Gerlach: A worm-like biomimetic crawling robot based on cylindrical dielectric elastomer actuators. Frontiers in Robotics and AI 7 (2020), 00009.

14. S. Pfeil, K. Katzer, A. Kanan, J. Mersch, M. Zimmermann, M. Kaliske, G. Gerlach: A biomimetic fish fin-like robot based on textile reinforced silicone. Micromachines 11 (2020), 298 (16 pages).

15. C. Schuster, F. Kuntz, A. Strasser, T. Härtling, K. Dornich, D. Richter: 3D relative dose measurement with a µm thin dosimetric layer. Radiation Physics and Chemistry, accepted.

16. I. A. Starkov, G. Suchaneck, A. S. Starkov, G. Gerlach: Modeling of hybrid relaxor-ferroelectric $Ba(Zr_{0.2}Ti_{0.8})O_3$ ceramics. Ferroelectrics 556 (2020) 8-15.

17. M. Stoehr, G. Gerlach, T. Härtling, S. Schoenfelder: Analysis of photoelastic properties of monocrystalline silicon. Journal of Sensors and Sensor Systems 9 (2020), 209-217.

18. G. Suchaneck, N. Kalanda, E. Artsiukh, M. Yarmolich, N. A. Sobolev: Monitoring of the formation of $SrMoO_4$ intergrain tunneling barriers in $Sr_2FeMoO_{6-\delta}$. arXiv2003.09997.

6.5. Conference and Workshop Contributions

19. E. Artiukh, G. Suchaneck, N. Kalanda, G. Gerlach: Magnetoresistance in $SrMoO_4$-$Sr_2FeMoO_{6-\delta}$ core-shell structures. Electroceramics XVII Online-conference, August 24-27, 2020, Darmstadt (Germany), Invited online talk, MM-5, https://event.electroceramicsxvii.exordo.com/presentation/82/magnetoresistance-in-srmoo4-sr2femoo6-core-shell-structures

20. A. Ehrenhofer, A. Mieting, S. Pfeil, J. Mersch, C. Cherif, G. Gerlach, T. Wallmersperger: An automatically rainproofing bike helmet through light-sensitive hydrogel meshes: design, modeling and experiments. In: Y. Bar-Cohen, I. Anderson, H. Shea (Eds.): Electroactive Polymer Actuators and Devices (EAPAD) XXII, Proceedings of the SPIE 11375, 2020. 113750N-1…12.

21. T. Härtling, M. Heymann, S. Münch, M. Schulze, C. Capraro, D. Schabbel, A. Vogel: Inline inspection of ceramic tape casting process by means of optical and eddy current methods. SMSI Measurement Science, 287, 2020 (DOI 10.5162/SMSI2020/D4.3).

22. G. Suchaneck: Synthesis of complex oxide films by means of reactive multitarget sputtering. 22nd International Conference – School "Advanced Materials and Technology", August 24-28, 2020, Palanga (Lithuania), Invited talk, Book of abstracts, p.14.

23. G. Suchaneck, E. Artiukh, M. Kalanda, M. Yarmolich, G. Gerlach: Electrical resistance and magnetoresistance in strontium ferromolybdate ceramics with strontium molybdate dielectric intergrain barriers. 22nd International Conference – School "Advanced Materials and Technology", August 24-28, 2020, Palanga (Lithuania), Book of abstracts, p.19.

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

24. V. Norkus, V. Krause: Sensoren – Schlüssel zur Umwelt (Sensors – Key to the Environment). UNI LIVE, Dresden, 09.01.2020

25. M. Stöhr, G. Gerlach, T. Härtling, S. Schönfelder: Absolute stress measurement by photoeleasticity in silicon. PhotoMechanics – International Conference on Full-field Measurement Techniques and Their Applications in Experimental Solid Mechanics PM-IDICS 2020.

26. E. Artsiukh, G. Suchaneck: Estimation of the degree of antisite disordering of magnetoactive ions in $Sr_2FeMoO_{6-\delta}$ by means of the intensity of the X-ray peak (101). Functional Materials and Nanotechnologies 2020 – FM&NT2020, November 23-26, 2020, Vilnius (Lithuania), Online talk, Book of Abstracts S11-2.

27. G. Suchaneck, E. Artiukh, N. Kalanda, G. Gerlach: Magnetoresistance in $SrMoO_4$-$Sr_2FeMoO_{6-\delta}$ core-shell structures. Scifed Magnetism Webinar (Magnetism-2020), August 24-25, 2020, Invited talk.

6.7. Patents

28. E.-F.M. Henke, K.E. Wilson, I.A. Anderson, R. Green, A. Richter, M. Franke, G. Gerlach: Stimuli-responsive sensor system, digital logic element, robotic system and method for detecting an external stimulus. Patent application EP 20164217.0-1020, 19.03.2020.

29. A. Tempelhahn, H. Budzier, G. Gerlach: Kalibrierverfahren und Korrekturverfahren für ein verschlussloses Infrarotkamerasystem und selbiges. (Calibration procedures and correction procedures for a shutterless infrared camera system and the like). Patent granted DD PS 10 2014 108 971.5, 13.08.2020.

7. GUEST LECTURES

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

27.09.-01.10.2020	Prof. Thomas Hellweg Universität Bielefeld	Acrylamide-based microgels: Structure, properties and potential applications
27.09.-01.10.2020	Prof. Dirk Kuckling Universität Paderborn	Polymers possessing cleavable bonds: Materials for sensors and drug delivery systems

8. AWARDS

Dipl.-Ing. Stefan Schreiber:

Diploma Award 2019 of the Institute for Solid-State Electronics, donated by DIAS Infrared GmbH and Heimann Sensor GmbH for his Diploma thesis „Entwurf und Aufbau einer Ansteuerelektronik für einen Sensor zur Bestimmung der thermophysikalischen Eigenschaften von Fluiden (Design and realization of the control electronics for a sensor to determine thermophysical properties of fluids)“.

Dr.-Ing. Manuela Heymann:

SICK-Award 2019 on Sensor Technology and Measuring System Technology for her PhD thesis „Leuchtstoffbasiertes Dosimetrieverfahren für elektronenbestrahlte Verpackungsmaterialien (Fluorescent-based dosimetry methods for electron irradiated packaging materials)“

Dr.-Ing. Tobias Ott:

Johann-Andreas-Schubert-Award 2020 of Saxonian Metal and Electrical Engineering Industry for his PhD thesis „Leistungsstarke Infrarotemitter mit schrägwinkelbedampften Emissionsschichten (High-performance infrared emitters with glancing-angle vapor-deposited emission layers)“

9. BOARD MEMBERSHIPS

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

- Vice-Rector Academic Affairs (since 08/2020).
- Deputy Chairman of the Saxony's Centre for Teaching and Learning (HDS) (since 08/2020).
- Spokesman of the DFG Research Training Group “Hydrogel-based Microsystems”.
- Member of the Council of the Electrical and Computer Engineering Department (until 08/2020).
- Dean of Educational Affairs of the Electrical and Computer Engineering Department (until 08/2020).
- Member of the Advisory Board of the Graduate Academy at TU Dresden.
- Member of the Advisory Council of the TUDIAS Study College.
- Member of the Executive Committee of Dresden International University (DIU).
- Member of the Advisory Council of the Electrical and Computer Engineering Department at TU Ilmenau.
- Member of the Executive Board of DTV – German Association of Technical-Scientific Societies.
- Member of the VDE Committee „VDE-Ehrenring“.
- Chief Editor, JSSS Journal of Sensors and Sensor Systems.
- Associated Editor-in-Chief, IEEE Sensors Journal.
- Member of the Scientific Board of the Journal „Technisches Messen“ (until 08/2020).
- Member of the Advisory Board of the Fraunhofer Institutes for Electron Beam and Plasma Technology (FEP), Dresden.
- Member of the Advisory Board of the Kurt-Schwabe-Institute for Measuring and Sensor Technology Meinsberg e.V.
- Member of the Advisory Board of the Kurt-Schwabe Foundation.
- Member of the Scientific Advisory Board of the CiS Research Institute for Microsensor Systems and Photovoltaics, Erfurt.
- Chairman of Working Group “Microelectronics”, VDE Dresden Branch.
- Godfather of TU Dresden for the Martin-Andersen-Nexö High School (MANOS), Dresden.

Prof. Dr. rer. nat. et Ing.habil. Elfgard 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".
- Reviewer for 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).

Prof. Dr. rer. nat. et Ing.habil. Thomas Härtling:

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

PD Dr.-Ing. habil. Helmut Budzier

- Person in charge for literature at IFE.
- Network administrator at IFE.
- Reviewer for the scientific journals „IEEE Sensors Journal“ and „Journal of Sensors and Sensor Systems (JSSS)“.

PD Dr.-Ing. Margarita Günther:

- Member of the Council of the Research Training Group “Hydrogel-based Micro-systems”.

Dr. rer. nat. Gunnar 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.
- Member of the Council of the National Centre of Competence for Materials, Advanced Technologies, Coatings and their Applications (Prague).
- Member of the Engineering and Technology Panel for the Purpose of Phase I of the Evaluation of Research and Professional Activity of Research-oriented Institutes of the Czech Academy of Sciences for 2015–2019.
- Project referee of the Horizon 2020 program of the European Union.
- Project referee of the German Aerospace Center e. V. (DLR).
- 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.
- Project referee of the National Centre of Science and Technology Evaluation (NCSTE) of the Ministry of Education and Science of the Republic Kazakhstan.
- Guest co-editor “Advanced Magnetic Oxides”, Physica Status Solidi, Volume 257, Issue 3, march 2020.
- Reviewer for the scientific journals “Journal Applied Physics”, “Advanced Functional Materials”, “RSC Advances”, “Physica Status Solidi B”, “Thin Solid Films”, “Journal of Materials Science: Materials in Electronics”, “Applied Materials Today”, “Materials (MDPI)”, “Chemical Engineering Journal”, “Bulletin of the Polish Academy of Sciences – Technical Sciences”.
- Deputy member of the Employee Committee of TU Dresden.

10.1. SMSI 2020 – Sensor and Measurement Science International

Place: Congress Center Nuremberg

Date: Juni 22-25, 2020

General Chair: Gerald Gerlach, TU Dresden, Germany
General-Co-Chair: Klaus-Dieter Sommer, TU Ilmenau, Germany

Organizer: AMA Service GmbH

Topics:

1. Sensors and Instrumentation

Topical Chairs:
- Prof. Dr. Gerald Gerlach, TU Dresden, Germany
- Prof. Dr. Reinhard Lerch, Friedrich-Alexander-University Erlangen-Nuremberg, Germany
- Prof. Dr. Ulrich Schmid, TU Wien, Austria

- Sensor Principles and Quantities
- Sensor Materials and Technology
- Sensor Interface Electronics
- Applications

Satellite Conference: IRS² 2020 - Infrared Sensors and Systems

- IR thermal detectors
- IR photon detectors
- IR system components
- Thermal imaging
- Pyrometry
- Gas analysis
- IR spectroscopy
- Applications

2. Measurement Science

Topical Chairs:
- Prof. Dr. Klaus-Dieter Sommer, TU Ilmenau, Germany
- Prof. Dr. Luca Mari, Università Cattaneo - LIUC Castellana, Italy
- Prof. Dr. Fernando Puente León, Karlsruhe Institute of Technology, Germany

- Measurement Foundations
- Advanced Methods and Measurement Systems
- Networked and IoT-related Measurement Systems
- AI Approaches in Measurement
- Applications

3. System of Units and Metrological Infrastructure

Topical Chairs:
- Dr. Beat Jeckelmann, METAS Bern, Switzerland
- Dr. Matthias Bartholmai, BAM Berlin, Germany
- Dir. u. Prof. Dr. Peter Ulbig, PTB Braunschweig, Germany

- Revised SI and its Opportunities
- Metrology and Traceability
- Calibration Methods
- Advanced Testing Methods
- Regulations and Standards in Metrology

Conference Proceedings:
https://ama-science.org/proceedings/listing/3563

10.2. Workshop: ChemPhys – Chemical & Physical Sensors

Place: TU Dresden, Werner-Hartmann-Building

Date: June 30, 2020

Workshop chairs: Prof. Dr.-Ing. habil. Gerald Gerlach, TU Dresden
Prof. Dr.-Ing. Julia Körner, University Hannover
PD Dr.-Ing. habil. Margarita Günther, TU Dresden

Lectures:

S. Wang:	Inverstigation of smart hydrogels on VOC gas sensing.
A. Meeting:	Hydrogel-based sensor for environmental monitoring of heavy metal ions.
N. Puwenberg:	Direct magnetostatic stray field mapping with a new multimodal sensor concept for magnetic force microscopy.
M. Sharma:	U-shaped nanowire co-resonantly coupled canteliver magnetometry.
I. Lampouras:	Canteliver sensors, co-resonantly coupled systems.
G. Mu:	Hydrogel-based optical sensor and image processing method.
K. Rückmann:	Calcium carbonate and smart hydrogels – a potential combination?

11.1. 5th German-Czech Workshop on Nanomaterials

Place: Dresden, Fraunhofer FEP

Date: January 25-26, 2021

Organizing committee:
Co-Chairs: Peter Frach, Fraunhofer FEP
Gerald Gerlach, TU Dresden
Secretary: Harry Nizard, Fraunhofer FEP
Conference Administration: Annett Arnold, Fraunhofer FEP

Scope and Topics:

The German-Czech Workshop on Nanomaterials is organized every two years. Previous editions took place in Sankt Peter-Ording (2012), Prague (2014), Lübeck (2016) and České Budějovice (2018). The 5th edition will take place in Dresden and will be co-chaired by the Fraunhofer FEP and the Technische Universität Dresden.

The scope of the German-Czech Workshop on Nanomaterials covers
- cluster and nanoparticle growth,
- aggregation sources,
- related sputtering processes and their applications.

It aims at supporting the collaboration between active groups on both sides of the German-Czech border, but researchers from all over are naturally welcome as well.

Information:
https://www.fep.fraunhofer.de/en/events/Nanoworkshop.html

11.2. SMSI 2021 – Sensor and Measurement Science International

Place: Online conference

Date: Mai 3-6, 2021

General Chair: Gerald Gerlach, TU Dresden, Germany
General-Co-Chair: Klaus-Dieter Sommer, TU Ilmenau, Germany

Organizer: AMA Service GmbH

Topics:

1. Sensors and Instrumentation

Topical Chairs:
- Prof. Dr. Gerald Gerlach, TU Dresden, Germany
- Prof. Dr. Reinhard Lerch, Friedrich-Alexander-University Erlangen-Nuremberg, Germany
- Prof. Dr. Ulrich Schmid, TU Wien, Austria

- Sensor Principles and Quantities
- Sensor Materials and Technology
- Sensor Interface Electronics
- Applications

Satellite Conference: IRS² 2021 - Infrared Sensors and Systems

- IR thermal detectors
- IR photon detectors
- IR system components
- Thermal imaging,
- Pyrometry
- Gas analysis
- IR spectroscopy
- Applications

2. Measurement Science

Topical Chairs:
- Prof. Dr. Klaus-Dieter Sommer, TU Ilmenau, Germany
- Prof. Dr. Luca Mari, Università Cattaneo - LIUC Castellana, Italy
- Prof. Dr. Eric Benoit, Université Savoie Mont Blanc, Chambéry, France
- Prof. Dr. Bernhard Zagar, Johannes-Kepler-Universität Linz, Austria

- Measurement Foundations
- Advanced Measurement Methods
- Networked and IoT-related Measurement Systems
- AI Approaches in Measurement
- Education for Measurement and Measurement for Education
- Applications

3. System of Units and Metrological Infrastructure

Topical Chairs:
- Dr. Beat Jeckelmann, Muntelier, Switzerland
- Dr. Matthias Bartholmai, BAM Berlin, Germany
- Prof. Dr. Harald Bosse, PTB Braunschweig, Germany
- Prof. Dr. Pavel Neyezhmakov, National Scientific Centre, Institute for Metrology, NSCIM, Kharkiv, Ukraine

- Revised SI and its Opportunities
- Metrological Traceability in the Digital Transformation Process
- Advanced Calibration Methods
- Advanced Testing Methods
- Regulations and Normative Documents on Metrology

Conference information:
https://www.smsi-conference.com/