TECHNISCHE UNIVERSITÄT DRESDEN

ELECTRICAL AND COMPUTER ENGINEERING DEPARTMENT

SOLID-STATE ELECTRONICS LABORATORY

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

2018 ANNUAL REPORT

Solid-State Electronics Laboratory:

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

This brochure provides you an overview of the most important events and results of the previous year 2018.

2018 was a very important milestone of the TU Dresden on the way to defend its title as a “University of Excellence”. Our university has been successful threefold in the competition for funding new Clusters of Excellence as well as for further funding of existing Clusters of Excellence. In January 2019 three new Clusters will start their operation: CeTI – Centre for Tactile Internet, ct.qmat – Complexity and Topology in Quantum Materials (together with University of Würzburg), and PoL – Physics of Life. Here, CeTI is led by our Department for Electrical and Computer Engineering. The establishment of this Cluster of Excellence will certainly have impact on our Department as well as the fact that the funding of the current Center for Advancing Electronics Dresden (cfaed) from means of the Excellence Initiative will end in the coming year.

In January 2018 Dr. Thomas Härtling, who heads the Group of Optical Test Methods and Nanosensorics at the Fraunhofer-Institute for Ceramic Technologies and Systems (IKTS), was appointed as Honorary Professor for Nanotechnology and Nanosensorics. We cordially congratulate him and wish him great success! Prof. Härtling is strongly involved in several projects at our IFE and teaches courses in the fields of nanotechnology and nanoelectronics (see Sections 3.1 and 4.2).

It was also very gratifying for our IFE that DFG has extended the funding of our Reaserch Training Group “Hydrogel-based Microsystems” for a second term of 4 ½ additional years until 2022 (see Section 4.2). This allows us to welcome the next generation of doctoral students in October 2019. We are also very happy that the number of doctoral students for the currently participating eight professors has even increased from 10 in the past to 14. We owe this success to the extraordinary results of our previous doctoral students and the great dedication of the involved colleagues. In September 2019 the RTG “Hydrogel-based Microsystems” will organize the conference “APMM 2019 – Active Polymeric Materials and Microsystems” (see Section 10.2). A number of well-known international scientists has already confirmed to attend and to contribute to the Conference making APMM 2019 a very promising highlight in the next year.

In November 2018 another DFG-funded Research Training Group – “Interactive Fiber-Elastomer Compounds I-FEC – has been launched where our IFE is participating with two PhD students. Spokesman of this RTG is Prof. Chokri Cherif, head of the Institute for Textile Machinery and High-Performance Material Technology. Subject of the RTG is the structural integration of intelligent sensor-actuator networks in fiber-elastomer compounds (see Section 4.2).

Many other events and results would be worth to be mentioned here. However, this would go beyond the space of this foreword, so that I can only refer to the following Sections of this brochure. Lastly, I must mention that our particular thanks go again this year to all of our partners and collaborators in other institutes and institutions as well as in our university administration for their efforts in any event. We wish that in the coming year we can again have you by our side as reliable partners.

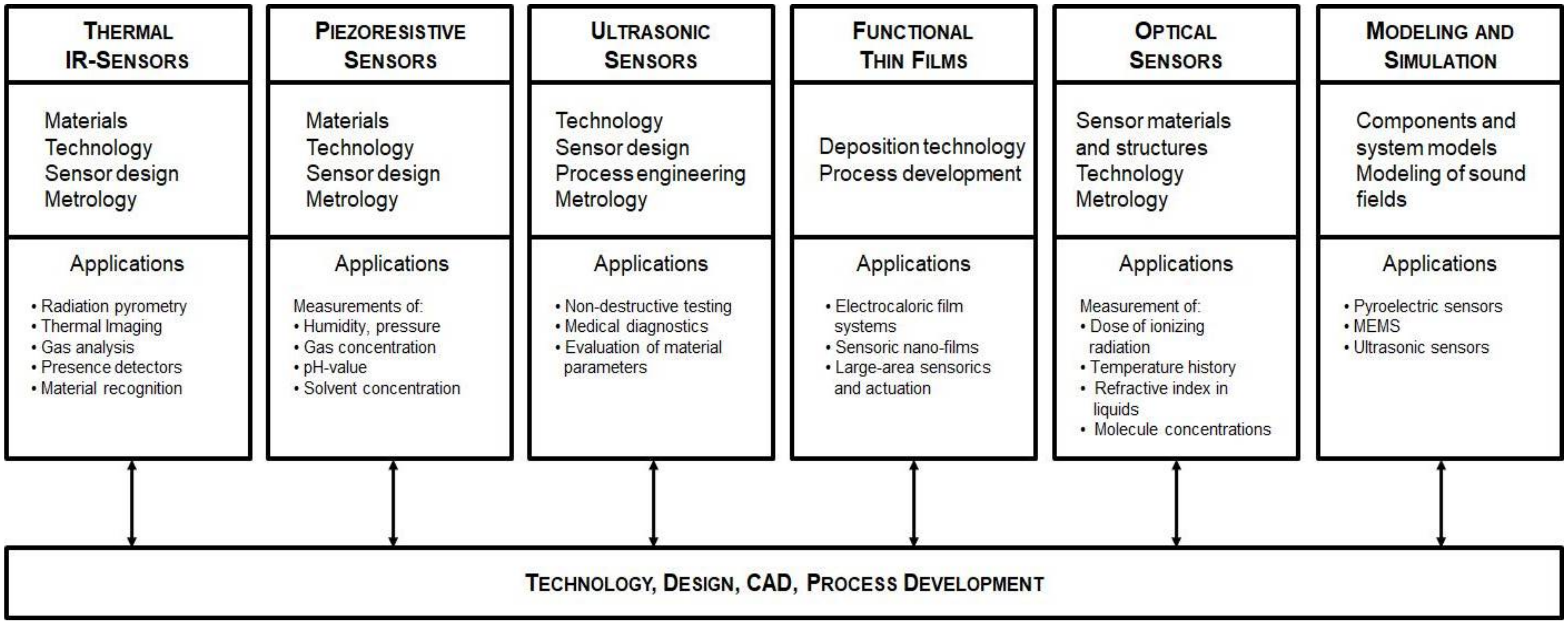
Prof. Dr.-Ing. habil. Gerald Gerlach

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) and the Chair of Polymeric 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
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
Binder, Simon	Dipl.-Ing.	Research assistant
Budzier, Helmut	Dr.-Ing.	Senior researcher
Burkhardt, Anke	Dr. rer. medic.	Research assistant
Collasch, Heike		Secretary
Delan, Annekatrin	Dipl.-Phys.	Research assistant
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.	Research assistant
Härtling, Thomas	Hon.-Prof. Dr.rer.nat. et Ing. habil.	Honorary professor[1]
Hecker, Dominic	Dr.-Ing.	Research assistant (until 02/18)
Henke, Markus	Dr.-Ing.	Postdoc
Herbst, Sabine		Laboratory assistant
Hildisch, Jan	M.Sc.	Research assistant (until 12/18)
Juhrig, André	Dipl.-Ing.	Research assistant
Junker, Steffen	Dipl.-Ing.	Research assistant
Kleiner, Anja	Dipl.-Ing.	Research assistant (until 02/18)
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 (until 06/18)
Kuß, Julia	Dr.-Ing.	Research assistant /Course advisor
Lehmann, Ulrike		Laboratory assistant
Liebschner, Rocco	M.Sc.	Research assistant
Malberg, Insa	Dipl.-Jur.	Officer
Nizard, Harry	Dr. rer. nat.	Research assistant
Norkus, Christian		Laboratory assistant
Norkus, Volkmar	Dr.-Ing.	Senior researcher
Ott, Tobias	Dipl.-Ing.	Research assistant
Pfeil, Sascha	Dipl.-Ing.	Research assistant (since 11/18)
Rath, Katharina	B.A.	Technical employee
Schmidt, Ulrike	Dipl.-Ing.	Research assistant
Schossig, Marco	Dipl.-Ing.	Research assistant (until 07/18)
Suchaneck, Gunnar	Dr. rer. nat.	Senior researcher
Timmermann, Lukas	Dipl.-Ing.	Research assistant (until 09/18)
Wolf, Mario	Dipl.-Ing.	Research assistant

[1] Head of the Research Group for Optical Test Methods and Nanosensorics at Fraunhofer IKTS Dresden

3. TEACHING AND ADVANCED TRAINING

Most of the study courses offered at TU Dresden in engineering sciences are organized as 5-year-diploma courses. At the Department of Electrical Enginnering and Information technology, this concerns the courses Electrical Engineering, Information Systems Technology, Mechatronics, and Regenerative Energy Systems. Additionally, a master course on Nanoelectronic Systems is 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, Infrared Measurement Technology). In the area of Ultrasonic Sensorics and Measurement Technology subject-specific lectures are offered to the students.

The huge demand of economy for graduates in engineering sciences, especially in electrical engineering, motivates to provide a more intensive mentoring of “Fundamentals in Electrical Engineering” freshmen. In order to reduce the dropout rate without diminishing 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 mentoring both of two lab works for all students of our department and of the Dynamic Networks course for the students for the courses Information Systems Technology and Industrial Engineering Program, two freshmen exercise classes were supervised in summer term 2018 and one in the winter term 2018/2019 by IFE personnel.

In particular, the following courses were given during the 2018 summer term and the 2018/2019 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: Computer Engineering II	PD Dr. Budzier, Dr. Suchaneck 0/0/2	(1) Compulsory course
Lab work: Circuitry course 1	DI Juhrig, DI Junker, DI Kostka Dr. Norkus, DI Ott, 0/0/2	(1, 5, 6, 7, 8) Compulsory course
Lab work: Circuitry course 2	DI Krause, MSc Liebschner, DI Juhrig, DI Junker 0/0/2	(1, 5, 6, 7, 8) Compulsory course
Tutor: Basics of Electrical Engineering	Dr. Suchaneck (0/2/0)	(1, 6) Compulsory course
Tutor: Electrical and magnetic fields	Dr. Suchaneck, DI Krause (0/2/0)	(1) Compulsory course
Tutor: Dynamic Networks course exercises for (2)	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, 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.

3.2. Advanced Training Course: Noncontact Temperature Measurement and Thermal Imaging Techniques

Date: October 18, 2018
November 7, 2019

Lecturers: PD Dr.-Ing. Helmut Budzier, TU Dresden
Prof. Dr. Gerald Gerlach, TU Dresden

Target Group:
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. 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 diclofenac -sensitive hydrogel films
- Sensor simulation and sensor design
- Measurement technology
- Application to measurement of pH-value 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 film 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 TRR39: “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“ (10/2013 - 09/2022).

- Research Training Group (Graduiertenkolleg) 2430 „Interactive Fiber-Elastomer-Composites“ (since 11/2018)

- Priority Programme SPP 1599: „Caloric Effects in Ferroic Materials: New Concepts for Cooling“, Project “Electrocaloric Multilayer and Radial Cooling Device Concepts” (10/2012 – 09/2019).

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 2430/11865/1 “I-FEC Interactive Fiber-Elastomer-Composites”

Spokesman:	Prof. Dr.-Ing. habil. Dipl.-Wirt.-Ing. Chokri Cherif
Project leader 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 freedoms of deformation, long deformation paths, and high actuating power with sensorial feedback, as well as
- as well as on in-depth scientific analyses of structural and material behavior on multiple scales.

Due to their high intrinsic deformation capacity, I-FRCs 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 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-FRCs are a new class of materials offering new properties. For example, the development of I-FRCs 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 proposed Research Training Group is the simulation-based development of smart material combinations and gradations for self-sufficient I-FRCs with structurally integrated actuator and sensor networks to actively and locally adjust component stiffness. I-FRCs 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: [8]

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. Simon Binder M.Sc. Jan Erfkamp Dipl.-Phys. Nikolai Gulnizkij M.Sc. Christoph Kroh
Postdoc	Dr. rer. nat. Daniela Franke
Funded by:	DFG (German Research Foundation)
Funding period:	01.10.2013 – 31.03.2018 (1st period) 01.04.2018 – 30.09.2022 (2nd period)
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 thermally controlled hydrogel actuator generates a counterforce that compensates the swelling pressure of the hydrogel. By this way, relaxation and drift effects are avoided (Dipl.-Ing. Simon Binder). - Hydrogel-based piezoresistive chemo- and biosensors: By means of a targeted synthesis and functionalization, e.g. with enzymes, novel stimuli-sensitive hydrogels will be designed and piezoresistive hydrogel sensors will be produced and characterized (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 the plasmonic sensor surface. For this, fundamental principles of the optical readout of hydrogel-based sensors for the application in the food industry should be researched (M.Sc. Christoph Kroh). - 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 (Dr.-Ing. Ulrike Schmidt).
- 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: [Diss3], [6], [9-10], [14], [23], [24], [43-46]

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:	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 – 09/2019

Objectives/results:
- Development of a technology for the fabrication of multilayer electrocaloric elements by means of reactive sputtering of high-resistive, $(Ba,Ca)(Zr,Ti)O_3$ thin films electrocaloric at room temperature.
- 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: [15], [19], [29], [36], [54-57]

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: [5], [10], [25], [33-35]

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. medic. Anke Burkhardt
Funded by:	DFG (German Research Foundation)
Funding period:	02/2015 – 09/2018

Objectives/results:

- Goal: Development of a non-invasive procedure for space- and time-resolved monitoring of the temperature and the denatuation 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 effects 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 proteins, work on phantom fabrication.

Related references: [21], [37-38], [40-42], [52], [59]

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 – 08/2019

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 special structured ultrasound transducers for focussing the sound field and steering the ultrasound beam.
- Improvement of the soft mold technique for the fabrication of small-scaled, spherically curved PZT-polymer composite with an operating frequency of 40MHz.

Related references: [50]

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
Funded by:	DFG (German Research Foundation)
Funding period:	07/2017 – 07/2020

Objectives/results:

- Goal: Providing a robust, feasible measuring technique to determine simultaneously sound velocities and thicknesses of layered structures (based on the results of a previous project).
- 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 algorithm.

Related references: [21], [42]

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, Dipl.-Ing. Steffen Junker, Christian Norkus
Funded by:	DFG (German Research Foundation)
Funding period:	08/2015 – 03/2019

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

Related references: [17]

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.

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)

Project leader:	Prof. Dr.-Ing. habil. Gerald Gerlach
Co-workers 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: [55], [58]

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, Christian Norkus, 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:

- Fabrication of special Si-DIEs.
- Design and realization of a measurement device for the contactless measurement of the surface temperature on Si-DIE's.
- Investigation of the thermal activation of Si-DIE's and measurement of the thermal time behavior.
- Design and assembly of special IR-sensors and their characterization.
- Assembly of a demonstrator.

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.-Ing. Siegfried Kostka, Christian Norkus
Funded by:	SAB (Development Bank of Saxony)
Funding period:	12/2015 – 07/2018

Objectives/results:

- New microbolometer-based systems for the mid infrared.
- Digital signal processing for microbolometer.

- Optically independent calibration for uncooled thermography systems.
- Durable vacuum housing for detectors.

Related references: [7]

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, e.g. by ozonization, to make the cleaning process safer, more efficient and cheaper.

Related references: [31-32]

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 the 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 larg-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 Depositing the SmS_x Layers 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:	03/2016 – 02/2018

Objectives/results:

- Aim: Development of a manufacturing technology for high-purity, homogeneous targets of SmS_x, as well as a coating technology for the deposition the SmS_x layers by magnetron sputtering.
- 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.
- Focus of the project part: Development of a coating technology for the deposition of SmS_x layers by magnetron sputtering. The layers should be suitable for sensor applications (for example for strain gauges).

Related references: [22]

Cooperation project: **Integrated into Components 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 - 07/2019

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 rotationally symmetric component by thin-film technology and microstructure technology.
- 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 insulation 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 – 04/2019

Objectives/results:

- Increase the intrinsic motivation of students from the first to fourth semester from the participating faculties 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.
- Identification of areas of application of knowledge acquired in the course of studies.
- Formats at the Electrical and Computer Engineering Department:
  - "Firm rallye" / Excursions to Preh Car Connect GmbH (23.10.2018), ESG Elektroniksystem- and Logistik-GmbH for students (19.-20.11.2018).
  - Workshop „Think-tank – More practice in the study“ for teachers and students of STEM subjects (16.1.2018). cf. https://tu-dresden.de/deinstudienerfolg/ofp/ideenfabrik
  - BeING Inside – Interdisciplinary engineering practise (together with the Faculties of Chemistry and Food Chemistry, Mechanical Science and Engineering, as well as BASF Schwarzheide for students and grade 11 pupils (19.-23.3.2018).
  - Three workshop for study applicants: “Rookie becomes an engineer” with Bertrandt Services, DAS Environmental Expert, Diehl Aviation Gilching, Fraunhofer IPMS, FSD Fahrzeugsystemdaten, Preh Car Connect, SEMPA

Systems, SPLU Experts, Sunfire, Von Ardenne as well as XENON Automatisierungstechnik (22.8.2018), „Expert workshop“ – Discussion of expected skills of an engineer with regard to interdisciplinary and (inter) national working groups of different sizes (5.9.2018 with Schreibzentrum TUD), and „How to be a maker“ – Introduction to the organizational structure of the Makerspace. Illustration of the creative process in engineering work based on a practical task and its implementation by means of Arduino-Kit „Uno 1“(10.-12.9.2018).

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 Subjects.

General Project Managers:	Prof. Dr.-Ing. habil. Gerald Gerlach, Prof. Dr. Thomas Köhler (Media Centre) apl. Prof. Dr. Carmen Hagemeister (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 – 08/2019

Objectives/results:

- Developing online self-assessment tests for the study program in Electrical Engineering at TU Dresden.
- Accompanying information and counseling.
- 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 dropouts.
- Testing prior technical knowledge and skillson the basis of problem-oriented specialized 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-workers at IFE:	Dr.-Ing. Markus Henke
Collaboration:	Biomimetics Lab, Auckland Bioengineering Institute, The University of Auckland, Auckland, New Zealand
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.
- Improvement of DE and bionic roboter manufactoring

Related references: [13], [27], [39], [48-49]

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)
- 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 fabricating nanoparticles and nanocomposite layers
- 60 MHz plasma source for depositing plasma polymers and inorganic compo-site layers
- Gas flow sputter source for creating 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) to characterize 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)
- Single-channel ultrasonic test instrument for non-destructive examination
- Ultrasound field measuring station with x-y-z positioning system
- 8-channel ultrasonic sending-receiving system (125 MS/s sampling rate per channel) for signal analysis
- 10-channel ultrasonic sending-receiving system (500 MS/s sampling rate per channel) for microscopy applications (up to 200 MHz)
- Measuring set-up for sound velocity determination in fluids without reference reflectors (Single-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 2018, 18 doctoral students (including 6 external ones) were supervised by the Chair of Solid-State Electronics. The following PhD theses were successfully defended:

[DISS 1] Manuela Heymann: **Fluorescence-based Dosimetry Methods for Electron-irradiated Packaging Materials.**

Supervisors: Prof. Dr.-Ing. habil. Gerald Gerlach
Hon.-Prof. Dr. rer. nat. et Ing. habil. Thomas Härtling

Day of defence: April 20, 2018

Increasing requirements for quality assurance demand reliable monitoring systems for sterilization techniques. Hence, the application of high-performance polymers and integration of sophisticated functionalities lead to a substantial need for alternative sterilization processes in life sciences. Heat or steam sterilization causes often lack of functionality and is yet not applicable. Electron beam sterilization is a promising option to classical sterilization methods due to its advantages such as safety, high-speed processing, and applicability to sensitive materials. The technique relies on its effect on microbial germs e. g. on surfaces of medical products or food packaging. However, up to now, no reliable in situ proof of electron beam sterilization exists. To measure applied electron beam dose during sterilization, luminescence, optical film, electron spin resonance and calorimetric dosimeters are used. Commercial dosimeter systems exhibit several drawbacks in application. Alanine dosimeters, based on electron spin resonance, are very reliable and have a wide dose range, but they require very expensive evaluation tools and are not able to be read out in situ. Optical dosimeters show restrictions in the detectable dose range. An additional heating step before analysis is necessary, thus making in situ evaluations impossible. Further, they are sensitive to UV irradiation in surrounding light.
A novel optical technique which allows to prove electron beam sterilization based on an optically active material is a promising approach to overcome before-mentioned drawbacks. The optically active material needs to be non-toxic and small in particle size and should change its optical properties during electron beam exposure. Those properties are combined in the phosphor sodium yttrium fluoride doped with ytterbium and erbium. The rare-earth-doped fluoride belongs to up-conversion phosphors, exhibits stable and characteristic optical properties, and is proven to be sensitive to electron beam treatment. Envisaging an in situ evaluation, an integration of the phosphor into packaging material, that is suitable for medical applications, is the next step towards an industrial usage. In this thesis, an optical control system for electron beam sterilization in packaging material is presented. The work considers the qualification of the optically active material, the integration into the packaging material and the evaluation of the resulting properties of the packaging material with respect to mechanical and sealing behavior, biocompatibility and migration behavior.

Publication:
M. Heymann: Leuchtstoffbasiertes Dosimetrieverfahren für elektronenbestrahlte Verpackungsmaterialien. Dresdner Beiträge zur Sensorik, Band 69. Dresden: TUDpress 2018.

[DISS 2] Mathias Busek: **Modeling and Control of Nutrient Suppley in Microfluidic Cell Culture Systems**

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

Day of defence: May 8, 2018

The focus of this work lies on the development of a microfluidic system for the cultivation of different cells and tissues connected in parallel in a branched artificial blood network with integrated on-demand oxygen supply. Therefore, different microfluidic approaches are carried out. Later on, these systems are realized using a layer-by-layer manufactoring technology. Each device consists mainly of integrated micro pumps, valves, channels and reservoirs as well as oxygenator elements for gas exchange. Non-invasive flow and oxygen measurement techniques are applied to characterize and compare the developed microfluidic systems in accordance with the performance requirements. Each development step is accompanied by comprehensive system modelling. The simulation uses the lumped element approach to calculate the mass and flow transport in the microfluidic system. Finally, these synthesized network models are validated and the realized layouts are weigthed against each other.

Publication:
M. Busek: Modellierung und Regelung der Nährstoffversorgung in mikrofluidischen Zellkultursystemen. Dresdner Beiträge zur Sensorik, Band 70. Dresden: TUDpress 2018.

[DISS 3] Ulrike Schmidt **Hydrogel-based (bio-)chemical sensors**

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

Day of defence: June 21, 2018

In the present study, new concepts for implantable chemical and biochemical sensors were developed and investigated. They are based on the combination of hydrogels and piezoresistive pressure sensors, whereby the pressure sensors measure the swelling pressure of hydrogels produced by the species to be detected. In particular, the physiologically relevant concentration ranges of pH (pH 7.8...6.8) and glucose (2...20 mmol/l) were considered. The pH-sensitive hydrogels are based on photopolymerized copolymers of the monomers hydroxypropyl methacrylate (HPMA), 2-(dimethylamino) ethyl methacrylate (DMAEMA) with pH-sensitive tertiary amino groups and tetraethylene glycol dimethacrylate (TEGDMA) as crosslinker. In order to

achieve a sensitivity to glucose, the enzymes glucose oxidase and catalase were physically (diffusion and molecular imprinting) or chemically (EDC/NHS and acryloyl chloride) immobilized in the pH-sensitive gel networks by means of different immobilization methods. The HPMA/DMAEMA/TEGDMA-hydrogels have been characterized in different compositions and geometries in terms of swelling behavior, mechanical and other properties to improve their sensitivity, reproducibility and response time with resput to analyte concentration changes (pH, glucose) in physiological media (PBS) for integration in piezoresistive pressure sensors. The established pH and glucose dip sensors exhibited promising sensitivities and response times of several minutes to hours. Increasing the operating temperature to physiologically relevant 37 °C reduced the response time to down to 3 min. By means of appropriate construction and connection techniques, dip sensors for in-line process monitoring, for instance in the environmental protection, water and process measuring technology as well as implantable sensor concepts for medicine and biotechnology were created. Different encapsulation methods were used to protect the electronic components and to ensure biocompatibility (Parylene C, medical grade silicone) simultaneously without restricting the functionality and flexibility of the sensor setup. The results show the high potential of the hydrogel-based piezoresistive sensors for a wide diversity of detectable analytes, such as physiological parameters (pH, glucose concentration).

Publication:

U. Schmidt: Hydrogel-basierte (bio-)chemische Sensoren. Dresdner Beiträge zur Sensorik, Band 71. Dresden: TUDpress 2018.

5.2. Diploma theses

(Supervisors in brackets)

[DA 1] 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 / Hon.-Prof. Dr. rer. nat. et Ing. habil. T. Härtling)

[DA 2] Sascha Pfeil:
Bionische Roboter auf Basis dielektrischer Elastomere (Bionic robots based on dielectric elastomers)
(Prof. Dr.-Ing. habil. G. Gerlach / Prof. Dr.-Ing. A. Richter, Dr.-Ing. E.-F. Markus Henke)

[DA 3] Marcel Gehringer:
Verfahren zur Temperaturmessung in kraftkompensierten Sensoren und Charakterisierung kraftkompensierter Sensoren auf Hydrogelbasis (Method for temperature measurement in force-compensated sensors and characterization of force-compensated hydrogel-based sensors)
(Prof. Dr.-Ing. habil. G. Gerlach / PD Dr.-Ing. habil. M. Günther, Dipl.-Ing. S. Binder)

[DA 4] Stefan Schreiber:
Entwurf und Aufbau einer Ansteuerelektronik für einen Sensor zur Bestimmung der thermophysikalischen Eigenschaften von Fluiden (Design and assembly of a control electronics for a sensor to determine the thermophysical properties of fluids)
(Prof. Dr.-Ing. habil. G. Gerlach / PD Dr.-Ing. habil. H. Budzier, Dr. M. Seilmayer [HZDR, Rossendorf])

5.3. Master theses

[MA 1] Annacot Nahas Hassan:
Design, characterization and test of silicon-based spectrometers for consumer applications
(Prof. Dr.-Ing. habil. G. Gerlach / Hon.-Prof. Dr. rer. nat. et Ing. habil. T. Härtling, Dr. T. Kautzsch [Infineon Technologies Dresden])

[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, Dr.-Ing. M. Busek [Fraunhofer IWS, Dresden])

5.4. Study Projects

[SA 1] Manuel-Pascal Below:
Benchmark von SLAM-Verfahren in einer Simulationsumgebung (Benchmark of SLAM processes in a simulation environment)
(PD Dr.-Ing. habil. H. Budzier, Dr.-Ing. S. Wagner [Fraunhofer IVI, Dresden])

[SA 2] Gloriya, Dimitrova:
Bestimmung des thermischen Zeitverhaltens angeregter Si-Chips (Determination of the thermal time behavior of thermally excited Si chips)
(Prof. Dr.-Ing. habil. G. Gerlach, Dipl.-Ing. S. Junker)

[SA 3] Yuanhe Cui:
Charakterisierung von Hydrogel-basierten piezoresistiven Ethanolsensoren (Characterization of hydrogel-based piezoresistive ethanol sensors)
(Prof. Dr.-Ing. habil. G. Gerlach, M.Sc. J. Erfkamp)

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 produced at the Solid-State Electronics Laboratory. The 68 volumes published earlier were continued by three new ones in 2018:

M. Heymann: Leuchtstoffbasiertes Dosimetrieverfahren für elektronenbestrahlte Verpackungsmaterialien. Dresdner Beiträge zur Sensorik, Band 69. Dresden: TUDpress 2018. ISBN: 978-3-95908-134-4

M. Busek: Modellierung und Regelung der Nährstoffversorgung in mikrofluidischen Zellkultursystemen. Dresdner Beiträge zur Sensorik, Band 70. Dresden: TUDpress 2018. ISBN: 978-3-95908-137-5

U. Schmidt: Hydrogel-basierte (bio-)chemische Sensoren. Dresdner Beiträge zur Sensorik, Band 71. Dresden: TUDpress 2018.

6.2. Book Chapters

1. H. Budzier, G. Gerlach: Passive Thermography, Thermal Imaging. Chapter 12 in: N. Ida, N. Meyendorf (Eds.): Handbook of Advanced Non-Destructive Evaluation, Springer International Publishing, https://doi.org/10.1007/978-3-319-30050-4_12-1.

2. H. Budzier, G. Gerlach: Active Thermography. Chapter 13 in: N. Ida, N. Meyendorf (Eds.): Handbook of Advanced Non-Destructive Evaluation, Springer International Publishing, https://doi.org/10.1007/978-3-319-30050-4_13-1.

3. G. Gerlach: Mikromechanik. In: W. Krause (Hrsg.): Konstruktionselemente der Feinmechanik. Abschn.14.4., vollständig überarbeitete und erweiterte Auflage. München: Carl Hanser Verlag 2018. 989-1017.

4. E.-F. M. Henke, K. E. Wilson, G. A. Slipher, R. A. Mrozek, I. A. Anderson: Artificial muscle logic devices for autonomous local control. In: S. M. Welch, M. S. Strano (Eds.): Robotic Systems and Autonomous Platforms, Woodham Publishing, 2018, 29-40.

5. G. Suchaneck, A. Eydam, G. Gerlach: Thermal Wave Techniques. Chapter 15 in: N. Ida, N. Meyendorf (Eds.): Handbook of Advanced Non-Destructive Evaluation, Springer International Publishing, https://doi.org/10.1007/978-3-319-30050-4_15-1.

6.3. Papers in Journals

6. S. Binder, G. Gerlach: Kraftkompensierte chemische Sensoren auf Basis bisensitiver interpenetrierender Polymernetzwerke. Technisches Messen 85 (2018), S45–S51.

7. H. Budzier, G. Gerlach: Grenzen der thermischen, räumlichen und zeitlichen Auflösung ungekühlter Thermografiekameras. Technisches Messen 85 (2018) 1, 65-69.

8. 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.

9. J. Erfkamp, M. Günther, G. Gerlach: Hydrogel-based piezoresistive sensor for the detection of ethanol. Journal of Sensors and Sensor Systems 7 (2018), 219-226.

10. A. Eydam, G. Suchaneck, G. Gerlach: Thermal pulse studies of integrated piezoceramics. Advanced Engineering Materials 20 (2018), 1800435.

11. G. Gerlach, R. Lerch: AMA-Konferenz SENSOR/IRS2 2017 in Nürnberg. Editorial und Gastherausgeberschaft. Technisches Messen 85 (2018) 7-8, 469-470.

12. 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.

13. E.-F. M. Henke, K. Wilson, I. Anderson: Modeling of dielectric elastomer oscillators for soft biomimetic applications. Bioinspiration & Biomimetics, 13 (2018), 046009.

14. C. Kroh, R. Wuchrer, M. Günther, T. Härtling, G. Gerlach: Evaluation of the pH-sensitive swelling of a hydrogel by means of a plasmonic sensor substrate. Journal of Sensors and Sensor Systems 7 (2018), 51-55.

15. R. Liebschner, G. Gerlach: 3D-FEM simulation of a MEMS based electrocaloric $Ba(Zr_{0.2}Ti_{0.8})O_3$-thin film microfluidic refrigeration device. Energy Technology 6 (2018) 8,1553-1559.

16. D. Lin, H.-G. Maas, P. Westfeld, H. Budzier, G. Gerlach: An advanced radiometric calibration approach for uncooled thermal cameras. The Photogrammetric Record 33 (2018), 30-48.

17. T. Ott, M. Schossig, G. Gerlach: Convective losses of thermal infrared emitters with cantilevered heating elements. Sensors and Actuators A 279 (2018), 416-423.

18. I. Tobehn-Steinhäuser, M. Günther, S. Görlandt, S. Herbst, H. Wünscher, T. Ortlepp, G. Gerlach: Multisensors for whole-cell analytics. IAPGOS (2018) 2, 39 - 41.

19. G. Suchaneck, G. Gerlach: Electrocaloric cooling - A new application of relaxor ferroelectrics. Acta Physica Polonia 133 (2018), 1003-1005.

20. R.N. Zhukov, T.S. Ilina, E.A. Skryleva, B.R. Senatulin, I.V. Kubasov, D.A. Kiselev, G. Suchaneck, M.D. Malinkovich, Yu.N. Parkhomenko, A.G. Savchenko: Formation of the microcrystalline structure in $LiNbO_3$ thin films by pulsed light annealing. Journal of Nano- and Electronic Physics 10 (2018), 02009.

6.4. Conference and Workshop Contributions

21. A. Burkhardt, A. Juhrig, M. Wolf, L. Timmermann, E. Kühnicke: Schallfeldbasierte Dämpfungsmessung. 44. Deutsche Jahrestagung für Akustik – DAGA 2018, 19.-22.03.2018, München, Proceedings, 1403-1406.

22. A. Delan, R. Ngoumeni, K. Vondkar, D. Glöß, G. Gerlach: Samariumsulfidschichten für Sensoranwendungen. In: Sensoren und Messsysteme, 26.–27.06.2018, Nürnberg. ITG-Fachbericht 281. Berlin, Offenbach: VDE Verlag, 468-470.

23. J. Erfkamp, M. Günther, G. Gerlach: Detection of ammonia based on stumuli-responsive hydrogels. Eurosensors XXXII, September 9-12, 2018, Graz, Proceedings, MDPI 2018.

24. J. Erfkamp, M. Günther, G. Gerlach: Piezoresistive Biosensoren auf der Basis Enzym-funktionalisierter Hydrogele. In: D. Beckmann, S. Kaufhold (Eds.): 19. Heiligenstädter Kolloquium: Technische Systeme für die Lebenswissenschaften. Heilbad Heiligenstadt, 24.-26.09.2018. Heilbad Heiligenstadt: Institut für Bioprozess- und Analysenmesstechnik 2018, 277-284.

25. A. Eydam, G. Suchaneck, G. Gerlach: Nondestructive evaluation of embedded piezoelectrics by thermal methods. In: W.-G. Drossel (Ed.): 6th Scientific Symposium CRC/Transregio 39 PT-PIESA Lightweight Design by Integrating Functions. 27.-28.03.2018, Chemnitz. 26-27.

26. G. Gerlach: Hydrogel-based chemical sensors. In: IMCS 2018 – 17th International Meeting on Chemical Sensors, Vienna, July 16-19, 2018, 318-319.

27. E.-F. M. Henke, K. E. Wilson, I. A. Anderson: ANSWER: Autonomous soft sobots without electronics. Proc. SPIE, 2018, 10594, 10594-64.

28. J. Hildisch, H. Bartzsch, M. Gittner, S. Barth, P. Frach: New approaches for improving isolation strength of magnetron sputtered dielectric films, PSE 2018, 16th International Conference on Plasma Surface Engineering, September 17-21, 2018, Garmisch-Partenkirchen, Abstract PO3070.

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31. N. Steinke, R. Wuchrer, S. Döring, G. Gerlach, T. Härtling: Plasmonic sensor system for on-site monitoring of diclofenac molecules. In: Sensoren und Messsysteme, 26.–27.06.2018, Nürnberg. ITG-Fachbericht 281. Berlin, Offenbach: VDE Verlag, 496-498.

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33. G. Suchaneck, A. Eydam, G. Gerlach: Nondestructive evaluation of embedded piezoceramics by thermal wave and thermal pulse methods. In: BIT´s 4th Annual World Congress of Smart Materials-2018 (WCSM-2018), March 6-8, 2018, Osaka (Japan), Invited talk, Electronic proceedings, p. 130.

34. G. Suchaneck, A. Eydam, G. Gerlach: Nondestructive evaluation of embedded piezoceramics by thermal wave and thermal pulse methods. CICMT (Ceramic Interconnects and Ceramic Microsystems Technology) 2018, April 18-20, 2018, Aveiro (Portugal), Invited talk, Electronic proceedings, 20-21.

35. G. Suchaneck, U. V. Yakhnevych, A. Eydam, D. Yu. Sugak, S. B. Ubizskii, I. I. Syvorotka, G. Gerlach: Depth profiling of dopant concentration and pyroelectric properties of $LiNbO_3$ single crystals high-temperature treated in the presence of metal ions. 14th Russia/CIS/Baltic/Japan Symposium on Ferroelectricity RCBJSF 2018, May 14-18, 2018, St. Petersburg (Russia), Abstract book, p. 74.

36. G. Suchaneck, G. Gerlach: High-performance lead-free electrocaloric materials based on $BaZr_xTi_{1-x}O_3$ solid solutions. E-MRS Spring Meeting and Exhibit 2018, June 18-22, 2018, Strasbourg (France), talk C 3.3.

37. L. Timmermann, M. Wolf, C. Wolf, A. Juhrig, K. Rath, F. Krujatz, E. Kühnicke: Ortsaufgelöste Bestimmung der Transversalwellengeschwindigkeit in Gewebephantomen. 44. Deutsche Jahrestagung für Akustik – DAGA 2018, 19.-22.03.2018, München, Proceedings, 1271-1274.

38. L. Timmermann, M. Wolf: Spatially-resolved determination of transverse wave speed in tissue phantoms using high-frequent ultrasound. The 12th International Conference on Sensor Technologies and Applications, SENSORCOMM 2018, 16.-20.09.2018, Venedig, Proceedings, 103-105.

39. K. E. Wilson, E.-F. M.Henke, G. A. Slipher, I. A. Anderson: Frequency adjustable soft oscillators. Proceedings of the SPIE, 2018, 10594, 10594-69.

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41. M. Wolf, L. Timmermann, A. Juhrig, K. Rath, F. Krujatz, E. Kühnicke: Temperature monitoring in tissue phantoms via spatially resolved measurement of longitudinal wave speed. The 12th International Conference on Sensor Technologies and Applications, SENSORCOMM 2018, 16.-20.09.2018, Venedig, Proceedings, 98-102.

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

42. A. Burkhardt: Schallfeldbasierte Dämpfungsmessung. Doktorandenseminar Ultraschallmesstechnik, 28.-30.10.2018, Kurort Gohrisch.

43. G. Gerlach: Hydrogels as versatile material for (bio)chemical sensors. Plenary talk. IEEE International Conference on Smart Materials and Spectroscopy SMS 2018. Hammamet, 12.-15.10.2018, Tunisia.

44. G. Gerlach: Hydrogel-based chemical sensors. Universität Bremen, IMSAS, 02.07.2018.

45. G. Gerlach: Hydrogel-basierte energieautonome Sensorsysteme. Keynote-Vortrag, 9. GMM-Fachtagung Energieautonome Sensorsysteme. 28.03.-01.03.2018, Dresden.

46. G. Gerlach: Hydrogel-based MEMS sensors. 01.11.2018, IIT Madras, Chennai, Indien.

47. G. Gerlach: Properties of and demands on sensors. 02.11.2018, Anna University, Chennai, Indien.

48. E.-F. M. Henke, S. Pfeil, K. E. Wilson, G. Gerlach, A. Richter: Soft dielectric elastomer robots. EuroEAP 2018, 04.-06.06.2018 Lyon, France.

49. E.-F. M. Henke, S. Pfeil, K. E. Wilson, G. Gerlach, A. Richter: Hybrid soft dielectric elastomer robots exploiting pneumatics to generate large actuation. MRS Fall Meeting 2018, 25.-30.11.2018 Boston, MA, USA.

50. A. Juhrig: Entwicklung hochfrequenter Annular-Array Prüfköpfe für die Ultraschallmikroskopie. Doktorandenseminar Ultraschallmesstechnik, 28.-30.10.2018, Kurort Gohrisch.

51. V. Norkus, V. Krause: Sensoren – Schlüssel zur Umwelt. UNI LIVE, Dresden, 11.01.2018.

52. L. Timmermann, M. Wolf, C. Wolf, A. Juhrig, K. Rath, F. Krujatz, E. Kühnicke: Ortsaufgelöste Bestimmung der Transversalwellengeschwindigkeit in Gewebephantomen. Workshop Messtechnische Anwendungen von Ultraschall, 18.-20.06.2018, Drübeck.

53. I. Tobehn-Steinhäuser, M. Günther, S. Görlandt, S. Herbst, H. Wünscher, T. Ortlepp, G. Gerlach: Multisensors for whole-cell analytics. 9th Workshop on Chemical and Biological Micro Laboratory Technology. 20.-22.02.2018.

54. G. Suchaneck: Electrokalorische Kühlung. Bitzer-Professur für Kälte-, Kryo- und Kompressorentechnik, TU Dresden, 11.01.2018.

55. G. Suchaneck: Multitarget reactive sputter deposition of complex oxide thin films. University of Aveiro, Aveiro (Portugal), 20.04.2018.

56. G. Suchaneck: Electrocaloric cooling. I. Basic principles, theoretical limits, II. Device prototypes. ITMO National University St. Petersburg, 16. und 18.05. 2018.

57. G. Suchaneck: Elektrokalorische Festkörperkühlschränke – eine zukünftige Technologie? 69. BHT – Freiberger Universitätsforum, TU BA Freiberg, 07.06.2018.

58. G. Suchaneck: Multi-target reactive sputter deposition of SFMO - challenges and approaches. Steering Meeting Horizon 2020 Marie Skłodowska-Curie Research and Innovation Staff Exchange Project SPINMULTIFILM, Strasbourg, 19.06. 2018.

59. M. Wolf, L. Timmermann, A. Juhrig, C. Wolf, K. Rath, F. Krujatz, E. Kühnicke: Temperaturüberwachung in Gewebephantomen mittels ortsaufgelöster Messung der Longitudinalwellengeschwindigkeit. Workshop Messtechnische Anwendungen von Ultraschall, 18.-20.06.2018, Drübeck.

6.6. Patents

60. 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 the force compensation principle with a simplified construction). Patent application DE PS 10 2017 214 452 B3 vom 09.05.2018.

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 Research Training Group „Hydrogel-based microsystems“ (GRK 1865) enabling in most cases the financement of the travel costs and lectures.

03.09.-05.09.2018	Dipl.-Ing. Henning Ebert (Biotronik SE & Co. KG)	Insight into the industry
03.09.-05.09.2018	Dr. Ivan Minev (Biotec Dresden)	Conductive and printable hydrogels for applications in bioelectronic interfaces
03.09.-05.09.2018	Dr. Laura De Laporte (Leibniz Institut für Interactive Materials Aachen)	Microgels for tissue regeneration
03.09.-05.09.2018	Prof. Martin Hoffmann (Ruhr-Universität Bochum)	Passive condition monitoring with MEMS-based sensors
03.09.-05.09.2018	Dr. Leopold Gruner (White IP Patentanwälte)	Patent law
03.09.-05.09.2018	Prof. Aranzazu Del Campo (Leibniz Institut für Neue Materialien Saarbrücken)	Reconstructing the cellular microenvironment with synthetic microgels
03.09.-05.09.2018	Dr. Felix Plamper (RWTH Aachen)	(Micro-)Gels and nonequilibrium
03.09.-05.09.2018	Prof. Alexander Alexeev (Georgia Institute of Technology, USA)	Designing microgel actuated microdevices using mesoscale modeling
03.09.-05.09.2018	Dr. Julia Körner (University of Utah, USA)	Smart hydrogel sensors for biomedical applications
03.09.-05.09.2018	Dr. Günter Auernhammer (Leibniz Institut für Polymerforschung Dresden)	Flexible liquid interfaces: The influence of substrate and surface rheology on wetting

8. AWARDS

Dipl.-Ing. Simon Binder, Prof. Dr.-Ing. habil. Gerald Gerlach:

Poster Prize of the ProcessNet/AMA Expert Group Measurement and Sensor Technology at the 13th Dresden Sensor Symposium 2017 for the contribution “Reduktion der Ansprechzeit hydrogelbasierter Sensoren (Reduction of the response time of hydrogel-based sensors)“.

Dr.-Ing. Markus Klemm:

SICK Measurement Technology Award 2017 for his thesis „Acoustic Simulation and Characterization of Capative Micromachined Ultrasonic Transducers“.

9. BOARD MEMBERSHIPS

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

- Member of the 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.
- Member of the Executive Board DTV – the 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“.
- 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 Microsensor Systems, Erfurt.
- Chairman of Working Group “Microelectronics”, VDE Dresden Branch.
- Member of the Board of Directors of the fair SENSOR+TEST-Messtechnikmesse Nuremberg.
- Member of the Board of Directors of the fms – the Research Society for Measurement Technology, Sensorics and Medical e. V. Dresden, now Council of the Expert Group Measurement and Sensor Technology (FMS) of DECHEMA
- Godfather of TU Dresden for the Martin-Andersen-Nexö High 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 IFE.
- Network administrator of 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 Council of the Research Training Group “Hydrogel-based Micro-systems”.

Hon.-Prof. Dr.-Ing. Thomas Härtling:

- Member of the AMA Science Board.
- Member 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 Dresden University of Technology.
- 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).
- 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.
- Referee of the scientific journals “Journal of Materials Chemistry C”, “Advanced Functional Materials”, “Applied Surface Science”, “Advanced Science”, “Materials Science in Semiconductor Processing”, “Physica Status Solidi (RRL)”, “IOP Journal of Physics: Conference Series”, “Indian Journal of Physics”, “Modern Electronic Materials”, “Ferroelectrics”, “Catalysis Today”.
- Deputy Staff Council at TU Dresden.

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

Place: Berlin

Date: March 11-16, 2018

Organisation: Thomas Hellweg (Universität Bielefeld)
Walter Richtering (RTWH Aachen)
Gerald Gerlach (TU Dresden)

10.2. Sensors & Measuring Systems 2018

Place: Congress Center Nuremberg-West, Germany

Date: June 26-27, 2018

Chairmen: Leonhard Reindl, University Freiburg
Jürgen Wöllenstein, Fraunhofer IPM

Organization: VDI/VDE-Society for Measurement and Automatic Control (GMA) and AMA - Association for Sensors and Measurement e. V.

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

11. CONFERENCES 2019

11.1. Sensors & Measuring Systems 2019

Place: Congress Center Nuremberg-West, Germany

Date: June 25-26, 2019

Chairmen: Rainer Tutsch, TU Braunschweig
Andreas Schütze, Saarland University

Organization: VDI/VDE-Society Measurement and Automatic Control (GMA) and AMA - Association for Sensors and Measurement e. V.

Key topics:

A Sensors
- A1 Sensors for mechanical values, inertial sensors
- A2 Force, torque and pressure sensors
- A3 Chemical and biosensors
- A4 Optical and infrared sensors
- A5 Temperature sensors
- A6 Magnetic sensors
- A7 Microwave, terahertz and radar sensors
- A8 Acoustic and resonant sensors
- A9 MEMS and nanosensors
- A10 Sensors for high-temperature applications
- A11 Sensory-active materials

B Measurement systems
- B1 Measurement uncertainty
- B2 Modelling, simulation and validation
- B3 Signal processing, sensor data fusion, and machine learning
- 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 Energy self-sufficient sensors
- B8 Smart metering and smart grids
- B9 Analytical measuring systems
- B10 Imaging / tomographic techniques
- B11 Optical measurement techniques and laser measuring systems
- B12 Impedance spectroscopy
- B13 Particle measurement

C: Applications

C1 Internet of things
C2 Manufactoring engineering, process automation and Industry 4.0
C3 Power engineering and renewable energies
C4 Environmental engineering, agriculture and forestry
C5 Medical engineering
C6 Food and biotechnology
C7 Material testing and characterization
C8 Structural monitoring and structural health monitoring
C9 Safety engineering, safety und security
C10 Autonomous systems, robotics
C11 Automotive and rail engineering
C12 Aerospace engineering
C13 Transport and product logistics

Further information: www.ama-science.org

11.2. APMM 2019 – Active Polymeric Materials and Microsystems

Place: Dresden, Penck - Hotel

Date: September 16-19, 2019

Chairmen: Gerald Gerlach, TU Dresden

International Steering Committee:

- Iain Anderson, University of Auckland, NZ
- Thomas Hellweg, University of Bielefeld, DE
- Dirk Kuckling, University of Paderborn, DE
- Angel Licea-Claverie, University of Tijuana, MX
- John Madden University of British Columbia, CA
- Jules J. Magda, University of Utah, US
- Martin Moeller, DWI Aachen, DE
- Maurizio Porfiri, New York University, US
- Walter Richtering, RWTH Aachen, DE
- Sebastian Seiffert, University of Mainz, DE
- Carmen Scholz, University of Huntsville, US
- Luisa Torsi, Università degli Studi di Bari, IT
- Marek Urban, Clemson University, US
- Regine von Klitzing, TU Darmstadt, DE
- Andreas Walter, University of Freiburg, DE

Topics:

- Electro-active Materials
- Hydrogels and Microgels
- Synthesis and Characterization, Material Properties
- Responsive and Adaptive Systems
- Hydrogel-based Sensors, Actuators, Devices and Microsystems
- Soft Robotics
- Microfluidics
- System Integration, Additive Manufacturing
- Modeling and Simulation

Important Deadlines and Dates:

Abstracts submission:	March 31, 2019
Acceptance notification:	April 15, 2019
Early bird registration:	April 30, 2019
Late new posters submission:	July 31, 2019

Information and Contakt:

https://tu-dresden.de/ing/elektrotechnik/ife/graduiertenkolleg/apmm-2019

11.3. 14. Dresden Sensor-Symposium

Place: Westin Bellevue, Dresden

Date: Dezember 2-4, 2019

Organization: DECHEMA e. V.

Topics:

- Sensor technology
- Process measurement
- Environmental sensorics
- Biomedical sensorics

Further information: www.dechema.de/DSS14.html; www.ama-science.org

12. VDE WORKING GROUP MICROELECTRONICS

12.1. Mission

The Working Group “Microelectronics” was founded in 2003 as part of the regional branch of VDE. It provides a panel of experience exchange focused on the area of microelectronics to engineers, technical staff, scientists and students.

The settlement of the world-leading suppliers of computer processors, random access memories, and silicon wafers in the Dresden region, and the advanced development of the traditional microelectronics companies made Saxony with the center of Dresden to one of the world’s leaders in microelectronics.

The Working Group meetings are arranged mostly directly at enterprises or research institutes. Thereby, the objectives of the work 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 industry, universities and their students as well as scientific institutions.

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

- Wafer fabrication,
- Technology,
- Installation engineering,
- Electronic components and their design,
- Applications (for instance, sensorics, automotive, biotech, medical engineering).

Prof. Dr.-Ing. habil. G. Gerlach is chairman of the working group „Microelectronics“.

12.2. Meetings 2018

June 13th, 2018	„Infrared sensors and measurement techniques“ InfraTec GmbH, Dresden
November 22nd, 2018	„Semiconductor sensors from Dresden“ IDT Europe GmbH (formerly ZMD), Dresden
December 12th, 2018	„Nanoelectronic materials and devices“ NaMLab GmbH, Dresden