Christian-Albrechts-Universität zu Kiel

Collaborative Research Centre 1261

# Magnetoelectric Sensors: From Composite Materials to Biomagnetic Diagnostics

biomagnetic sensing

SFB 1261

**Preproposal for Third Funding Period**
**2024/2 – 2028/1**

Preproposal for 3rd Funding Period of

Collaborative Research Center 1261

# Magnetoelectric Sensors: From Composite Materials to Biomagnetic Diagnostics

| | |
|---|---|
| For the years | 2024/2 – 2025 – 2026 – 2027 – 2028/1 |
| Coordinating University | Christian-Albrechts-Universität zu Kiel |


| **Speaker:** | **Business Address:** |
|---|---|
| Prof. Dr.-Ing. Gerhard Schmidt | Digital Signal Processing and System Theory<br>Department of Electrical and Information Engineering<br>Christian-Albrechts-Universität zu Kiel<br>Kaiserstr. 2, D-24143 Kiel<br><br>Phone: +49 (0) 431 880 6125<br>E-mail: gus@tf.uni-kiel.de |

**Substitutional Speakers:**

| | |
|---|---|
| Prof. Dr. xxx | Inorganic Functional Materials<br>Department of Materials Science<br>Christian-Albrechts-Universität zu Kiel<br>Kaiserstr. 2, D-24143 Kiel<br><br>Phone: +49 (0) 431 xxx<br>E-mail: xxx |
| Prof. Dr. xxx | Integrated Systems and Photonics<br>Institute of Electrical and Information Engineering<br>Christian-Albrechts-Universität zu Kiel<br>Kaiserstr. 2, D-24143 Kiel<br><br>Phone: +49 (0) 431 xxx<br>E-mail: xxx |

## 1. Tabular Summary of all Projects

| Project number and title | | Research area | Principal investigators (institute) |
|---|---|---|---|
| **Project area A: Sensor Technology** | | | |
| A1 | Magnetostrictive Multilayers for Magnetoelectric Sensors | Magnetic Materials | McCord (FE, MS) |
| | | Functional Materials | Meyners (FE, MS) |
| A2 | Hybrid Magnetoelectric Sensors based on Mechanically Soft Composite Materials | Nano Materials | Adelung (FE, MS) |
| | | | Ameri (FE, MS) |
| | | | Schröder (FE, MS) |
| A4 | ΔE-Effect Sensors | Networked Electronic Systems | Rieger (FE, EIE) |
| | | | Spetzler |
| A5(E) | Piezotronic Magnetoelectric Composites | Nano Materials | Adelung (FE, MS) |
| A6 | Microstructure and Structural Change of Magnetoelectric and Piezotronic Sensors | | Kienle (FE, MS) |
| | | | Murphy |
| A8 | Modelling of Magnetoelectric Sensors | | Gerken (FE, EIE) |
| A9 | Surface Acoustic Wave Magnetic Field Sensors | | Lofink |
| | | | Quandt (FE, MS) |
| A10 | Magnetic Noise of Magnetoelectric Sensors | Magnetic Materials | McCord (FE, MS) |
| | | | Wulfinghoff (FE, MS) |
| **Project area B: Magnetoelectric Sensor Systems for Medical Applications** | | | |
| B1 | Sensor Noise Performance and Analogue System Design | | Höft (FE, EIE) |
| | | | Rieger (FE, EIE) |
| B2 | Digital Signal Processing | | Bergholz ((FM, UKSH) |
| | | | Ellrichmann (FM, UKSH) |
| | | Signal Processing | Schmidt (FE, EIE) |
| B7(E) | | | Faupel (FE, EIE) |
| | | | Selhuber-Unkel |
| B9 | Magnetoelectric Sensors for Movement Detection and Analysis | | Maetzler (FM, UKSH) |
| | | Signal Processing | Schmidt (FE, EIE) |
| B10 | Magnetoelectric Sensor Systems for Cardiologic Applications | | Frey |
| | | Signal Processing | Schmidt (FE, EIE) |
| B11(N) | | | Bergholz |
| | | | Ellrichmann |
| | | Signal Processing | Schmidt (FE, EIE) |
| B12(N) | | | Altintas (FE, MS) |
| | | | Gerken (FE, EIE) |
| | | | Gundlach (FM, UKSH) |
| B13(N) | | | Ellrichmann (FM, UKSH) |
| | | | Lofink |
| T1(E) | | | Deuschl (FM, UKSH) |
| | | | Helmers (FM, UKSH) |
| | | | Höft (FE, EIE) |

| Central Projects | | | |
|---|---|---|---|
| Z1 | MEMS Magnetoelectric Sensor Fabrication | | Gojdka |
| | | | Meyners (FE, MS) |
| Z2 | Magnetoelectric Sensor Characterization | | Höft (FE, EIE) |
| | | | Rieger (FE, EIE) |
| IRTG | Integrated Research Training Group | | Gerken (FE, EIE) |
| | | | Maetzler (FM, UKSH) |
| | | | McCord (FE, MS) |
| SOP | Scientific Outreach Project | | Enzigmüller |
| | | | Parchmann |
| Z3 | | Signal Processing | Schmidt (FE, EIE) |

**Participating institutions**

**Christian-Albrechts-Universität zu Kiel (CAU)**

**Faculty of Engineering (FE)**
Institute of Electrical and Information Engineering (EIE)
Department of Materials Science (MS)

**Faculty of Mathematics and Natural Sciences (FMNS)**
Institute of Experimental and Applied Physics (IEAP)

**Faculty of Medicine (FM)**
University Hospital Schleswig-Holstein, Campus Kiel (UKSH)
Department for Neurology (UKSH neuro)
ergänzen

**Leibniz-Institute for Science and Mathematics Education (IPN)**

**Fraunhofer Institute for Silicon Technology, Itzehoe (ISIT)**

Weitere ergänzen (Heidelberg, Ilmenau)

**Project Descriptions – Table of Contents**

## 2. Summary of all Projects

### A1: Magnetostrictive Multilayers for Magnetoelectric Sensors

Project website

### Principal Investigators

McCord, Jeffrey, Prof. Dr.-Ing.
06.10.1965

Nanoscale Magnetic Materials – Magnetic Domains
Department of Materials Science
Christian-Albrechts-Universität zu Kiel
Kaiserstr. 2, D-24143 Kiel

Phone: +49 (0) 431 880 6123
E-mail: jmc@tf.uni-kiel.de

Meyners, Dirk, Dr.
22.05.1973

Inorganic Functional Materials
Department of Materials Science
Christian-Albrechts-Universität zu Kiel
Kaiserstr. 2, D-24143 Kiel

Phone: +49 (0) 431 880 6202
E-mail: dm@tf.uni-kiel.de

### Summary of the Research Project

Project A1 focuses on magnetostrictive layer conceptual design, deposition, and post-processing, as well as volumetric magnetic characterization, lateral and time-resolved magnetic imaging. The overall aim of the project is to implement layer schemes with high signal sensitivity and, in conjunction, to eliminate magnetic noise sources that degrade the performance of magnetoelectric (ME) sensors. The challenge is to significantly improve the detection limit of ME sensors while at the same time limiting magnetic domain activity. A second key objective is to establish layer systems for the various sensor concepts that enable the sensors to operate without an external magnetic bias.

The applied thin film approach based on magnetron sputter deposition allows the fabrication of complex multilayer structures with a high degree of design freedom. In the multilayers, magnetic coupling effects across interfaces and structural edges are used to resolve the above-mentioned antagonism while taking into account the different sensor-specific requirements arising from the respective sensor size, excitation schemes, and application scenarios.

In the current period, it has been shown that magnetic or electrical excitation of modulated sensors lead to transitions between domain states with different periodicities, thereby increasing the level of magnetic noise. In SAW sensors wave reflections, wave front dephasing, and secondary wave generation originating from magnetic domain walls have been observed. As a solution, different individual soft magnetic film concepts have been established for converse ME and SAW sensors, which stay single domain even under high amplitude sensor excitation.

In the funding period to be applied for, the portfolio of layer concepts will be extended to solutions for nonlinear sensor characteristics, low losses at high operation frequencies, higher temperature resistance, and defined directional sensor response, in line with new or modified sensor concepts in projects A4, A7, A9, Z1. Magnetically trimmable layer structures that can be precisely tuned to the required sensor characteristics, in particular with working point tuneability will be investigated.

**Project-relevant Previous Publications**

[1] Müller, C.; Durdaut, P.; Holländer, R. B.; Kittmann, A.; Schell, V.; **Meyners, D.**; Höft, M.; Quandt, E.; **McCord, J.**: Imaging of Love Waves and Their Interaction with Magnetic Domain Walls in Magnetoelectric Magnetic Field Sensors. Adv. Elect. Materials**,** 8 (2022), 2200033. DOI: 10.1002/aelm.202200033 (open access).

[2] Schell, V.; Spetzler, E.; Wolff, N.; Bumke, L.; Kienle, L.; **McCord, J.**; Quandt, E.; **Meyners, D.**: Exchange biased surface acoustic wave magnetic field sensors. Sci. Rep.**,** 13 (2023), 8446. DOI: 10.1038/s41598-023-35525-6 (open access).

[3] Thormählen, L.; Seidler, D.; Schell, V.; Munnik, F.; **McCord, J.**; **Meyners, D.**: Sputter Deposited Magnetostrictive Layers for SAW Magnetic Field Sensors. Sensors**,** 21 (2021), 8386. DOI: 10.3390/s21248386 (open access).

[4] Durdaut, P.; Müller, C.; Kittmann, A.; Schell, V.; Bahr, A.; Quandt, E.; Knöchel, R.; Höft, M.; **McCord, J.**: Phase Noise of SAW Delay Line Magnetic Field Sensors. Sensors**,** 21 (2021), 5631. DOI: 10.3390/s21165631 (open access).

[5] Liang, X.; Matyushov, A.; Hayes, P.; Schell, V.; Dong, C.; Chen, H.; He, Y.; Will-Cole, A.; Quandt, E.; Martins, P.; **McCord, J.**; Medarde, M.; Lanceros-Mendez, S.; van Dijken, S.; Sun, N. X.; Sort, J.: Roadmap on Magnetoelectric Materials and Devices. IEEE Trans. Magn.**,** 57 (2021), 1–57. DOI: 10.1109/TMAG.2021.3086635.

[6] Schell, V.; Müller, C.; Durdaut, P.; Kittmann, A.; Thormählen, L.; Lofink, F.; **Meyners, D.**; Höft, M.; **McCord, J.**; Quandt, E.: Magnetic anisotropy controlled FeCoSiB thin films for surface acoustic wave magnetic field sensors. Appl. Phys. Lett.**,** 116 (2020), 073503. DOI: 10.1063/1.5140562.

[7] Urs, N. O.; Golubeva, E.; Röbisch, V.; Toxvaerd, S.; Deldar, S.; Knöchel, R.; Höft, M.; Quandt, E.; **Meyners, D.**; **McCord, J.**: Direct Link between Specific Magnetic Domain Activities and Magnetic Noise in Modulated Magnetoelectric Sensors. Phys. Rev. Applied**,** 13 (2020), 024018. DOI: 10.1103/PHYSREVAPPLIED.13.024018.

[8] Kittmann, A.; Müller, C.; Durdaut, P.; Thormählen, L.; Schell, V.; Niekiel, F.; Lofink, F.; **Meyners, D.**; Knöchel, R.; Höft, M.; **McCord, J.**; Quandt, E.: Sensitivity and noise analysis of SAW magnetic field sensors with varied magnetostrictive layer thicknesses. Sens. Actuator A Phys.**,** 311 (2020), 111998. DOI: 10.1016/j.sna.2020.111998.

[9] Su, J.; Niekiel, F.; Fichtner, S.; Kirchhof, C.; **Meyners, D.**; Quandt, E.; Wagner, B.; Lofink, F.: Frequency tunable resonant magnetoelectric sensors for the detection of weak magnetic field. J. Micromech. Microeng.**,** 30 (2020), 75009. DOI: 10.1088/1361-6439/ab8dd0.

[10] Özden, M.-Ö.; Teplyuk, A.; Gümüs, Ö.; **Meyners, D.**; Höft, M.; Gerken, M.: Magnetoelectric cantilever sensors under inhomogeneous magnetic field excitation. AIP Advances**,** 10 (2020), 025132. DOI: 10.1063/1.5136239 (open access).

Reviewers (to be removed finally)
Jeffrey McCord
Zeynep Altintas
Benjamin Spetzler

## A2: Development of Mechanically Soft Composite Magnetoelectric Multisensory for Wearable Devices

### Principal Investigators

Adelung, Rainer, Prof. Dr. med.
15.03.1971

Functional Nanomaterials
Department of Materials Science
Christian-Albrechts-Universität zu Kiel
Kaiserstr. 2, D-24143 Kiel

Phone: +49 (0) 431 880 6116
E-mail: ra@tf.uni-kiel.de

Ameri, Tayebeh, Prof. Dr.
xx.xx.xxxx

xxx
Department of Materials Science
Christian-Albrechts-Universität zu Kiel
Kaiserstr. 2, D-24143 Kiel

Phone: +49 (0) 431 880 xxxx
E-mail: xx@tf.uni-kiel.de

Schröder, Stefan, Dr.
25.04.1989

Multicomponent Materials
Department of Materials Science
Christian-Albrechts-Universität zu Kiel
Kaiserstr. 2, D-24143 Kiel

Phone: +49 (0) 431 880 6232
E-mail: ssch@tf.uni-kiel.de

### Summary of the Research Project

Project A2 focuses on the development of a mechanically soft composite magnetoelectric multisensory system for wearable devices. The aim is to explore the potential of bio-magnetic applications in self-powered wearables while fabricating hybrid sensors with enhanced functionality. The project builds upon successful hybrid sensor designs from the current funding period and incorporates various components such as flexible magnetic composite structures, magnetostrictive composites with integrated energy harvesting, micro magnetostrictive composites, and flexible (self-polarized) electret thin films for pseudo piezo materials.

The proposed future work builds upon significant achievements in the current funding period, specifically in flexible magnetic composite structures and flexible (self-polarized) electret thin films. Extensive research has enhanced sensor performance through integrated energy harvesting in magnetostrictive composites. Highly stable corona-charged thin film electrets and tuneable pseudo piezoelectric soft materials have also been developed. This solid foundation enables refinement for more advanced mechanically soft composite magnetoelectric multisensory systems in wearable devices.

The research project recognizes the huge application potential of unexplored bio-magnetic applications in self-powered wearable devices. It aims to cooperate with application projects from the B area: It could support B9 for the analysis movement disorders through multi-sensory devices. Furthermore, the project will investigate the feasibility of implantable devices (in exchange with B10) and development of a positioning system for minimal invasive surgery, potentially utilizing a self-powered (electro-)magnetic transmitter (B11(N)).

To achieve its objectives, the project will follow a comprehensive work plan. It will ensure the biocompatibility of the developed materials, e.g. focusing on fluorene-free solutions. The project will integrate multisensory input/output functionalities into the system and develop encapsulation techniques for reliable packaging. It will also involve the integration of magnetic and piezoelectric components, along with the design and fabrication of readout structures and wireless ME-EM (Magnetoelectric-Electromagnetic) transducer structures. Close collaboration with the simulation (A10) and microstructural characterization (A6) ensures a comprehensive understanding of the developed mechanically soft composite magnetoelectric multisensory system in theory and microstructure.

**Project-relevant Previous Publications**

[1] Barg, I.; Kohlmann, N.; Rasch, F.; Strunskus, T.; **Adelung, R.**; Kienle, L. et al. (2023): Strain-Invariant, Highly Water Stable All-Organic Soft Conductors Based on Ultralight Multi-Layered Foam-Like Framework Structures. In: Adv Funct Materials 33 (21), Artikel 2212688. DOI: 10.1002/adfm.202212688.

[2] Brinza, M.; **Schröder, S.**; Ababii, N.; Gronenberg, M.; Strunskus, T.; Pauporte, T.; et al. (2023): Two-in-One Sensor Based on PV4D4-Coated TiO2 Films for Food Spoilage Detection and as a Breath Marker for Several Diseases. In: Biosensors 13 (5). DOI: 10.3390/bios13050538.

[3] Jordt, P.; Wolff, N.; Hrkac, Stjepan B.; Shree, S.; Di W.; Harder, R. J.; et al. (2021): Visualizing Intrinsic 3D-Strain Distribution in Gold Coated ZnO Microstructures by Bragg Coherent X-Ray Diffraction Imaging and Transmission Electron Microscopy with Respect to Piezotronic Applications. In: Adv. Electron. Mater. 7 (11), S. 2100546. DOI: 10.1002/aelm.202100546.

**Keiner der drei PIs ist Autor!**

[4] Ospina, J. D. P.; Langner, S.; **Ameri, T.**; Brabec, C. J. (2017): Solubility and miscibility for diluted polymers and their extension to organic semiconductors. In: Encyclopedia of Physical Organic Chemistry, 6 Volume Set 1, S. 697.

[5] **Schröder, S.**; Ababii, N.; Lupan, O.; Drewes, J.; Magariu, N.; Krüger, H. et al. (2022): Sensing performance of CuO/Cu2O/ZnO:Fe heterostructure coated with thermally stable ultrathin hydrophobic PV3D3 polymer layer for battery application. In: Materials Today Chemistry 23, S. 100642. DOI: 10.1016/j.mtchem.2021.100642.

[6] **Schröder, S.**; Ababii, N.; Brînză, M.; Magariu, N.; Zimoch, L.; Bodduluri, M. T. et al. (2023): Tuning the Selectivity of Metal Oxide Gas Sensors with Vapor Phase Deposited Ultrathin Polymer Thin Films. In: Polymers 15 (3). DOI: 10.3390/polym15030524.

[7] Shadabfar, M.; Ehsani, M.; Khonakdar, H. A.; Abdouss, M.; **Ameri, T.** (2023): Waterborne conductive carbon paste with an eco-friendly binder. In: Cellulose 30 (3), S. 1759–1772. DOI: 10.1007/s10570-022-04998-5.

[8] **RA: Nano Energy, accepted?**

[9] **Schröder, S.**; Brinza, M.; Cretu, V.; Zimoch, L.; Gronenberg, M.; Ababii, N. et al. (2023): A New Approach in Detection of Biomarker 2-propanol with PTFE-coated TiO2 Nanostructured Films. In: accepted manuscript.

[10] **Schröder, S.**; Hinz, A. M.; Strunskus, T.; Faupel, F. (2021): Molecular Insight into Real-Time Reaction Kinetics of Free Radical Polymerization from the Vapor Phase by In-Situ Mass Spectrometry. In: The Journal of Physical Chemistry A 125 (7), 1661-1667. DOI: https://doi.org/10.1021/acs.jpca.0c11180.

**Bitte noch (open access) am Ende vor dem Punkt ergänzen, für jene Paper für die das zutrifft.**

## A4: Development of Mechanically Soft Composite Magnetoelectric Multisensory for Wearable Devices

### Principal Investigators

Rieger, Robert, Prof. Dr.
26.10.1975

Networked Electronic Systems
Institute of Electrical and Information Engineering
Christian-Albrechts-Universität zu Kiel
Kaiserstr. 2, D-24143 Kiel

Phone: +49(0) 431 880 6151
E-mail: rri@tf.uni-kiel.de

Spetzler, Benjamin, Dr.-Ing.
29.04.1992

Micro- and Nanoelectronic Systems
Department of Electrical Engineering and Information Technology
Technische Universität Ilmenau
Ehrenbergstraße 29, D-98693 Ilmenau

Phone: +49 (0) 3677 69- 3222
E-mail: benjamin.spetzler@tu-ilmenau.de

### Summary of the Research Project

This project focuses on developing self-contained sensing dice for planar and 3D magnetic field detection based on miniaturized matrices of ΔE-effect sensors. Grounded on the theory and technology developed in the previous funding period, we will establish spatially resolved multi-directional measurements with miniature sensor arrays not available to-date. Such matrices with high spatial resolution or more than a few independent sensor elements do not exist. Addressing these shortcomings is especially essential for applications targeting mobile measurements. Robust sensing and communication nodes will be realized in MEMS and ASIC technology to enable a compact design of <1 cm³ as a reliable sensing technology for biomedical applications.

Existing sensor system models will be extended to guide the system design and optimize large-scale, three-dimensional sensor matrices, including flux concentrators and flux guides. Upon these findings, sensing structures will be developed and fabricated for the medical applications pursued in the CRC and beyond. Targeted are two-dimensional sensing fields for spatio-temporal monitoring of magnetic activity as well as tri-axial sensing cubes. Each structure will include miniaturized electronics for edge-based signal processing, power management, and communication. This will be done using heterogeneous integration with COTS, MEMS, and ASIC technology.

A close collaboration is envisioned with other projects in the CRC. The sensor fabrication will be based on the shadow-mask technology developed in the previous funding period in A4 and be done in collaboration with A1, Z1, and A6. The electronics development is founded in the sub-circuits and concepts previously developed in A4, which will be used to realize the novel matrix readout and processing electronics. The new concepts and implementations are researched in collaboration with B1 and Z2. Project A4 will maintain continuous engagement with the application projects B10 and B11(N) and supply sensor systems for measurements. Similarly, A4 will provide existing signal and noise models and samples to explore the origin of magnetic noise in collaboration with project A10. It is envisioned that the results and systems realized in this project will also directly impact cutting-edge research beyond this consortium, specifically building fruitful links of exchange with the neighboring CRC 1461 hosted in Kiel that deals with brain-inspired neuromorphic circuits.

**Project-relevant Previous Publications**

[1] **Spetzler, B.**; Bald, C.; Durdaut, P.; Reermann, J.; Kirchhof, C.; Teplyuk, A.; Meyners, D.; Quandt, E.; Höft, M.; Schmidt, G.; Faupel, F.: Exchange biased delta-E effect enables the detection of low frequency pT magnetic fields with simultaneous localization, Scientific Reports, 11(1), (2021) 5269, doi: 10.1038/s41598-021-84415-2 (open access).

[2] **Spetzler, B.**; Wiegand, P.; Durdaut, P.; Höft, M.; Bahr, A.; **Rieger, R.**; Faupel, F.: Modeling and parallel operation of exchange-biased delta-E effect magnetometers for sensor arrays, Sensors, 21(22), (2021) 7594, doi: 10.3390/s21227594 (open access).

[3] Matyushov, A. D.; **Spetzler, B.**; Zaeimbashi, M.; Zhou, J.; Qian, Z.; Golubeva, E. V.; Tu, C.; Guo, Y.; Chen, B. F.; Wang, D.; Will-Cole, A.; Chen, H.; Rinaldi, M.; McCord, J.; Faupel, F.; Sun, N. X.: Curvature and stress effects on the performance of contour-mode resonant ΔE effect magnetometers, Advanced Materials Technologies, 6(9), (2021) 2100294, doi: 10.1002/admt.202100294.

[4] **Spetzler, B.**; Golubeva, E. V.; Friedrich, R.-M.; Zabel, S.; Kirchhof, C.; Meyners, D.; McCord, J.; Faupel, F.: Magnetoelastic coupling and delta-E effect in magnetoelectric torsion mode resonators, Sensors, 21(6), (2021) 2022, doi: 10.3390/s21062022 (open access).

[5] Simmich, S.; Bahr, A.; **Rieger, R.**: Noise Efficient Integrated Amplifier Designs for Biomedical Applications, Electronics, 10(13), 1522, 2021 doi: 10.3390/electronics10131522 (open access).

[6] **Spetzler, B.**; Kirchhof, C.; Reermann, J.; Durdaut, P.; Höft, M.; Schmidt, G.; Quandt, E.; Faupel, F.: Influence of the quality factor on the signal to noise ratio of magnetoelectric sensors based on the delta-E effect, Applied Physics Letters, 114(18), (2019) 183504, doi: 10.1063/1.5096001.

[7] **Rieger, R.**; Rif'an, M.: Integrated ExG, Vibration and Temperature Measurement Front-End for Wearable Sensing, IEEE Trans. Circuits Syst. I – Reg. Papers, 65(8), (2018) 2422–2430, doi: 10.1109/TCSI.2017.2785863.

[8] **Rieger, R.**; Sulistiyanto, N.: Integrated Circuit for Superregenerative Low-Frequency Amplification, IEEE Trans. Circuits Syst. II – Express Briefs, 65(1), (2018) 31–35, doi: 10.1109/TCSII.2017.2672782.

[9] **Rieger, R.**; Ou, S.-H.: Pulse-Width-Modulating Bio-Signal ADC for Rapid ASIC Design and IP Core Re-use, IEEE Design and Test, 33(4), (2016) 49–60, doi: 10.1109/MDAT.2016.2536657.

[10] **Rieger, R.**: Signal-Folding for Range-Enhanced Acquisition and Reconstruction, IEEE Trans. Circuits Syst. I – Reg. Papers, 62(10), (2015) 2617–2625, doi: 10.1109/TCSI.2015.2476317.

Reviewers (to be removed finally)
Benjamin Spetzler | Stefan Schröder | Andreas Bahr

## A6: Microstructure and Structural Change of Magnetoelectric and Piezotronic Sensors

### Principal Investigators

Murphy, Bridget, PD Habil. Dr. rer. nat.
15.06.1969

Ruprecht Haensel Laboratory
Institute of Experimental and Applied Physics
Christian-Albrechts-Universität zu Kiel (CAU)
Leibnizstr. 19, D-24143 Kiel

Phone: +49 (0) 431 880 5558
E-mail: murphy@physik.uni-kiel.de

Kienle, Lorenz, Prof. Dr. rer. nat.
09.04.1967

Synthesis and Real Structure
Department of Materials Science
Christian-Albrechts-Universität zu Kiel (CAU)
Kaiserstr. 2, D-24143 Kiel

Phone: +49 (0) 431 880 6196
E-mail: lk@tf.uni-kiel.de

### Summary of the Research Project

The current limitations of detecting ultralow magnetic fields with state-of-the-art magnetoelectric (ME) sensors impose fundamental material questions to the amorphous and crystalline structure of sensor components. The specific nanostructure and its structural change must be correlated to growth conditions and heat treatments, but also linked to functionality of the operating sensor. Diverse material systems included in thin film sensor concepts are targeted in A6 to examine these structural and functional properties with advanced analytical methods of transmission electron microscopy (TEM) and Synchrotron-based X-ray scattering combining multiscale information with excellent resolution and precision. Together with project partners from A1 we intend to continue the methodological combination of Synchrotron-based pair distribution analysis with advanced electron diffraction techniques to examine the transition from amorphous to (semi-)crystalline states of novel (exchange bias) magnetic (multi-)layer systems (e.g., FeCoSiB, FeCoC, FeGaC, A1) relevant for surface acoustic wave (SAW, A9) and electrically modulated (A7) and ΔE-sensor concepts (A4). A6 aims to understand the impact of sputtering gas pressure and annealing temperatures during sensor preparation and packaging as the essential processing parameters. In situ heating experiments in the TEM and with brilliant Synchrotron X-ray sources will interrelate the short-to-long range ordering with magnetic properties of the sensors.

Together with A9, crystalline piezomaterials (e.g., AlScN) as components of novel SAW thin film sensors will be examined with respect to the crystallographic texture and strain distribution on multiscales. To this context, aberration corrected STEM provides information on epitaxial interface structures and local strain and coherent X-ray diffraction imaging (CXDI) can visualize strain in 3D. The focus will be on the examination of Silicon and Sapphire substrate-based SAW sensor structures during operation to investigate possible substrate losses, e.g. clamping of acoustic waves at structural defects. Novel methodological advances of in operando X-ray scattering will be exploited to design experiments for standing wave excitations and time-resolved pulsed-probe measurements coupled with in situ SEM observations. This approach provides the experimental link between the SAW sensor performance and simulations targeting the material behavior in sensor operation, e.g., the distribution of Rayleigh-wave modes to support the understanding of structural parameters (epitaxial strain, c-axis orientation, etc.) with loss and fatigue phenomena. The ultimate goal of our research is to identify rules for the

synthesis and design of tailor-made materials for highly sensitive and low noise magnetoelectric ME sensors.

**Project-relevant Previous Publications**

[1] Wolff, N.; Braniste, T.; Krüger, H.; Mangelsen, S.; Islam, M. R.; Schürmann, U.; Saure, L. M.; Schütt, F.; Hansen, S.; Terraschke, H.; Adelung, R.; Tiginyanu, I.; **Kienle, L.** Synthesis and Nanostructure Investigation of Hybrid β-Ga2O3/ZnGa2O4 Nanocomposite Networks with Narrow-Band Green Luminescence and High Initial Electrochemical Capacity. Small 2023, 19 (18), 2207492. https://doi.org/10.1002/smll.202207492 (open acess).

[2] Schell, V.; Spetzler, E.; Wolff, N.; Bumke, L.; **Kienle, L.**; McCord, J.; Quandt, E.; Meyners, D. Exchange Biased Surface Acoustic Wave Magnetic Field Sensors. Sci Rep 2023, 13 (1), 8446. https://doi.org/10.1038/s41598-023-35525-6 (open acess).

[3] Su, J.; Fichtner, S.; Ghori, M. Z.; Wolff, N.; Islam, M. R.; Lotnyk, A.; Kaden, D.; Niekiel, F.; **Kienle, L**.; Wagner, B.; Lofink, F. Growth of Highly C-Axis Oriented AlScN Films on Commercial Substrates. Micromachines 2022, 13 (5), 783. https://doi.org/10.3390/mi13050783 (open acess)..

[4] Schönweger, G.; Petraru, A.; Islam, M. R.; Wolff, N.; Haas, B.; Hammud, A.; Koch, C.; **Kienle, L.**; Kohlstedt, H.; Fichtner, S. From Fully Strained to Relaxed: Epitaxial Ferroelectric Al1-XScxN for III-N Technology. Advanced Functional Materials 2022, 32 (21), 2109632. https://doi.org/10.1002/adfm.202109632 (open acess).

[5] Masciocchi, G.; van der Jagt, J. W.; Syskaki, M.-A.; Lamperti, A.; Wolff, N.; Lotnyk, A.; Langer, J.; **Kienle, L**.; Jakob, G.; Borie, B.; Kehlberger, A.; Ravelosona, D.; Kläui, M. Control of Magnetoelastic Coupling in Ni/Fe Multilayers Using He+ Ion Irradiation. Appl. Phys. Lett. 2022, 121 (18), 182401. https://doi.org/10.1063/5.0107942.

[6] Wolff, N.; Fichtner, S.; Haas, B.; Islam, M. R.; Niekiel, F.; Kessel, M.; Ambacher, O.; Koch, C.; Wagner, B.; Lofink, F.; **Kienle, L**. Atomic Scale Confirmation of Ferroelectric Polarization Inversion in Wurtzite-Type AlScN. Journal of Applied Physics 2021, 129 (3), 034103. https://doi.org/10.1063/5.0033205.

[7] Wolff, N.; Jordt, P.; Jetter, J.; Vogt, H.; Lotnyk, A.; Seemann, K.; Ulrich, S.; Quandt, E.; Murphy, B. M.; **Kienle, L**. Nanostabilization of Tetragonal Distorted FeCo Variants in Ultra-Thin FeCo/TiN Multilayer Films. Materials Characterization 2021, 172, 110871. https://doi.org/10.1016/j.matchar.2021.110871.

[8] Islam, Md. R.; Wolff, N.; Yassine, M.; Schönweger, G.; Christian, B.; Kohlstedt, H.; Ambacher, O.; Lofink, F.; **Kienle, L**.; Fichtner, S. On the Exceptional Temperature Stability of Ferroelectric Al1-XScxN Thin Films. Appl. Phys. Lett. 2021, 118 (23), 232905. https://doi.org/10.1063/5.0053649.

[9] Jordt, P.; Wolff, N.; Hrkac, S. B.; Shree, S.; Wang, D.; Harder, R. J.; Kübel, C.; Adelung, R.; Shpyrko, O. G.; Magnussen, O. M.; **Kienle, L.**; **Murphy, B. M.** Visualizing Intrinsic 3D-Strain Distribution in Gold Coated ZnO Microstructures by Bragg Coherent X-Ray Diffraction Imaging and Transmission Electron Microscopy with Respect to Piezotronic

Applications. Advanced Electronic Materials 2021, 7 (11), 2100546. https://doi.org/10.1002/aelm.202100546 (open acess).

[10] Jordt, P.; Hrkac, S. B.; Gröttrup, J.; Davydok, A.; Krywka, C.; Wolff, N.; **Kienle, L**.; Adelung, R.; Magnussen, O. M.; **Murphy, B. M.** Local Strain Distribution in ZnO Microstructures Visualized with Scanning Nano X-Ray Diffraction and Impact on Electrical Properties. Advanced Engineering Materials 2021, 23 (11), 2100201. https://doi.org/10.1002/adem.202100201 (open acess).

## A7: Electrically Modulated Magnetoelectric Sensors

### Principal Investigator

Quandt, Eckhard, Prof. Dr.-Ing.
05.04.1960

Inorganic Functional Materials
Department of Materials Science
Christian-Albrechts-Universität zu Kiel
Kaiserstr. 2, D-24143 Kiel

Phone: +49 (0) 431 880 6200
E-mail: eq@tf.uni-kiel.de

### Summary of the Research Project

Research of the previous funding periods has shown that electrically modulated mesoscopic magnetoelectric composites, targeting high frequency mechanical resonances (the so-called U-modes), far higher than flexural modes, lead to dramatically enhanced overall performance as a magnetic field sensor. In this approach the high frequency resonances are excited with the piezoelectric layer while the sensor is immersed in an inductor, using the converse magnetoelectric effect via the induced voltage as the sensor signal.

In the second funding period the use of exchange biased multilayer dedicated for the inverse magnetoelectric effect resulted in a significant improvement of the limit of detection (LOD). The LODs for sensors using single layer magnetostrictive materials (200 $pT/Hz^{1/2}$ at DC and 70 $pT/Hz^{1/2}$ at 10 Hz) could be improved by an order of magnitude to 16 $pT/Hz^{1/2}$ at DC and 7.5 $pT/Hz^{1/2}$ at 10 Hz. These LODs - which are the best within the CRC - in combination with the bandwidth of about 1 kHz have led to the fact that these sensors could be used for first magnetocardiological investigations.

The research in the third funding period will focus on a further improvement of the achievable LODs by using specifically designed multilayer films (in close collaboration with project A1), by increasing the frequency of the employed U-mode into the low MHz range, by changing the design of the resonator in order to achieve homogeneous stress states within the detection coil and to investigate alternative clamping concepts in order to reduce drift of the resonance frequency, e.g., due to temperature variations. In collaboration with subproject B9, the sensors will be used for more advanced magnetocardiological investigations. According to the specific requirements, the property profile will be adapted accordingly.

### Project-relevant Previous Publications

[1] Elzenheimer, E.; Hayes, P.; Thormählen, L.; Engelhard, E.; Zaman, A.; **Quandt, E.**; Frey, N.; Höft, M.; Schmidt, G.: Investigation of Convers Magnetoelectric Thin-Film Sensors for Magnetocardiography, IEEE Sensors Journal 23 (2023), 5660-5669, DOI: 10.1109/JSEN.2023.3237910

[2] Elzenheimer, E.; Bald, C.; Engelhardt, E.; Hoffmann, J.; Hayes, P.; Arbustini, J.; Bahr, A.; **Quandt, E.**; Höft, M.; Schmidt, G.: Quantitative Evaluation for Magnetoelectric Sensor Systems in Biomagnetic Diagnostics, Sensors 22 (2022), 1018, https://doi.org/10.3390/s22031018.

[3] Liang, X.; Matyushov, A.; Hayes, P.; Schell, V.; Dong, C.; Chen, H.; He, Y.; Will-Cole, A.; **Quandt, E.**; Martins, P.; McCord, J.; Medarde, M.; Lanceros-Méndez, S.; van Dijken, S.; Sun, N. X.; Sort, J.: Roadmap on Magnetoelectric Materials and Devices, IEEE Transactions on Magnetics 57 (2021), 400157, DOI:10.1109/TMAG.2021.3086635

[4] Urs, N. O.; Golubeva, E.; Röbisch, V.; Toxvaerd, S.; Deldar, S.; Knöchel, R.; Höft, M.; **Quandt, E**.; Meyners, D.; McCord, J.: Direct Link between Specific Magnetic Domain Activities and Magnetic Noise in Modulated Magnetoelectric Sensors, Physical Review Applied 13 (2020) 024018, DOI: 10.1103/PhysRevApplied.13.024018.

[5] Hayes, P.; Klug, M. J.; Toxværd, S.; Durdaut, P.; Schell, V.; Teplyuk, A.; Burdin, D.; Winkler, A.; Weser, R.; Fetisov, Y., Höft, M.; Knöchel, R.; McCord, J.; **Quandt, E.**: Converse Magnetoelectric Composite Resonator for Sensing Small Magnetic Fields, Scientific Reports 9 (2019),16355, DOI:10.1038/s41598-019-52657-w.

[6] Tu, C.; Chu, Z-Q.; Spetzler, B.; Hayes, P.; Dong, C.-Z.; Liang, X.-F.; Chen, H.-H.; He, Y.-F.; Lisenkov, I.; Lin, H.; Lin, Y.-H.; McCord, J.; Faupel, F.; **Quandt, E.**; Sun, N.-X.: Mechanical-Resonance-Enhanced Thin-Film Magnetoelectric Heterostructures for Magnetometers, Mechanical Antennas, Tunable RF Inductors, and Filters, Materials 12 (2019), 2259; DOI:10.3390/ma12142259

[7] Jovičević Klug, M.; Thormählen, L.; Röbisch, V.; Toxværd, S. D.; Höft, M.; Knöchel, R.; **Quandt, E.**; Meyners, D.; McCord, J.: Antiparallel exchange biased multilayers for low magnetic noise magnetic field sensors. Applied Physics Letters 114 (2019), 192410, DOI: 10.1063/1.5092942.

[8] Hayes, P.; Schell, V.; Salzer, S.; Burdin, D.; Yarar, E.; Piorra, A.; Knöchel, R.; Fetisov, Y.K.; **Quandt, E.**: Electrically modulated magnetoelectric AlN/FeCoSiB film composites for DC magnetic field sensing, Journal of Physics D: Applied Physics, Vol. 51(2018), doi: 10.1088/1361-6463

[9] Hayes, P.; Salzer, S.; Reermann, J.; Yarar, E.; Röbisch, V.; Piorra, A.; Meyners, D.; Höft, M.; Knöchel, R.; Schmidt, G.; **Quandt, E.**: Electrically modulated magnetoelectric sensors, Appl. Phys. Lett. 108 (2016), 182902. DOI: 10.1063/1.4948470.

[10] Lage, E.; Kirchhof, C.; Hrkac, V.; Kienle, L.; Jahns, R.; Knöchel, R.; **Quandt, E.**; Meyners, D.: Exchange biasing of magnetoelectric composites, Nature Materials 11 (2012), 523-529.

## A8: Modelling of Magnetoelectric Sensors

### Principal Investigator

Gerken, Martina, Prof. Dr.
24.01.1973

Integrated Systems and Photonics
Institute of Electrical and Information Engineering
Christian-Albrechts-Universität zu Kiel (CAU)
Kaiserstr. 2, D-24143 Kiel

Phone: +49 (0) 431 880 6250
E-mail: mge@tf.uni-kiel.de

### Summary of the Research Project

The aim of this project is a theoretical investigation of the behavior of magnetoelectric sensors and sensor arrays based on piezoelectric and magnetostrictive composite materials. In prior research, analytical and numerical methods were developed assuming a linear small-signal behavior with constant material parameters. The behavior of surface-acoustic-wave (SAW) sensors and electrically-modulated cantilever sensors was investigated in cooperation with the experimental project. A second focus was modelling of the deep-brain-stimulation system including sensors in a sensor array as well as the head properties. The simulations are implemented employing the finite element method (FEM).

In the next funding period, one main focus will be the theoretical investigation of SAW sensors with phononic crystal resonant enhancement. Resonant enhancement by structuring of the magnetostrictive phase allows for an amplification for small signal amplitudes while also influencing the magnetic properties. A detailed study of the combined effects will be carried out for different configurations. The second focus will be the multiscale modelling of vector sensor systems for biomedical applications. Here, sensors arranged in arrays with different orientations to achieve vector magnetic field measurements will be studied. The signal response will be calculated for different geometries. A particular focus will be on the interaction with biological tissue regarding the effects of sensor coupling via secondary currents.

This project will collaborate closely on the sensor design with the groups in research area A. On the system aspects, it will be in close cooperation with the corresponding projects in research area B.

### Project-relevant Previous Publications

[1] Schmalz, J.; Spetzler, E.; Mccord, J.; **Gerken, M.**: Investigation of Unwanted Oscillations of Electrically Modulated Magnetoelectric Cantilever Sensors. Sensors, 23(11), (2023), 5012 (open access).

[2] Zuo, S.; Schmalz, J.; Özden, M-Ö.; **Gerken, M.**; Su, J.; Niekiel, F.; Lofink, F.; Nazarpour, K.; Heidari, H.: Ultrasensitive Magnetoelectric Sensing System for Pico-Tesla

MagnetoMyoGraphy. IEEE Transactions on Biomedical Circuits and Systems, 14(5), (2020), 971-984 (open access).

[3] Schmalz, J.; Krantz, M. C.; Knies, A.; Lüder, H.; **Gerken, M.**: Signal-to-noise ratio enhanced electrode configurations for magnetoelectric cantilever sensors, AIP Advances, 10(7), (2020), 075314 (open access).

[4] Schmalz, J.; Kittmann, A.; Durdaut, P.; Spetzler, B.; Faupel, F.; Hoeft, M.; Quandt, E.; **Gerken, M.**: Multi-Mode Love-Wave SAW Magnetic-Field Sensors, Sensors, 20(12), (2020), 3421 (open access).

[5] Krantz, M.; **Gerken, M.**: Limit of Thermal-Vibration Noise in Magnetic Field Detection with Magnetoelectric-Composite Cantilevers, Physical Review Applied, 13(5), (2020), 054047 (open access).

[6] Özden, M-Ö.; Teplyuk, A.; Gümüs, Ö.; Meyners, D.; Höft, M.; **Gerken, M.**: Magnetoelectric cantilever sensors under inhomogeneous magnetic field excitation, AIP Advances, 10(2), (2020), 025132 (open access).

[7] Kittmann, A.; Durdaut, P.; Zabel, S.; Reermann, J.; Schmalz, J.; Spetzler, B.; Meyners, D.; Sun, N. X.; McCord, J.; **Gerken, M.**; Schmidt, G.; Höft, M.; Knöchel, R.; Faupel, F.; Quandt, E.: Wide Band Low Noise Love Wave Magnetic Field Sensor System, Scientific Reports, 8(1), (2018), 278.

[8] Hrkac, S. B.; Koops, C. T.; Abes, M.; Krywka, C.; Müller, M.; Burghammer, M.; Sztucki, M.; Dane, T.; Kaps, S.; Mishra, Y. K.; Adelung, R.; Schmalz, J.; **Gerken, M.**; Lage, E.; Kirchhof, C.; Quandt, E.; Magnussen, O. M.; Murphy, B. M.: Tunable Strain in Magnetoelectric ZnO Microrod Composite Interfaces, ACS Applied Materials and Interfaces, 9(30), (2017), 25571-25577.

[9] Gugat, J. L.; Schmalz, J.; Krantz, M. C.; **Gerken, M.**: Magnetic Flux Concentration Effects in Cantilever Magnetoelectric Sensors, IEEE Trans. Magn. 52 (2016), 7403008.

[10] Kirchhof, C.; Krantz, M; Teliban, J.; Jahns, R.; Marauska, S. Wagner, B.; Knöchel, R.; **Gerken, M.**; Meyners, D.; Quandt, E.: Giant magnetoelectric effect in vacuum, Appl. Phys. Lett. 102 (2013), 232905.

## A9: Surface Acoustic Wave Magnetic Field Sensors

### Principal Investigators

Quandt, Eckhard, Prof. Dr.-Ing.
05.04.1960

Inorganic Functional Materials
Department of Materials Science
Christian-Albrechts-Universität zu Kiel
Kaiserstr. 2, D-24143 Kiel

Phone: +49 (0) 431 880 6200
E-mail: eq@tf.uni-kiel.de

Lofink, Fabian, Prof. Dr. rer. nat.
05.09.1977

Microsystem Materials
Department of Materials Science
Christian-Albrechts-Universität zu Kiel
Kaiserstr. 2, D-24143 Kiel

Phone: +49 (0) 4821 17 1198
E-mail: fabian.lofink@isit.fraunhofer.de

### Summary of the Research Project

Based on initial investigations on Love wave Surface Acoustic Wave (SAW) sensors in the first funding period of the CRC 1261 under project A3, the new project A9 on SAW sensors was started in the second funding period, which includes two parts: (1) SAW sensors based on quartz single crystals (SC SAW) and (2) based on AlScN layers on Si wafers (Thin Film SAW). The two parts are closely related, since processing and material selection for the interdigital transducer electrodes, the guiding, and the magnetic layer systems are done in a comparable way. Both concepts use the ΔE-effect in magnetostrictive layer systems as the sensing mechanism. These sensors use shear horizontal acoustic surface waves that are guided by a guiding layer (Love waves) with an amorphous magnetostrictive layer system on top. The velocity of these waves follows the magnetoelastically-induced changes of the shear modulus according to the magnetic field present. The delay line operation of the SAW sensor translates these changes into a phase shift.

In the current second funding period, in case of the SC SAW sensors a number of design parameters have been investigated for their influence with respect to the achieved limit of detection (LOD). The best results were achieved with the employment of exchanged biased magnetostrictive layers, since this significantly suppressed the noise caused by magnetic domains without compromising the sensitivity. The achieved LODs are 28 $pT/Hz^{1/2}$ at 10 Hz and 10 $pT/Hz^{1/2}$ at 100 Hz, which corresponds to an improvement of approximately a factor of 8 compared to the values at the beginning of the funding period. The work of this funding period will be focused on a further improvement of the sensor's performance by (1) systematic investigations of the use of ferroelectric crystals (instead of quartz), which allows, e.g., a wide range in the variation of the operational frequency, and (2) the investigation on specially designed exchanged biased magnetostrictive layers, which allow the operation of these sensors without a magnetic bias field.

For thin film SAW sensors, the c-axis oriented growth of the AlScN acoustic layer on Si(100), SiO2 and sapphire was first investigated in the 2nd funding period. It was found that the use of an AlN seed layer significantly increased the layer growth (c-axis quality, piezo-acoustic coupling) even for Sc concentrations > 30% and thus improved the acoustic quality. Accordingly fabricated acoustical layers were then investigated in different layer stacks for thin film SAW sensors, with first measurements already showing a sensitivity of 1000°/mT and a LOD of 72 pT/√Hz at 10 kHz. Design studies of layer stacks and IDT apertures have been performed, and the corresponding devices are being fabricated. To increase sensitivity and suppress noise, the

use of phononic crystals in the delay line of a SAW was modeled. Aspects of patterning and integration of such acoustic quasicrystals have been investigated. Work in this funding period will focus on measures to improve sensitivity and LOD of thin film SAW sensors. To this end, the concept of phononic crystals in the delay line is further investigated. Next, the substrate losses (clamping and energy dissipation) and their reduction are studied. To increase the amplitude of shear waves in thin film SAWs, growth of AlScN with inclined c-axis on sapphire is explored.

**Project-relevant Previous Publications**

[1] Schell, V.; Spetzler, E.; Wolff, N.; Bumke, L.; Kienle, L.; McCord, J.; **Quandt, E.**; Meyners, D.: Exchange biased surface acoustic wave magnetic field sensors, Scientific Reports, accepted.

[2] Moench, S.; Meyer, J.; Zukauskaite, A.; Lebedev, V.; Fichtner, S.; Su, J.; Niekiel, F.; Giese, T.; Thormählen, L.; **Quandt, E.**; **Lofink**, **F.**: AlScN-Based SAW Magnetic Field Sensor for Isolated Closed-Loop Hysteretic Current Control of Switched-Mode Power Converters, IEEE Sensors Letters 6(101), 2500904 (2022), 10.1109/LSENS.2022.3205853

[3] Müller, C.; Durdaut, P.; Holländer, R. B.; Kittmann, A.; Schell, V.; Meyners, D.; Höft, M.; **Quandt, E.**; McCord, J.: Imaging of Love Waves and Their Interaction with Magnetic Domain Walls in Magnetoelectric Magnetic Field Sensors, Advanced Electronic Materials 8 (2022), 2200033, DOI:10.1002/aelm.202200033

[4] Su, J.; Fichtner, S.; Ghori, M. Z.; Wolff, N.; Islam, Md. R.; Lotnyk, A.; Kaden, D.; Niekiel, F.; Kienle, L.; Wagner, B.; **Lofink**, **F.:** Growth of Highly c-Axis Oriented AlScN Films on Commercial Substrates, Micromachines, 13(5), 783 (2022), 10.3390/mi13050783

[5] Meyer, J. M.; Schell, V.; Su, J.; Fichtner, S.; Yarar, E.; Niekiel, F.; Giese, T.; Kittmann, A.; Thormählen, L.; Lebedev, V.; Moench, S.; Zukauskaite, **A.; Quandt, E.; Lofink, F.**: Thin-Film-Based SAW Magnetic Field Sensors, Sensors 21 (2021), 8166, https://doi.org/10.3390/s21248166.

[6] Wolff, N.; Fichtner, S.; Haas, B.; Islam, M. R.; Niekiel, F.; Kessel, M.; Ambacher O., Koch, Ch.; Wagner, B.; **Lofink**, **F.**; Kienle, L.: Atomic Scale Confirmation of Ferroelectric Polarization Inversion in Wurtzite-Type AlScN, J. Appl. Phys. 129, 034103 (2021), 10.1063/5.0033205

[7] Schell, V., Müller, C.; Durdaut, P.; Kittmann, A.; Thormählen, L.; **Lofink, F.**; Meyners, D.; Höft, M.; McCord, J.; **Quandt, E.**: Magnetic anisotropy controlled FeCoSiB thin films for surface acoustic wave magnetic field sensors, Appl. Phys. Lett. 116 (2020), 073503, https://doi.org/10.1063/1.5140562.

[8] Kittmann, A.; Müller, C.; Durdaut, P.; Thormählen, L.; Schell, V.; Niekiel, F.; **Lofink, F.**; Meyners, D.; Knöchel, R.; Höft, M.; McCord, J.; **Quandt, E.**: Sensitivity and noise analysis of SAW magnetic field sensors with varied magnetostrictive layer thicknesses, Sensors and Actuators A 311 (2020), 111998, https://doi.org/10.1016/j.sna.2020.111998.

[9] Kittmann, A.; Durdaut, P.; Zabel, S.; Reermann, J.; Schmalz, J.; Spetzler, B.; Meyners, D.; Sun, N.X.; McCord, J.;, Gerken, M.; Schmidt, G.; Höft, M.; Knöchel, R.; Faupel, F.;

**Quandt, E.**: Wide Band Low Noise Love Wave Magnetic Field Sensor System, Scientific Reports, (2018) 8:278, DOI:10.1038/s41598-017-18441-4.

[10] Lage, E.; Kirchhof, C.; Hrkac, V.; Kienle, L.; Jahns, R.; Knöchel, R.; **Quandt, E.**, Meyners, D.: Exchange biasing of magnetoelectric composites, Nature Materials 11 (2012), 523-529.

Reviewer (to be removed finally)
Michael Höft | Martina Gerken | Björn Gojdka

## A10: Influence of Imperfections on the Magnetic Noise of Magnetoelectric Sensors – Modeling and Experiment

### Principal Investigators

McCord, Jeffrey, Prof. Dr.-Ing.
06.10.1965

Nanoscale Magnetic Materials – Magnetic Domains
Department of Materials Science
Christian-Albrechts-Universität zu Kiel
Kaiserstr. 2, D-24143 Kiel

Phone: +49 (0) 431 880 6123
E-mail: jmc@tf.uni-kiel.de

Wulfinghoff, Stephan, Prof. Dr.-Ing.
23.12.1982

Computational Materials Science
Department of Materials Science
Christian-Albrechts-Universität zu Kiel
Kaiserstr. 2, D-24143 Kiel

Phone: +49 (0) 431 880 6243
E-mail: swu@tf.uni-kiel.de

### Summary of the Research Project

A detailed understanding of the magnetic noise behavior in magnetoelectric sensor structures is of fundamental interest for the realization of magnetic field sensors with ultra-low detection limits. The aim of the project is to understand and quantify the influence of geometrical and physical imperfections on the magnetic noise of magnetoelectric sensors. Magnetically relevant imperfections include physical deviations that distinguish the real system from an idealized one. Examples are inhomogeneous magnetic material properties, local eigenstresses, and especially a field-varying magnetic domain structure including magnetic domain walls. Magneto-thermal noise contributions and mechano-magnetoelastic nonlinearities also contribute to the magnetic noise behavior, the ultimate limits of which are not yet understood.

Dedicated experimental characterization, such as structural analysis, magnetometry, time-resolved in-situ magneto-optical magnetic domain response analysis and electrical noise measurements, will be combined with analytical models, micromagnetic models, and newly developed multiscale simulation methods with the goal of eventually transferring the knowledge about the microscopic noise origins, gained during the current funding period to the full sensor scale. The influence of material and micromagnetic aspects as well as sensor design will be investigated. Different sensor types will be covered in combination with noise investigations. This will provide the most relevant insights into the noise influencing magnetic features, and we will allow us to derive strategies for noise reduction as well as identify possible final feasibility limits.

The investigations will be completed together with the layer design in project A1, the sensor modeling in project A8, and the sensor concepts in projects A4, A7, and A9. Relevant structural parameters will be investigated together with project A6.

### Project-relevant Previous Publications

[1] Schmalz, J.; Spetzler, E.; **McCord, J.**; Gerken, M.: Investigation of Unwanted Oscillations of Electrically Modulated Magnetoelectric Cantilever Sensors. Sensors**,** 23 (2023), 5012. DOI: 10.3390/s23115012 (open access).

[2] Dorn, C.; **Wulfinghoff, S.**: Computing Magnetic Noise with Micro-Magneto-Mechanical Simulations, IEEE Transactions on Magnetics, 59 (2023), 1-4. DOI: 10.1109/TMAG.2022.3212764.

[3] Dorn, C.; **Wulfinghoff, S.**: A Magneto-Mechanically Coupled Material Model for Magnetic Sensor Investigation, Proc. Appl. Math. Mech., 22 (2023), e202200008. DOI: 10.1002/pamm.202200008.

[4] Schell, V.; Spetzler, E.; Wolff, N.; Bumke, L.; Kienle, L.; **McCord, J.**; Quandt, E.; Meyners, D.: Exchange biased surface acoustic wave magnetic field sensors. Sci. Rep.**,** 13 (2023), 8446. DOI: 10.1038/s41598-023-35525-6 (open access).

[5] Müller, C.; Durdaut, P.; Holländer, R. B.; Kittmann, A.; Schell, V.; Meyners, D.; Höft, M.; Quandt, E.; **McCord, J.**: Imaging of Love Waves and Their Interaction with Magnetic Domain Walls in Magnetoelectric Magnetic Field Sensors. Adv. Elect. Materials**,** 8 (2022), 2200033. DOI: 10.1002/aelm.202200033 (open access).

[6] Sielenkämper, M.; **Wulfinghoff, S.**: A thermomechanical finite strain shape memory alloy model and its application to bistable actuators. Acta Mechanica, 233(8) (2022), 3059-3094. DOI: 10.1007/s00707-022-03236-0.

[7] Durdaut, P.; Müller, C.; Kittmann, A.; Schell, V.; Bahr, A.; Quandt, E.; Knöchel, R.; Höft, M.; **McCord, J.**: Phase Noise of SAW Delay Line Magnetic Field Sensors. Sensors**,** 21 (2021), 5631. DOI: 10.3390/s21165631 (open access).

[8] Urs, N. O.; Golubeva, E.; Röbisch, V.; Toxvaerd, S.; Deldar, S.; Knöchel, R.; Höft, M.; Quandt, E.; Meyners, D.; **McCord, J.**: Direct Link between Specific Magnetic Domain Activities and Magnetic Noise in Modulated Magnetoelectric Sensors. Phys. Rev. Applied**,** 13 (2020), 024018. DOI: 10.1103/PHYSREVAPPLIED.13.024018.

[9] Durdaut, P.; Rubiola, E.; Friedt, J.-M.; Müller, C.; Spetzler, B.; Kirchhof, C.; Meyners, D.; Quandt, E.; Faupel, F.; **McCord, J.**; Knöchel, R.; Höft, M.: Fundamental Noise Limits and Sensitivity of Piezoelectrically Driven Magnetoelastic Cantilevers. J. Microelectromech. Syst.**,** 29 (2020), 1347–1361. DOI: 10.1109/JMEMS.2020.3014402.

[10] **Wulfinghoff, S.**; Cavaliere, F.; Reese, S.: Model order reduction of nonlinear homogenization problems using a Hashin–Shtrikman type finite element method. Computer Methods in Applied Mechanics and Engineering, 330 (2018), 149-179. DOI: 10.1016/j.cma.2017.10.019.

Reviewer (to be removed finally)
Dirk Meyners | Stefan Schröder | Stephan Wulfinghoff

## B1: Sensor Noise Performance and Analogue System Design

### Principal Investigators

Höft, Michael, Prof. Dr.-Ing.
02.07.1972, German

Microwave Engineering
Institute of Electrical and Information Engineering
Christian-Albrechts-Universität zu Kiel
Kaiserstr. 2, D-24143 Kiel

Phone: +49 (0) 431 880 6150
E-mail: mh@tf.uni-kiel.de

Rieger, Robert, Prof. Dr.
26.10.1975, German

Networked Electronic Systems
Institute of Electrical and Information Engineering
Christian-Albrechts-Universität zu Kiel
Kaiserstr. 2, D-24143 Kiel

Phone: +49 (0) 431 880 6151
E-mail: rri@tf.uni-kiel.de

### Summary of the Research Project

This project is aiming at customized analog signal processing, analogue signal conditioning, as well as sensor conditioning for the different magnetoelectric sensors which are researched in the CRC. Therefore, it provides the essential link between sensor hardware (A projects) and various applications (B projects). It also plays an important role in the overall measurement system design, which is required for bringing magnetoelectric sensors to application in biomagnetic diagnostics.

An in-depth noise analysis of the different magnetoelectric sensors provides the basis for the design of sensor systems that have a high signal-to-noise ratio (SNR) and are optimized for a specific application. Finding and adjusting the optimal operating point of a sensor is one of the major challenges for designing a robust sensor system. Consequently, it is necessary to investigate different methods for sensor conditioning. Possible techniques to be investigated range from impedance matching of interdigital transducers (IDTs) in surface acoustic wave magnetoelectric sensors to the creation of advanced and functional printed circuit boards (PCBs) using additive manufacturing techniques, and to the adaptation and/or compensation of the Earth's magnetic field with system-intrinsic coil systems on PCB level. In addition, the focus will be on the integration capability of the complete sensor systems using combinations of highly optimized application specific integrated circuits (ASICs), field programmable gate arrays (FPGAs), and System-in-package integration (SIP). This opens new possibilities for the implementation of complex modulation and readout methods for electrically modulated magnetoelectric sensors as well as the application of different sensor concepts in large area arrays. As a result, electronics, techniques for sensor conditioning and readout mechanisms are expected to be found that provide the same performance in terms of SNR and limit of detection in a usual clinical environment as under laboratory conditions.

All findings regarding the noise behavior of the sensitive elements are reported back to the A projects, and the B projects will be equipped with the latest measurement systems. All new concepts are being investigated and established in close cooperation with project Z2.

**Project-relevant Previous Publications**

[1] Durdaut, P.; **Höft, M.**: Performance Analysis of Resonantly Driven Piezoelectric Sensors Operating in Amplitude Mode and Phase Mode. Sensors 2023, 23, 1899, doi: 10.3390/s23041899 (open access).

[2] Wang, H.; Arbustini, J.; Elzenheimer, E.; Schell, V.; **Höft, M.**; Quandt, E.; Schmidt, G.; Heidari, H.; Bahr A.: Study of Chopping Magnetic Flux Modulation on Surface Acoustic Wave Based Magnetic Sensor, 29th IEEE International Conference on Electronics, Circuits and Systems, 2022, 1-4, doi: 10.1109/ICECS202256217.2022.9970919.

[3] Muñoz, J.; Arbustini, J.; Elzenheimer, E.; Hoffmann, J.; Thormählen, L.; Hayes, P.; Niekiel, F.; Heidari, H.; **Höft, M.**; Quandt, E.; Schmidt, G.; Bahr A.: Digital Approaches on Frequency Tuning for Magnetoelectric Sensors**,** 29th IEEE International Conference on Electronics, Circuits and Systems (ICECS), 2022, doi: 10.1109/ICECS202256217.2022.9970919.

[4] Wolframm, H.; Schell, V.; Quandt, E.; **Höft, M.**; Bahr, A.: High sensitivity magnetoelastic surface acoustic wave (SAW) magnetic field sensors, Proc. SPIE 12205, Spintronics XV, 1220505 (3 October 2022), doi: 10.1117/12.2633398.

[5] Arbustini, J.; Muñoz, J.; Wang, H.; Elzenheimer, E.; Hoffmann, J.; Thormählen, L.; Hayes, P.; Niekiel, F.; Heidari, H.; **Höft, M.**; Quandt, E.; Schmidt, G.; Bahr, A.: MEMS Magnetic Field Source for Frequency Conversion Approaches for ME Sensors**,** Current Directions in Biomedical Engineering 8 (2), 2022, 309-312, doi: 10.1515/cdbme-2022-1079 (open access).

[6] Elzenheimer, E.; Bald C.; Engelhardt, E.; Hoffmann, J.; Hayes, P.; Arbustini, J.; Bahr A.; Quandt, E.; **Höft, M.**; Schmidt, G.: Quantitative Evaluation for Magnetoelectric Sensor Systems in Biomagnetic Diagnostics**,** Sensors, 22 (3), 1018, 2022, doi: 10.3390/s22031018 (open access).

[7] Simmich, S.; **Rieger, R**.: Analysis of Current-Reuse and Split-Voltage Topology for Biomedical Amplifier Arrays, IEEE PRIME, Villasimius, Italy, 2022, doi: 10.1109/PRIME55000.2022.9816819.

[8] Spetzler, B.; Wiegand, P.; Durdaut, P.; **Höft, M.**; Bahr, A.; **Rieger, R.**; Faupel, F.: Modeling and Parallel Operation of Exchange-Biased Delta-E Effect Magnetometers for Sensor Arrays, Sensors, 21 (22), 7594, 2021, doi: 10.3390/s21227594 (open access).

[9] Simmich, S.; Bahr, A.; **Rieger, R.**: Noise Efficient Integrated Amplifier Designs for Biomedical Applications, Electronics, 10 (13), 1522, 2021, doi: 10.3390/electronics10131522 (open access).

[10] **Rieger, R.**; Rif'an, M.: Integrated ExG, Vibration and Temperature Measurement Front-End for Wearable Sensing, IEEE Trans. Circuits Syst. I - Reg. Papers, 65(8), (2018) 2422–2430, doi: 10.1109/TCSI.2017.2785863.

Reviewer (to be removed finally)
Julius Pochhammer
Bridget Murphy
Fabian Lofink

## B2: Digital Signal Processing

### Principal Investigators

Bergholz, Robert, Prof. Dr. med.
27.06.1976

Pediatric Surgery

University Hospital Schleswig-Holstein,
Campus Kiel
Christian-Albrechts-Universität zu Kiel
Arnold-Heller-Str. 3, Haus 41, D-24105 Kiel

Phone: +49 (0) 431 500 20409
E-mail: robert.bergholz@uksh.de

**Ellrichmann**, Mark, Prof. Dr. med., MaHM
14.01.1975

Interdisciplinary Endoscopy
Medical Department 1
University Hospital Schleswig-Holstein,
Campus Kiel
Christian-Albrechts-Universität zu Kiel
Arnold-Heller-Str. 3, Haus 41, D-24105 Kiel

Phone: +49 (0) 431 500 22373
E-mail: mark.ellrichmann@uksh.de

Schmidt, Gerhard, Prof. Dr.-Ing
23.11.1971

Digital Signal Processing and System Theory
Institute of Electrical and Information
Engineering
Christian-Albrechts-Universität zu Kiel
Kaiserstr. 2, D-24143 Kiel

Phone: +49 (0) 431 880 6125
E-mail: gus@tf.uni-kiel.de

### Summary of the Research Project

The objective of this project is to establish and enhance a general digital frontend that connects the sensor system outputs after analogue enhancement (project B1) with the (bio-) medical applications of the CRC. This includes several stages of digital enhancement as well as localization and calibration stages.

In the previous funding period the read-out schemes of the magnetoelectric sensors (mainly established in the first funding period) are extended towards multichannel approaches. In the largest work package, the positions and orientations of the sensors are determined. Using six to eight magnetic actuators, a precision of about 2 cm and 20 ° could be achieved with rather simple sensor models (point models) in real-time. Furthermore, blind source separation algorithms had been implemented that allowed, for instance, the separation of heart signals of pregnant woman and their fetuses, which was tested in real-time with artificially generated signals. Finally, nonlinearities at high signal amplitudes were compensated by extending the existing noise cancellation schemes towards non-linear noise cancellation approaches. Overall, the resulting system was able to bridge the gap between sensor and application projects, passing the improved sensor signals, as well as the estimated positions and orientations of the sensors, to the application projects, where the signals and positions/orientations were used to solve inverse problems.

During the forthcoming funding period, the aforementioned system is intended to undergo further expansion through the incorporation of "online" sensor calibration, accompanied by

appropriate equalization structures. In this context, "online" refers to the implementation of adaptive calibration procedures that are carried out in real-time during medical interventions. The objective is to enhance the system's calibration capabilities, allowing it to dynamically adapt and optimize sensor performance throughout the course of those procedures.

The procedures chosen for translation of the system into actual medical applications are:

1. **Tracking of an endoscopic smart pill**: Several gastrointestinal and neurological diseases are accompanied by an impaired motility of the small bowel. So far, only few modalities are available that can either quantify or visualize the gastrointestinal functionality. All of these diagnostic options encounter several drawbacks in clinical practice: low sensitivity, time consuming, costly and lack of function during physical activity. To overcome the mentioned disadvantages, project B13(N) will investigate the use of an endoscopic smart pill that is (in its final stage) swallowed by the patient and transported within the small and large intestine until it is expelled via naturalis. The smart pill will consist of MEMS cantilevers with an integrated hard magnet acting as a narrow-band transmitter. The respective positions and movements of the MEMS actuators within the gastrointestinal tract will be localized in B2 by fixed a setup with fixed sensor positions in a multidimensional manner.
2. **Tracking of the distal tip of an endoscope:** In gastrointestinal endoscopy, despite a direct view onto the mucosal surface, localizing the exact position of the tip of an endoscope (i.e. in the colon and with an echoendoscope) can be very challenging. Therefore, the determination of the position of the distal tip of the endoscope in relation to anatomical landmarks implies a great clinical need in training and routine. Electromagnetic actuators, developed in Z1 and B13N, will be attached to the distal tip of an endoscope, respective signals will be picked up by sensors at the body surface of the patient thereby calculating the precise position and orientation of the scope withing the body in a three-dimensional image.
3. **Tracking of an ultrasound probe** (either an external probe scanning through the patient’s surface, such as in routine abdominal ultrasound examinations or intracorporal ultrasound that is used on a rod-shaped device during surgical procedures): Currently, the documentation of the pose of the ultrasound devices relies on the examiner manually noting the position and line of view, which is error-prone and acts as a confounder for the imaging diagnostics. An automated pose estimation will erase this user dependent bias. Furthermore, magnetic localization can be combined with the analysis of the ultrasound data in order to further enhance the pose (position and localization) estimation. The pose estimation schemes could be extended from routine 2D to novel 3D ultrasound devices. The combination of the pose of the ultrasound probe with the images generated can lead to a three-dimensional reconstruction of the examined organs and structures and may lead to a completely novel imaging modality not yet existent in clinical practice.

Finally, adaptive signal enhancement stages will be investigated that help sensor operation during strong magnetic DC fields as they appear whenever magnetic nano particles need to be excited.

**Project-relevant Previous Publications**

[1] **Schmidt, G.**; **Bergholz, R.**; Quandt, E.; Sun, N.; Klinkenbusch, L.; Bald, C.; Schmidt, T.: Vorrichtung zur Posenschätzung eines magnetfeldmessenden Objekts, (2023) patent application DE 10 2023 116 342.6.

[2] Bald, C.; **Bergholz, R.**; **Schmidt, G.**: Automatic Localization of an Ultrasound Probe with the Help of Magnetic Sensors, Current Directions in Biomedical Engineering, vol. 8, no. 2, pp. 317-320, 2022, DOI: 10.1515/cdbme-2022-1081 (open access).

[3] Elzenheimer E.; Bald C.; Engelhardt E.; Hoffmann J.; Hayes P.; Arbustini J.; Bahr A.; Quandt E.; Höft M.; **Schmidt G.**: Quantitative Evaluation for Magnetoelectric Sensor Systems in Biomagnetic Diagnostics, MDPI Sensors, vol. 22, no. 3, 1018, 2022, DOI:10.1515/cdbme-2022-1176 (open access).

[4] Bald, C.; **Schmidt, G.**: Processing Chain for Localization of Magnetoelectric Sensors in Real-time, MDPI Sensors, vol. 21, issue 16, 5675 (2021), DOI: 10.3390/s21165675 (open access).

[5] Spetzler, B.; Bald, C.; Durdaut, P.; Reermann, J.; Kirchhof, C.; Teplyuk, A.; Meyners, D.; Quandt, E.; Höft, M.; **Schmidt, G.**; Faupel, F.: Exchange Biased Delta-E Effect Enables the Detection of Low Frequency pT Magnetic Fields with Simultaneous Localization, Scientific Reports 11, Article no. 5269, (2021), DOI: 10.1038/s41598-021-84415-2 (open access).

[6] **Ellrichmann, M.**; Bethge, J.; Boesenkoetter, J.; Conrad, C.; Noth, R.; Bahmer, T.; Nikolaus, S.; Aden, K.; Zeissig, S.; Schreiber, S.: Subclinical Pulmonary Involvement in Active IBD Responds to Biologic Therapy. J Crohns Colitis, vol. 2, no. 15, pp. 1339-1345, (2021), DOI: 10.1093/ecco-jcc/jjab024.

[7] **Bergholz, R**.; Fromm. F.; Meinzer, A.; Muehlfeld, C.; Boettcher, M.; Wenke, K.; Tiemann, B.; Reinshagen, K.; Krebs, T.: Stereological Lung Parameters After Fetoscopic Abdominal Decompression of Congenital Diaphragmatic Hernia in an Ovine Model: A Pilot Study. J Laparoendosc Adv Surg Tech A, (2021), vol 31, no 6, pp 712-718 DOI: 10.1089/lap.2020.0954.

[8] **Bergholz, R.**; Krebs, T.; Cremieux, B.; Georgi, C.; Fromm, F.; Boettcher, M.; Andreas, T.; Tiemann, B.; Wenke, K.; Reinshagen, K.; Hecher, K.: Fetoscopic techniques for prenatal covering of gastroschisis in an ovine model are technically demanding and do not lead to permanent anchoring on the fetus until the end of gestation. Surg Endosc. Surgical Endoscopy, (2021), vol 35, no 2, 745-753, DOI: 10.1007/s00464-020-07441-7.

[9] Ye, L.; Yuan, X.; Pang, M.; Bethge, J.; **Ellrichmann, M.;** Du, J.; Zeng, X.; Tang, C.; Schreiber, S.; Hu, B.: Magnetic bead-assisted endoscopic submucosal dissection: a gravity-based traction method for treating large superficial colorectal tumors. Surg Endosc., vol. 33, no. 6, pp. 2034-2041, 2019, DOI: 10.1007/s00464-019-06799-7.

[10] Durdaut, P.; Reermann, J.; Zabel, S.; Kirchhof, C.; Quandt, E.; Faupel, F.; **Schmidt, G.**; Knöchel, R.; Höft, M.: Modeling and Analysis of Noise Sources for Thin-Film Magnetoelectric Sensors Based on the Delta-E Effect, IEEE Transactions on Instrumentation and Measurement, vol. 66, no. 10, pp. 2771-2779, 2017, DOI: 10.1109/TIM.2017.2709478.

Reviewer (to be removed finally)
Ann-Kristin Helmers
Julius Pochhammer
Fabian Lofink

## B9: Magnetoelectric Sensors for Movement Detection and Analysis

### Principal Investigators

Maetzler, Walter Prof. Dr. med.
09.09.1971

Neurogeriatrics
Department of Neurology, University Hospital Schleswig-Holstein, Campus Kiel
Christian-Albrechts-Universität zu Kiel
Arnold-Heller-Str. 3, Haus 41, D-24105 Kiel

Phone: +49 (0) 431 500 23981
E-mail: w.maetzler@neurologie.uni-kiel.de

Schmidt, Gerhard, Prof. Dr.-Ing
23.11.1971

Digital Signal Processing and System Theory
Department of Electrical Engineering and Information Engineering
Christian-Albrechts-Universität zu Kiel
Kaiserstr. 2, D-24143 Kiel

Phone: +49 (0) 431 880 6125
E-mail: gus@tf.uni-kiel.de

### Summary of the Research Project

This project investigates the potential of an entirely novel movement detection strategy based on magnetoelectric (ME) sensors to detect pathological movement. Parkinson's disease, stroke, and Multiple Sclerosis serve as model diseases. We argue that an ME-based movement detection and analysis system combines advantages of ambulatory movement detection techniques (e.g., flexible use, affordable, exact, and objective), while over-coming relevant disadvantages and shortcomings of currently used movement detection systems (for example, it allows analysis of relative movement between sensors, network analysis across sensors, and does not have drift).

During the first funding period (2019-2023), we initially demonstrated the application of ME sensors in motion analysis based on a simplified 1D motion scenario. To transfer these results into medical applications, a comprehensive real-time simulation pipeline (digital twin) based on a kinematic and a magnetic model was established. Subsequently, a method for full 6D motion sensing in a distributed sensor/actuator network was developed. This includes collaboration with related CRC projects to develop novel 3D ME sensors and 3D actuators. The method was applied to the estimation of foot kinematics in a clinical pilot study.

Eventually, by the end of this funding period, a detection algorithm for human movements in the range of 40-50 cm (sensor-actuator distance) is available, which has an accuracy of few cm, and can be used to distinguish between physiological and pathological movements, e.g. during walking. This algorithm can be applied in parallel to a network of at least two coils and three sensors.

Our central goal for the next funding period is the advancement of our system towards a home assessment-like scenario. AI-based algorithms like deep neural networks are to be used in both activity and pathology classification. We propose algorithm training based on databases established as part of the Keep Control project (Warmerdam et al. 2021 & 2022), supported by our digital twin approach (data generation and augmentation). The hardware is to be improved to the extent that a scaled up wearable sensor/actuator network can be operated in a performance-optimized and power-efficient way. This includes the exploitation of ME sensor-specific features like activity detection and resonance frequency-shifting. The detection

algorithm is to incorporate data from supplementary sensors (like inertial measurement units) in terms of a sensor fusion approach.

This system will substantially add to our general understanding of physiological and pathological human movement under supervised and unsupervised conditions.

**Project-relevant Previous Publications**

[1] Hoffmann, J.; Bald, C.; Schmidt, T.; Boueke, M.; Engelhardt, E.; Krüger, K.; Elzenheimer, E.; Hansen, C.; **Maetzler, W.**; **Schmidt, G.**: Designing and Validating Magnetic Motion Sensing Approaches with a Real-time Simulation Pipeline. Current Directions in Biomedical Engineering, (2023), (accepted).

[2] Hoffmann, J.; Roldan-Vasco, S.; Krüger, K.; Niekiel, F.; Hansen, C.; **Maetzler, W.**; Orozco-Arroyave, J.R.; **Schmidt, G.**: Pilot Study: Magnetic Motion Analysis for Swallowing Detection Using MEMS Cantilever Actuators. Sensors, (2023), 3594, DOI: 10.3390/s23073594 (open access).

[3] Hoffmann, J.; Hansen, C.; **Maetzler, W.**; **Schmidt, G.**: A Concept for 6D Motion Sensing with Magnetoelectric Sensors. Current Directions in Biomedical Engineering 8(2), (2022), 451-454, DOI: 10.1515/cdbme-2022-1115 (open access).

[4] Romijnders, R.; Warmerdam, E.; Hansen, C.; **Schmidt, G.**; **Maetzler, W.**: A Deep Learning Approach for Gait Event Detection from a Single Shank-Worn IMU: Validation in Healthy and Neurological Cohorts. Sensors (Basel). 2022 May 19.;22(10):3859, DOI: 10.3390/s22103859 (open access).

[5] Warmerdam, E.; Hansen, C.; Romijnders, R.; Hobert., M.A.; Welzel, J.; Maetzler, W.: Full-Body Mobility Data to Validate Inertial Measurement Unit Algorithms in Healthy and Neurological Cohorts. **Data** 2022.; **7**.; 136, DOI: 10.3390/data7100136 (open access).

[6] Hoffmann, J.; Elzenheimer, E; Bald, C.; Hansen.; C.; **Maetzler, W.**; **Schmidt, G.**: Active Magnetoelectric Motion Sensing: Examining Performance Metrics with an Experimental Setup. Sensors.; (2021).; 8000, DOI: 10.3390/s21238000 (open access).

[7] Romijnders, R.; Warmerdam, E.; Hansen, C.; Welzel, J.; **Schmidt, G.**; **Maetzler, W.**: Validation of IMU-based gait event detection during curved walking and turning in older adults and Parkinson's Disease patients. J Neuroeng Rehabil. 2021 Feb 6.;18(1):28, DOI: 10.1186/s12984-021-00828-0 (open access).

[8] Warmerdam, E.; Romijnders, R.; Hansen, C.; Elshehabi, M.; Zimmermann, M.; Metzger, FG.; von Thaler, AK.; Berg,, D.; **Schmidt, G.**; **Maetzler, W.**: Arm swing responsiveness to dopaminergic medication in Parkinson's disease depends on task complexity. NPJ Parkinsons Dis. 2021 Oct 5.;7(1):89, DOI: 10.1038/s41531-021-00235-1 (open access).

[9] Warmerdam, E.; Romijnders, R.; Geritz, J.; Elshehabi, M.; Maetzler, C.; Otto, JC.; Reimer, M.; Stuerner, K.; Baron, R.; Paschen, S.; Beyer, T.; Dopcke, D.; Eiken, T.; Ortmann, H.; Peters, F.; Recke, FV.; Riesen, M.; Rohwedder, G.; Schaade, A.; Schumacher, M.; Sondermann, A.; **Maetzler, W.**; Hansen, C.: Proposed Mobility Assessments with Simultaneous Full-Body Inertial Measurement Units and Optical Motion Capture in Healthy Adults and Neurological Patients for Future Validation

Studies: Study Protocol. Sensors (Basel). 2021 Aug 30.;21(17):5833, DOI: 10.3390/s21175833 (open access).

[10] Warmerdam, E.; Romijnders, R.; Welzel, J.; Hansen, C.; **Schmidt, G.**; **Maetzler, W.**: Quantification of Arm Swing during Walking in Healthy Adults and Parkinson's Disease Patients: Wearable Sensor-Based Algorithm Development and Validation. Sensors (Basel). 2020 Oct 21.;20(20):5963, DOI: 10.3390/s20205963 (open access).

## B10: Magnetoelectric Sensor Systems for Cardiologic Applications

### Principal Investigators

Frey, Norbert, Prof. Dr. med.
15.10.1966, German

Department of Internal Medicine III, Cardiology, Angiology and Pneumology
Heidelberg University Hospital and Heidelberg University
Im Neuenheimer Feld 410, D-69120 Heidelberg

Phone: +49 (0) 6221 56 8670
E-mail: norbert.frey@med.uni-heidelberg.de

Schmidt, Gerhard, Prof. Dr.-Ing
23.11.1971, German

Digital Signal Processing and System Theory
Institute of Electrical and Information Engineering
Christian-Albrechts-Universität zu Kiel
Kaiserstr. 2, D-24143 Kiel

Phone: +49 (0) 431 880 6125
E-mail: gus@tf.uni-kiel.de

### Summary of the Research Project

For the treatment of cardiac arrhythmias e.g. due to scarring of tissue after myocardial infarction, precise localization of the arrhythmogenic substrate is required. Electroanatomical mapping of the cardiac activation allows accurate spatial and temporal reconstruction of the electrical activation of the human heart. It is routinely performed by invasive catheterization. Our goal in this project is to develop a noninvasive approach to electroanatomic mapping that can be combined with invasive catheterization and prospectively replace it. The advantages of a non-invasive method would be twofold: First, the risks associated with invasive procedures could be avoided when electroanatomic mapping is required, and second, the barrier to performing electroanatomic mapping could be lowered. This would be a great opportunity for research and disease detection and prevention. A combination with non-invasive ablation of cardiac arrhythmias e.g. by radiation therapy would provide the basis for a completely noninvasive approach. The main challenge of non-invasive mapping is that the number of unknown parameters of interest usually exceeds largely the number of available measurements. The noninvasive mapping of activation will help in optimization of cardiac resynchronization therapy (CRT).

In the current funding period, we have developed a time-variant heart model based on allpass state-space approaches, in which the parameters of an initial model are optimized in a nested loop. A Kalman-based filter uses the model to optimally estimate the current density of the heart using a given spatio-temporal electric conduction model. Then, a gradient descent method is used to adjust the parameters of the conduction model given a current-density estimate by minimizing the mean square error between the Kalman filters prediction and the measurements. These two steps are repeated until convergence. So far, we have been able to show the feasibility of the algorithm in a simulation where the number of voxels exceeded the number of sensors (voxel volume of about 1 to 10 $mm^3$) by a factor of 50.

We have also taken initial steps to create an open-source multimodal dataset consisting of segmented ECG, MCG, and MRI measurements that will serve as the basis for clinical evaluation of our algorithm. Specifically, we have identified the estimation of the 3D cardiac axis as another potential application of our magnetoelectric sensors for cardiology applications. The measurements show that the 2D projection of the cardiac axis calculated from the MCG is consistent with the 2D cardiac axis calculated using the standard ECG.

To ensure the computational tractability of the problem, we already exploited the spatial sparsity of electrical interactions between voxels. In order to further reduce the computational burden, we would like to explore ways to exploit the temporal sparseness of voxel activity as well. This could be done by partitioning the model into compartments and computing only those compartments in which activity is expected to be present at the current time step. This should allow to reduce the voxel volume to 0.2 $cm^3$ and below. Incorporating individual sensor SNR into the loss function calculation will be another approach to improve the performance.

Some practical issues arose during the construction of the Kiel Cardio Database. We plan to investigate these in the next funding period. The relative position of the heart to the MCG sensors changes over time due to breathing. This must be considered for successful non-invasive mapping. Initial results show that respiration can be estimated from the raw MCG signals. However, tracking the MCG sensors by placing new magnetic transduces from project Z1 on the patient's body and using the localization algorithm developed in Projects B2 and B9 would improve these estimates. It will be necessary to investigate the specific dependence of the heart position on the respiratory state.

During the second funding period the SAW and converse sensors reach sensitivities that allow to perform cardiologic measurements with averaging of about one minute. We anticipate that the extensions proposed by the sensor project will lead to unaveraged measurements of at least the R-peak region. Together with the breathing compensation in the state-space model sufficient SNR is expected to be applied to patient measurements with ME sensors.

As an initial application, we propose to determine the 3D axis of the heart as measured by the MCG. It is well known that a change in the 2D axis of the heart, as measured by the ECG, is an indicator of pathological changes in the heart. Measuring this parameter using magnetic signals would drastically reduce the preparation time, making daily measurements feasible. We postulate that relevant information for early detection of pathologies is contained in the additional dimension provided by our approach. To investigate this, we will perform a serial study of inpatient 3D cardiac axis changes using magnetoelectric sensors. Finally, we propose to study clinical relevance of the change in wavefront transition of the heart represented by 3D axis induced by conventional right ventricular pacing (RVP), cardiac resynchronization therapy (CRT) and conduction system pacing (CSP). RVP results in an artificial left bundle branch block (LBB) – a condition that has proven to be hazardous especially in heart failure patients. Correction of artificial and spontaneous LBB by CRT or CSP results in a marked change in case of CRT or even normalization of the heart vector (3D axis) in CSP. To investigate this, we will perform a serial study of inpatient 3D cardiac axis changes in patients with LBB corrected by CSP or CRT as well as patients with RV-Pacing using magnetoelectric sensors. Further applications will be in patients with premature ventricular contractions (PVC), which have distinct activation pattern. After estimating the 3D axes the ultimate goal is to precisely determine the PVCs site of origin.

## Project-relevant Previous Publications

[1] Engelhardt E.; Elzenheimer E.; Hoffman J.; Schmidt T.; Zaman A.; **Frey N.**; **Schmidt G.**: A Concept for Myocardial Current Density Estimation with Magnetoelectric Sensors,

DGBMT 2023, Annual Conference of the German Society for Biomedical Engineering, 2023, (accepted) (open access).

[2] Elzenheimer E.; Hayes P.; Thormählen L.; Engelhardt E.; Zaman A.; Quandt E.; **Frey N.**; Höft M.; **Schmidt G.**: Investigation of Converse Magnetoelectric Thin Film Sensors for Magnetocardiography, IEEE Sensors Journal Print ISSN, pp. 5660-5669, 2023, DOI: 10.1109/JSEN.2023.3237910.

[3] Engelhardt E.; Zaman A.; Elzenheimer E.; **Frey N.**; **Schmidt G.**: Towards Analytically Computable Quality Classes for MCG Sensor Systems, BMT 2022, Joint Annual Conference of the Austrian, German and Swiss Societies for Biomedical Engineering, 2022, DOI:10.1515/cdbme-2022-1176 (open access).

[4] Elzenheimer E.; Bald C.; Engelhardt E.; Hoffmann J.; Hayes P.; Arbustini J.; Bahr A.; Quandt E.; Höft M.; **Schmidt G.**: Quantitative Evaluation for Magnetoelectric Sensor Systems in Biomagnetic Diagnostics, MDPI Sensors, vol. 22, no. 3, 1018, 2022, DOI:10.1515/cdbme-2022-1176 (open access).

[5] Siry D.; Riffel J.; Salatzki J.; André F.; Weberling L.; Ochs M.; Atia N.; Hillier E.; Albert D.; Katus H.; Giannitsis E.; **Frey N**.; Friedrich M.: A head-to-head comparison of fast-SENC and feature tracking to LV long axis strain for assessment of myocardial deformation in chest pain patients, BMC Med Imaging, 22(1):159 (2022), DOI: 10.1186/s12880-022-00886-3 (open access).

[6] Bald, C.; **Schmidt, G.**: Processing Chain for Localization of Magnetoelectric Sensors in Real-time, MDPI Sensors, vol. 21, issue 16, 5675 (2021), DOI: 10.3390/s21165675 (open access).

[7] Reermann, J.; Elzenheimer, E.; **Schmidt, G.**: Real-time Biomagnetic Signal Processing for Uncooled Magnetometers in Cardiology, IEEE Sensors Journal 15 (10), (2019), 4237-4249, DOI: 10.1109/JSEN.2019.2893236 (open access).

[8] **Frey N**.; Steeds R.; Rudolph T.; Thambyrajah J.; Serra A.; Schulz E.; Maly J.; Aiello M.; Lloyd G.; Bortone A.; Hauptmann K.; Clerici A.; Delle Karth G.; Rieber J.; Indorfi C.; Mancone M.; Belle L.; Lauten A.; Arnold M.; Bouma BJ.; Lutz M.; Pohlmann C.; Kurucova J.; Thoenes M.; Bramlage P.; Messika-Zeitoun D.: IMPULSE registry group; Symptoms, disease severity and treatment of adults with a new diagnosis of severe aortic stenosis, Heart 105(22):1709-1716 (2019), DOI: 10.1136/heartjnl-2019-314940 (open access).

[9] Reermann, J.; Durdaut, P.; Salzer, S.; Demming, T.; Piorra, A.; Quandt, E.; **Frey, N.**; Höft, M.; **Schmidt, G.**: Evaluation of Magnetoelectric Sensor Systems for Cardiological Applications, Measurement (Elsevier) 116, (2018), 230-238, DOI: 10.1016/j.measurement.2017.09.047 (open access).

[10] Kittmann, A.; Durdaut, P.; Zabel, S.; Reermann, J.; Schmalz, J.; Spetzler, B.; Meyners, D.; Sun, N. X.; McCord, J.; Gerken, M.; **Schmidt, G.**; Höft, M.; Knöchel, R.; Faupel, F.; Quandt, E.: Wide Band Low Noise Love Wave Magnetic Field Sensor System, Scientific Reports, vol. 8, no. 278 (2018), DOI:10.1038/s41598-017-18441-4 (open access).

## B11(N): Magnetic Sensor Gloves for Robot-assisted Surgery

### Principal Investigators

Bergholz, Robert Prof. Dr. med.
27.06.1976

Pediatric Surgery
University Hospital Schleswig-Holstein, Campus Kiel
Christian-Albrechts-Universität zu Kiel
Arnold-Heller-Str. 3, Haus 41, D-24105 Kiel

Phone: +49 (0) 431 500 20409
E-mail: robert.bergholz@uksh.de

Schmidt, Gerhard, Prof. Dr.-Ing
23.11.1971

Digital Signal Processing and System Theory
Department of Electrical Engineering and Information Engineering
Christian-Albrechts-Universität zu Kiel
Kaiserstr. 2, D-24143 Kiel

Phone: +49 (0) 431 880 6125
E-mail: gus@tf.uni-kiel.de

### Summary of the Research Project

This project aims to explore the capabilities of motion capture algorithms utilizing magnetoelectric sensors and various magnetic transducers attached to fixed installations, fingers, and arms. The primary objective is to devise a novel input device for controlling the end-effectors and instruments used in robotic-assisted surgery. The project also involves comparing and potentially integrating this new system with existing motion capture systems that rely on different sensor modalities such as optical or IMU-based motion capture.

The existing input devices employed in robotic surgery rely on conventional haptic controllers that are responsive to the manual force applied by the surgeon's hand. However, these controllers lack the ability to detect movements of individual finger segments. Consequently, the end-effectors and instruments of the robotic system are limited to forceps-like tools that offer only two states, namely "open" or "closed," and can be rotated along the wrist with a maximum of seven degrees of freedom. As a result, the range of motions available to the surgeon is constrained by these tools.

The proposed novel input device in this research component takes the form of a glove, incorporating a diverse array of magnetoelectric (ME) sensors and magnetic actuators for motion capturing. Each kinematic chain element, including the finger segments (three in each finger, except for two in the thumb), is equipped with at least one sensor. In fact, due to the sensors' small size, it is even feasible to employ multiple sensors on certain elements. The investigation will therefore explore ME actuators, such as cantilevers comprising piezoelectric and powder-magnet layers, as well as coils wrapped around individual fingers and 3D-coils.

In the context of motion capture for surgical applications, it is essential to achieve sensor or actuator localization at intervals of no more than 50 milliseconds. This requirement presents a significant computational challenge. Considering that a hand comprises approximately 20 kinematic elements, a minimum of 40 sensors (two hands) need to be localized within this limited timeframe. Any delay in localization would lead to noticeable instrument "drag" following the movement of the surgeon's hand, compromising the quality of the surgical procedure.

Localization can be achieved through various methods. Traditional magnetic pose estimation algorithms, as utilized in Projects B2 and B9, represent one approach. However, they are

associated with a substantial computational burden. Alternatively, new techniques based on relative positioning, specifically determining the orientation between kinematic chain elements by using prior knowledge, can be employed. Of particular interest is a novel approach developed at Kiel University, which revolves around the utilization of spatially and temporally rotating magnetic fields. This method employs an iterative procedure to efficiently compute the position and orientation of each sensor. By combining these distinct methodologies, it becomes possible to leverage the unique advantages offered by each approach, ultimately enhancing the overall localization process.

By utilizing a glove as an input device in robotic surgery, it becomes possible to capture and leverage the full range of movements exhibited by the surgeon's hand and fingers for operating the robot. Presently, footswitches are employed to control camera steering, activate energy devices for tissue cutting and sealing, or handle clip appliers. However, this necessitates a learning curve for the surgeon and carries the inherent risk of inadvertently activating instruments with their feet, potentially endangering the patient. Gesture recognition technology can greatly enhance patient safety in this regard. Moreover, the implementation of an input device capable of accurately tracking the individual positions, orientations, and articulations of the surgeon's fingers opens up new possibilities for designing robotic instruments that closely resemble human fingers. This advancement can significantly enhance maneuverability and dexterity in delicate surgical fields, particularly when operating on blood vessels or engaging in intricate procedures. By mimicking the capabilities of human fingers, these innovative robotic instruments offer heightened precision and enable surgeons to navigate complex anatomical structures with greater ease and accuracy.

In addition to investigating localization capabilities, this project will also explore gesture recognition techniques using convolutional neural networks. Prototypes incorporating these technologies will undergo testing using a CE-Mark approved robotic surgical system to assess their usability and performance.

In summary, the primary objective of this project is to develop an innovative input device tailored for robot-assisted surgery. The envisioned device aims to enhance the dexterity of surgeons during robotic procedures, leading to reduced operating time and increased user-friendliness. Crucially, it seeks to prioritize patient safety above all. By leveraging advanced technologies, this project endeavors to improve surgical outcomes while ensuring the well-being of patients.

**Project-relevant Previous Publications**

[1] **Schmidt, G.**; **Bergholz, R.**; Quandt, E.; Sun, N.; Klinkenbusch, L.; Bald, C.; Schmidt, T.: Vorrichtung zur Posenschätzung eines magnetfeldmessenden Objekts, (2023) patent application DE 10 2023 116 342.6.

[2] **Schmidt, G.**; **Bergholz, R.**; Quandt, E.; Sun, N.; Klinkenbusch, L.; Bald, C.; Schmidt, T.: Vorrichtung zur Posenschätzung eines magnetfeldmessenden Objekts, patent application DE 10 2023 116 342.6, 2023.

[3] Krebs, T.; Kayser, T.; Lorenzen, U.; Grünewald. M.; Kayser, M.; Saltner, A.; Durmaz, L.; Reese, L.; Brownlee, E.; Reischig, K.; Baastrup, J.; Meinzer, A.; Kalz, A.; Becker, T.; **Bergholz, R.:** Evaluation of a new robotic system for infant surgery – a study in piglets

of less than 10kg body weight. Children (Basel). 2023 May 3;10(5):831. DOI: 10.3390/children10050831.

[4] Hoffmann, J.; Roldan-Vasco, S.; Krüger, K.; Niekiel, F.; Hansen, C.; Maetzler, W.; Orozco-Arroyave, J.R.; **Schmidt, G.**: Pilot Study: Magnetic Motion Analysis for Swallowing Detection Using MEMS Cantilever Actuators. Sensors, (2023), 3594, DOI: 10.3390/s23073594 (open access).

[5] Krebs, T.; Egberts, J. H.; Lorenzen, U.; Krause, M. F.; Reischig, K.; Meiksans, R.; Baastrup, J.; Meinzer, A.; Alkatout. I.; Cohrs, G.; Wieker, H.; Lüthje, A.; Vieten, S.; Schultheiss, G.; **Bergholz, R.:** Robotic infant surgery with 3 mm instruments: a study in piglets of less than 10 kg body weight. J Robot Surg. 2021 Mar 26. Doi: 10.1007/s11701-021-01229-0.

[6] Hoffmann, J.; Hansen, C.; Maetzler, W.; **Schmidt, G.**; A Concept for 6D Motion Sensing with Magnetoelectric Sensors. Current Directions in Biomedical Engineering 8(2), (2022), 451-454, DOI: 10.1515/cdbme-2022-1115, (open access).

[7] Elzenheimer, E.; Bald, C.; Engelhardt, E.; Hoffmann, J.; Hayes, P.; Arbustini, J.; Bahr, A.; Quandt, E.; Höft, M.; **Schmidt, G.**: Quantitative Evaluation for Magnetoelectric Sensor Systems in Biomagnetic Diagnostics. Sensors, (2022), 1018, DOI: 10.3390/s22031018 (open access).

[8] Hoffmann, J.; Elzenheimer, E.; Bald, C.; Hansen, C.; Maetzler, W.; **Schmidt, G.**: Active Magnetoelectric Motion Sensing: Examining Performance Metrics with an Experimental Setup. Sensors, (2021), 8000, DOI: 10.3390/s21238000 (open access).

[9] **Bergholz, R.**; Botden, S.; Gemert, W. V.; Tytgat, S.; Boettcher, M.; Verweeij, J.; Ehlert H.; Reinshagen, K.; Gidaro, S.: Evaluation of a new robotic-assisted laparoscopic surgical system for procedures in small cavities. J Robotic Surg (2019). DOI: 10.1007/s11701-019-00961-y.

[10] Kittmann, A.; Durdaut, P.; Zabel, S.; Reermann, J.; Schmalz, J.; Spetzler, B.; Meyners, D.; Sun, N. X.; McCord, J.; Gerken, M.; **Schmidt, G.**; Höft, M.; Knöchel, R.; Faupel, F.; Quandt, E.: Wide Band Low Noise Love Wave Magnetic Field Sensor System, Scientific Reports, vol. 8, no. 278 (2018), DOI:10.1038/s41598-017-18441-4 (open access).

## B12(N): Bioinspired Nanocomposites for Early Detection of Complications in Gastrointestinal Surgery

### Principal Investigators

Altintas, Zeynep, Prof. Dr.-Ing.
xx.xx.xxxx (birthday)

Bioinspired Materials and Biosensor Technologies
Department of Materials Science
Christian-Albrechts-Universität zu Kiel
Kaiserstr. 2, D-24143 Kiel

Phone: +49 (0) 431-880 6198
E-mail: za@tf.uni-kiel.de

Gerken, Martina, Prof. Dr.
24.01.1973

Integrated Systems and Photonics
Institute of Electrical and Information Engineering
Christian-Albrechts-Universität zu Kiel
Kaiserstr. 2, D-24143 Kiel

Phone: +49 (0) 431-880 6250
E-mail: mge@tf.uni-kiel.de

Gundlach, Jan-Paul, Dr. med.
xx.xx.xxxx (birthday)

Clinic of General, Visceral-, Thoracic-, Transplantation- and Pediatric Surgery
Faculty of Medicine & University Hospital Schleswig-Holstein, Campus Kiel (UKSH)
Christian-Albrechts-Universität zu Kiel
Arnold-Heller-Str. 3, D-24105 Kiel

Phone: +49 (0) 4821 17 1198
E-mail: jan-paul.gundlach@uksh.de

### Summary of the Research Project

Around 1.8 million colorectal cancer cases were registered worldwide in 2018. In Germany, around 115,000 people undergo colon cancer surgery with partial removal (resection) and associated connection of hollow organs. Leaks in the connecting seam, so-called anastomotic leaks (AL) occur in between 3–30% of the patients, mainly in rectal anastomosis and include consequential risks such as sepsis, subsequent operations, longer hospital stays and increased mortality of up to 16%. Since there is currently no way of detecting an AL directly or in the process of its formation, a clarification by means of computed tomography (CT) or laboratory findings will be only carried out if the general condition of the patient deteriorates or the quality of a target drainage suggests an AL. This detection is complex, often unspecific and only takes place at an advanced stage which increases the severity of possible complications. On the other hand, the safe exclusion of AL could significantly reduce the duration of inpatient monitoring. The aim of the proposed project B12(N) is to develop an in vivo diagnostics implant relying on magnetically labeled synthetic receptors combined with a wireless magnetic-field readout system based on magnetoelectric sensors. To long-term goal is to continuously monitor for inflammation after surgery based on the elevated levels of inflammation biomarkers for early detection of AL.

Analyte-specific recognition elements are generally of biological origin and exhibit low chemical stability, short shelf-life, and poor durability in harsh environmental conditions. By avoiding these limitations and offering animal-free cost-efficient production, molecularly imprinted

polymer (MIP) based synthetic receptors have been attracting enormous attention for biosensing, in vitro, and in vivo applications. MIPs are synthesized via a templating technique for creating molecular recognition material displaying a receptor-like affinity for a variety of template structures, with templates being an entire molecule (e.g., protein, virus, bacterium) or a small fragment of it i.e., peptide epitope. First, we will define a suitable target biomarker within the framework of clinical studies through the discontinuous determination of different markers (e.g., interleukins, matrix metalloproteinases, and growth factors) from wound drainages which are placed close to the anastomoses and through immunohistochemical analysis of anastomotic tissue material from patients who have undergone a second operation due to AL. Next, we aim to determine the most suitable peptide epitopes of target biomarkers as templates using computational studies. The synthesis recipes of epitope-mediated MIPs are then established by screening the molecular interactions between the epitopes and the building block (i.e., functional monomers) with the aid of molecular dynamic simulations, which are expected to provide exceptionally higher sensing performance in comparison to conventional counterparts. The magnetically labelled in silico-designed MIPs targeting AL biomarkers are synthesized and characterized. Their influence on complex three-dimensional cell structures will be demonstrated in cell culture using anastomosis-mimicking cell assemblies with fibroblasts (holo- and paraclone). The materials are then incorporated into a hydrogel-forming implantable microneedle-based smart dressing.

A magnetoelectric sensor system will be investigated for excitation of the magnetic nanoparticles in the smart dressing and readout of the magnetic response. In the later application, the sensor system needs to be attached to the outside of the body while the biosensitive implant is at a distance of up to 15 cm away on the inside of the body. Thus, a magnetic excitation system based on an array of coils will be developed to allow for focused magnetic excitation at a distance. It is planned to use an alternating excitation field and record the magnetic response for frequency sweeps. The Brownian relaxation of the magnetic nanoparticles in an alternating magnetic field will be monitored. Since the relaxation time depends on the size of the particles as well as the matrix, an in-depth study of the relaxation of MIPS functionalized magnetic nanoparticles in different hydrogel matrices will be performed. The best response is expected for small particles with significant specific loading upon presence of inflammation biomarkers. A phantom system will be realized based on microfluidic plastic tubing to study distance, concentration, and size effects without mechanical moving parts. As an alternative to linear Brownian relaxation, third-order nonlinear effects will be investigated. A magnetoelectric sensor array will be combined with an excitation field compensation system to measure the magnetic-nanoparticle response. Affinity, selectivity, and specificity of the combined implant-sensor system will be determined.

The present project aims to establish an innovative magnetosensor for real sample analysis for early detection of AL in gastrointestinal surgery. Its evaluation is carried out by functional proof in in vivo animal experiments. For this purpose, the hydrogel-forming implantable microneedle-based smart dressing will be positioned near the anastomosis during deliberately induced suture errors compared to correctly executed bowel sutures in large animals (pigs). This will provide proof of local parameter overshooting by statistical valuation and assessment of the applicability in human medicine.

**Project-relevant Previous Publications**

[1] **Altintas, Z**.; Pocock, J.; Thompson, K.A.; Tothill, I.E.: Comparative investigations for adenovirus quantification: Plastic or natural antibodies? Biosensors and Bioelectronics, 74: p. 996-1004 (2015). DOI: 10.1016/j.bios.2015.07.076.

[2] Sehit, E.; Drzazgowska, J.; Buchenau, D.; Yesildag, C.; Lensen, M.; **Altintas, Z**. Ultrasensitive nonenzymatic electrochemical glucose sensor based on gold nanoparticles and molecularly imprinted polymers. Biosensors and Bioelectronics, 165 (112432) (2020). Invited Paper. DOI: 10.1016/j.bios.2020.112432.

[3] **Altintas, Z.**; Takiden, A.; Utesch, T.; Mroginski, M.A.; Schmid, B.; Scheller, F.W.; Sussmuth, R. Integrated approaches toward high-affinity artificial protein binders obtained via computationally simulated epitopes for protein recognition. Advanced Functional Materials, 29 (15): 1807332 (2019) Cover Paper. DOI:10.1002/adfm.201807332.

[4] Pirzada, M.; Sehit E.; **Altintas, Z.**: Cancer biomarker detection in human serum samples using nanoparticle decorated epitope-mediated hybrid MIP. Biosensors and Bioelectronics, 166, 112464: p. 1-11 (2020). Invited Paper. DOI: 10.1016/j.bios.2020.112464.

[5] Özden, M-Ö.; Teplyuk, A.; Gümüs, Ö.; Meyners, D.; Höft, M.; **Gerken, M.**: Magnetoelectric cantilever sensors under inhomogeneous magnetic field excitation, AIP Advances, 10(2), (2020), 025132 (open access).

[6] Titov, I.; Rutschke, N.; Kraft, F. A.; Köpke, M.; Nebling, E.; **Gerken, M.**: Detection of fluorescence-labeled DNA with in-plane organic optoelectronic devices, Biomedical optics express, 13 (12), (2022) 6300–6316, DOI: 10.1364/BOE.475358 (open access).

[7] Kraft, F. A.; Baur, H.; Bommer, M.; Latz, A.; Fitschen-Oestern, S.; Fuchs, S.; **Gerken, M.**: Label-free multiplex sensing from buffer and immunoglobulin G sensing from whole blood with photonic crystal slabs using angle-tuning of an optical interference filter, Biomedical optics express, 14 (5), (2023) 2293–2310, DOI: 10.1364/BOE.489138 (open access).

[8] Knaack H.; Lenk L.; Philipp LM.; Miarka L.; Rahn S.; Viol F.; Hauser C.; Egberts JH.; **Gundlach, J.-P.**; Will O.; Tiwari S.; Mikulits W.; Schumacher U.; Hengstler JG.; Sebens S.: Liver metastasis of pancreatic cancer: the hepatic microenvironment impacts differentiation and self-renewal capacity of pancreatic ductal epithelial cells. Oncotarget. (2018) 9(60):31771-31786. DOI: 10.18632/oncotarget.25884. (open access).

[9] **Gundlach, J.-P.**; Kerber, J.; Hendricks, A.; Bernsmeier, A.; Halske, C.; Röder, C.; Becker, T.; Röcken, C.; Braun, F.; Sebens, S.; Heits, N.: Paracrine Interaction of Cholangiocellular Carcinoma with Cancer-Associated Fibroblasts and Schwann Cells Impact Cell Migration. J Clin Med. (2022) 11(10):2785. doi: 10.3390/jcm11102785. (open access).

[10] **Gundlach, J.-P.;** Madjidyar, J.; Marczynski-Bühlow, M.; Pokorny, S.; Bähr, T.M.; Cremer, J.; Lutter, G.: Off-pump tricuspid valved stent implantation: the next step. Eur J Cardiothorac Surg. (2014) 45(3):e46-53. doi: 10.1093/ejcts/ezt612. (open access).

Reviewer (to be removed finally)
Günther Deuschl | Florian Niekiel | Robert Bergholz

## B13(N): Magnetic Smart Pill for Colon Analysis

### Principal Investigators

Ellrichmann, Mark, Prof.
14.01.1975

Interdisciplinary Endoscopy,
Medical Department 1
University Hospital Schleswig-Holstein,
Campus Kiel
Christian-Albrechts-Universität zu Kiel
Arnold-Heller-Str. 3, Haus C, D-24105 Kiel

Phone: +49 (0) 431 500 22373
E-mail: mark.ellrichmann@uksh.de

Lofink, Fabian, Prof. Dr. rer. nat.
05.09.1977

MEMS-Applications
Fraunhofer Department of Silicon Technology
Fraunhoferstr. 1, D-25524 Itzehoe

Phone: +49 (0) 4821 17 1198
E-mail: fabian.lofink@isit.fraunhofer.de

### Summary of the Research Project

Gastrointestinal motility refers to the coordinated movement of the digestive tract, allowing for the proper digestion and absorption of nutrients. Several gastrointestinal and neurological diseases are closely associated with abnormal motility especially of the small bowel. Conditions such as irritable bowel syndrome (IBS), gastroparesis, chronic intestinal pseudo-obstruction, and inflammatory bowel disease (IBD) often exhibit disruptions in gastrointestinal motility which result in symptoms like abdominal pain, bloating, constipation, diarrhea, and malabsorption of nutrients significantly impacting the patient`s quality of life.

Diagnosing and evaluating gastrointestinal motility disorders pose challenges in clinical practice. Currently, only a limited number of modalities are available to quantify or visualize gastrointestinal functionality. However, the existing diagnostic options have notable limitations in clinical settings: low sensitivity, time-consuming procedures, and high costs. Moreover, most existing methods lack the ability to assess gastrointestinal motility during physical activity, which is important for understanding real-life functioning.

Current smart pills applied for intestinal diagnostics are swallowed and then record different measured values with their integrated sensors during movement in the intestinal tract. For motility diagnostics, such pills have only a very limited use due to their poor or no spatial resolution of their own position. As current smart pills are active and thus require a substantial number of electronic components and a battery, they also have a considerable large size of about 3 cm in length. Thus, swallowing is at least uncomfortable, in many cases even impossible. Especially for patients with pathological situations in the intestine such as strictures, these large sizes of the pills can lead to a contraindication. As a result, the use of today's smart pills is often not possible in diagnostically relevant cases.

In the current funding period, the use of ME sensors for the diagnosis of motility of the intestinal tract is to be investigated in this new project. It will investigate whether the use of a significant smaller (~ 5 mm) and battery-free magnetic probe (in vivo) for the diagnosis of motility in the intestine is feasible, and how its 3D movement in the human body can be detected with magnetoelectric (ME) sensors (ex vivo). Finally, the question will be answered whether this approach is even suitable for use in diagnostics under everyday conditions. The magnetic probe

to be applied is a MEMS cantilever with an integrated hard magnet at its tip that acts as a narrow-band transmitter when resonantly excited. In vivo

excitation can be provided either by excitation electronics integrated into a probe pill or by external excitation coils. Last would result in a completely passive probe. The cantilever-based ME sensors of the SFB are characterized by a high-quality factor, which leads to a particularly high magnetic sensitivity in the sensors' resonance combined with a detection limit in the pT regime. Once the sensor frequency is matched to the frequency of the magnetic probe, the ME sensor will listen very sensitive to the probe and simultaneously effectively suppresses interference from other sources. By using several such tuned ME sensors at the same time at various selected positions, a precise 3D localization and tracking of the probe should be possible.

In the project, application studies will be carried out using a torso/intestinal phantom including flow and 3D movement of the probe. The resolution with which a 3D localization and tracking of the magnetic probe with ME-sensors can be realized is studied, and whether localization is even possible when the patient is moving. Battery-free operation of the probe is also explored, and miniaturization < 1 $cm^3$ of the probe is pursued.

In a second study, the applicability of the above-described magnetoelectric 3D mapping in the context of endoscopy is to be investigated. The field of flexible endoscopy has revolutionized the way we diagnose and treat various medical conditions within the human body. Flexible endoscopes, equipped with a light source and a camera, are commonly used in clinical practice to visualize and access internal organs, tissues, and cavities. However, one significant challenge that clinicians face during endoscopic procedures is accurately tracking the distal tip of the endoscope within the complex anatomy of the human body.

So far, only one approach is available on the market for the use in colonoscopy involving an electromagnetic tracking system. These systems utilize sensors embedded in the endoscope and an external electromagnetic field generator to track the position and orientation of the distal tip. This system only visualizes the geometric position of the scope without any relation to anatomical landmarks within the human body. Therefore, electromagnetic actuators, developed in this project, will be attached to the distal tip of an endoscope, respective signals will be picked up by ME-sensors at the body surface of the patient thereby calculating the precise position and orientation of the scope withing the body in a three-dimensional image in relation to anatomical landmarks defined by CT scan or MRI. The respectives sensors for localization and tracking will be evaluated in project B2.

**Project-relevant Previous Publications**

[1] Bodduluri, M. T.; Gojdka, B.; Wolff, N.; Kienle, L.; Lisec, T.; **Lofink, F.**: Investigation of Wafer-Level Fabricated Permanent Micromagnets for MEMS, Micromachines, 13(5), 742 (2022), 10.3390/mi13050742.

[2] Gojdka, B.; Dankwort, T.; Lisec, T.; Nowak, M.-A.; Bodduluri, M.-T.; Ahmed, M.; Grünzig, S.; **Lofink, F.**: Magnetically excited piezoelectric Energy Harvester for micropower supply and wakeup applications, Sensors Actuators and Microsystems, 455 (2021), 10.1109/Transducers50396.2021.9495625.

[3] Spetzler, B.; Su, J.; Friedrich, R.-M.; Niekiel, F.; Fichtner, S.; **Lofink, F.**; Faupel F.: Influence of the piezoelectric material on the signal and noise of magnetoelectric magnetic field sensors based on the delta-E effect, APL Materials 9, 031108 (2021), 10.1063/5.0042448.

[4] **Ellrichmann, M.;** Bethge, J.; Boesenkoetter, J.; Conrad, C.; Noth, R.; Bahmer, T.; Nikolaus, S.; Aden, K.; Zeissig, S.; Schreiber, S.: Subclinical Pulmonary Involvement in Active IBD Responds to Biologic Therapy. J Crohns Colitis, vol. 2, no. 15, pp. 1339-1345, 2021, 10.1093/ecco-jcc/jjab024.

[5] Su, J.; Niekiel, F.; Fichtner, S.; Kirchhof, C.; Meyners, D.; Quandt, E.; Wagner, B.; **Lofink, F.**: Frequency tunable resonant magnetoelectric sensors for the detection of weak magnetic field, J. Micromech. Microeng. 30, 075009 (2020), DOI: 10.1088/1361-6439/ab8dd0.

[6] Yarar, E.; Fichtner, S.; Hayes, P.; Piorra, A.; Reimer, T.; Lisec, T.; Frank, P.; Wagner, B. **Lofink, F.**; Meyners, D.; Quandt, E.: MEMS-based AlScN Resonating Energy Harvester with Solidified Powder Magnet, J. Microelectromech. S., 1057 (2019), DOI: 10.1109/JMEMS.2019.2945550.

[7] Niekiel, F.; Su, J.; Bodduluri, M. T.; Liseca, T.; Blohm, L.; Pieper, I.; Wagner, B.; **Lofink, F.**: Highly Sensitive MEMS Magnetic Field Sensors with Integrated Powder-based Permanent Magnets, Sensors and Actuators A 297, 111560 (2019), DOI: 10.1016/j.sna.2019.111560.

[8] Ye, L.; Yuan, X.; Pang, M.; Bethge, J.; **Ellrichmann, M.;** Du, J.; Zeng, X.; Tang, C.; Schreiber, S.; Hu, B.: Magnetic bead-assisted endoscopic submucosal dissection: a gravity-based traction method for treating large superficial colorectal tumors. Surg Endosc., vol. 33, no. 6, pp. 2034-2041, 2019, DOI: 10.1007/s00464-019-06799-7.

[9] Zeissig, S.; Rosati, E.; Dowds, C.M.; Aden, K.; Bethge, J.; Schulte, B.; Pan, W.H.; Mishra, N., Zuhayra, M.; Marx, M.; Paulsen, M.; Strigli, A.; Conrad, C.; Schuldt, D.; Sinha, A.; Ebsen, H.; Kornell, S.C.; Nikolaus, S.; Arlt, A.; Kabelitz, D.; **Ellrichmann, M.;** Lützen, U.; Rosenstiel, P.C.; Franke, A.; Schreiber, S.: Vedolizumab is associated with changes in innate rather than adaptive immunity in patients with inflammatory bowel disease. Gut, vol. 68, no. 1, pp. 25-39, 2019, DOI: 10.1136/gutjnl-2018-316023.

[10] **Ellrichmann, M.;** Wietzke-Braun, P.; Dhar, S.; Nikolaus, S.; Arlt, A.; Bethge, J.; Kuehbacher, T.; Wintermeyer, L.; Balschun, K.; Klapper, W.; Schreiber, S.; Fritscher-Ravens, A.: Endoscopic ultrasound of the colon for the differentiation of Crohn's disease and ulcerative colitis in comparison with healthy controls. Aliment Pharmacol Ther., vol. 39, no. 8, pp. 823-833, 2014, DOI: 10.1111/apt.12671.

**SOP: Scientific Outreach Project**

**Principal Investigators**

Enzingmüller, Carolin, Dr.
17.03.1984

Department of Chemistry Education
Leibniz-Institute for Science and Mathematics Education (IPN)
Christian-Albrechts-Universität zu Kiel
Olshausenstr. 62, D-24118 Kiel

Phone: +49 (0) 431 880 3145
E-mail: enzingmueller@leibniz-ipn.de

Parchmann, Ilka, Prof. Dr.
11.06.1969

Department of Chemistry Education
Leibniz-Institute for Science and Mathematics Education (IPN)
Christian-Albrechts-Universität zu Kiel
Olshausenstr. 62, D-24118 Kiel

Phone: +49 (0) 431 880 3494
E-mail: parchmann@leibniz-ipn.de

**Summary of the Research Project**

The CRC 1261 has developed an effective outreach program, reaching diverse audiences such as the public, school students, and teachers. Early-career researchers have actively participated through collaboration with the iRTG. In the second funding period, the CRC has embraced interactive visualizations as a powerful means of communication in collaboration with the Kiel Science Communication Network. Building on past success, the SOP aims to enhance outreach efforts in the third funding phase with two distinct outreach programs.

Visuals for communication and training: The outreach program focuses on interactive visualizations to effectively communicate CRC research progress, methodologies, and outcomes. By enabling the audience to interact with the visualizations, the CRC aims to foster a deeper understanding and appreciation of its research within the general public and in learning contexts. The SOP will tie the design and creation of interactive visualizations to support measures for junior scientists. This approach offers them opportunities to refine their communication skills, collaborate with experts in visualization design, and contribute to the development of innovative communication tools.

Attracting the next generation: A shortage of engineers is still a major challenge in many countries. To this regard, the CRC offers a promising context as it investigates and develops solutions for medical demands and contexts which have been shown to be of high interest for school students. Building on former goals of the CRC that could not have been fully achieved yet due to the CoVid19 pandemic we aim to set a focus on the development of a study and career orientation program for school students that allows better insights but also an early involvement in CRC topics and research groups. This program will be integrated into school structures, allowing continuous engagement throughout upper secondary education. It will explore factors that influence career aspirations, such as sense of belonging and identity development, through research conducted within the IPN research context and supported by the CRC's iRTG.

The results of the SOP will be communicated through the website of the CRC, journals for teachers and researchers, and they will be presented at conferences and outreach symposia. The SOP will also continue to support public events in cooperation with Kiel University and KiNSIS press offices.

**Project-relevant Previous Publications**

[1] Broß, C.; Plöger, T.; **Enzingmüller, C.**; **Parchmann, I.**: Kristalle unter Spannung: Piezoelektrizität als Beispiel für Struktur-Eigenschafts-Beziehungen. CHEMKON, 29(8), (2022), 240-246. https://doi.org/10.1002/ckon.202100024.

[2] Broß, C.; **Enzingmüller, C.**; **Parchmann, I.**; & Schmidt, G.: Teaching magnetoelectric sensing to secondary school students: Considerations for educational STEM outreach. Sensors, 21(21), (2021). https://doi.org/10.3390/s21217354.

{3] **Enzingmüller, C.**; Broß, C.; Laumann, D., **Parchmann, I.**; Schmidt, G.: Magnetfelder am Herzen messen. MNU Journal, 74(2), (2021), 149-153.Laumann, D.; Hayes, P.; Enzingmüller, C.; Quandt, E.; & Parchmann, I.: Magnetostriction Measurements with a Low-Cost Magnetostrictive Cantilever Beam, American Journal of Physics, 88(6), (2020), 448-455. https://doi.org/10.1119/10.0000640.

[4] Laumann, D.; Hayes, P.; **Enzingmüller, C.**; Quandt, E.; **Parchmann, I.**: Magnetostriction Measurements with a Low-Cost Magnetostrictive Cantilever Beam, American Journal of Physics, 88(6), (2020), 448-455. https://doi.org/10.1119/10.0000640

[5] **Enzingmüller, C.**; Laumann, D.; Kampschulte, L.; **Parchmann, I.**: Kommunikation interdisziplinärer Forschung im Bereich Biomagnetic Sensing. In C. Maurer (ed.): Naturwissenschaftliche Bildung als Grundlage für berufliche und gesellschaftliche Teilhabe: Gesellschaft für Didaktik der Chemie und Physik, Jahrestagung in Kiel 2018, Universität Regensburg, (2019), 564-567.

[6] Kampschulte L.; **Enzingmüller, C.**; Wentorf, W.; Quandt, E.; **Parchmann, I.**: Medizinische Sensoren entwickeln: Zusammenarbeit verschiedener Disziplinen. Naturwissenschaften im Unterricht – Chemie, 29(164), (2018), 41-45.

[7] Sevian, H.; Dori, Y. J.; **Parchmann, I.**: How does STEM context-based learning work: what we know and what we still do not know, International Journal of Science Education, 40:10, (2018), 1095-1107.

[8] Blankenburg, J.; Höffler, T.; **Parchmann, I.**: Fostering today what is needed tomorrow: Investigating students' interest in science. Science Education, 100(2), (2016), 364-391.

[9] **Parchmann, I.**; Kampschulte, L.: Bildung im digitalen Zeitalter - Perspektiven und Möglichkeiten außerschulischer Lernorte. In Paderborner Podium. Paderborn: Heinz Nixdorf MuseumsForum, (2017), 128-143.

[10] Tirre, F.; Kampschulte, L.; Thoma, G.-B.; Höffler, T.; **Parchmann, I.**: Design of a student lab program for nanoscience and technology – An intervention study on students' perceptions of the nature of science, the nature of scientists and the nature of scientific inquiry. Research in Science & Technological Education, (2018).

**IRTG: Integrated Research Training Group**

**Principal Investigators**

Gerken, Martina, Prof. Dr.
24.01.1973

Integrated Systems and Photonics
Institute of Electrical and Information Engineering
Christian-Albrechts-Universität zu Kiel
Kaiserstr. 2, D-24143 Kiel

Phone: +49 (0) 431 880 6250
E-mail: mge@tf.uni-kiel.de

Maetzler, Walter, Prof. Dr.
09.09.1971

Department of Neurology
University Hospital Schleswig-Holstein, Campus Kiel
Christian-Albrechts-Universität zu Kiel
Arnold-Heller-Str. 3, Hs. 41, D-24105 Kiel

Phone: +49 (0) 431 500 23981
E-mail: w.maetzler@neurologie.uni-kiel.de

McCord, Jeffrey, Prof. Dr.-Ing.
06.10.1965

Nanoscale Magnetic Materials
– Magnetic Domains

Department of Materials Science
Christian-Albrechts-Universität zu Kiel
Kaiserstr. 2, D-24143 Kiel

Phone: +49 (0) 431 880 6123
E-mail: jmc@tf.uni-kiel.de

**Summary of the Integrated Research Training Group**

In addition to conducting outstanding scientific research, the CRC 1261 aims to provide an exceptional educational experience for young researchers to prepare them for their future careers. The Integrated Research Training Group (IRTG) within the CRC focuses on promoting scientific independence and interdisciplinary training for all early-stage researchers. The IRTG's program also emphasizes the development of key qualifications needed in today's scientific communities, going beyond the general approach of the CRC to impart additional knowledge and skills. The IRTG program provides the skills and knowledge needed to succeed in academia as well as in the non-academic job market.

An important aspect of the IRTG program is the monitoring and evaluation of our initiatives, facilitated by a formal evaluation process in conjunction with the Scientific Outreach Project (SOP) of the CRC. This ensures that our measures remain effective and adaptable. Following the most recent summative evaluation, changes are being implemented that will be carried over into the new funding period.

The IRTG strongly encourages direct communication among doctoral researchers involved in the CRC projects, equipping all IRTG members with comprehensive scientific, methodological, and organizational knowledge right from the beginning, enabling them to quickly grasp the essence of their individual projects and the overarching theme of the CRC. This approach ensures timely completion of their projects and theses, supported by team-based supervision that emphasizes interdisciplinary learning. During the booster phase a mentor guides the new

doctoral researchers through the projects and laboratories, were they are provided with key papers to be discussed with fellow young researcher from each group. Mandatory basic courses (e.g. academic writing and good scientific practice) further assist the academic career start. IRTG activities are regularly organized, including scheduled seminars and retreats exclusively for early-stage researchers, invitations of guest scientists with subsequent discussions, participation in conferences and summer schools, field trips to other research institutions and recurring retreats. Furthermore, public outreach activities are an integral part of the IRTG. The doctoral researchers plan and organize these important events. External research stays are funded to allow for an international experience in another laboratory and networking. The newly-established Thesis Advisory Committee ensures close advising and mentoring of the IRTG docoral researchers, providing them with focused research discussions with experts, academic-writing experience and feedback in preparation of their dissertation and disputation.

The IRTG collaborates with various institutions at Kiel University, which offer a wide range of lectures, workshops and general courses. In addition, specialized courses are offered in close exchange with the early-career researchers, which allow IRTG members to expand their knowledge. Equal opportunities and women's career advancement are prioritized by offering a combination of existing university- and CRC-organized courses and events. To this end, a Gender Equality Consortium has been formed at the Faculty of Engineering of Kiel University and the CRCs and research networks located there.

Ultimately, the core focus of the IRTG is to support doctoral researchers in achieving their scientific research goals, provide them with an exceptional educational experience, and prepare them for their future careers.

Reviewer (to be removed finally)
Andreas Bahr
Rainer Adelung
Robert Rieger

## Z1: MEMS Magnetoelectric Sensor Fabrication

### Principal Investigators

Meyners, Dirk, Dr.
22.05.1973

Inorganic Functional Materials
Department of Materials Science
Christian-Albrechts-Universität zu Kiel
Kaiserstr. 2, D-24143 Kiel

Phone: +49 (0) 431 880 6202
E-mail: dm@tf.uni-kiel.de

Gojdka, Björn, Dr.-Ing.
20.01.1981

MEMS Applications
Fraunhofer Institute for Silicon Technology ISIT
Fraunhoferstr. 1, D-25524 Itzehoe

Phone: +49 (0) 4821 17 1412
E-mail: bjoern.gojdka@isit.fraunhofer.de

### Summary of the Service Project

The central task of the project is to fabricate magnetoelectric sensors in large numbers and with high reproducibility so that they can be reliably used in the CRC's application projects of research area B. For this purpose, a technology platform has been established during the current funding period. The platform combines the micro- and nanosystems capabilities offered by the cleanroom laboratories at the two sites of CAU and ISIT.

In the Kieler Nanolabor at CAU, the sensor fabrication is based on bulk micromachining combining magnetron sputter deposition, plasma enhanced chemical vapor deposition, conventional optical lithography, ion beam etching, wet chemical etching, and reactive ion etching. The following techniques are also available for possible future development: pulsed laser deposition, atomic layer deposition, electro plating, electron beam lithography, and laser writing.

The 200 mm wafer line at ISIT offers a wide range of back-end-of-line processes for MEMS manufacturing. Examples include vacuum wafer-level packaging, highly selective gas-phase etching by $XeF_2$, grinding and chemical-mechanical polishing, (thick) polysilicon on silicon oxide, deep reactive ion etching, micro assembly processes, atomic layer deposition, RF and DC sputter deposition, electro plating, spin and spray coating, stepping and 1:1 lithography as well as comprehensive measurement equipment for process control monitoring. Furthermore, ISIT provides it's propietary PowderMEMS microfabrication technique. It allows for the wafer-level integration of functional three-dimensional microstructures like magnets or dense seismic masses.

In the current period, the bulk micromachining of miniaturized cantilever sensors for direct detection and ΔE-effect read-out was a main work package. The process flow has been revised twice with the help of failure mode effect analysis and specific design rules. The technology platform has been extended to bulk SAW sensors and A projects have been supported by partially processed wafers.

For the funding period to be applied for, it is expected that these core tasks will remain. In addition, the project will adopt fabrication processes for the newly introduced converse ME sensors.

By repeatedly adapting the technology platform to the latest findings, Z1 fulfills its central role as an interface between the projects of the sensor research area A and the projects of area B dedicated to sensor application. An important aspect of the platform revisions will be the implementation of ISIT's PowderMEMS technology which will contribute integrated magnetic structures to the CRC, e.g. for integrated bias and AC magnetic field sources.

**Project-relevant Previous Publications**

[1] Niekiel, M. F.; Meyer, J. M.; Lewitz, H.; Kittmann, A.; Nowak, M. A.; Lofink, F.; **Meyners, D.**; Zollondz, J.-H.: What MEMS Research and Development Can Learn from a Production Environment. Sensors**,** 23 (2023), 5549. DOI: 10.3390/s23125549 (open access).

[2] Schell, V.; Spetzler, E.; Wolff, N.; Bumke, L.; Kienle, L.; McCord, J.; Quandt, E.; **Meyners, D.**: Exchange biased surface acoustic wave magnetic field sensors. Scientific reports**,** 13 (2023), 8446. DOI: 10.1038/s41598-023-35525-6 (open access).

[3] Bodduluri, M. T.; Dankwort, T.; Lisec, T.; Grünzig, S.; Khare, A.; Ahmed, M.; **Gojdka, B.**: Fully Integrated High-Performance MEMS Energy Harvester for Mechanical and Contactless Magnetic Excitation in Resonance and at Low Frequencies. Micromachines**,** 13 (2022). DOI: 10.3390/mi13060863 (open access).

[4] Bodduluri, M. T.; **Gojdka, B.**; Wolff, N.; Kienle, L.; Lisec, T.; Lofink, F.: Investigation of Wafer-Level Fabricated Permanent Micromagnets for MEMS. Micromachines**,** 13 (2022). DOI: 10.3390/mi13050742 (open access).

[5 Lisec, T.; Behrmann, O.; **Gojdka, B.**: PowderMEMS-A Generic Microfabrication Technology for Integrated Three-Dimensional Functional Microstructures. Micromachines**,** 13 (2022). DOI: 10.3390/mi13030398 (open access).

[6] Spetzler, B.; Bald, C.; Durdaut, P.; Reermann, J.; Kirchhof, C.; Teplyuk, A.; **Meyners, D.**; Quandt, E.; Höft, M.; Schmidt, G.; Faupel, F.: Exchange biased delta-E effect enables the detection of low frequency pT magnetic fields with simultaneous localization. Sci Rep**,** 11 (2021), 5269. DOI: 10.1038/s41598-021-84415-2 (open access).

[7] Su, J.; Niekiel, F.; Fichtner, S.; Thormaehlen, L.; Kirchhof, C.; **Meyners, D**.; Quandt, E.; Wagner, B.; **Lofink, F**.: AlScN-based MEMS magnetoelectric sensor. Appl. Phys. Lett.**,** 117 (2020), 132903. DOI: 10.1063/5.0022636

[8] Su, J.; Fichtner, S.; Ghori, M. Z.; Wolff, N.; Islam, M. R.; Lotnyk, A.; Kaden, D.; **Niekiel, F**.; Kienle, L.; Wagner, B.; **Lofink, F**.: Growth of Highly c-Axis Oriented AlScN Films on Commercial Substrates. Micromachines**,** 13 (2022). DOI: 10.3390/mi13050783.

[9] Schell, V.; Müller, C.; Durdaut, P.; Kittmann, A.; Thormählen, L.; **Lofink, F.**; **Meyners, D.**; Höft, M.; McCord, J.; Quandt, E.: Magnetic anisotropy controlled FeCoSiB thin films for surface acoustic wave magnetic field sensors. Appl. Phys. Lett.**,** 116 (2020). DOI: 10.1063/1.5140562.

[10] Su, J.; Niekiel, F.; Fichtner, S.; Kirchhof, C.; **Meyners, D.**; Quandt, E.; Wagner, B.; Lofink, F.: Frequency tunable resonant magnetoelectric sensors for the detection of weak magnetic field. J. Micromech. Microeng.**,** 30 (2020), 75009. DOI: 10.1088/1361-6439/ab8dd0.

Reviewer (to be removed finally)
Lorenz Kienle | Walter Maetzler | Benjamin Spetzler

## Z2: Magnetoelectric Sensor Characterization

### Principal Investigators

Höft, Michael, Prof. Dr.-Ing.
02.07.1972, German

Microwave Engineering
Institute of Electrical and Information Engineering
Christian-Albrechts-Universität zu Kiel
Kaiserstr. 2, D-24143 Kiel

Phone: +49 (0) 431 880 6150
E-mail: mh@tf.uni-kiel.de

Rieger, Robert, Prof. Dr.
26.10.1975, German

Networked Electronic Systems
Institute of Electrical and Information Engineering
Christian-Albrechts-Universität zu Kiel
Kaiserstr. 2, D-24143 Kiel

Phone: +49 (0) 431 880 6151
E-mail: rri@tf.uni-kiel.de

### Summary of the Service Project

The primary objective of this central project is to characterize the individual magnetoelectric sensors that are being investigated and manufactured in the A projects. Due to the intricacies of sensor fabrication, magnetoelectric sensors cannot be identically processed by default, leading to performance deviations for each individual sensor. Therefore, a robust link between the sensor fabrication and their different intended (bio-)medical applications becomes important. To ensure reproducible sensor performance and provide quantitative feedback to the fabrication projects, a variety of quantitative metrics have already been successfully defined and implemented. These metrics include assessing the frequency response, noise amplitude spectral density, input-output-amplitude relation, limit-of-detection, limit-of-quantification, bandwidth, and dynamic range, among others. Additionally, the suite of current metrics will undergo expansion and refinement to encompass emerging requirements. New metrics will be developed and implemented based on an in-depth analysis of the unique needs and performance aspects of the current (bio-)medical applications. The data accumulated from the evaluation will be utilized to implement robust and insightful quality assurance protocols. Furthermore, an expansion of the ongoing exchange with the Physikalisch-Technische Bundesanstalt, Germany's leading authority on metrology and measurement technology, is planned. This will enable more general quality assurance of the magnetoelectric sensors. Additionally, the already established evaluation metrics will be collaboratively together with them for a more general magnetometer evaluation and comparison, addressing the current lack of a regulatory standard.

In order to ensure a reproducible magnetic operation point, a comprehensive investigation will be carried out focusing on an initialization method of the ME sensors based on equilibration. This approach aims to establish a standardized procedure and takes the hysteric effects caused by the magnetostrictive layer into account. Moreover, support in sensor selection for all (bio-)medical application projects, ensuring optimal operation within their specific contexts, will be provided. This support will include guidance during the sensor selection process, provision of technical advice concerning functionality, and assistance in the integration of selected sensors into magnetoelectric systems or for appropriate use in medical studies. Continuous feedback and collaboration with these projects will foster further refinement of the sensors. Additionally, support is provided to medical personnel in the preparation of related experiments involving

both healthy subjects and patients is provided. The hardware currently available within this central project, including amplifiers, signal generators, stimulators, and interfaces, will be continuously upgraded and expanded, in close collaboration with project B1.

**Project-relevant Previous Publications**

[1] Elzenheimer, E.; Hayes, P.; Thormählen, L.; Engelhardt, E.; Zaman, A.; Quandt, E.; Frey, N.; **Höft, M.**; Schmidt, G.: Investigation of Converse Magnetoelectric Thin Film Sensors for Magnetocardiography, IEEE Sensors Journal 23 (6), 2023, 5660-5669, doi: 10.1109/JSEN.2023.3237910.

[2] Wang, H.; Arbustini, J.; Elzenheimer, E.; Schell, V.; **Höft, M.**; Quandt, E.; Schmidt, G.; Heidari, H.; Bahr A.: Study of Chopping Magnetic Flux Modulation on Surface Acoustic Wave Based Magnetic Sensor, 29th IEEE International Conference on Electronics, Circuits and Systems, 2022, 1-4, doi: 10.1109/ICECS202256217.2022.9970919.

[3] Muñoz, J.; Arbustini, J.; Elzenheimer, E.; Hoffmann, J.; Thormählen, L.; Hayes, P.; Niekiel, F.; Heidari, H.; **Höft, M.**; Quandt, E.; Schmidt, G.; Bahr A.: Digital Approaches on Frequency Tuning for Magnetoelectric Sensors**,** 29th IEEE International Conference on Electronics, Circuits and Systems (ICECS), 2022, doi: 10.1109/ICECS202256217.2022.9970919.

[4] Arbustini, J.; Muñoz, J.; Wang, H.; Elzenheimer, E.; Hoffmann, J.; Thormählen, L.; Hayes, P.; Niekiel, F.; Heidari, H.; **Höft, M.**; Quandt, E.; Schmidt, G.; Bahr, A.: MEMS Magnetic Field Source for Frequency Conversion Approaches for ME Sensors**,** Current Directions in Biomedical Engineering 8 (2), 2022, 309-312, doi: 10.1515/cdbme-2022-1079 (open access).

[5] Wolframm, H.; Schell, V.; Quandt, E.; **Höft, M.**; Bahr, A.: High sensitivity magnetoelastic surface acoustic wave (SAW) magnetic field sensors, Proc. SPIE 12205, Spintronics XV, 1220505 (3 October 2022), doi: 10.1117/12.2633398.

[6] Elzenheimer, E.; Bald C.; Engelhardt, E.; Hoffmann, J.; Hayes, P.; Arbustini, J.; Bahr A.; Quandt, E.; **Höft, M.**; Schmidt, G.: Quantitative Evaluation for Magnetoelectric Sensor Systems in Biomagnetic Diagnostics**,** Sensors, 22 (3), 1018, 2022, doi: 10.3390/s22031018 (open access).

[7] Simmich, S.; **Rieger, R**.: Analysis of Current-Reuse and Split-Voltage Topology for Biomedical Amplifier Arrays, IEEE PRIME, Villasimius, Italy, 2022, doi: 10.1109/PRIME55000.2022.9816819.

[8] Spetzler, B.; Wiegand, P.; Durdaut, P.; **Höft, M.**; Bahr, A.; **Rieger, R.**; Faupel, F.: Modeling and Parallel Operation of Exchange-Biased Delta-E Effect Magnetometers for Sensor Arrays, Sensors, 21 (22), 7594, 2021, doi: 10.3390/s21227594 (open access).

[9] Simmich, S.; Bahr, A.; **Rieger, R.**: Noise Efficient Integrated Amplifier Designs for Biomedical Applications, Electronics, 10 (13), 1522, 2021, doi: 10.3390/electronics10131522 (open access).

[10] **Rieger, R.**; Rif'an, M.: Integrated ExG, Vibration and Temperature Measurement Front-End for Wearable Sensing, IEEE Trans. Circuits Syst. I - Reg. Papers, 65(8), (2018) 2422–2430, doi: 10.1109/TCSI.2017.2785863.

## Z3: Central Tasks of the Collaborative Research Centre

### Principal Investigators

Schmidt, Gerhard, Prof. Dr.-Ing
23.11.1971

Digital Signal Processing and System Theory
Institute for Electrical Engineering and Information Engineering
Christian-Albrechts-Universität zu Kiel
Kaiserstr. 2, D-24143 Kiel

Phone: +49 (0) 431 880 6125
E-mail: gus@tf.uni-kiel.de

### Summary of the Central Project

In the project Z3 “Central Tasks of the Collaborative Research Centre”, the organizational and administrative tasks of the CRC are integrated. The projects are supported in administrative and management questions by a central office for the administration and management of the CRC. The speaker and the executive board as well as the principal investigators and the scientists in the CRC are disburdened from administrative and coordinative tasks by the central office to give them the possibility to follow their scientific and technical tasks.

Essentially, the tasks covered by the central office of the CRC are:

- Contact for the DFG, the direction of the CAU and for the administration of the CAU in administrative and coordinative questions,
- Support of the speaker in the coordination of the CRC,
- Coordination of the preparation of reports and the continuation proposal,
- Organization of CRC-colloquiums, lecture events and educational events,
- Coordination and maintenance of the CRC website,
- Invitation of external scientists and support of the members of the CRC in case of temporary stays abroad,
- Cost monitoring of the CRC.

## 3. Scientific Profiles of all Principle Investigators

| Principle Investigator | Year of Dissertation | Institute |
|---|---|---|
| Adelung, Rainer, Prof. Dr. | 2000 | Department of Materials Science |
| Altintas, Zeynep, Prof. Dr. | 2012 | Department of Materials Science |
| Ameri, Tayebeh, Prof. Dr. | | Department of Materials Science |
| Bergholz, Robert, Prof. Dr. | 2005 | Department of Pediatric Surgery, UKSH Kiel |
| Ellrichmann, Mark, Prof. Dr. | 2004 | Department of Interdisciplinary Endoscopy, UKSH Kiel |
| Enzingmüller, Carolin, Dr. | 2017 | Leibniz Institute for Science and Mathematics Education |
| Frey, Norbert, Prof. Dr. | 1994 | Heidelberg University Hospital and Heidelberg University |
| Gerken, Martina, Prof. Dr. | 2003 | Department of Electrical and Information Engineering |
| Gojdka, Björn, Dr. | 2012 | Fraunhofer Institute for Silicon Technology ISIT |
| Gundlach, Jan-Paul, Dr. | 2014 | Eintrag fehlt noch |
| Höft, Michael, Prof. Dr. | 2002 | Department of Electrical and Information Engineering |
| Kienle, Lorenz, Prof. Dr. | 1998 | Department of Materials Science |
| Lofink, Fabian, Prof. Dr. | 2014 | Fraunhofer Institute for Silicon Technology ISIT |
| Maetzler, Walter, Prof. Dr. | Eintrag fehlt noch | Department of Neurology, UKSH Kiel |
| McCord, Jeffrey, Prof. Dr. | Eintrag fehlt noch | Department of Materials Science |
| Meyners, Dirk, Dr. | 2006 | Department of Materials Science |
| Murphy, Bridget, Dr. | Eintrag fehlt noch | Eintrag fehlt noch |
| Parchmann, Ilka, Prof. Dr. | Eintrag fehlt noch | Leibniz Institute for Science and Mathematics Education |
| Quandt, Eckhard, Prof. Dr. | 1990 | Department of Materials Science |
| Rieger, Robert, Prof. Dr. | Eintrag fehlt noch | Department of Electrical and Information Engineering |
| Schmidt, Gerhard, Prof. Dr. | Eintrag fehlt noch | Department of Electrical and Information Engineering |
| Schröder, Stefan, Dr. | Eintrag fehlt noch | Department of Materials Science |
| Spetzler, Benjamin, Dr. | 2021 | Ilmenau University of Technology |
| Wulfinghoff, Stephan, Prof. Dr. | 2014 | Department of Materials Science |

**Scientific Profiles – Table of Contents**

**Adelung, Rainer, Prof. Dr.**

**Personal Data**

| **Title, Name, Position, Institution, and ORCID** | |
|---|---|
| Title | Prof. Dr. |
| First name | Rainer |
| Name | Adelung |
| Current position | Professor (W3) |
| Current institution(s)/site(s), country | Department of Materials Science, Faculty of Engineering Kiel University, Kiel, Germany and Kiel Nano, Surface and Interface Science (KiNSIS), Kiel University, Germany |
| Identifiers/ORCID | 0000-0002-2617-678X |

**Qualifications and Career**

| **Stages** | **Periods and Details** |
|---|---|
| Degree programme | 1991 - 1995 Diploma Study of Physics,<br>Diploma Thesis (1995 - 1997)<br>Diploma in Experimental Physics, Kiel University |
| Doctorate | 1997 - 2000 Doctoral Studies in physics at the Institute for Experimental and Applied Physics, 2000 Doctor in Physics (summa cum laude), Kiel University, Germany<br>Supervisor: Prof. Dr. Michael Skibowski<br>Subject: Experimental solid-state physics |
| Stages of academic / professional career | Since 2010 W3 professorship, Chair for Functional Nanomaterials, Kiel University, Germany<br><br>2007 - 2010 W2 DFG Heisenberg professorship (tenure-track), Kiel University, Germany<br><br>2002 - 2007 Head of a scientifically independent subgroup at the Chair of Materials Composites (of Prof. F. Faupel), Kiel University, Germany<br><br>2006 Habilitation and venia legendi, Kiel University<br><br>2001 - 2002 Postdoctoral fellow at the Material Science Department at the Case Western Reserve University, USA, Feodor Lynen Research Fellowship by the Alexander von Humboldt Foundation |

**Engagement in the Research System**

Rainer Adelung is a referee for the DFG, also for the collaborative programmes, and serves at several journal boards. He is well known as a distinguished speaker at national and international conferences. He is active in academic self-governance, including serving as managing Institute Director, Chair of Examinations, member of the Convent and Senate, and on various committees, e.g. Graduate School, Internationalisation, Diversity.

**Selected Functions**

| | |
|---|---|
| 2021 – present | Spokesperson of Cluster of Excellence Initiative, Kiel University |
| 2021 – present | Vice Spokesperson of the CRC 1461 'Neurotronics', Kiel University |
| 2020 – present | Deputy Spokesperson of Graphene Flagship Spearhead project AEROGrAFT, funded by the European Commission |
| 2020 – present | Spokesperson of the RTG 2154 'Materials for Brain', Kiel University |
| 2013 – 2019 | Spokesperson of the priority research area Kiel Nano, Surface and Interface Science (KiNSIS) of Kiel University |

**Organization of Scientific Meetings – Selection**

- Organizer, International Intelligent Materials; June 29 – July 1, 2022, Kiel, Germany.
- Programme Committee, ICNBME; 2019, 2021, 2023, Chisinau, Republic of Moldova.
- Programme Committee, Euro Intelligent Materials; 2013, 2015, 2017, Kiel, Germany.
- Conference Co-Chair, SPIE micro technologies; May 4–6, 2015, Barcelona, Spain.

**Scientific Results**

**Category A**

[1] Santos-Carballal, D.; Lupan, O.; Magariu, N.; Ababii, N.; Krüger, H.; Teja Bodduluri, M.; de Leeuw, N.H., Hansen, S.; **Adelung, R.** (2023): Al2O3/ZnO composite-based sensors for battery safety applications: An experimental and theoretical investigation. Nano Energy, 109, 108301. doi: 10.1016/j.nanoen.2023.108301 (open access).

[2] Lupan, O.; Ababii, N.; Santos-Carballal, D.; Terasa, M.; Magariu, N.; Zappa, D.; Comini, E.; Pauporté, T.; Siebert, L.; Faupel, F.; Vahl, A.; Hansen, S.; de Leeuw, N.H.; **Adelung, R.** (2021): Tailoring the selectivity of ultralow-power heterojunction gas sensors by noble metal nanoparticle functionalization. Nano Energy, 88, 106241. doi: 10.1016/j.nanoen.2021.106241 (open access).

[3] Siebert, L.; Luna-Cerón, E.; García-Rivera, L.E.; Oh, J.; Jang, J.; Rosas-Gómez, D.A.; Pérez-Gómez, M.D.; Maschkowitz, G.; Fickenscher, H.; Oceguera-Cuevas, D.; Holguín-León, C.G.; Byambaa, B.; Hussain, M.A.; Enciso-Martinez, E.; Cho, …; **Adelung, R.**; Lee, E.; Shin, S.R. (2021): Light-controlled growth factors release on tetrapodal ZnO-incorporated 3D-printed hydrogels for developing smart wound scaffold. Advanced Functional Materials, 31(22), 2007555. doi: 10.1002/adfm.202007555.

[4] Schütt, F.; Rasch, F.; Deka, N.; Reimers, A.; Saure, L.M.; Kaps, S.; Rank, J.; Carstensen, J.; Kumar Mishra, Y.; Misseroni, D.; Romani Vázquez, A.; Lohe, M.R.; Shaygan Nia, A.; Pugno, N.M.; Feng, X.; **Adelung, R.** (2021): Electrically powered repeatable air explosions using microtubular graphene assemblies. Materials Today, 48, 7–17. doi: 10.1016/j.mattod.2021.03.010 (open access).

[5] Siebert, L.; Wolff, N.; Ababii, N.; Terasa, M.; Lupan, O.; Vahl, A.; Duppel, V.; Qiu, H.; Tienken, M.; Mirabelli, M.; Sontea, V.; Faupel, F.; Kienle, L.; **Adelung, R.** (2020): Facile fabrication of semiconducting oxide nanostructures by direct ink writing of readily available metal microparticles and their application as low power acetone gas sensors. Nano Energy, 70, 104420. doi: 10.1016/j.nanoen.2019.104420 (open access).

[6] Schütt, F.; Zapf, M.; Signetti, S.; Strobel, J.; Krüger, H.; Röder, R.; Carstensen, J.; Wolff, N.; Marx, J.; Carey, T.; Schweichel, M.; Terasa, M.I.; Siebert, L.; Hong, H.K.; Kaps, S.; Fiedler, B.; Mishra, Y.K.; Lee, Z.; Pugno, N.M.; **Adelung, R.** (2020): Conversionless efficient and broadband laser light diffusers for high brightness illumination applications. Nature Communications, 11(1), 1437. doi: 10.1038/s41467-020-14875-z (open access).

[7] Mishra, Y.K.; **Adelung, R.** (2018): ZnO tetrapod materials for functional applications. Materials Today, 21(6), 631–651. doi: 10.1016/j.mattod.2017.11.003 (open access).

[8] Schütt, F.; Signetti, S.; Krüger, H.; Röder, S.; Smazna, D.; Kaps, S.; Gorb, S.N.; Mishra, Y. K.; Pugno, N.M.; **Adelung, R.** (2017): Hierarchical self-entangled carbon nanotube tube networks. Nature Communications, 8(1), 1215. doi: 10.1038/s41467-017-01324-7 (open access).

[9] Gedamu, D.; Paulowicz, I.; Kaps, S.; Lupan, O.; Wille, S.; Haidarschin, G.; Mishra, Y.K.; **Adelung, R.** (2013): Rapid fabrication technique for interpenetrated ZnO nanotetrapod networks for fast UV sensors. Advanced Materials, 26(10), 1541–1550. doi: 10.1002/adma.201304363.

[10] Mecklenburg, M.; Schuchardt, A.; Mishra, Y.K.; Kaps, S.; **Adelung, R.**; Lotnyk, A.; Kienle, L.; Schulte, K. (2012): Aerographite: Ultra lightweight, flexible nanowall, carbon Microtube material with outstanding mechanical performance. Advanced Materials, 24(26), 3486–3490. doi: 10.1002/adma.201200491.

**Category B**

**Patents**

[1] **Adelung, R.**; Hanson, S.; Barr, J.; Carstensen, J. (2021): Method for preparing cycle-stable silicon anode for secondary battery and silicon anode for secondary battery, US2023075928A1, EP4103766A1, DE102020103469A1

[2] Gapeeva, A.; Qiu, H.; Baum, M.; **Adelung, R.** (2021): Antifouling yarn and antifouling yarn production method and use, DE102020112729A1, EP4149260A1

[3] Schütt, F.; Reimers, A.; Bahr, J.; Saure, L.M.; Rasch, F.; Rank, J.; Deka, N.; **Adelung, R.**; Kaps, S. (2021): Method for activating a gas, electrothermal gas actuator, and use of a gas actuator, DE102020110746A1, WO2021213577A1

[4] Gerngross, M.-D.; Baytekin-Gerngross, M.; Carstensen, J.; Adelung, R. (2021): Polymer-Kompositstruktur aufweisend eine Aluminium-Polymer Verankerungsschicht sowie Ätzverfahren, DE102021111149A1, WO2022228601A1

[5] Siebert, L.; Adelung, R.; Carstensen, J.; Schadte, P.; Kuntze, A.; Bahr, J. (2020): Polymerkomposit sowie Herstellungsverfahren dazu, DE102020105849A1, EP3906277A1

[6] Antoine, T.E.; Hillard, J.; **Adelung, R.**; Mishra, Y.M.; Shukla, D.; Prausnitz, M. (2017): Devices and methods for the treatment of a zoonotic herpesvirus infection, US2021369666A1

[7] Jordan, P.; Hager, S.; Erhard, D.; **Adelung, R.**; Mess, K.; Paulowicz, I.; Schütt, F. (2016): Filling needle for use in a tube layer for transferring a flowable medium, in particular a pharmaceutical product, DE102015222397, US10335348B2.

[8] Selhuber-Unkel, C.; Hölken, I.; Gutekunst, S.B.; **Adelung, R.** (2016): Microporous hydrogels, EP15166793.8, US10688469B2.

[9] **Adelung, R.**; Mishra, Y.K.; Röhl, C.; Shukla, D.; Spors, D.; Tiwari, V. (2015): Virus traps, US9182399.

### Academic Distinctions

2023 DGM Prize of the German Materials Society (DGM)
2017 Dimitrie Cantemir Medal of the Academy of Sciences of Moldova
2010 Call for a W3 professorship at the TU Hamburg

### Data Protection and Consent to the Processing of Optional Data

If you provide voluntary information (marked as optional) in this CV, your consent is required. Please confirm your consent by checking the box below.

[X] **I expressly consent to the processing of the voluntary (optional) information, including "special categories of personal data"[1] in connection with the DFG's review and decision-making process regarding my proposal.** This also includes forwarding my data to the external reviewers, committee members and, where applicable, foreign partner organisations who are involved in the decision-making process. To the extent that these recipients are located in a third country (outside the European Economic Area), I additionally consent to them being granted access to my data for the above-mentioned purposes, even though a level of data protection comparable to EU law may not be guaranteed. For this reason, compliance with the data protection principles of EU law is not guaranteed in such cases. In this respect, there may be a violation of my fundamental rights and freedoms and resulting damages. This may make it more difficult for me to assert my rights under the General Data Protection Regulation (e.g. information, rectification, erasure, compensation) and, if necessary, to enforce these rights with the help of authorities or in court.

I may **revoke** my consent in whole or in part at any time – with effect for the future, freely and without giving reasons – vis-à-vis the DFG (postmaster@dfg.de). The lawfulness of the processing carried out up to that point remains unaffected. Insofar as I transmit "special categories of personal data" relating to third parties, I confirm that the necessary legitimation under data protection law exists (e.g. based on consent). I have taken note of the DFG's Data Protection Notice relating to research funding, which I can access at www.dfg.de/privacy_policy and I will forward it to such persons whose data the DFG processes as a result of being mentioned in this CV.

[1] Special categories of personal data are those "revealing racial or ethnic origin, political opinions, religious or philosophical beliefs, or trade union membership, and (...) genetic data, biometric data for the purpose of uniquely identifying a natural person, data concerning health or data concerning a natural person's sex life or sexual orientation" (Article 9(1) GDPR).

**Altintas, Zeynep, Prof. Dr.**

**Personal Data**

| **Title, Name, Position, Institution, and ORCID** | |
|---|---|
| Title | Prof. Dr. |
| First name | Zeynep |
| Name | Altintas |
| Current position | Permanent full professor (W3) |
| Current institution(s)/site(s), country | Bioinspired Materials and Biosensor Technologies, Department of Materials Science, Faculty of Engineering, Kiel University, Germany |
| Identifiers/ORCID | 0000-0002-5461-3289 |

**Qualifications and Career**

| **Stages** | **Periods and Details** |
|---|---|
| Degree programme | |
| Doctorate | 2011 – 2012 Microelectronics and Bioengineering, Facuty of Natural Science and Engineering, Sabanci University, Turkey<br>„Dr. -Ing“ (summa cum laude), Supervisors: Prof. Yasar Gurbuz & Prof. Ugur Sezerman<br>Subject: Biomedical sensors<br>2010 EMBL Ph.D. student, European Institute of Bioinformatics, Cambridge, the UK<br>Subject: Computational biology<br>2009 – 2010 Doctoral Researcher, Analytical Chemistry, Cranfield Health, Cranfield University, the UK<br>Subject: Biomedical sensors |
| Stages of academic / professional career | Since 2022 Professorship (W3), Chair for Bioinspired Materials and Biosensor Technologies, Kiel University, Germany<br>2016 - 2022 Head of Biosensors and Receptor Development Group at Technical University of Berlin, Germany<br>2016 Visiting Professor and Scientific Advisor at the National Research Institute of Electronics and Cryptology, TUBITAK, Turkey<br>2013 - 2016 Faculty Member at Biomedical Engineering, School of Engineering, Cranfield University, the UK<br>2012 - 2013 Postdoctoral fellow at the Cranfield Biotechnology Center, the UK |

### Engagement in the Research System

Zeynep Altintas is a referee for funding agencies, including EU, DFG, Wisconsin Groundwater Coordinating Council, Dutch Research Council (NWO), the DAAD PRIME, BMBF & EU Cofund Projects, Israel Science Foundation (ISF), and French National Research Agency (ANR). She is well known as a distinguished speaker, organizer and session chair at national and international conferences. She is active in academic self-governance, including serving as member of various committees, e.g., Examinations, Internationalisation, Diversity.

### Selected Functions

- Associate editor of Sensing and Bio-Sensing Research (Elsevier)
- Editorial board member of Biosensors and Bioelectronics (Elsevier)
- Editorial board member of Scientific Reports (Nature)
- Editorial board member of Micromachines (MDPI, Switzerland)
- Editorial board member of Materials (MDPI, Switzerland)
- Expert reviewer for book series of WILEY (John Wiley & Sons, Inc.)
- Expert reviewer for book series of WILEY-IEEE
- Special issue editor in Materials: “Nanomaterials in Health Care Diagnostics”

### Organization of Scientific Meetings – Selection

- Committee member of Micromachines International Travel Awards for doctoral and postdoctoral researchers
- Member of scientific committee, 1st International Congress on Medical Sciences and Biotechnology, 14–16 October 2019 (Usak, Turkey).
- Member of scientific committee, 2nd International Congress on Analytical and Bioanalytical Chemistry, 11–14 March 2020 (Antalya, Turkey).

### Scientific Results

### Category A

[1] Pirzada, M.; **Altintas, Z.** (2022): Nanomaterials for virus sensing and tracking. Chemical Society Reviews, 51, 5805-5841. https://pubs.rsc.org/en/content/-articlehtml/2022/cs/d1cs01150b (open access).

[2] Mansuriya, B.D.; **Altintas, Z**. (2021): Enzyme-free electrochemical nano-immunosensor based on graphene quantum dots and gold nanoparticles for cardiac biomarker determination. Nanomaterials, 11(3), 578. https://www.mdpi.com/2079-4991/11/3/578 (open access).

[3] Sehit, E.; Drzazgowska, J.; Buchenau, D.; Yesildag, C.; Lensen, M.; **Altintas, Z**. (2020): Ultrasensitive nonenzymatic electrochemical glucose sensor based on gold nanoparticles and molecularly imprinted polymers. Biosensors and Bioelectronics, 165 (112432). https://www.sciencedirect.com/science/article/abs/pii/S0956566320304267 (open access).

[4] Pirzada, M.; Sehit, E.; **Altintas, Z.** (2020): Cancer biomarker detection in human serum samples using nanoparticle decorated epitope-mediated hybrid MIP. Biosensors and

Bioelectronics, 166, 112464: p. 1-11. https://www.sciencedirect.com/-science/article/abs/pii/S0956566320304577 (open access).

[5] Drzazgowska, J.; Schmid, B.; Süssmuth, R.D.; **Altintas, Z**. (2020): Self-assembled monolayer epitope bridges for molecular imprinting and cancer biomarker sensing. Analytical Chemistry, 92(7): p.4798-4806. https://doi.org/10.1021/acs.analchem.9b03813 (open access).

[6] Tchinda, R.; Tutsch, A.; Schmid, B.; Sussmuth, R.D.; **Altintas, Z**. (2019): Recognition of protein biomarkers using epitope-mediated molecularly imprinted films: Histidine or cysteine modified epitopes? Biosensors and Bioelectronics, 123: p. 260-268. DOI: 10.1016/j.bios.2018.09.010 (open access).

[7] **Altintas, Z.;** Takiden, A.; Utesch, T.; Mroginski, M.A.; Schmid, B.; Scheller, F.W.; Sussmuth, R.D. (2019): Integrated approaches toward high-affinity artificial protein binders obtained via computationally simulated epitopes for protein recognition. Advanced Functional Materials, 29 (15): 1807332. https://doi.org/10.1002/adfm.201807332 (open access).

[8] **Altintas, Z**.; Akgun, M.; Kokturk, G.; Uludag, Y. (2018): A fully automated microfluidic-based electrochemical sensor for real-time bacteria detection. Biosensors and Bioelectronics, 100: p. 541-548. https://www.sciencedirect.-com/science/article/abs/pii/S0956566317306541 (open access).

[9] Waffo, A.F.T.; Yesildag, C.; Caserta, G.; Katz, S.; Zebger, I.; Lensen, M.C.; Wollenberger, U.; Scheller, F.W., **Altintas, Z.** (2018): Fully electrochemical MIP sensor for artemisinin. Sensors and Actuators B: Chemical, 275: p.163-173. DOI: 10.1016/j.snb.2018.08.018 (open access).

[10] **Altintas, Z.** (2017): Biosensors and Nanotechnology -Applications in Health Care Diagnostics. John Wiley & Sons Press, Online ISBN: 9781119065036. Print ISBN: 9781119065012. https://onlinelibrary.wiley.com/doi/book/10.1002/9781119065036.

**Category B**

**Patents**

[1] **Altintas, Z.;** Tothill, I.E. (2014). Molecularly imprinting polymer-based affinity nanomaterials for pharmaceuticals capture, filtration and detection. GB1413210.4, 31 July 2014.

[2] **Altintas, Z**.; Guerreiro, A.; Piletsky, S.; Tothill, I.E. (2014). Affinity molecular receptor for viruses capture and sensing. GB1413209.6, 4 August 2014.

[3] **Altintas, Z.;** Abdin, M.J.; Tothill, I.E. (2014). MIP-NPs for endotoxin filtration and monitoring. GB1413206.2, 30 July 2014.

**Academic Distinctions**

**Visiting Professorships, Fellowships, Research Awards and Prizes – Selection**

- Visiting professorship – The National Research Institute of Electronics and Cryptology, TUBITAK (2016)
- Visiting professorship – The University of Pavia, Italy (2020)

- Visiting professorship – The University of Leicester, the UK (2020)
- Life Outstanding Investigator Award for Women (2022)
- The World's Top 2% Scientists List of Stanford University (2021 & 2022)
- The Aventis Life Sciences Bridge Award for Outstanding Young Investigator in Germany (2021) – along with €100,000 prize money
- The Royal Society of Chemistry Research Award (2019)
- Marie Curie Individual Fellowship for Experienced Researcher (2016–2018)
- TUBITAK fellowship for internationally recognized scientist (2016) – along with €16,000 prize money
- Aptamer Solution Competition, £50,000 prize money as the winner of the UK (2012)
- The Gursel Sonmez Research Award for outstanding Ph.D. researcher and Ph.D. thesis (2012) – Certificate and ca €1000

**Other Information**

The group is very active in attracting third-party funding in all areas, from basic research to applied science. Of the current 13 doctoral students and postdoctoral fellows, 12 are funded by third parties, among others, EU, DFG, Humboldt Foundation, TUBITAK, and Aventis Foundation.

**Data Protection and Consent to the Processing of Optional Data**

If you provide voluntary information (marked as optional) in this CV, your consent is required. Please confirm your consent by checking the box below.

[**X**] **I expressly consent to the processing of the voluntary (optional) information, including "special categories of personal data"[2] in connection with the DFG's review and decision-making process regarding my proposal.** This also includes forwarding my data to the external reviewers, committee members and, where applicable, foreign partner organisations who are involved in the decision-making process. To the extent that these recipients are located in a third country (outside the European Economic Area), I additionally consent to them being granted access to my data for the above-mentioned purposes, even though a level of data protection comparable to EU law may not be guaranteed. For this reason, compliance with the data protection principles of EU law is not guaranteed in such cases. In this respect, there may be a violation of my fundamental rights and freedoms and resulting damages. This may make it more difficult for me to assert my rights under the General Data Protection Regulation (e.g. information, rectification, erasure, compensation) and, if necessary, to enforce these rights with the help of authorities or in court.

I may **revoke** my consent in whole or in part at any time – with effect for the future, freely and without giving reasons – vis-à-vis the DFG (postmaster@dfg.de). The lawfulness of the processing carried out up to that point remains unaffected. Insofar as I transmit "special categories of personal data" relating to third parties, I confirm that the necessary legitimation under data protection law exists (e.g. based on consent).

I have taken note of the DFG's Data Protection Notice relating to research funding, which I can access at www.dfg.de/privacy_policy and I will forward it to such persons whose data the DFG processes as a result of being mentioned in this CV.

[2] Special categories of personal data are those "revealing racial or ethnic origin, political opinions, religious or philosophical beliefs, or trade union membership, and (...) genetic data, biometric data for the purpose of uniquely identifying a natural person, data concerning health or data concerning a natural person's sex life or sexual orientation" (Article 9(1) GDPR).

**Ameri, Tayebeh, Prof. Dr.**

**Personal Data**

| Title, Name, Position, Institution, and ORCID | |
|---|---|
| Title | Prof. Dr. Tech. |
| First name | Tayebeh |
| Name | Ameri |
| Current position | Heisenberg Professor (W3) |
| Current institution(s)/site(s), country | Kiel University, Germany |
| Identifiers/ORCID | 0000-0002-8928-3697 |

**Qualifications and Career**

| Stages | Periods and Details |
|---|---|
| Degree programme | B.Sc. Physics, 1999 – 2003, Isfahan University of Technology, Isfahan, Iran<br>M.Sc. Solid State Physics, 2003 – 2006, Ferdowsi University, Mashhad, Iran |
| Doctorate | 2010, Prof. Christoph J. Brabec, Johannes Kepler University, Linz, Austria (Ph.D. candidate at Konarka GmbH) |
| Stages of academic/professional career | Since 2023 Heisenberg Professor (W3) for “Composite Materials” at the Faculty of Engineering of the CAU Kiel, Germany<br><br>Since 2023 Honorary Lecturer for “Chemical Engineering” at the School of Engineering of the University of Edinburgh, UK<br><br>2021 – 2023 Senior Lecturer (Associate Professor) for “Chemical Engineering” at the School of Engineering of the University of Edinburgh, UK<br><br>2018 – 2020 Lecturer (Privatdozent) & Independent Research Team Leader for “Printed Optoelectronics” at the Physical Chemistry Department of the Ludwig-Maximilian University of Munich, Germany<br><br>2013 – 2017 Habilitant for “Near IR Sensitization of Polymer/Fullerene Solar Cells” at the Technical Faculty of the Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany<br><br>2010 – 2013 Postdoc & Group Leader for “Organic Photovoltaics” at the Technical Faculty of the Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany |

**Supplementary Career Information**

Four and half month maternity and parental leave in 2015, First-generation academics, Four times migration between different countries, Single child-carer for two and half years in Edinburgh.

## Engagement in the Research System

- Symposium organizer at the E-MRS Spring Meeting, Strasbourg, France (2024)
- Symposium organizer of the E-MRS 2023 Fall Meeting, Warsaw, Poland (2023)
- Editor of Materials Today Energy (2023 – Present)
- Member of the German Physical Society (2023 – Present)
- Member of the Women's Engineering Society (WES), UK (2021 – Present)
- Undergraduate liaison officer of the Molly Fergusson Initiative, UoE (2021 – 2023)
- School promotions committee member, UoE (2021 – 2023)
- Panel member of the Poland's National Science Centre, Panel ST7 (2021)
- Coordinator of the "e-conversion" Graduate Program (2019 – 2020)
- Member of Royal Society of Chemistry (2019 – Present)
- Member of German Academic Association (2015 – Present)

## Scientific Results

### Category A

[1] Semerci, A.; Buyruk, A.; Emin, S.; Mayer, P.; Kovacheva, D.; Hooijer, R.; Scheel, M. A.; Blätte, D.; Günther, M.; Hartmann, N. F.; Lotfi, S.; Hofmann, J. P.; Müller-Buschbaum, P.; Bein, T.; **Ameri, T**.: A Novel Multi-Functional Thiophene-Based Organic Cation as Passivation, Crystalline Orientation, and Organic Spacer Agent for Low-Dimensional 3D/1D Perovskite Solar Cells, Adv. Optical Mater., (2023) 2300267, doi: 10.1002/adom.202300267 (open access).

[2] Günther, M.; Kazerouni, N.; Blätte, D.; Dario Perea, J.; Thompson, B. C.; **Ameri, T.**: Models and Mechanisms of Ternary Organic Solar Cells, Nature Reviews Materials, 8, (2023) 456–471, doi: 10.1038/s41578-023-00545-1 (open access).

[3] Günther, M.; Lotfi, S.; Sánchez Rivas, S.; Blätte, D.; Hofmann, J. P.; Bein, T.; **Ameri, T.**: The neglected influence of zinc oxide light-soaking on stability measurements of inverted organic solar cells, Adv. Funct. Mater., 33, (2023) 2209768, doi: 10.1002/adfm.202209768 (open access).

[4] Shadabfar, M.; Ehsani, M.; Khonakdar, H. A.; Abdouss, M.; **Ameri, T.**: Waterborne conductive carbon paste with an eco-friendly binder, Cellulose, 30(3), (2022) 1759–1772, doi: 10.1007/s10570-022-04998-5 (open access).

[5] Khorshidi, E.; Rezaei, B.; Hanisch, J.; Böller, B.; Reus, M. A.; Müller-Buschbaumde, P.; **Ameri, T.**: Antisolvent additive engineering for boosting performance and stability of heterojunction perovskite solar cells using multifunctional AGQDs, ACS Appl. Mater. Interfaces, 14(49), (2022) 54623–54634, doi: 10.1021/acsami.2c12944 (open access).

[6] Buyruk, A.; Blätte, D.; Günther, M.; Scheel, M. A.; Hartmann, N. F.; Döblinger, M.; Weis, A.; Hartschuh, A.; Müller-Buschbaum, P.; Bein, T.; **Ameri, T.**: 1,10-Phenanthroline as an efficient bifunctional passivating agent for MAPbI3 perovskite solar cells, ACS Appl. Mater. Interfaces, 13(28), (2021) 32894–32905, doi: 10.1021/acsami.1c05055.

[7] Günther, M.; Blätte, D.; Lena Oechsle, A.; Sánchez Rivas, S.; Yousefi Amin, A. A.; Müller-Buschbaum, P.; Bein, T.; **Ameri, T.**: Increasing Photostability of Inverted Nonfullerene

Organic Solar Cells by using Fullerene Derivative Additives, ACS Appl. Mater. Interfaces, 13(16), (2021) 19072–19084, doi: 10.1021/acsami.1c00700.

[8] Gasparini, N.; Lucera, L.; Salvador, M.; Prosa, M.; Kubis, P.; Spyropoulos, G. D.; Egelhaaf, H-J.; Brabec, C. J.; **Ameri, T.**: High-performance ternary organic solar cells with thick active layer exceeding 11% efficiency, Energy Environ. Sci., 10(4), (2017) 885-892, doi: 10.1039/C6EE03599J.

[9] Ke, L.; Gasparini, N.; Min J.; Zhang, H.; Adam, M.; Fladischer, S.; Forberich, K.; Zhang, C.; Spiecker, E.; Tykwinski, R. R.; Brabec, C. J.; **Ameri, T.**: Panchromatic quaternary polymer/fullerene BHJ solar cells, based on the novel silicon naphthalocyanine and silicon phthalocyanine dye sensitizers, J. Mater. Chem. A, 5(6), (2017) 2550-2562, doi: 10.1039/C6TA08729A.

[10] Gasparini, N.; Jiao, X.; Heumueller, T.; Baran, D.; Matt, G. J.; Fladischer, S.; Spiecker, E.; Ade, E.; Brabec, C. J.; **Ameri,T.**: Designing ternary blend bulk heterojunction solar cells with reduced carrier recombination and fill factor of 77%, Nature Energy, 1, (2016) 16118, doi: 10.1038/NENERGY.2016.118.

**Category B**

[1] Li, N.; Stubhan, T.; Krantz, J.; Machui, F.; **Ameri, T.**; Brabec, C. J.: Verbesserte Recombinationseigenschaften in P-Type/N-Type Heterointerface für die Anwendung in Tandem Solarzellen, File No: 502-61.3-41/12 (all rights of this invention were sold and assigned to Cambrios Technology Corporation).

[2] Spyropoulos, G.; Salvador, M.; **Ameri, T.**; Egelhaaf, H.-J.; Brabec, C. J.: Method for fabricating a solar module, sub-laminate for fabricating a solar cell and solar module, Patented by European Patent Office, File No: 16720437.9 - 1230 / 3453059.

[3] Kazerouni, N.; Guenther, M.; Thompson, B. C.; **Ameri, T.**: Chapter “Ternary sensitization of organic solar cells, a multifunctional concept to boost power conversion efficiency” of book “Emerging Photovoltaic Technologies Photophysics and Devices”, Edited by Carlito Ponseca carlito, Pan Stanford Publishing, 2019.

**Academic Distinctions**

- 2021 WES Top 50 Women in Engineering (WE50) 2021: Engineering Heroes, UK
- 2021 International Association of Advanced Materials (IAAM) Scientist Medal
- 2020 Heisenberg Programme Award, DFG, Germany
- 2020 Arnold Sommerfeld Prize, Bavarian Academy of Science, Germany
- 2020 Medical Valley Award to launch the start-up SERINO on development of the next generation of IR detectors for pharmaceutical applications, Bavaria, Germany
- 2019 Wolfgang Finkelnburg Prize, Habilitation prize of the Technical Faculty, FAU, Germany
- 2016 Christiane Nüsslein-Volhard-Stiftung, Germany
- 2004 Top student award (M.Sc. Program), Ferdowsi University, Mashhad, Iran
- 2000 – 2003 Iran’s National Science Scholarship (for three consecutive years)
- 1999 – 2003 Top student award (B.Sc. Program), Isfahan University of Technology, Iran

## Other Information

Over 35 invited / plenary talks, e.g. MRS, E-MRS, nanoGe, DPG, etc.

## Data Protection and Consent to the Processing of Optional Data

If you provide voluntary information (marked as optional) in this CV, your consent is required. Please confirm your consent by checking the box below.

[X] **I expressly consent to the processing of the voluntary (optional) information, including "special categories of personal data"[3] in connection with the DFG's review and decision-making process regarding my proposal.** This also includes forwarding my data to the external reviewers, committee members and, where applicable, foreign partner organisations who are involved in the decision-making process. To the extent that these recipients are located in a third country (outside the European Economic Area), I additionally consent to them being granted access to my data for the above-mentioned purposes, even though a level of data protection comparable to EU law may not be guaranteed. For this reason, compliance with the data protection principles of EU law is not guaranteed in such cases. In this respect, there may be a violation of my fundamental rights and freedoms and resulting damages. This may make it more difficult for me to assert my rights under the General Data Protection Regulation (e.g. information, rectification, erasure, compensation) and, if necessary, to enforce these rights with the help of authorities or in court.

I may **revoke** my consent in whole or in part at any time – with effect for the future, freely and without giving reasons – vis-à-vis the DFG (postmaster@dfg.de). The lawfulness of the processing carried out up to that point remains unaffected. Insofar as I transmit "special categories of personal data" relating to third parties, I confirm that the necessary legitimation under data protection law exists (e.g. based on consent).

I have taken note of the DFG's Data Protection Notice relating to research funding, which I can access at www.dfg.de/privacy_policy and I will forward it to such persons whose data the DFG processes as a result of being mentioned in this CV.

[3] Special categories of personal data are those "revealing racial or ethnic origin, political opinions, religious or philosophical beliefs, or trade union membership, and (...) genetic data, biometric data for the purpose of uniquely identifying a natural person, data concerning health or data concerning a natural person's sex life or sexual orientation" (Article 9(1) GDPR).

**Bergholz, Robert, Prof. Dr.**

**Personal Data**

| Title, Name, Position, Institution, and ORCID | |
|---|---|
| Title | Professor Dr. med. |
| First name | Robert |
| Name | Bergholz |
| Current position | Professor (W2), Surgeon in Chief Pediatric Surgery |
| Current institution(s)/site(s), country | Kiel University and University Hospital of Schleswig Holstein (UKSH), Kiel Campus, Germany |
| Identifiers/ORCID | 0000-0001-6924-8440 |

**Qualifications and Career**

| Stages | Periods and Details |
|---|---|
| Degree programme | 1997 - 2004 Studies of Human Medicine at Free University of Berlin and Charité Berlin, University of Melbourne and Sydney, Australia, and Tulane Medical School, USA. Board Certified Physician 10/2004 |
| Doctorate | 2005 Prof. Dr. med. Gerd Burmester, Charité Berlin, Titel: "Autoantobody patterns in rheumatoid arthritis", Magna cum laude. |
| Stages of academic/professional career | Since 2019 Professor of Pediatric Surgery, Christian Albrechts University, Kiel, Germany<br><br>Since 2019 Surgeon-in-Chief, Pediatric Surgery, University Hospital Kiel, Germany<br><br>October 1st 2017 – April 2019 Deputy managing officer of the Department of Pediatric Surgery, UKE Medical School, Hamburg, Germany<br><br>Since June 1st 2011 Consultant Pediatric Surgeon, Department of Pediatric Surgery, UKE Medical School and Children's Hospital Altona, Hamburg, Germany<br><br>January 1st 2005 – May 2011 Surgical Resident. Department of Pediatric Surgery. UKE Medical School and Children's Hospital Altona, Hamburg; Department of Pediatric Surgery, University Hospital Muenster, North-Rhine Westfalia; Department of General- Visceral- Vascular- and Thoracic Surgery, Charité Medical School, Humboldt and Free University at Berlin, Germany |

**Engagement in the Research System**

- 3rd Chairperson of the Kurt-Semm-Zentrum, UKSH Kiel Campus, Germany (since March 2023)

- Chairperson of the “Zentrum für angeborene Fehlbildungen“, UKSH Kiel Campus, Germany (since June 2022)
- Member of the Review / Evaluation Group “Wissenschaftliche Juniorförderung am UKSH“ since 2019
- Team Leader of the workgroup “Fetal Surgery” of the German Society of Pediatric Surgery (3 year term, 2019, re-elected 2021)
- Reviewer: „Czech Health Research Council, GACR“, 2014
- Reviewer: „Horizon 2020“ (European Commission call 'Personalizing health and care' (H2020-PHC-2015)), 2014

**Scientific Results**

**Category A**

[1] Krebs, T.; Kayser, T.; Lorenzen, U.; Grünewald, M.; Kayser, M.; Saltner, A; Durmaz, L.; Reese, L.; Brownlee, E.; Reischig, K.; Baastrup, J.: Meinzer, A.; Kalz, A.; Becker, T.; **Bergholz, R**.: Evaluation of a new robotic system for infant surgery – a study in piglets of less than 10 kg body weight. Children (Basel). 2023 May 3;10(5):831. doi: 10.3390/children10050831 (open access).

[2] Kayser, M.; Krebs, T.F.; Alkatout, I.; Kayser, T.; Reischig, K.; Baastrup, J.; Meinzer, A.; Ulrich, K.; Osmonov, D.; **Bergholz, R.:** Evaluation of the Versius Robotic Surgical System for Procedures in Small Cavities.Children (Basel). 2022 Feb 3;9(2):199. doi: 10.3390/children9020199 (open access).

[3] **Bergholz, R.;** Fromm, F.; Meinzer, A.; Muehlfeld, C.; Boettcher, M.; Wenke, K.; Tiemann, B.; Reinshagen, K.; Krebs, T.: Stereological Lung Parameters After Fetoscopic Abdominal Decompression of Congenital Diaphragmatic Hernia in an Ovine Model: A Pilot Study. J Laparoendosc Adv Surg Tech A. 2021 Jun;31(6):712-718. doi: 10.1089/lap.2020.0954.

[4] Krebs, T.; Egberts, J.H.; Lorenzen, U.; Krause, M.F.; Reischig, K.; Meiksans, R.; Baastrup, J.; Meinzer, A.; Alkatout, I.; Cohrs, G.; Wieker, H.; Lüthje, A.; Vieten, S.; Schultheiss, G.; **Bergholz, R.:** Robotic infant surgery with 3 mm instruments: a study in piglets of less than 10 kg body weight. J Robot Surg. 2022 Feb;16(1):215-228. doi: 10.1007/s11701-021-01229-0.

[5] **Bergholz, R**.; Krebs, T.; Cremieux, B.; Georgi, C.; Fromm, F.; Boettcher, M.; Andreas, T.; Tiemann, B.; Wenke, K.; Reinshagen, K.; Hecher, K.: Fetoscopic techniques for prenatal covering of gastroschisis in an ovine model are technically demanding and do not lead to permanent anchoring on the fetus until the end of gestation. Surg Endosc. Surgical Endoscopy, 35(2), 745-753, DOI: 10.1007/s00464-020-07441-7.

[6] **Bergholz, R.**, Botden, S.; Gemert, W.V.; Tytgat, S.; Boettcher, M.; Verweeij, J.; Ehlert, H.; Reinshagen, K.; Gidaro, S.: Evaluation of a new robotic-assisted laparoscopic surgical system for procedures in small cavities. J Robotic Surg (2019). https://doi.org/10.1007/s11701-019-00961-y.

[7] **Bergholz, R.**, Klein, I.; Wenke, K.; Reinshagen, K.; Krebs, T.: Midterm Outcome of Transumbilically Laparoscopic-Assisted Versus Laparoscopic and Open Appendectomy in Children-A Matched Prospective Study. Eur J Pediatr Surg. 2015 Apr;25(2):216-9.

[8] Krebs, T.; Boettcher, M.; Schäfer, H.; Eschenburg, G.; Wenke, K.; Appl, B.; Roth, B.; Andreas, T.; Schmitz, C.; Fahje, R.; Jacobsen, B.; Tiemann, B.; Reinshagen, K.; Hecher, K.; **Bergholz, R**.: Gut inflammation and expression of ICC in a fetal lamb model of fetoscopic intervention for gastroschisis. Surg Endosc. 2014 Aug;28(8):2437-42

[9] **Bergholz, R.**, Krebs, T.; Klein, I.; Wenke, K.; Reinshagen, K.: Transumbilical Laparoscopic-assisted Versus 3-Port Laparoscopic and Open Appendectomy: A Case-Control Study in Children. Surg Laparosc Endosc Percutan Tech. 2014 Jun;24(3):244-7.

[10] **Bergholz, R.**, Krebs, T.; Wenke, K.; Andreas, T.; Tiemann, B.; Paetzel, J.; Jacobsen, B.; Fahje, R.; Schmitz, C.; Mann, O.; Roth, B.; Appl, B.; Hecher, K.: Fetoscopic management of gastroschisis in a lamb model. Surg Endosc. 2012 May;26(5):1412-6.

**Category B**

[1] Schmidt, G.; **Bergholz, R.**; Quandt, E.; Sun, N.; Klinkenbusch, L.; Bald, C.; Schmidt, T.: Vorrichtung zur Posenschätzung eines magnetfeldmessenden Objekts, (2023) patent application DE 10 2023 116 342.6.

[2] Bald, C.; **Bergholz, R.**; Schmidt, G.: Automatic Localization of an Ultrasound Probe with the Help of Magnetic Sensors, Current Directions in Biomedical Engineering, 8(2), (2022) 317-320 (open access), doi: 10.1515/cdbme-2022-1081.

**Academic Distinctions**

- Sept. 2000 - Sept. 2001: One year studies break with a research grant for working at the laboratories of Professor G. -R. Burmester, MD and St. Blaess, PhD. Charité Medical School, Department of Clinical Immunology and Rheumatology, 12.000 Deutsche Mark
- 1998 – 1999: Participant at the additional Benjamin Franklin College for highly motivated Students of Medicine at the Free University at Berlin. Winner of Second price with the oral presentation “Gene therapy: Viruses as Vectors” at the final Symposium

**Data Protection and Consent to the Processing of Optional Data**

If you provide voluntary information (marked as optional) in this CV, your consent is required. Please confirm your consent by checking the box below.

[X] **I expressly consent to the processing of the voluntary (optional) information, including “special categories of personal data”[4] in connection with the DFG’s review and decision-making process regarding my proposal.** This also includes forwarding my data to the external reviewers, committee members and, where applicable, foreign partner organisations who are involved in the decision-making process. To the extent that these recipients are located in a third country (outside the European Economic Area), I additionally consent to them being granted access to my data for the above-mentioned purposes, even though a level of data protection comparable to EU law may not be guaranteed. For this reason, compliance with the data protection principles of EU law is not guaranteed in such cases. In this respect, there may be a violation of my fundamental rights and freedoms and resulting

[4] Special categories of personal data are those “revealing racial or ethnic origin, political opinions, religious or philosophical beliefs, or trade union membership, and (...) genetic data, biometric data for the purpose of uniquely identifying a natural person, data concerning health or data concerning a natural person’s sex life or sexual orientation” (Article 9(1) GDPR).

damages. This may make it more difficult for me to assert my rights under the General Data Protection Regulation (e.g. information, rectification, erasure, compensation) and, if necessary, to enforce these rights with the help of authorities or in court.

I may **revoke** my consent in whole or in part at any time – with effect for the future, freely and without giving reasons – vis-à-vis the DFG (postmaster@dfg.de). The lawfulness of the processing carried out up to that point remains unaffected. Insofar as I transmit "special categories of personal data" relating to third parties, I confirm that the necessary legitimation under data protection law exists (e.g. based on consent).

I have taken note of the DFG's Data Protection Notice relating to research funding, which I can access at www.dfg.de/privacy_policy and I will forward it to such persons whose data the DFG processes as a result of being mentioned in this CV.

**Ellrichmann, Mark, Prof. Dr.**

**Personal Data**

| Title, Name, Position, Institution, and ORCID | |
|---|---|
| Title | Prof. Dr. med.; MaHM |
| First name | Mark |
| Name | Ellrichmann |
| Current position | Professor (W2), Director Interdisciplinary Endoscopy |
| Current institution(s)/site(s), country | University Hospital Schleswig-Holstein, Campus Kiel & Christian-Albrechts-University, Kiel, Germany |
| Identifiers/ORCID | 0000-0002-5817-5589 |

**Qualifications and Career**

| Stages | Periods and Details |
|---|---|
| Degree programme | 1994-2001 Studies of Human medicine, Ruhr-University Bochum, Germany |
| Doctorate | 2004 Prof. Dr. med. Frank Schmitz, Ruhr-University Bochum, Germany |
| Stages of academic/professional career | Since 2021 Professor (W2) Endoscopic Imaging, Christian-Albrechts-University, Kiel, Germany<br>Since 2013 Director Department of Interdisciplinary Endoscopy, Christian-Albrechts-University, Kiel, Germany<br>2010 - 2013 Senior Consultant Gastroenterology, Christian-Albrechts-University, Department of Gastroenterology, Kiel, Germany<br>2008 - 2010 Senior Consultant Gastroenterology, Ruhr-University Bochum, St. Josefs Hospital, Bochum, Germany<br>2001 - 2008 Specialisation in Internal Medicine / Gastroenterology, Ruhr-University Bochum, St. Josefs Hospital, Bochum, Germany |

**Supplementary Career Information**

2011 - 2013: Master of Hospital Management (MaHM), Christian-Albrechts-University, Kiel, Germany
2000 - 2004: Certificated studies Biomedical Engineering, Technical University Kaiserslautern, Germany

**Engagement in the Research System**

- Principal Investigator/coordinator, Center of Integrative Systemmedicine (ZisMed) (since 2017)
- Principal Investigator/coordinator CD4, Excellence cluster “Precision Medicine in Chronic Inflammation” (since 2017)
- Principal Investigator/coordinator, Proposal for a Collaborative Research Center (CRC)

in the German Research Foundation (DFG) (since 2021)
- Head of the scientific European and Germany Society of Cholangioscopy (ECG and GCG) (since 2020)
- Principle Investigator “Else-Kröner-Forschungskolleg – Brain-Gut-Axis“ (since 2020)

**Scientific Results**

**Category A**

[1] Gerges, C.; Albers, D.; Schmitz, L.; Goni, E.; Cappello, A.; Schirra, J.; Casper, M.; Dormann, A.J.; Hartmann, D.; Hollenbach, M.; Schneider, M.; Denzer, U.W.; Dechene, A.; Dollhopf, M.; Mayerle, J.; Schumacher, B.; van Geenen, E.M.; Neuhaus, H.; Siersema, P.D.; **Ellrichmann, M.;** Beyna, T.: Digital single-operator pancreatoscopy for the treatment of symptomatic pancreatic duct stones: a prospective multicenter cohort trial. Endoscopy. 2023 Feb;55(2):150-157. doi: 10.1055/a-1870-3403 (open access).

[2] de Jong, D.M.; Stassen, P.M.C.; Groot Koerkamp, B.; **Ellrichmann, M.;** Karagyozov, P.I.; Anderloni, A.; Kylänpää, L.; Webster, G.J.M.; van Driel, L.M.J.W.; Bruno, M.J.; de Jonge, P.J.F.: European Cholangioscopy study group. The role of pancreatoscopy in the diagnostic work-up of intraductal papillary mucinous neoplasms: a systematic review and meta-analysis. Endoscopy. 2023 Jan;55(1):25-35. doi: 10.1055/a-1869-0180 (open access).

[3] Bojarski, C.; Tangermann, P.; Barmeyer, C.; Buchkremer, J.; Kiesslich, R.; **Ellrichmann, M.;** Schreiber, S.; Schmidt, C.; Stallmach, A.; Roehle, R.; Loddenkemper, C.; Daum, S.; Siegmund, B.; Schumann, M.; Ullrich R.: Prospective, double-blind diagnostic multicentre study of confocal laser endomicroscopy for wheat sensitivity in patients with irritable bowel syndrome. Gut. 2022 Aug;71(8):1567-1576. doi: 10.1136/gutjnl-2021-325181 (open access).

[4] Peñate Medina, T.; Kolb, J.P.; Hüttmann, G.; Huber, R.; Peñate Medina, O.; Ha, L.; Ulloa, P.; Larsen, N.; Ferrari, A.; Rafecas, M.; **Ellrichmann, M.;** Pravdivtseva, M.S.; Anikeeva, M.; Humbert, J.; Both, M.; Hundt, J.E.; Hövener, J.B.: Imaging Inflammation - From Whole Body Imaging to Cellular Resolution. Front Immunol. 2021 Jun 24;12:692222. doi: 10.3389/fimmu.2021.692222 (open access).

[5] Ellrichmann, M.; Bethge, J.; Boesenkoetter, J.; Conrad, C.; Noth, R.; Bahmer, T.; Nikolaus, S.; Aden, K.; Zeissig, S.; Schreiber, S.: Subclinical Pulmonary Involvement in Active IBD Responds to Biologic Therapy. J Crohns Colitis. 2021 Aug 2;15(8):1339-1345. doi: 10.1093/ecco-jcc/jjab024 (open access).

[6] Ye, L.; Yuan, X.; Pang, M.; Bethge, J.; **Ellrichmann, M.;** Du, J.; Zeng, X.; Tang, C.; Schreiber, S.; Hu, B.: Magnetic bead-assisted endoscopic submucosal dissection: a gravity-based traction method for treating large superficial colorectal tumors. Surg Endosc. 2019 Jun;33(6):2034-2041. doi: 10.1007/s00464-019-06799-7 (open access).

[7] Bethge, J.; Ye, L.; **Ellrichmann, M.;** Khan, N.; Feng, Z.; Schreiber, S.; Hu, B.: Advanced endoscopic submucosal dissection with magnetic bead-assisted traction based on gravity for a flat colorectal neoplasm with severe fibrosis. Endoscopy. 2018 Aug;50(8):824-825. doi: 10.1055/a-0624-2148 (open access).

[8] Zeissig, S.; Sulk, S.; Brueckner, S.; Matthes K.; Hohmann, M.; Reichel, S.; **Ellrichmann, M.;** Arlt, A.; Will, U.; Hampe, J.: Severe bleeding is a rare event in patients receiving lumen-apposing metal stents for the drainage of pancreatic fluid collections. Gut. 2019 May;68(5):945-946. doi: 10.1136/gutjnl-2018-316581.

[9] **Ellrichmann, M.;** Dhar, S.; Hadeler, K.G.; Seehusen, F.; Cuming, T.; Feßler, A.T.; Niemann, H.; Schwarz, S.; Fritscher-Ravens, A.: Risk of infection after iatrogenic perforation of the gut wall? Evaluation of preventive strategies in a randomized controlled animal trial. Surg Endosc. 2016 Jul;30(7):3077-88. doi: 10.1007/s00464-015-4600-4 (open access).

[10] **Ellrichmann, M.;** Wietzke-Braun, P.; Dhar, S.; Nikolaus, S.; Arlt, A.; Bethge, J.; Kuehbacher, T.; Wintermeyer, L.; Balschun, K.; Klapper, W.; Schreiber, S.; Fritscher-Ravens, A.: Endoscopic ultrasound of the colon for the differentiation of Crohn's disease and ulcerative colitis in comparison with healthy controls. Aliment Pharmacol Ther. 2014 Apr;39(8):823-33. doi: 10.1111/apt.12671 (open access).

**Category B**

- European Patent 3445336, „Shellac microcapsule formulation and compositions" 2020

**Academic Distinctions**

- 2019: Science Award United European Gastroenterology Week
- 2015: Rome Foundation Award for excellent scientific performances
- 2014: Innovation Award Germany Society General Surgery

**Data Protection and Consent to the Processing of Optional Data**

If you provide voluntary information (marked as optional) in this CV, your consent is required. Please confirm your consent by checking the box below.

[X] **I expressly consent to the processing of the voluntary (optional) information, including "special categories of personal data"[5] in connection with the DFG's review and decision-making process regarding my proposal.** This also includes forwarding my data to the external reviewers, committee members and, where applicable, foreign partner organisations who are involved in the decision-making process. To the extent that these recipients are located in a third country (outside the European Economic Area), I additionally consent to them being granted access to my data for the above-mentioned purposes, even though a level of data protection comparable to EU law may not be guaranteed. For this reason, compliance with the data protection principles of EU law is not guaranteed in such cases. In this respect, there may be a violation of my fundamental rights and freedoms and resulting damages. This may make it more difficult for me to assert my rights under the General Data Protection Regulation (e.g. information, rectification, erasure, compensation) and, if necessary, to enforce these rights with the help of authorities or in court.

I may **revoke** my consent in whole or in part at any time – with effect for the future, freely and without giving reasons – vis-à-vis the DFG (postmaster@dfg.de). The lawfulness of the processing carried out up to that point remains unaffected. Insofar as I transmit "special categories of personal data" relating to third parties, I confirm that the necessary legitimation under data protection law exists (e.g. based on consent).

[5] Special categories of personal data are those "revealing racial or ethnic origin, political opinions, religious or philosophical beliefs, or trade union membership, and (...) genetic data, biometric data for the purpose of uniquely identifying a natural person, data concerning health or data concerning a natural person's sex life or sexual orientation" (Article 9(1) GDPR).

I have taken note of the DFG's Data Protection Notice relating to research funding, which I can access at www.dfg.de/privacy_policy and I will forward it to such persons whose data the DFG processes as a result of being mentioned in this CV.

**Enzingmüller, Carolin, Dr.**

**Personal Data**

| **Title, Name, Position, Institution, and ORCID** | |
|---|---|
| Title | Dr. |
| First name | Carolin |
| Name | Enzingmüller |
| Current position | Postdoctoral Researcher |
| Current institution(s)/site(s), country | IPN Kiel |
| Identifiers/ORCID | 0000-0002-6795-3602 |

**Qualifications and Career**

| **Stages** | **Periods and Details** |
|---|---|
| Degree programme | 2016 2nd Teaching Degree in Biology and German for Secondary Schools, Gymnasium Marne Europaschule, Marne<br>2009 Teaching Degree in Biology, German, and Philosophy for Secondary Schools,<br>Kiel University |
| Doctorate | 2017 PhD degree in Science Education, Prof. Dr. Helmut Prechtl, Kiel University, Germany |
| Stages of academic/professional career | Since 2022 Co-Founder and Principal Investigator of the transdisciplinary science communication research centre “Kiel Science Communication Network”, funded by the VolkswagenStiftung<br>Since 2020 Co-Leader of the Research Area “Science Communication and Enrichment” Leibniz-Institute for Science and Mathematics Education, Kiel<br>Since 2019 Principal Investigator of the Scientific Outreach Project in the CRC “Biomagnetic Sensing”<br>Since 2017 Postdoctoral Researcher, Chemistry Education, IPN – Leibniz Institute for Science and Mathematics Education |

**Engagement in the Research System**

Core Member of the Taskforce “Research and Practice in Science Communication” at the BMBF think tank #FACTORYWISSKOMM

**Scientific Results**

**Category A**

[1] Landis, S.; Piecyk, A.; Reitz, M.; **Enzingmüller**, **C**.; Schulenburg, H.; Bosch, T.; Dierking, K.; Deines, P.; Hunfeld-Häutle, J.; Rappaport, K.; Duscher, T. (in print): Meet the

Metaorganism: A web-based learning app for undergraduate and graduate biology students. Bioessays.

[2] Parchmann, I.; Bosch, T.; Claussen, C.; Duscher, T.; **Enzingmüller, C.;** Knüver, J.; Schulenburg, H. (in print): Wie arbeitet Wissenschaft heute? Vernetzte Zugänge für Universität und Schule forschungsbasiert „hoch drei“ entwickeln. MNU Journal.

[3] Broß, C.; **Enzingmüller, C.;** Parchmann, I.; Schmidt, G. (2021): Teaching magnetoelectric sensing to secondary school students: Considerations for educational STEM outreach. Sensors, 21(21). https://doi.org/10.3390/s21217354 (open access).

[4] **Enzingmüller, C.;** Prechtl, H. (2021): Constructing graphs in biology class: Secondary biology teachers' beliefs, motivation, and self-reported practices. International Journal of Science and Mathematics Education, 19(1), 1-19. https://doi.org/10.1007/s10763-019-09975-2 (open access).

[5] Laumann, D.; **Enzingmüller, C.;** Parchmann, I.; Quandt, E.; Hayes, P. (2020): Magnetostriction Measurements with a Low-Cost Magnetostrictive Cantilever Beam. American Journal of Physics, 88(3).

[6] **Enzingmüller, C.;** Kampschulte, L.; Parchmann, I. (2019): Science Outreach in Sonderforschungsbereichen. in C. Maurer (Hrsg.), Naturwissenschaftliche Bildung als Grundlage für berufliche und gesellschaftliche Teilhabe: Gesellschaft für Didaktik der Chemie und Physik Jahrestagung in Kiel 2018 (S. 548-551). Universität Regensburg.

[7] **Enzingmüller, C.;** Laumann, D.; Kampschulte, L.; Parchmann, I. (2019): Kommunikation interdisziplinärer Forschung im Bereich Biomagnetic Sensing. in C. Maurer (Hrsg.), Naturwissenschaftliche Bildung als Grundlage für berufliche und gesellschaftliche Teilhabe: Gesellschaft für Didaktik der Chemie und Physik Jahrestagung in Kiel 2018 (S. 564-567). Universität Regensburg.

[8] Kampschulte, L.; **Enzingmüller, C.;** Wentorf, W.; Quandt, E.; Parchmann, I. (2018): Medizinische Sensoren entwickeln: Zusammenarbeit verschiedener Disziplinen. Naturwissenschaften im Unterricht - Chemie, 29(164), 41-45.

**Zwei Referenzen sollten noch eingefügt werden. Bei [1] steht noch (in print)?**

**Category B**

[1] Steegh, A.; Nordine, J.; **Enzingmüller, C**.: (Eds.) (2023). Designing for Contemporary Relevance and Authenticity − Identity as a Lens for Reimagining Science Activities at the Interface of Science Education and Communication. Front. Educ. Sec. STEM Education.

[2] **Enzingmüller, C.** (2022, Octobre 4): Wissenschaftskommunikation als Design-Challenge. Wissenschaftkommunikation.de.

**Data Protection and Consent to the Processing of Optional Data**

If you provide voluntary information (marked as optional) in this CV, your consent is required. Please confirm your consent by checking the box below.

[X] **I expressly consent to the processing of the voluntary (optional) information, including "special categories of personal data"[6] in connection with the DFG's review and decision-making process regarding my proposal.** This also includes forwarding my data to the external reviewers, committee members and, where applicable, foreign partner organisations who are involved in the decision-making process. To the extent that these recipients are located in a third country (outside the European Economic Area), I additionally consent to them being granted access to my data for the above-mentioned purposes, even though a level of data protection comparable to EU law may not be guaranteed. For this reason, compliance with the data protection principles of EU law is not guaranteed in such cases. In this respect, there may be a violation of my fundamental rights and freedoms and resulting damages. This may make it more difficult for me to assert my rights under the General Data Protection Regulation (e.g. information, rectification, erasure, compensation) and, if necessary, to enforce these rights with the help of authorities or in court.

I may **revoke** my consent in whole or in part at any time – with effect for the future, freely and without giving reasons – vis-à-vis the DFG (postmaster@dfg.de). The lawfulness of the processing carried out up to that point remains unaffected. Insofar as I transmit "special categories of personal data" relating to third parties, I confirm that the necessary legitimation under data protection law exists (e.g. based on consent).

I have taken note of the DFG's Data Protection Notice relating to research funding, which I can access at www.dfg.de/privacy_policy and I will forward it to such persons whose data the DFG processes as a result of being mentioned in this CV.

[6] Special categories of personal data are those "revealing racial or ethnic origin, political opinions, religious or philosophical beliefs, or trade union membership, and (...) genetic data, biometric data for the purpose of uniquely identifying a natural person, data concerning health or data concerning a natural person's sex life or sexual orientation" (Article 9(1) GDPR).

**Frey, Norbert, Prof. Dr.**

**Personal Data**

| **Title, Name, Position, Institution, and ORCID** | |
|---|---|
| Title | Prof. Dr. med. |
| First name | Norbert |
| Name | Frey |
| Current position | Professor (W3) & Chair of the Department of Internal Medicine III, Cardiology, Angiology and Pneumology |
| Current institution(s)/site(s), country | Heidelberg University Hospital and Heidelberg University, Germany |
| Identifiers/ORCID | 0000-0001-7611-378X |

**Qualifications and Career**

| **Stages** | **Periods and Details** |
|---|---|
| Degree programme | 1987 - 1994 Medical School (Christian-Albrechts-University Kiel, Johns Hopkins Hospital, Baltimore, USA, Georgetown University Hospital, Washington DC, USA |
| Doctorate | 1994 MD thesis in Pharmacology, CAU Kiel University, Germany |
| Stages of academic/professional career | 2020 - present W3 Professor & Chair, Dept. of Internal Medicine III, Heidelberg University<br>2008 - 2020 W3 Professor & Chair, Dept. of Internal Medicine III, University Hospital Schleswig-Holstein, Campus Kiel<br>2007 - 2008 Vice head of Department, Dept. of Internal Medicine III, Heidelberg University<br>2006 Habilitation in Internal Medicine/Cardiology, Heidelberg University<br>2002 - 2008 Senior research group leader Molecular Cardiology, Heidelberg University<br>2002 - 2007 Fellow and Attending Physician, Dept. of Internal Medicine III, Heidelberg University<br>1999 - 2002 Postdoctoral fellow, (Molecular Cardiology), Dept. of Molecular Biology (Prof. Dr. E. N. Olson), UT Southwestern Medical Center, Dallas, TX, USA<br>1996 - 1999 Internship and Residency (Internal Medicine/Cardiology), Dept. of Internal Medicine II, University of Lübeck<br>1994 - 1996 Internship and Residency (Internal Medicine/Cardiology), Dept. of Internal Medicine III, Heidelberg University |

## Engagement in the Research System

- Member of the Research Coordinating Committee of the DZHK (since 2012)
- Speaker, Academy of the German Cardiac Society (DGK) (since 2016)
- Speaker, Nordic Center of Cardiovascular Research (NCCR) within DZHK Partner site Hamburg/Kiel/Lübeck (2019-2020)
- Member “Fachkollegium”, Deutsche Forschungsgemeinschaft (DFG) (since 2020)
- Vice Speaker, Collaborative Research Center (SFB) 1550, “Molecular Circuits of Heart Disease” (since 2022)
- Editor-in-Chief “Clinical Research in Cardiology” (since 2023)

## Scientific Results

### Category A

[1] Hilbel, T.; **Frey, N.:** Review of current ECG consumer electronics (pros and cons). J Electrocardiol. 2023 Mar-Apr;77:23-28. DOI: 10.1016/j.jelectrocard.2022.11.010. Epub 2022 Dec 17. PMID: 36566580 (open access).

[2] Kuhn, C.; Menke, M.; Senger, F.; Mack, C.; Dierck, F.; Hille, S.; Schmidt, I.; Brunke, G.; Bünger, P.; Schmiedel, N.; Will, R.; Sossalla, S.; Frank, D.; Eschenhagen, T.; Carrier, L.; Lüllmann-Rauch, R.; Rangrez, A.Y.; **Frey, N.:** FYCO1 Regulates Cardiomyocyte Autophagy and Prevents Heart Failure Due to Pressure Overload In Vivo. JACC Basic Transl Sci. 6(4):365-380, (2021).

[3] Rangrez, A.Y.; Borlepawar, A.; Schmiedel, N.; Deshpande, A.; Remes, A.; Kumari, M.; Bernt, A.; Christen, L.; Helbig, A.; Jungmann, A.; Sossalla, A.; Tholey, A.; Müller, O.J.; Frank, D.; **Frey, N.:** The E3 ubiquitin ligase HectD3 attenuates cardiac hypertrophy and inflammation in mice. Comm Biol 3:562, (2020).

[4] Eden, M.; Meder, B.; Völkers, M.; Poomvanicha, M.; Domes, K.; Branchereau, M.; Marck, P.; Will, R.; Bernt, A.; Rangrez, A.; Busch, M.; Hrabě de Angelis, M.; Heymes, C.; Rottbauer, W.; Most, P.; Hofmann, F.; **Frey, N.:** Myoscape controls cardiac calcium cycling and contractility via regulation of L-type calcium channel surface expression. Nat Commun 28:11317, (2016) .

[5] Rangrez, A.Y.; Bernt, A.; Poyanmehr, R.; Harazin, V.; Boomgaarden, I.; Kuhn, C.; Rohrbeck, A.; Frank, D.; **Frey, N.:** Dysbindin is a potent inducer of RhoA-SRF-mediated cardiomyocyte hypertrophy. J Cell Biol 203:643-56, (2013).

[6] Spaich, S.; Will, R.D.; Just, S.; Spaich, S.; Kuhn, C.; Frank, D.; Berger, I.; Wiemann, S.; Korn, B.; Koegl, M.; Backs, J.; Katus, H.A.; Rottbauer, W.; **Frey, N.:** Fbxl22, A Cardiac-Enriched F-Box Protein, Regulates Sarcomeric Protein Turnover and is Essential for Maintenance of Contractile Function In Vivo. Circ Res 111:1504-16, (2012).

[7] Will, R.D.; Eden, M.; Just, S.; Hansen, A.; Eder, A.; Frank, D.; Kuhn, C.; Seeger, T.S.; Oehl, U.; Wiemann, S.; Korn, B.; Koegl, M.; Rottbauer, W.; Eschenhagen, T.; Katus, H.A.; **Frey, N.:** Myomasp/LRRC39, a heart- and muscle-specific protein, is a novel component of the sarcomeric M-band and is involved in stretch sensing. Circ. Res 107:1253-64, (2010).

[8] **Frey, N.;** Frank, D.; Lippl, S.; Kuhn, C.; Kögler, H.; Barrientos, T.; Rohr, C.; Will, R.; Müller, O.J.; Weiler, H.; Bassel-Duby, R.; Katus, H.A.; Olson, E.N.: Calsarcin-2 deficiency increases exercise capacity in mice through calcineurin/NFAT activation. J Clin Invest 118:3598-608, (2008).

[9] Frank, D.; Kuhn, C.; van Eickels, M.; Gehring, D.; Hanselmann, C.; Lippl, S.; Will, R.; Katus, H.A.; **Frey, N.:** Calsarcin-1 protects against angiotensin-II induced cardiac hypertrophy. Circulation 116:2587-96, (2007).

[10] **Frey, N.;** Barrientos, T.; Shelton, J.M.; Frank, D.; Rutten, H.; Gehring, D.; Kuhn, C.; Lutz, M.; Rothermel, B.; Bassel-Duby, R.; Richardson, J.A.; Katus, H.A.; Hill, J.A.; Olson, E.N.: Mice lacking calsarcin-1 are sensitized to calcineurin signaling and show accelerated cardiomyopathy in response to pathological biomechanical stress. Nat Med 10:1336-43, (2004).

**Category B**

**Patents/Patent Applications**

[1] **CA000002954870A1** (filed 2016), **EP000003194959A1** (filed 2015), **US020170212135A1** (filed 2015): Means and methods for diagnosing heart failure on the basis of cholesterol parameters, shingomeylins and/or triacylglycerols.

[2] **EP000002909626B1** (filed 2018), **EP000003190418A1** (filed 2017), **US020160209433A1** (filed 2016), **US000009285378B2** (filed 2016): Means and methods for diagnosing heart failure in a subject.

[3] **WO002017134264A1** (filed 2017): Means and methods for differentiating between heart failure and pulmonary disease in a subject.

**Contributions to Policies and Structures in Health Care and Academic Education**

[1] **First „CardioOncology“ Unit in Germany**:

Lehmann, L.H.; Stein, F.; Jäger, D.; **Frey, N.:** The Heidelberg cardio-oncology unit (COUNT)-a possible blueprint for improved care of cardio-oncological patients. Clin Res Cardiol. 2022 Feb;111(2):227-229. DOI: 10.1007/s00392-021-01894-z. Epub 2021 Jun 28. PMID: 34181066; PMCID: PMC8817047 (open access).

[2] **Member of steering committee for Certification of Cardiac Arrest Centers in Germany:**

Rottk, N.; Scholz, K.H.; Busch, H.J.; **Frey, N.;** Kelm, M.; Thiele, H.; Böttiger, B.W.: Criteria for the certification of Cardiac Arrest Centers in Germany. Resuscitation. 2021 Dec;169:1-3. DOI: 10.1016/j.resuscitation.2021.09.034. Epub 2021 Oct 7. PMID: 34627867 (open access).

[3] **“Clinician-Scientist” Positionspapier der Deutschen Gesellschaft für Kardiologie**

Hilgendorf, I.; Backs, J.; Baldus, S.; **Frey, N.;** et al. Clinician Scientists in der kardiovaskulären Medizin. Kardiologie 17, 6–11 (2023). Doi: 10.1007/s12181-022-00582-0 (open access).

## Academic Distinctions

- 1990 DAAD Scholarship Johns Hopkins Medical School, Baltimore, USA
- 1999 Oskar-Lapp-Award, German Cardiac Society
- 1999 – 2001 DFG Postdoctoral Fellowship UT Southwestern Medical Center, Dallas, USA
- 2005 Franz-Maximilian-Groedel Award, German Cardiac Society
- 2009 Research Arthur-Weber Award, German Cardiac Society
- 2018 Fritz-Acker-Research Award, Fritz Acker Foundation

## Data Protection and Consent to the Processing of Optional Data

If you provide voluntary information (marked as optional) in this CV, your consent is required. Please confirm your consent by checking the box below.

[X] **I expressly consent to the processing of the voluntary (optional) information, including "special categories of personal data"[7] in connection with the DFG's review and decision-making process regarding my proposal.** This also includes forwarding my data to the external reviewers, committee members and, where applicable, foreign partner organisations who are involved in the decision-making process. To the extent that these recipients are located in a third country (outside the European Economic Area), I additionally consent to them being granted access to my data for the above-mentioned purposes, even though a level of data protection comparable to EU law may not be guaranteed. For this reason, compliance with the data protection principles of EU law is not guaranteed in such cases. In this respect, there may be a violation of my fundamental rights and freedoms and resulting damages. This may make it more difficult for me to assert my rights under the General Data Protection Regulation (e.g. information, rectification, erasure, compensation) and, if necessary, to enforce these rights with the help of authorities or in court.

I may **revoke** my consent in whole or in part at any time – with effect for the future, freely and without giving reasons – vis-à-vis the DFG (postmaster@dfg.de). The lawfulness of the processing carried out up to that point remains unaffected. Insofar as I transmit "special categories of personal data" relating to third parties, I confirm that the necessary legitimation under data protection law exists (e.g. based on consent).
d
I have taken note of the DFG's Data Protection Notice relating to research funding, which I can access at www.dfg.de/privacy_policy and I will forward it to such persons whose data the DFG processes as a result of being mentioned in this CV.

[7] Special categories of personal data are those "revealing racial or ethnic origin, political opinions, religious or philosophical beliefs, or trade union membership, and (...) genetic data, biometric data for the purpose of uniquely identifying a natural person, data concerning health or data concerning a natural person's sex life or sexual orientation" (Article 9(1) GDPR).

**Gerken, Martina, Prof. Dr.**

**Personal Data**

| Title, Name, Position, Institution, and ORCID | |
|---|---|
| Title | Prof. Dr. |
| First name | Martina |
| Name | Gerken |
| Current position | Professor of Electrical Engineering (W3) |
| Current institution(s)/site(s), country | Kiel University, Faculty of Engineering, Department of Electrical and Information Engineering, Germany |
| Identifiers/ORCID | 0000-0002-4234-7833 |

**Qualifications and Career**

| Stages | Periods and Details |
|---|---|
| Degree programme | 1993 - 1998 Dipl.-Ing. Electrical Engineering, University of Karlsruhe, Germany<br>Thesis work at Molecular Physics Laboratory, SRI International, Menlo Park, CA, USA<br>Supervisor: Dr. Gregory Faris<br>Subject: Scattering optical media |
| Doctorate | 1999 - 2003 Ph.D. Electrical Engineering, Ginzton Laboratory, Stanford University, CA, USA<br>Supervisor: Prof. Dr. David A.B. Miller<br>Subject: Photonic crystals |
| Stages of academic / professional career | 08 - 09/2021, 04/2022, 06-07/2022 Visiting professor Electrical Engineering, University College Dublin, Ireland<br>03 - 08/2016 Visiting professor Electrical Engineering, Glasgow University, Scotland, UK<br>Since 2015 Shareholder start-up company Founding of spin-off company Byonoy GmbH<br>Since 2008 Professorship (W3), Chair for Integrated Systems and Photonics, Kiel University, Germany<br>2003 - 2008 Junior group leader (C1), Light Technology Institute, University of Karlsruhe, Germany |

**Supplementary Career Information**

4 children, born 02/2006, 07/2008, 09/2010 and 07/2012

**Engagement in the Research System**

**Selected Functions**

2022 - present Vice dean of Faculty of Engineering, Kiel University
2022 - present Executive committee member of the Graduate Center, Kiel University

| | |
|---|---|
| 2021 - present | Board member of the integrated research training group (IRTG) of the DFG CRC1461 |
| 2020 - present | DFG review board member for 408-01 Electronic Semiconductors, Components, Circuits, Systems |
| 2016 - present | Board member of the integrated research training group (IRTG) of the DFG CRC1261 |
| 2014 - present | Project lead Centre for Networked Sensor Systems |
| 2013 - present | Management committee member of the Competence Centre on Nanosystems Technology |

**Scientific Results**

The focus of the Gerken group is to develop new sensor principles using microtechnology, nanotechnology and optical technology, as well as measurement system miniaturisation. The research extends from modelling and simulation to fabrication and experimental characterisation. In particular optical and magnetic sensor principles for biomedical applications have been investigated. This includes measurement techniques to monitor biomolecular dynamics. Many of the projects are carried out in interdisciplinary as well as international collaborations.

**Category A**

[1] Titov, I.; Rutschke, N.; Kraft, F.A.; Köpke, M.; Nebling, E.; **Gerken, M.** (2022): Detection of fluorescence-labeled DNA with in-plane organic optoelectronic devices. Biomedical optics express, 13(12), 6300–6316. doi: 10.1364/BOE.475358 (open access).

[2] De La Rue, R.M.; Herzig, H.P.; **Gerken, M.** (2020): Biomedical Optical Sensors: Differentiators for Winning Technologies. (Biomedical Optical Sensors). Springer Nature Switzerland AG. doi: 10.1007/978-3-030-48387-6.

[3] Krantz, M.C.; **Gerken, M.** (2020): Limit of Thermal-Vibration Noise in Magnetic Field Detection with Magnetoelectric-Composite Cantilevers. Phys. Rev. Appl., 13(5), 054047. doi: 10.1103/PhysRevApplied.13.054047 (open access).

[4] Murat, Y.; Petersons, K.; Lanka, D.; Lindvold, L.; Yde, L.; Stensborg, J.; **Gerken, M.** (2020): All Solution-Processed ITO Free Flexible Organic Light-Emitting Diodes. Mater. Adv., 1(8), 2755–2762. doi: 10.1039/D0MA00618A. **Selected for and featured in Materials Advances HOT Article Collection** (open access).

[5] Schmalz, J.; Kittmann, A.; Durdaut, P.; Spetzler, B.; Faupel, F.; Höft, M.; Quandt, E.; **Gerken, M.** (2020): Multi-Mode Love-Wave SAW Magnetic-Field Sensors. Sensors, 20(12), 3421. doi: 10.3390/s20123421 (open access).

[6] Titov, I.; Kopke, M.; Schneidewind, N.C.; Buhl, J.; Murat, Y.; **Gerken, M.** (2020): OLED-OPD Matrix for Sensing on a Single Flexible Substrate. IEEE Sens. J., 20(14), 7540–7547. doi: 10.1109/JSEN.2020.2986051 (open access).

[7] Lüder, H.; **Gerken, M.** (2019): FDTD Modelling of Nanostructured OLEDs: Analysis of Simulation Parameters for Accurate Radiation Patterns. Opt. Quantum Electron., 51(5), 139. doi: 10.1007/s11082-019-1838-4. **Springer Nature 2019 Highlight in the area of Physics** (open access).

[8] Nazirizadeh, Y.; Behrends, V.; Prósz, A.; Orgovan, N.; Horvath, R.; Ferrie, A.M.; Fang, Y.; Selhuber-Unkel, C.; **Gerken, M.** (2016): Intensity interrogation near cutoff resonance for label-free cellular profiling. Scientific reports, 6, 24685. doi:10.1038/srep24685 (open access).

[9] Jahns, S.; Bräu, M.; Meyer, B. O.; Karrock, T.; Gutekunst, S. B.; Blohm, L.; Selhuber-Unkel, C.; Buhmann, R.; Nazirizadeh, Y.; **Gerken, M.** (2015): Handheld imaging photonic crystal biosensor for multiplexed, label-free protein detection. Biomedical optics express, 6(10), 3724–3736. doi: 10.1364/BOE.6.003724 (open access).

[10] Karrock, T.; **Gerken, M.** (2015): Pressure sensor based on flexible photonic crystal membrane. Biomedical optics express, 6(12), 4901-4911. doi: 10.1364/BOE.6.004901 (open access).

**Category B**

[1] **Gerken**, **M.**; Kraft, F.; Bläsi, J.: „Optisches Element“, Priority 07.07.2022, DE 10 2022 117 029.2 applied for on 07.07.2022.

[2] **Gerken, M.**; Titov, I.; Böckmann, S.: „Vorrichtung und Verfahren zur Extraktion von Wasser aus einer Bodenprobe “, Priority 13.08.2021, DE 10 2021 121 165.4 applied for on 13.08.2021.

[3] **Gerken, M.;** Buhl, J.; Bremer, M.; Hein, S.: „OLED-Wellenleiteranordnung sowie Herstellungsverfahren dazu“, Priority 17.09.2019, DE10 2019 124 950.3 applied for on 17.09.2019, PCT/DE2020/100796 applied for on 12.09.2020.

[4] Nazirizadeh, Y.; **Gerken, M.**; Metz, P.; Karrock, T.: „Mobile photometrische Messvorrichtung und Verfahren zur mobilen photometrischen Messung an Mikrotitierplatten“ Priority 27.10.2014, DE102014115564A1 applied for on 27.10.2014, WO2016066156A3 applied for on 23.06.2016.

[5] Nazirizadeh, Y.; Karrock, T.; **Gerken, M.**; Roider, J.: "Vorrichtung zur optischen Darstellung des Augeninnendrucks sowie Verfahren dazu" Priority 13.06.2012, PCT/DE2013/100214 applied for on 13.06.2012, WO2013185757A1 applied for on 19.12.2013, EP2861126A1 applied for on 22.04.2015, US9730788B2 granted on 15.08.2017.

[6] Nazirizadeh, Y.; **Gerken, M.**: "Verfahren zur Bestimmung der Dicke von Objekten mit Hilfe eines Licht-Mikroskops" Priority 16.11.2011, DE102011118641A1 applied for on 16.11.2011.

[7] Nazirizadeh, Y.; **Gerken, M.**: "Mikroskopie mit einem Objektträger oder Deckglas mit photonischem Kristall zur Kontrasterhöhung." Priority 26.01.2010, DE102010005860A1 applied for on 26.01.2010, WO2011091782A1 applied for on 04.08.2011, EP2529265B1 granted on 24.08.2016.

[8] Nazirizadeh, Y.; **Gerken, M.**: "Vorrichtung und Verfahren zum Nachweis biologischen Materials" Priority 26.01.2010, DE102010005859B3 granted on 19.05.2011, WO2011091781A1 applied for on 04.08.2012, US20120293800A1 applied for on 22.11.2012, EP2529200A1 applied for on 05.12.2012

[9] Riedel, B.; **Gerken, M.**; Hauß, J.; Lemmer, U.: "Ladungsträger-Transportschicht, Verfahren zu ihrer Herstellung und elektrooptisches Bauelement." Priority 22.08.2009, EP2287938B1 erteilt 01,08.2012, US8613872B2 granted on 24.12.2013.

[10] Nazirizadeh, Y.; **Gerken, M.**; Lemmer, U.: "Optisches Element, Verfahren zu Nachweis des Vorhandenseins von Substanzen und Verwendung des optischen Elements." Priority 29.04.2009, EP2246693A1 applied for on 03.11.2010, WO2010124824A1 applied for on 03.11.2010.

### Academic Distinctions

| | |
|---|---|
| 2022 - present | EIC Transition Grant |
| 2020 - 2022 | ERC Proof of Concept Grant |
| 2016 | Feodor Lynen research stipend of the Alexander von Humboldt Foundation |
| 2013 | Science award of the state capital Kiel |
| 2012 - 2017 | ERC Starting Grant |
| 2008 | Adolf-Martens-Award for the Area of Material sciences, material research and testing |
| 2007 - 2012 | NanoFutur-Award of the BMBF |
| 1999 - 2002 | Sequoia Capital Stanford Graduate Fellowship |

### Data Protection and Consent to the Processing of Optional Data

If you provide voluntary information (marked as optional) in this CV, your consent is required. Please confirm your consent by checking the box below.

[X] **I expressly consent to the processing of the voluntary (optional) information, including "special categories of personal data"[8] in connection with the DFG's review and decision-making process regarding my proposal.** This also includes forwarding my data to the external reviewers, committee members and, where applicable, foreign partner organisations who are involved in the decision-making process. To the extent that these recipients are located in a third country (outside the European Economic Area), I additionally consent to them being granted access to my data for the above-mentioned purposes, even though a level of data protection comparable to EU law may not be guaranteed. For this reason, compliance with the data protection principles of EU law is not guaranteed in such cases. In this respect, there may be a violation of my fundamental rights and freedoms and resulting damages. This may make it more difficult for me to assert my rights under the General Data Protection Regulation (e.g. information, rectification, erasure, compensation) and, if necessary, to enforce these rights with the help of authorities or in court.

I may **revoke** my consent in whole or in part at any time – with effect for the future, freely and without giving reasons – vis-à-vis the DFG (postmaster@dfg.de). The lawfulness of the processing carried out up to that point remains unaffected. Insofar as I transmit "special categories of personal data" relating to third parties, I confirm that the necessary legitimation under data protection law exists (e.g. based on consent). I have taken note of the DFG's Data Protection Notice relating to research funding, which I can access at www.dfg.de/privacy_policy and I will forward it to such persons whose data the DFG processes as a result of being mentioned in this CV.

[8] Special categories of personal data are those "revealing racial or ethnic origin, political opinions, religious or philosophical beliefs, or trade union membership, and (...) genetic data, biometric data for the purpose of uniquely identifying a natural person, data concerning health or data concerning a natural person's sex life or sexual orientation" (Article 9(1) GDPR).

**Gojdka, Björn, Dr.**

**Personal Data**

| **Title, Name, Position, Institution, and ORCID** | |
|---|---|
| Title | Dr.-Ing. |
| First name | Björn |
| Name | Gojdka |
| Current position | Head of Group |
| Current institution(s)/site(s), country | Fraunhofer Institute for Silicon Technology ISIT, Itzehoe, Germany |
| Identifiers/ORCID | 0000-0001-9097-2329 |

**Qualifications and Career**

| **Stages** | **Periods and Details** |
|---|---|
| Degree programme | 2001 - 2007 Studies of physics (focus on solid state physics), Kiel University, Germany<br>- Diploma with distinction<br>- Exchange scholarship at the University of Aberdeen, Scotland (2004 - 2005)<br>- Stipendiary of the German National Academic Foundation (Studienstiftung des deutschen Volkes) |
| Doctorate | 2009 - 2012, Prof. Dr. Franz Faupel, Kiel University, Germany<br>- PhD student in SFB855 – Biomagnetic Sensing<br>- Visiting researcher at Ecole Polytechnique Federal de Lausanne, Switzerland (2010)<br>- Dr.-Ing. summa cum laude |
| Stages of academic/professional career | Since 2020 Head of Group "Agglomerated Microsystems" at Fraunhofer ISIT, Itzehoe, Germany<br>2019 - 2020 MEMS Researcher, Fraunhofer Institute for Silicon Technology ISIT, Itzehoe, Germany<br>2015 - 2019 Teacher at high school (Gymnasium) for physics, mathematics and computer science, Freiburg i. Br. and Kiel, Germany<br>Second state examination for secondary school teaching profession with distinction, Freiburg i. Br.<br>2012 - 2014 Executive Board Officer of the CTO, Testo AG, Titisee-Neustadt, Germany<br>2008 Business consultant, visiting associate, The Boston Consulting Group, Frankfurt, Germany and Zurich, Switzerland |

### Engagement in the Research System

- Referee for Nature Communications (2023)

### Scientific Results

### Category A

[1] **Gojdka, B.**; Cichon, D.; Stahl-Offergeld, M.; Schröder, D.; Clausen, N.; Hedayat, C.; Hohe, H.-P.; Lisec, T.: "Fully Integrated Back-Biased 3d Hall Sensor with Wafer-Level Integrated Permanent Micromagnets," 2023 IEEE 36th International Conference on Micro Electro Mechanical Systems (MEMS), Munich, Germany, 2023, pp. 1099-1102, doi: 10.1109/MEMS49605.2023.10052184 (open access).

[2] Bodduluri, M. T.; Dankwort, T.; Lisec, T.; Grünzig, S.; Khare, A.; Ahmed, M.; **Gojdka, B.**: "Fully Integrated High-Performance MEMS Energy Harvester for Mechanical and Contactless Magnetic Excitation in Resonance and at Low Frequencies", Micromachines 13, 863 (2022), doi: 10.3390/mi13060863 (open access).

[3] Bodduluri, M. T.; **Gojdka, B.**; Wolff, N.; Kienle, L.; Lisec, T.; Lofink, F.; "Investigation of wafer-level fabricated permanent micromagnets for MEMS", Micromachines 13, 742 (2022)

[4] Lisec, T.; Behrmann, O.; **Gojdka, B.**: "PowderMEMS—A generic microfabrication technology for integrated three-dimensional functional microstructures", Micromachines 13, 398 (2022), doi: 10.3390/mi13030398 (open access).

[5] Ahmed, M.; Dankwort, T.; Grünzig, S.; Lange V.; **Gojdka, B.**: "Broadband Zero-Power Wakeup MEMS Device for Energy-Efficient Sensor Nodes", Micromachines 13, 407 (2022), doi: 10.3390/mi13030407 (open access).

[6] **Gojdka, B.**; Cichon, D.; Lembrecht, Y.; Bodduluri, M. T.; Lisec, T.; Stahl-Offergeld, M.; Hohe, H.-P.; Niekiel, F.: "Demonstration of Fully Integrable Long-Range Microposition Detection with Wafer-Level Embedded Micromagnets", Micromachines 13, 235 (2022), doi: 10.3390/mi13020235 (open access).

[7] Jahns, R.; Zabel, S.; Marauska, S.; **Gojdka, B.**; Wagner, B.; Knöchel, R.; Adelung, R.; Faupel, F.: "Microelectromechanical magnetic field sensor based on ΔE effect", Applied Physics Letters 105, 052414 (2014), doi:10.1063/1.4891540 (open access).

[8] **Gojdka, B.**; Hrkac, V.; Xiong, J.; Gerken, M.; Kienle, L.; Strunskus, T.; Zaporojtchenko, V.; Faupel, F.; „A critical evaluation of the 0-3 approach for magnetoelectric nanocomposites with metallic nanoparticles", Journal of Applied Physics 112, 044303 (2012), doi: 10.1063/1.4745892 (open access).

[9] **Gojdka, B.**; Zaporojtchenko, V.; Hrkac, V.; Xiong, J.; Kienle, L.; Strunskus, T.; Faupel, F.: „Highly versatile concept for precise tailoring of nanogranular composites with a gas aggregation cluster source", Applied Physics Letters 100, 133104 (2012), doi: 10.1063/1.3696640 (open access).

[10] **Gojdka, B.**; Jahns, R.; Meurisch, K.; Greve, H.; Adelung, R.; Quandt, E.; Faupel, F.: „Fully Integrable Magnetic Field Sensor based on delta-E Effect", Applied Physics Letters 99,

223502 (2011), doi: 10.1063/1.3664135 (open access); Featured in Nature as „research highlight", Nature 480, 155 (2011), doi: 10.1038/480155c

### Category B

[1] **Gojdka**, **B.**; Lisec, T.; Dankwort, T.; Clausen, N.: Patent "Verfahren zur designunabhängigen Anpassung der Resonanzfrequenz mikromechanischer Oszillatoren", angemeldet 21.3.2023

[2] Lisec, T.; **Gojdka**, **B.**; Hohe, H.-P.; Cichon, D.; Stahl-Offergeld, M.: Patent „Back-bias integriert auf Wafer-Level", angemeldet 18.8.2022

[3] Lisec, T.; Päsler, M.; Kapels, H.; **Gojdka**, **B.**: Patent „Vorrichtung mit einem porösen Körper zum Aufnehmen einer Wärmemenge und Verfahren zum Bereitstellen einer Vorrichtung", DE 10 2021 202 630 A1.

### Academic Distinctions

2013 - Price for the best PhD thesis of the Faculty of Engineering of Kiel University in 2012

### Data Protection and Consent to the Processing of Optional Data

If you provide voluntary information (marked as optional) in this CV, your consent is required. Please confirm your consent by checking the box below.

[X] **I expressly consent to the processing of the voluntary (optional) information, including "special categories of personal data"[1] in connection with the DFG's review and decision-making process regarding my proposal.** This also includes forwarding my data to the external reviewers, committee members and, where applicable, foreign partner organisations who are involved in the decision-making process. To the extent that these recipients are located in a third country (outside the European Economic Area), I additionally consent to them being granted access to my data for the above-mentioned purposes, even though a level of data protection comparable to EU law may not be guaranteed. For this reason, compliance with the data protection principles of EU law is not guaranteed in such cases. In this respect, there may be a violation of my fundamental rights and freedoms and resulting damages. This may make it more difficult for me to assert my rights under the General Data Protection Regulation (e.g. information, rectification, erasure, compensation) and, if necessary, to enforce these rights with the help of authorities or in court.

I may **revoke** my consent in whole or in part at any time – with effect for the future, freely and without giving reasons – vis-à-vis the DFG (postmaster@dfg.de). The lawfulness of the processing carried out up to that point remains unaffected. Insofar as I transmit "special categories of personal data" relating to third parties, I confirm that the necessary legitimation under data protection law exists (e.g. based on consent).

I have taken note of the DFG's Data Protection Notice relating to research funding, which I can access at www.dfg.de/privacy_policy and I will forward it to such persons whose data the DFG processes as a result of being mentioned in this CV.

[1] Special categories of personal data are those "revealing racial or ethnic origin, political opinions, religious or philosophical beliefs, or trade union membership, and (...) genetic data, biometric data for the purpose of uniquely identifying a natural person, data concerning health or data concerning a natural person's sex life or sexual orientation" (Article 9(1) GDPR).

**Gundlach, Jan-Paul, Dr.**

**Personal Data**

| **Title, Name, Position, Institution, and ORCID** | |
|---|---|
| Title | Dr. med. |
| First name | Jan-Paul |
| Name | Gundlach |
| Current position | Associate Doctor |
| Current institution(s)/site(s), country | University Hospital Schleswig-Holstein (UKSH), Campus Kiel & Kiel University, Germany |
| Identifiers/ORCID | 0000-0002-8845-6832 |

**Qualifications and Career**

| **Stages** | **Periods and Details** |
|---|---|
| Degree programme | 2007 - 2013 Medical studies at the Christian- Albrechts- Univers Kiel, Germany<br>2019 - 2021 Master in Hospital Management at the Christia Albrechts-University Kiel, Germany |
| Doctorate | 2014 Prof. Dr. Georg Lutter, Department of Cardiac surgery, UKSH, Campus Kiel: Minimally invasive implantation of the tricuspid valve in the beating heart |
| Stages of academic/professional career | 2023 habilitation thesis submitted to the Dean's Office, Department of General, visceral-, thoracic, transplantation- and pediatric surgery, UKSH, Campus Kiel & Christian – Albrechts – University Kiel: Tumor biological studies to identify new biomarkers in pancreatic and cholangiocellular carcinoma<br>2023 Board certificate in emergency medicine<br>2022 Board certificate medical quality management<br>2022 Walter-Brendel-Kolleg for transplant medicine by the German transplant society (Berlin)<br>2021 Laboratory animal science advanced course (FELASA C)<br>2021 Master thesis Dr. Malte Raetzel & Prof. Felix Braun: Transplant Department, UKSH, Campus Kiel: Influence of a bonus point reporting system (matchMELD) for hepatocellular carci-noma on the success of a liver transplantation<br>2021 Board certificate radiation protection<br>2020 specialist in visceral surgery (Board certificate)<br>2020 Drug law advanced course<br>Since 2019 quality management officer of the trans-plant department, UKSH Campus Kiel<br>2015 research year supported by the Christian- Albrechts- |

| | |
|---|---|
| | University Kiel: Death receptor signaling in hepatobiliary cancers<br><br>Fellow of the liver transplantation network Kiel and participation in clinical studies<br><br>2015 Drug law examiner course advanced course<br><br>Since 2014 assistant doctor at the Department of General, visceral-, thoracic, transplantation- and pediatric surgery, University Hospital Schleswig-Holstein (UKSH), Campus Kiel |

**Engagement in the Research System**

- Member of the convention of the faculty of medicine (since 2020)

**Scientific Results**

**Category A**

[1] Geismann, C.; Hauser, C.; Grohmann, F.; Schneeweis, C.; Bölter, N.; **Gundlach, J.P.**; Schneider, G.; Röcken, C.; Meinhardt, C.; Schäfer, H.; Schreiber, S.; Arlt, A.: NF-κB/RelA controlled A20 limits TRAIL-induced apoptosis in pancreatic cancer. Cell Death Dis. 2023 Jan 3;14(1):3, doi: 10.1038/s41419-022-05535-9 (open-access).

[2] Rambow, A.C.; Aschenbach, I.; Hagelund, S.; Tawfik, D.; **Gundlach, J.P.**; Weiße, S.; Maass, N.; Trauzold, A. (2022): Endogenous TRAIL-R4 critically impacts apoptotic and non-apoptotic TRAIL-induced signaling in cancer cells. Front Cell Dev Biol. 2022 Sep 9;10:942718, doi: 10.3389/fcell.2022.942718 (open-access).

[3] **Gundlach, J.P.**; Kerber, J.*; Hendricks, A.; Bernsmeier, A.; Halske, C.; Röder, C.; Becker, T.; Röcken, C.; Braun, F.; Sebens, S.*; Heits, N.* (2022): Paracrine interaction of cholangiocellular carcinoma with cancer-associated fibroblasts and Schwann cells impact cell migration. J Clin Med. 2022 May 15;11(10):2785, doi: 10.3390/jcm11102785 (open-access).

[4] **Gundlach, J.P.**; Linecker, M.; Dobbermann, H.; Wadle, F.; Becker, T.; Braun, F. (2022): Patients benefit from liver transplantation for hepatocellular carcinoma outside Milan without harming the health care system. Cancers (Basel). 2022 Feb 23;14(5):1136, doi: 10.3390/cancers14051136 (open-access).

[5] **Gundlach, J.P.**; Braun F.; Mötter, F.; Bernsmeier, A.; Barrio, P.; Ehmke, N.; Günther, R.; Hinrichsen, H.; Becker, T.; Weinmann, W.; Schröck, S.; Yegles, M.; Wurst, F.M. (2022): Phosphatidylethanol (PEth) for Monitoring Sobriety in Liver Transplant Candidates: Differences Between Alcohol and Non-Alcohol Candidates. Ann Transplant. 2022 Jun 7;27:e936293, doi: 10.12659/AOT.936293 (open-access).

[6] **Gundlach, J.P.**; Schmidt, S.; Bernsmeier, A.; Günther, R.; Kataev, V.; Trentmann, J.; Schäfer, J.P.; Röcken, C.; Becker, T.; Braun, F. (2021): Indication of Liver Transplantation for Hepatocellular Carcinoma Should Be Reconsidered in Case of Microvascular Invasion and Multilocular Tumor Occurrence**.** J Clin Med. 2021 Mar 10;10(6):1155, doi: 10.3390/jcm10061155 (open-access).

[7] **Gundlach, J.P.**; Hauser, C.; Schlegel, F.M.; Willms, A.; Halske, C.; Röder, C.; Krüger, S.; Röcken, C.; Becker, T.; Kalthoff, H.; Trauzold, A. (2021): Prognostic significance of high mobility group A2 (HMGA2) in pancreatic ductal adenocarcinoma: malignant functions of cytoplasmic HMGA2 expression. J Cancer Res Clin Oncol. 2021 Nov;147(11):3313-3324, doi: 10.1007/s00432-021-03745-w (open-access).

[8] **Gundlach, J.P.**; Günther, R.; Both, M.; Trentmann, J.; Schäfer, J.P.; Cremer, J.T.; Röcken, C.; Becker, T.; Braun, F.; Bernsmeier, A. (2020): Inferior Vena Cava Constriction After Liver Transplantation Is a Severe Complication Requiring Individually Adapted Treatment: Report of a Single-Center Experience. Ann Transplant. 2020 Aug 4;25:e925194, doi: 10.12659/AOT.925194 (open-access).

[9] Goody, D.; Gupta, S.K.; Engelmann, D.; Spitschak, A.; Marquardt, S.; Mikkat, S.; Meier, C.; Hauser, C.; **Gundlach, J.P.**; Egberts, J.H.; Martin, H.; Schumacher, T.; Trauzold, A.; Wolkenhauer, O.; Logotheti, S.; Pützer, B.M. (2019): Drug Repositioning Inferred from E2F1-Coregulator Interactions Studies for the Prevention and Treatment of Metastatic Cancers. Theranostics. 2019 Feb 20;9(5):1490-1509, doi: 10.7150/thno.29546 (open-access).

[10] Tawfik, D.*; Groth, C.*; **Gundlach, J.P.**; Peipp, M.; Kabelitz, D.; Becker, T.; Oberg, H.H.; Trauzold, A.; Wesch, D. (2019): TRAIL-Receptor 4 Modulates γδ T Cell-Cytotoxicity Toward Cancer Cells. Front Immunol. 2019 Aug 28;10:2044, doi: 10.3389/fimmu.2019.02044 (open-access).

### Data Protection and Consent to the Processing of Optional Data

If you provide voluntary information (marked as optional) in this CV, your consent is required. Please confirm your consent by checking the box below.

[X] **I expressly consent to the processing of the voluntary (optional) information, including "special categories of personal data"[10] in connection with the DFG's review and decision-making process regarding my proposal.** This also includes forwarding my data to the external reviewers, committee members and, where applicable, foreign partner organisations who are involved in the decision-making process. To the extent that these recipients are located in a third country (outside the European Economic Area), I additionally consent to them being granted access to my data for the above-mentioned purposes, even though a level of data protection comparable to EU law may not be guaranteed. For this reason, compliance with the data protection principles of EU law is not guaranteed in such cases. In this respect, there may be a violation of my fundamental rights and freedoms and resulting damages. This may make it more difficult for me to assert my rights under the General Data Protection Regulation (e.g. information, rectification, erasure, compensation) and, if necessary, to enforce these rights with the help of authorities or in court.

I may **revoke** my consent in whole or in part at any time – with effect for the future, freely and without giving reasons – vis-à-vis the DFG (postmaster@dfg.de). The lawfulness of the processing carried out up to that point remains unaffected. Insofar as I transmit "special categories of personal data" relating to third parties, I confirm that the necessary legitimation under data protection law exists (e.g. based on consent).

[10] Special categories of personal data are those "revealing racial or ethnic origin, political opinions, religious or philosophical beliefs, or trade union membership, and (...) genetic data, biometric data for the purpose of uniquely identifying a natural person, data concerning health or data concerning a natural person's sex life or sexual orientation" (Article 9(1) GDPR).

I have taken note of the DFG's Data Protection Notice relating to research funding, which I can access at www.dfg.de/privacy_policy and I will forward it to such persons whose data the DFG processes as a result of being mentioned in this CV.

**Höft, Michael, Prof. Dr.**

**Personal Data**

| Title, Name, Position, Institution, and ORCID | |
|---|---|
| Title | Prof. Dr.-Ing. |
| First name | Michael |
| Name | Höft |
| Current position | Professor (W3) |
| Current institution(s)/site(s), country | Kiel University (CAU), Germany |
| Identifiers/ORCID | 0000-0001-9352-2868 |

**Qualifications and Career**

| Stages | Periods and Details |
|---|---|
| Degree programme | 1992 - 1997 Studies of Electrical Engineering (diploma with focus on microelectronics), Hamburg University of Technology, Germany |
| Doctorate | 2002 Prof. Dr.-Ing. Klaus Schünemann, Hamburg University of Technology, Germany |
| Stages of academic/professional career | Since 2013 Professor (W3), Head of the Chair of Microwave Engineering at the Faculty of Engineering of the CAU Kiel<br>2010 - 2013 Group Leader at Panasonic Industrial Devices Europe GmbH, Lüneburg<br>2004 - 2010 Team Leader at Panasonic Industrial Devices Europe GmbH, Lüneburg<br>2002 - 2004 Research Engineer at Panasonic Industrial Devices Europe GmbH, Lüneburg<br>1997 - 2002 Scientific assistant at the Institute of High-Frequency Technology of Hamburg University of Technology |

**Engagement in the Research System**

- Member of the Scientific Program Committee of the International Conference on Electromagnetic Wave Interaction with Water and Moist Substances (ISEMA) 2023, Brisbane, Australia
- Member of the Technical Program Commitee of the Microwave Conference (MIKON) 2022, Gdansk, Poland
- Member of the Technical Program Sub-Committee "Planar Filters" of European Microwave Week (EuMW) 2021, London, UK and 2022 Milan, Italy
- General Chair of the ISEMA 2021, Kiel, Germany
- Student Challenge Co-Chair of the European Microwave Week (EuMW) 2017, Nuremberg, Germany
- Member of the VDE ITG specialist group "Microwave Engineering" (since 2017)

## Scientific Results

### Category A

[1] Durdaut, P.; **Höft, M.**: Performance Analysis of Resonantly Driven Piezoelectric Sensors Operating in Amplitude Mode and Phase Mode. Sensors, 23(4), (2023) 1899, doi: 10.3390/s23041899 (open access).

[2] Yalaz, M.; Maling, M.; Deuschl, G.; Juárez-Paz, L.M.; Butz, M.; Schnitzler, A.; Helmers, A.-K.; **Höft, M.**: MaDoPO: Magnetic Detection of Positions and Orientations of Segmented Deep Brain Stimulation Electrodes: A Radiation-Free Method Based on Magnetoencephalography, Brain Sciences, 12(1), (2022) 86, doi: 10.3390/brainsci12010086 (open access).

[3] Elzenheimer, E.; Bald, C.; Engelhardt, E.; Hoffmann, J.; Hayes, P.; Arbustini, J.; Bahr, A.; Quandt, E.; **Höft, M.**; Schmidt, G.: Quantitative Evaluation for Magnetoelectric Sensor Systems in Biomagnetic Diagnostics, Sensors, 22(3), (2022) 1018, doi: 10.3390/s22031018 (open access).

[4] Durdaut, P.; Müller, C.; Kittmann, A.; Schell, V.; Bahr, A.; Quandt, E.; Knöchel, R.; **Höft, M.**; McCord, J.: Phase Noise of SAW Delay Line Magnetic Field Sensors, Sensors, 21(16), (2021) 5631, doi: 10.3390/s21165631 (open access).

[5] Yalaz, M.; Teplyuk, A.; Deuschl, G.; **Höft, M.**: Dipole Fit Localization of the Deep Brain Stimulation Electrode using 3D Magnetic Field Measurements, IEEE Sensors Journal, 20(16), (2020) 9550-9557, doi: 10.1109/JSEN.2020.2988067.

[6] Durdaut, P.; Rubiola, E.; Friedt, J.-M.; Müller, C.; Spetzler, B.; Kirchhof, C.; Meyners, D.; Quandt, E.; Faupel, F.; McCord, J.; Knöchel, R.; **Höft, M.**: Fundamental Noise Limits and Sensitivity of Piezoelectrically Driven Magnetoelastic Cantilevers, Journal of Microelectromechanical Systems, 29(5), (2020) 1347-1361, doi: 10.1109/JMEMS.2020.3014402.

[7] Özden, M. Ö.; Teplyuk, A.; Gümüs, Ö.; Meyners, D.; **Höft, M**.; Gerken, M.: Magnetoelectric Cantilever Sensors under Inhomogeneous Magnetic Field Excitation, AIP Advances, 10(2), (2020) 025132, doi: 10.1063/1.5136239 (open access).

[8] Durdaut, P.; Kittmann, A.; Rubiola, E.; Friedt, J.-M.; Quandt, E.; Knöchel, R.; **Höft, M.**: Noise Analysis and Comparison of Phase- and Frequency-Detecting Readout Systems: Application to SAW Delay Line Magnetic Field Sensor, IEEE Sensors Journal 19(18), (2019) 8000–8008, doi: 10.1109/JSEN.2019.2914965.

[9] Durdaut, P.; Kittmann A.; Bahr, A.; Quandt, E.; Knöchel, R.; **Höft, M.**: Oscillator Phase Noise Suppression in Surface Acoustic Wave Sensor Systems, IEEE Sensors Journal, 18(12), (2018), 4975-4980, doi: 10.1109/JSEN.2018.2832289.

[10] Durdaut, P.; Penner, V.; Kirchhof, C.; Quandt, E.; Knöchel, R.; **Höft, M.**: Noise of a JFET Charge Amplifier for Piezoelectric Sensors, IEEE Sensors Journal, 17(22), (2017), 7364-7371, doi: 10.1109/JSEN.2017.2759000.

### Category B

[1] Schimmack, M.; Taute, W.; **Höft, M.**: Filtereinrichtung mit Mikrowellenresonator, DE 10 2017 122 809 B3, 10. Jan. 2019.

[2] Quandt, E.; Kittmann, A.; Zabel, S.; Yarar, E.; Faupel, F.; Knöchel, R.; **Höft, M.**; Durdaut, P.: Sensorelement für Magnetfelder mit hoher Frequenzbandbreite, DE 10 2016 123 274 B4, 22 Nov 2018.

[3] **Höft, M.**: Dielectric multimode resonator, EP 1 962 369 B1, 4. June 2014.

[4] **Höft, M.**; Nakakubo, H.; Ishizaki, T.: Laminated RF device with vertical resonators having stack arrangement of laminated layers including dielectric layers, US 8,451,073 B2, 28. May 2013.

[5] Shimamura, T.; **Höft, M.**: Multi-layered device and electronic equipment using thereof, US 8,106,722 B2, 31. Jan. 2012.

[6] **Höft, M.**; Bartz, O.; Magath, T.; Burger, S.; Suehiro, Y.: Analogue RF device for wireless telecommunication, EP 1 933 460 B1, 20. Apr. 2011.

[7] **Höft, M.**; Bartz, O.: Temperature Compensation of Combline Resonators using Composite Inner Conductor, EP 1 760 824 B1, 11. Aug. 2010.

[8] **Höft M.**; Bartz, O.: Tunable bandpass filter, EP 1 885 018 B1, 2. Sept. 2009.

[9] Sobrido, R.; Burger, S.; Höft, M.: Microwave Filters including a Capacitive Coupling Element, EP 1 791 212 B1, 15. July 2009.

[10] Müller, J.; **Höft, M.**: Microwave Band-Pass Filter, EP 1 708 303 B1, 25. July 2007

### Academic Distinctions

- 2010 Best Paper Award, German Microwave Conference 2010
- 2004 Award of the metal- and electro-industry 2004 of the employer association “Nordmetall” for the PhD-thesis
- 1995 Philips-Award for the best intermediate diploma

### Data Protection and Consent to the Processing of Optional Data

If you provide voluntary information (marked as optional) in this CV, your consent is required. Please confirm your consent by checking the box below.

[X] **I expressly consent to the processing of the voluntary (optional) information, including “special categories of personal data”[11] in connection with the DFG’s review and decision-making process regarding my proposal.** This also includes forwarding my data to the external reviewers, committee members and, where applicable, foreign partner organisations who are involved in the decision-making process. To the extent that these recipients are located in a third country (outside the European Economic Area), I additionally consent to them being granted access to my data for the above-mentioned purposes, even though a level of data protection comparable to EU law may not be guaranteed. For this reason, compliance with the data protection principles of EU law is not guaranteed in such cases. In this respect, there may be a violation of my fundamental rights and freedoms and resulting damages. This may make it more difficult for me to assert my rights under the General Data Protection Regulation (e.g. information, rectification, erasure, compensation) and, if necessary, to enforce these rights with the help of authorities or in court.

[11] Special categories of personal data are those “revealing racial or ethnic origin, political opinions, religious or philosophical beliefs, or trade union membership, and (...) genetic data, biometric data for the purpose of uniquely identifying a natural person, data concerning health or data concerning a natural person’s sex life or sexual orientation” (Article 9(1) GDPR).

I may **revoke** my consent in whole or in part at any time – with effect for the future, freely and without giving reasons – vis-à-vis the DFG (postmaster@dfg.de). The lawfulness of the processing carried out up to that point remains unaffected. Insofar as I transmit “special categories of personal data” relating to third parties, I confirm that the necessary legitimation under data protection law exists (e.g. based on consent).

I have taken note of the DFG’s Data Protection Notice relating to research funding, which I can access at www.dfg.de/privacy_policy and I will forward it to such persons whose data the DFG processes as a result of being mentioned in this CV.

**Kienle, Lorenz, Prof. Dr.**

**Personal Data**

| Title, Name, Position, Institution, and ORCID | |
|---|---|
| Title | Prof. Dr. |
| First name | Lorenz |
| Name | Kienle |
| Current position | Professor (W2) |
| Current institution(s)/site(s), country | Kiel University, Germany |
| Identifiers/ORCID | 0000-0002-9638-3290 |

**Qualifications and Career**

| Stages | Periods and Details |
|---|---|
| Degree programme | 1988 - 1994 Chemistry Studies at University Stuttgart, Diploma in Solid State Chemistry at University Stuttgart |
| Doctorate | 1994 - 1998, Prof. Dr. Hans-Jörg Deiseroth, Siegen University, Germany |
| Stages of academic/professional career | Since 2010 Professor (W2) for Synthesis and Real Structure, CAU Kiel<br>2008 - 2010 Heisenberg Professor, CAU Kiel<br>2007 Visiting scientist, National Center for Nanoscience and Technology, Beijing, China<br>2004 - 2008 Heisenberg Fellow and Group Leader Electron, Max Planck Institute for Solid State Research, Stuttgart<br>2004 Habilitation at Siegen University (venia legendi for Inorganic Chemistry)<br>1994 - 1998 Scientific Assistant, Institute for Inorganic Chemistry, Siegen University |

**Engagement in the Research System**

- Speaker, Subcluster “Conflict and Conciliation”, Cluster of Excellence ROOTS (since 2022)
- Vice Dean, Faculty of Engineering, CAU Kiel (since 2022)
- Dean, Faculty of Engineering, CAU Kiel (2020 - 2022)
- Vice Dean Faculty of Engineering, CAU Kiel (2016 - 2019)
- Principal Investigator of the Excellence Cluster ROOTS (since 2020)
- DFG Liaison Officer (Vertrauensdozent) for CAU Kiel (since 2015)
- Member of the Commission on Research Ethics at CAU Kiel (since 2014)
- Principal Investigator of the Graduate School „Human Developments in
- Landscapes” (2011 - 2016)
- Executive Director of the Department of Material Science, CAU (2011 - 2015)

- Head of the TEM center Kiel (listed by DFG as core facility) (since 2009)
- Heisenberg Professorship (DFG) and head of the group “Synthesis and Real Structure”, CAU (2008)
- Heisenberg grant (DFG) (2006)
- Docent at the University of Siegen, Ulm and Giessen (2002 - 2007)

**Scientific Results**

The Chair of Synthesis and Real Structure is establishing a bridge between the engineering and natural sciences via the application and development of advanced techniques of analytics. The TEM center (TEM for transmission electron microscopy, center founded in 2010) serves as the basis and experimental platform for multidisciplinary analytical research in Kiel. Significant contributions from diverse disciplines, like chemistry, physics, medical sciences, archaeology are well visible, e.g., by joined publications and cooperation within larger third-party funded projects. The scientific approach of the Chair Synthesis and Real Structure combines different cutting-edge analytical techniques in order to derive relevant information about the atomic, chemical, magnetic and electronic structure of solids on a wide range of length scales. Particular emphasis is on the interrelation of physical properties (function) and atomic structure where only advanced and self-developed techniques of in operando examination provide novel aspects of functional materials.

**Category A**

[1] Rohmer, J.; Jetter, J.; Lotnyk, A.; **Kienle, L.**; Quandt, E.; James, R.D.: Exploding and weeping ceramics. Nature, 599, (2021) 416-420. doi: 10.1038/s41586-021-03975-5 (open access).

[2] Fichtner, S.; Wolff, N.; Lofink, F.; **Kienle, L.**; Wagner, B.: AlScN: A III-V semiconductor based ferroelectric. J. Appl. Phys., 125(11), (2019) 114103-1 - 114103-7. doi: 10.1063/1.5084945 (open access).

[3] Chluba, C.; Ge, W.; Lima de Miranda, R.; Strobel, J.; **Kienle L.**; Quandt, E.; Wuttig, M.: Ultralow-Fatigue Shape Memory Alloy Films. Science, 348(6238), (2015): 1004–7 doi: 10.1126/science.1261164.

[4] Hrkac, V.; Lage, E.; Köppel, G.; Strobel, J.; McCord, J.; Quandt, E.; Meyners, D.; **Kienle, L.**: Amorphous FeCoSiB for Exchange Bias Coupled and Decoupled Magnetoelectric Multilayer Systems: Real-Structure and Magnetic Properties. Journal of Applied Physics, 116(13), (2014) 134302 doi: 10.1063/1.4896662.

[5] Abdelaziz, R.; Disci-Zayed, D.; Hedayati, M.K.; Pöhls, J.-H.; Zillohu, A.U.; Erkartal, B.; Chakravadhanula, V.S.K.; Duppel, V.; **Kienle, L.**; Elbahri, M.: Green Chemistry and Nanofabrication in a Levitated Leidenfrost Drop. Nature Communications, 4(1), (2013). doi: 10.1038/ncomms3400 (open access).

[6] Lage, E.; Kirchhof, C.; Hrkac, V.; **Kienle, L.**; Jahns, R.; Knöchel, R.; Quandt, E.; Meyners, D.: Exchange Biasing of Magnetoelectric Composites. Nature Materials, 11(6), (2012) 523–29. doi: 10.1038/nmat3306 (open access).

[7] Bechtold, C.; Buschbeck, J.; Lotnyk, A.; Erkartal, B.; Hamann, S.; Zamponi, C.; Schultz, L.; Ludwig, A.; **Kienle, L.**; Fähler, S.; Quandt, E.: Artificial Single Variant Martensite in

Freestanding Fe70Pd30 Films Obtained by Coherent Epitaxial Growth. Advanced Materials, 22(24), (2010) 2668–71. doi: 10.1002/adma.201000599.

[8] Meiss, S.A.; Rohnke, M.; **Kienle, L.**; El Abedin, S.Z.; Endres, F.; Janek, J.: Employing Plasmas as Gaseous Electrodes at the Free Surface of Ionic Liquids: Deposition of Nanocrystalline Silver Particles. ChemPhysChem, 8(1), (2007) 50–53. doi: 10.1002/cphc.200600582.

[9] Hu, Y.-S.; **Kienle, L.**; Guo, Y.-G.; Maier, J.: High Lithium Electroactivity of Nanometer-Sized Rutile TiO2. Advanced Materials, 18(11), (2006) 1421–26. doi: 10.1002/adma.200502723.

[10] Balaya, P.; Li, H.; **Kienle, L.**; Maier, J.: Fully Reversible Homogeneous and Heterogeneous Li Storage in RuO2 with High Capacity. Advanced Functional Materials, 13(8), (2003) 621–25. doi: 10.1002/adfm.200304406.

## Academic Distinctions

- 2008 - 2010 Heisenberg Professor, CAU Kiel 1998 Price (Förderpreis) of the Mannesmann-Mobilfunk Stiftung for applied research in the area of communication
- 2004 - 2008 Heisenberg Fellow and Group Leader Electron, Max Planck Institute for Solid State Research, Stuttgart

## Data Protection and Consent to the Processing of Optional Data

If you provide voluntary information (marked as optional) in this CV, your consent is required. Please confirm your consent by checking the box below.

[X] **I expressly consent to the processing of the voluntary (optional) information, including "special categories of personal data"[12] in connection with the DFG's review and decision-making process regarding my proposal.** This also includes forwarding my data to the external reviewers, committee members and, where applicable, foreign partner organisations who are involved in the decision-making process. To the extent that these recipients are located in a third country (outside the European Economic Area), I additionally consent to them being granted access to my data for the above-mentioned purposes, even though a level of data protection comparable to EU law may not be guaranteed. For this reason, compliance with the data protection principles of EU law is not guaranteed in such cases. In this respect, there may be a violation of my fundamental rights and freedoms and resulting damages. This may make it more difficult for me to assert my rights under the General Data Protection Regulation (e.g. information, rectification, erasure, compensation) and, if necessary, to enforce these rights with the help of authorities or in court.

I may **revoke** my consent in whole or in part at any time – with effect for the future, freely and without giving reasons – vis-à-vis the DFG (postmaster@dfg.de). The lawfulness of the processing carried out up to that point remains unaffected. Insofar as I transmit "special categories of personal data" relating to third parties, I confirm that the necessary legitimation under data protection law exists (e.g. based on consent).

I have taken note of the DFG's Data Protection Notice relating to research funding, which I can access at www.dfg.de/privacy_policy and I will forward it to such persons whose data the DFG processes as a result of being mentioned in this CV.

[12] Special categories of personal data are those "revealing racial or ethnic origin, political opinions, religious or philosophical beliefs, or trade union membership, and (...) genetic data, biometric data for the purpose of uniquely identifying a natural person, data concerning health or data concerning a natural person's sex life or sexual orientation" (Article 9(1) GDPR).

**Lofink, Fabian, Prof. Dr.**

**Personal Data**

| **Title, Name, Position, Institution, and ORCID** | |
|---|---|
| Title | Prof. Dr. rer. nat. |
| First name | Fabian |
| Name | Lofink |
| Current position | Professor (W3, CAU Kiel);<br>Head of Department MEMS Applications (Fh ISIT) |
| Current institution(s)/site(s), country | Christian-Albrechts-Universität zu Kiel, Germany;<br>Fraunhofer Institute for Silicon Technology, Germany |
| Identifiers/ORCID | 0009-0003-3517-8466 |

**Qualifications and Career**

| **Stages** | **Periods and Details** |
|---|---|
| Degree programme | 2001 - 2004 Study of physics: Johannes Gutenberg-Universität Mainz, Germany; 2004 - 2008 Technical University of Berlin, Germany; Diploma in Physics (Interaction of clusters with intense light) at Technical University of Berlin, 2008 |
| Doctorate | 2014 Prof. H.P. Oepen and Prof. R. Wiesendanger, Magnetic systems of reduced dimensions, University of Hamburg, Department of Physics, Germany |
| Stages of academic/professional career | Dec 2022 Offered a full professorship (W3) for “Microsystems Materials and Technologies”, Departement of Materials Science, Kiel University, Materials and Technologies for Microsystems<br><br>Since 2017 Head of Department MEMS Applications, Fraunhofer Institute for Silicon Technology (ISIT), Itzehoe (Germany), Microelectromechanical systems<br><br>2016 - 2017 Head of Department Microsystems Technology, Fraunhofer Institute for Silicon Technology (ISIT), Itzehoe (Germany), Microelectromechanical systems<br><br>2013 - 2016 Research Scientist, Fraunhofer Institute for Silicon Technology (ISIT), Itzehoe (Germany), Department Microsystems Technology, Microelectromechanical systems<br><br>2009 - 2013 Research Scientist, University of Hamburg (Germany), Department of Physics, Magnetic systems of reduced dimensions<br><br>2006 - 2008 Research Assistant, Technical University of Berlin (Germany) Interaction of clusters with intense light |

## Scientific Results

### Category A

[1] Moench, S.; Meyer, J.; Zukauskaite, A.; Lebedev, V.; Fichtner, S.; Su, J.; Niekiel, F.; Giese, T.; Thormählen, L.; Quandt, E.; **Lofink**, **F.**: AlScN-Based SAW Magnetic Field Sensor for Isolated Closed-Loop Hysteretic Current Control of Switched-Mode Power Converters, IEEE Sensors Letters 6(101), 2500904 (2022), 10.1109/LSENS.2022.3205853 (open access).

[2] Bodduluri, M.T.; Gojdka, B.; Wolff, N.; Kienle, L.; Lisec, T.; **Lofink, F.**: Investigation of Wafer-Level Fabricated Permanent Micromagnets for MEMS, Micromachines, 13(5), 742 (2022), 10.3390/mi13050742 (open access).

[3] Su, J.; Fichtner, S.; Ghori, M.Z.; Wolff, N.; Islam, Md.R.; Lotnyk, A.; Kaden, D.; Niekiel, F.; Kienle, L.; Wagner, B.; **Lofink, F.**: Growth of Highly c-Axis Oriented AlScN Films on Commercial Substrates, Micromachines, 13(5), 783 (2022), 10.3390/mi13050783 (open access).

[4] Meyer, J.; Schell, V.; Su, J.; Fichtner, S.; Yarar, E.; Niekiel, F.; Giese, T.; Kittmann, A.; Thormählen, L.; Lebedev, V.; Moench, S.; Žukauskaite, A.; Quandt, E.; **Lofink, F.**: Thin-Film-Based SAW Magnetic Field Sensors, Sensors 21, 8166 (2021), 10.3390/s21248166 mi13050783 (open access).

[5] Islam, Md.R.; Wolff, N.; Yassine, M.; Schoenweger, G.; Christian, B.; Kohlstedt, H.; Ambacher, O.; **Lofink, F.;** Kienle, L.; Fichtner, S.: On the exceptional temperature stability of ferroelectric Al1-xScxN thin films, Applied Physics Letters, 118(23), 232905 (2021), 10.1063/5.0053649.

[6] Spetzler, B.; Su, J.; Friedrich, R.-M.; Niekiel, F.; Fichtner, S.; **Lofink, F.;** Faupel, F.: Influence of the piezoelectric material on the signal and noise of magnetoelectric magnetic field sensors based on the delta-E effect, APL Materials 9, 031108 (2021), 10.1063/5.0042448.

[7] Wolff, N.; Fichtner, S.; Haas, B.; Islam, Md.R.; Niekiel, F; Kessel, M.; Ambacher, O.; Koch, Ch.; Wagner, B.; **Lofink, F.;** Kienle, L.: Atomic Scale Confirmation of Ferroelectric Polarization Inversion in Wurtzite-Type AlScN, J. Appl. Phys. 129, 034103 (2021), 10.1063/5.0033205.

[8] Kittmann, A.; Müller, C.; Durdaut, P.; Thormählen, L.; Niekiel, F.; **Lofink, F.;** Meyners, D.; Knöchel, R.; Höft, M.; McCord, J.; Quandt, E.: Sensitivity and noise analysis of SAW magnetic field sensors withvaried magnetostrictive layer thicknesses, Sensors and Actuators A 311, 111998 (2020), 10.1016/j.sna.2020.111998.

[9] Schell, V.; Müller, C.; Durdaut, P.; Kittmann, A.; Thormählen, L.; **Lofink, F.;** Meyners, D.; Höft, M.; McCord, J.; Quandt, E.; Magnetic anisotropy controlled FeCoSiB thin films for surface acoustic wave magnetic field sensors, Appl. Phys. Lett. 116, 073503 (2020), /10.1063/1.5140562.

[10] Niekiel, F.; Su, J.; Bodduluri, M.T.; Liseca, T.; Blohm, L.; Pieper, I.; Wagner, B.; **Lofink, F.**: Highly Sensitive MEMS Magnetic Field Sensors with Integrated Powder-based Permanent Magnets, Sensors and Actuators A 297, 111560 (2019), 10.1016/j.sna.2019.111560.

**Category B**

[1] Fichtner, S.; Kaden, D.; Wagner, B.; Lofink, F.: Ferroelektrisches Material, MEMS-Bauteil mit einem ferroelektrischen Material, MEMS-Vorrichtung mit einem ersten MEMS-Bauteil, Verfahren zur Herstellung eines MEMS-Bauteils und Verfahren zur Herstellung eines CMOS-kompatiblen MEMS-Bauteils, DE102018203812

[2] Lisec, T.; Lofink, F.: Ein Verfahren zum Herstellen einer gegenläufig magnetisierten Magnetstruktur, DE102019210177

[3] Fichtner, S.; Wagner, B.; Lofink, F.: Ferroelektrische Halbleitervorrichtung und Verfahren zur Herstellung einer Speicherzelle, DE102018212736

[4] Lisec, T.; Lofink, F.: Verfahren zum Herstellen eines Hohlraums mit poröser Struktur, EP3284714B1

[5] Lisec, T.; Lofink, F.: Verfahren zum Herstellen einer magnetischen Struktur und Vorrichtung, DE102016215616B4

**Data Protection and Consent to the Processing of Optional Data**

If you provide voluntary information (marked as optional) in this CV, your consent is required. Please confirm your consent by checking the box below.

[X] **I expressly consent to the processing of the voluntary (optional) information, including "special categories of personal data"[1] in connection with the DFG's review and decision-making process regarding my proposal.** This also includes forwarding my data to the external reviewers, committee members and, where applicable, foreign partner organisations who are involved in the decision-making process. To the extent that these recipients are located in a third country (outside the European Economic Area), I additionally consent to them being granted access to my data for the above-mentioned purposes, even though a level of data protection comparable to EU law may not be guaranteed. For this reason, compliance with the data protection principles of EU law is not guaranteed in such cases. In this respect, there may be a violation of my fundamental rights and freedoms and resulting damages. This may make it more difficult for me to assert my rights under the General Data Protection Regulation (e.g. information, rectification, erasure, compensation) and, if necessary, to enforce these rights with the help of authorities or in court.

I may **revoke** my consent in whole or in part at any time – with effect for the future, freely and without giving reasons – vis-à-vis the DFG (postmaster@dfg.de). The lawfulness of the processing carried out up to that point remains unaffected. Insofar as I transmit "special categories of personal data" relating to third parties, I confirm that the necessary legitimation under data protection law exists (e.g. based on consent).

I have taken note of the DFG's Data Protection Notice relating to research funding, which I can access at www.dfg.de/privacy_policy and I will forward it to such persons whose data the DFG processes as a result of being mentioned in this CV.

[1] Special categories of personal data are those "revealing racial or ethnic origin, political opinions, religious or philosophical beliefs, or trade union membership, and (...) genetic data, biometric data for the purpose of uniquely identifying a natural person, data concerning health or data concerning a natural person's sex life or sexual orientation" (Article 9(1) GDPR).

**Maetzler, Walter, Prof. Dr.**

**Personal Data**

| Title, Name, Position, Institution, and ORCID | |
|---|---|
| Title | Prof. Dr. med. |
| First name | Walter |
| Name | Maetzler |
| Current position | Professor (W2) |
| Current institution(s)/site(s), country | University Hospital Schleswig-Holstein, Campus Kiel and Kiel University, Germany |
| Identifiers/ORCID | 0000-0002-5945-4694 |

**Qualifications and Career**

| Stages | Periods and Details |
|---|---|
| Degree programme | 1991 - 1996 Study of Medicine at the Innsbruck Medical School, Innsbruck, Austria |
| Doctorate | 2002 Prof. Cordula Nitsch, MD Thesis in Neuroanatomy, Basel Medical School, Switzerland, Parvalbumin overexpression augments excitotoxic injury and accelerates distinct calcification processes in the forebrain of the mouse |
| Stages of academic/professional career | Since 2017 Professor of Neurogeriatrics, Faculty of Medicine, Kiel University<br><br>Since 2016 Deputy Chair, Dept. of Neurology, University Hospital Schleswig-Holstein, Kiel<br><br>2013 Graduation to Associate Professor, Department of Neurology, Univ. of Tuebingen, Germany<br><br>2010 Postdoctoral lecturing qualification (Habilitation) in Neurology, Eberhard Karls University Tuebingen (Prof. T. Gasser), In-vivo Darstellung und pathophysiologische Aspekte von Proteinaggregation bei Lewykörper-Erkrankungen<br><br>2009 - 2016 Consultant and Executive consultant in Neurology, Dept. of Neurology and Hertie Institute for Clinical Brain Research, University of Tuebingen<br><br>2007 Graduazion to Neurologist, Dept. of Neurology, Univ. of Tuebingen, Germany<br><br>2003 - 2009 Resident in Neurology, Department of Neurology and Hertie Institute for Clinical Brain Research, University of Tuebingen, Germany<br><br>2000-2001 Resident in Psychiatry, Chur, and Neurology, Montana, Switzerland<br><br>2000 Graduation to General Practitioner, Hospitals in Austria |

| | |
|---|---|
| | and Switzerland<br><br>Experience in conducting clinical trials: Investigator in 7 clinical trials, e.g. www.nejm.org/doi/10.1056.<br><br>Regulatory expertise:<br><br>- Chief Clinical Investigator for a European-wide observational study investigating 2000 patients with inflammatory and neurodegenerative diseases (www.idea-fast.eu, IMI project) for the development and validation of digital surrogate markers for fatigue (positive EMA qualification advise)<br><br>- Parkinson cohort lead (600 patients) in a European-wide clinical validation study (www.mobilise-d.eu, total N=2400, IMI project) for the development and validation of digital parameters for mobility (positive EMA qualification opinion, currently seeking FDA qualification advise) |

**Engagement in the Research System**

- Reviewer for > 40 scientific journals, including Lancet Neurology, Lancet Digital Health, JAMA Neurology, Nature Reviews Neurology, Brain, Annals of Neurology
- Reviewer of EU research funding programs (FP7, Horizon), DFG, BMBF, national and international funding organizations
- Associate Editor for Journal of Alzheimer's Disease (2010-2014), PLOS ONE (2013-2016) and for Geriatric Care (ongoing)
- Guest Editor for an issue in Movement Disorders Journal (Mobile sensors in Parkinson's disease) (2016), and for an Issue in International Journal of Alzheimer's Disease (Biomarkers in neurodegenerative diseases) (2014)
- Co-Chair, Working Group on Technology, Movement Disorders Society
- Member, Task Force Geriatrics, German Society of Neurology (DGN)
- Fellow of the European Academy of Neurology (FEAN)

**Scientific Results**
**Category A**

[1] Bianchini, E.; Warmerdam, E.; Romijnders, R.; Stürner, K.H.; Baron, R.; Heinzel, S.; Pontieri, F.E.; Hansen, C.; **Maetzler W.** (2023): Turning When Using Smartphone in Persons With and Those Without Neurologic Conditions: Observational Study. J Med Internet Res, 25:e41082. Doi:10.2196/41082 (open access).

[2] Devos, D.; …. **Maetzler, W.**; … Moreau, C., FAIR-PARK-II study group (2022). Trial of Deferiprone in Parkinson's disease. NEJM, 387(22):2045-55, doi: 10.1056/NEJMoa2209254 (open access).

[3] Viceconti, M.; Tome, M.; Dartee, W.; Knezevic, I.; Hernandez, Penna S.; Mazzà, C.; Caulfield, B.; Garcia-Aymerich, J.; Becker, C.; **Maetzler, W.**; Troosters, T.; Sharrack, B.; Davico, G.; Corriol-Rohou, S.; Rochester, L.; Mobilise-D Consortium. (2022) On the use of

wearable sensors as mobility biomarkers in the marketing authorization of new drugs: A regulatory perspective. Front Med 9:996903. doi: 10.3389/fmed.2022.996903 (open access).

[4] **Maetzler, W**.; Pilotto, A. (2021): Digital assessment at home - mPower against Parkinson disease. Nat Rev Neurol, 17(11):661-62. Doi:10.1038/s41582-021-00567-9 (open access).

[5] Langer, A.; Hasenauer, S.; Flotz, A.; Gassner, L.; Pokan, R.; Dabnichki, P.; Wizany, L.; Gruber, J.; Roth, D.; Zimmel, S.; Treven, M.; Schmoeger, M.; Willinger, U.; **Maetzler, W.**; Zach, H. (2021): A randomised controlled trial on effectiveness and feasibility of sport climbing in Parkinson's disease. NPJ Parkinson's Disease, 7(1), 49, doi: 10.1038/S41531-021-00193-8 (open access).

[6] Warmerdam, E.; Romijnders, R.; Hansen, C.; Elshehabi, M.; Zimmermann, M.; Metzger, F. G.; von Thaler, A. K.; Berg, D.; Schmidt, G.; **Maetzler, W.** (2021): Arm swing responsiveness to dopaminergic medication in Parkinson's disease depends on task complexity. NPJ Parkinson's Disease, 7(1), 89, doi: 10.1038/S41531-021-00235-1 (open access).

[7] Warmerdam, E.; Hausdorff, J. M.; Atrsaei, A.; Zhou, Y.; Mirelman, A.; Aminian, K.; Espay, A. J.; Hansen, C.; Evers, L. J. W.; Keller, A.; Lamoth, C.; Pilotto, A.; Rochester, L.; Schmidt, G.; Bloem, B. R.; **Maetzler, W.** (2020): Long-term unsupervised mobility assessment in movement disorders. Lancet Neurology (Vol. 19, Issue 5, pp. 462–470). Lancet Publishing Group, doi: 10.1016/S1474-4422(19)30397-7.

[8] del Din, S.; Elshehabi, M.; Galna, B.; Hobert, M. A.; Warmerdam, E.; Suenkel, U.; Brockmann, K.; Metzger, F.; Hansen, C.; Berg, D.; Rochester, L.; **Maetzler, W.** (2019): Gait analysis with wearables predicts conversion to parkinson disease. Annals of Neurology, 86(3), 357–367, doi: 10.1002/ana.25548 (open access.

[9] Killeen, T.; Elshehabi, M.; Filli, L.; Hobert, M. A.; Hansen, C.; Rieger, D.; Brockmann, K.; Nussbaum, S.; Zörner, B.; Bolliger, M.; Curt, A.; Berg, D.; **Maetzler, W.** (2018): Arm swing asymmetry in overground walking. Scientific Reports, 8(1), 12803, doi: 10.1038/s41598-018-31151-9 (open access).

[10] Pham, M. H.; Warmerdam, E.; Elshehabi, M.; Schlenstedt, C.; Bergeest, L.-M.; Heller, M.; Haertner, L.; Ferreira, J. J.; Berg, D.; Schmidt, G.; Hansen, C.; **Maetzler, W.** (2018): Validation of a Lower Back "Wearable"-Based Sit-to-Stand and Stand-to-Sit Algorithm for Patients With Parkinson's Disease and Older Adults in a Home-Like Environment. Frontiers in Neurology, 9, 652, doi: 10.3389/fneur.2018.00652 (open access.

**Academic Distinctions**

- 2021 Best Poster of the German Geriatric Society Congress
- 2020 Supervisor of the best German Thesis in Geriatrics (Bethesda Prize)
- 2017-2023 Annually among the top 3 of the publication ranking of the Medical Faculty of Kiel University
- 2013 Research Prize of the German Parkinson Society

**Data Protection and Consent to the Processing of Optional Data**

If you provide voluntary information (marked as optional) in this CV, your consent is required. Please confirm your consent by checking the box below.

[X] **I expressly consent to the processing of the voluntary (optional) information, including "special categories of personal data"[14] in connection with the DFG's review and decision-making process regarding my proposal.** This also includes forwarding my data to the external reviewers, committee members and, where applicable, foreign partner organisations who are involved in the decision-making process. To the extent that these recipients are located in a third country (outside the European Economic Area), I additionally consent to them being granted access to my data for the above-mentioned purposes, even though a level of data protection comparable to EU law may not be guaranteed. For this reason, compliance with the data protection principles of EU law is not guaranteed in such cases. In this respect, there may be a violation of my fundamental rights and freedoms and resulting damages. This may make it more difficult for me to assert my rights under the General Data Protection Regulation (e.g. information, rectification, erasure, compensation) and, if necessary, to enforce these rights with the help of authorities or in court.

I may **revoke** my consent in whole or in part at any time – with effect for the future, freely and without giving reasons – vis-à-vis the DFG (postmaster@dfg.de). The lawfulness of the processing carried out up to that point remains unaffected. Insofar as I transmit "special categories of personal data" relating to third parties, I confirm that the necessary legitimation under data protection law exists (e.g. based on consent).

I have taken note of the DFG's Data Protection Notice relating to research funding, which I can access at www.dfg.de/privacy_policy and I will forward it to such persons whose data the DFG processes as a result of being mentioned in this CV.

[14] Special categories of personal data are those "revealing racial or ethnic origin, political opinions, religious or philosophical beliefs, or trade union membership, and (...) genetic data, biometric data for the purpose of uniquely identifying a natural person, data concerning health or data concerning a natural person's sex life or sexual orientation" (Article 9(1) GDPR).

**McCord, Jeffrey, Prof. Dr.**

**Personal Data**

| **Title, Name, Position, Institution, and ORCID** | |
|---|---|
| Title | Prof. Dr.-Ing. |
| First name | Jeffrey |
| Name | McCord |
| Current position | Professor (W2) |
| Current institution(s)/site(s), country | Kiel University, Germany |
| Identifiers/ORCID | 0000-0003-0237-6450 |

**Qualifications and Career**

| **Stages** | **Periods and Details** |
|---|---|
| Degree programme | 1987 - 1992 Studies of Materials Science, Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU), Germany |
| Doctorate | 1997 “Magnetic domain behavior in magnetoresistive sensor elements“, Prof. Dr. Alex Hubert, FAU |
| Stages of academic/professional career | Since 2011 Professor (W2) for “Nanoscale Magnetic Materials - Magnetic Domains” at the Faculty of Engineering of Kiel University (CAU)<br>2019 Guest-Scientist at CICnanogune, San Sebastian, Spain<br>2012 - 2011 Head of the Department „Nanomagnetism“ at the Helmholtz-Centre Dresden-Rossendorf (HZDR), Germany<br>2008 - 2010 Managing Director of evico magnetics GmbH, Dresden, Germany<br>2007 - 2011 Guest-Scientist - Guest-Professorship at the Laboratory of Material Physics of University of Lorraine, Nancy, France<br>Since 2006 Co-Founder and joint partner of ecivo magnetics GmbH, Dresden<br>2002 - 2010 Research Scientist and Group Leader at the Leibniz Institute for Solid State and Materials Research Dresden (IFW Dresden), Germany<br>1997 - 2001 Research and Development Scientist at the IBM Storage Division, San Jose, USA<br>1992 - 1997 Research Assistant at the chair “Materials for Electronics” at FAU |

## Engagement in the Research System

- Co-Speaker of the priority research area “Kiel Nano Surface & Interface Science” (KiNSIS) at Kiel University (since 2018)
- Member of the convention of the faculty of engineering (since 2016)
- Director of the Department for Material Science (2015 - 2018)
- Program Co-Chair of the International Conference on Magnetics (INTERMAG) 2017, Dublin
- Member of committees for numerous international conferences (since 2023: Intermag 2023 Conference, Sendai, Japan; International Symposium on Metallic Multilayers MML 2023, Seoul, Korea; Joint European Magnetic Symposia, JEMS 2023, Madrid, Spain; Conference on Magnetism and Magnetic Materials MMM 2023, Dallas, USA, International Symposium on Integrated Magnetics (iSIM) 2023, Rio de Janeiro, Brasil)
- Editorial Board Member – Scientific Reports
- Organizer IEEE Magnetics Summer School 2008, Dresden
- Lecturer at Summerschools on magnetism (IEEE, EMA)
- Reviewer for national and international research funding organizations (German, Switzerland, France, Poland, South Africa, etc.)
- Reviewer for international journals (e.g. Nature, Nature Materials, Physical Review Letters, Advanced Materials, Physical Review B, Applied Physics Letters, …)

## Scientific Results

### Category A

[1] Block, F.; Klingbeil, F.; Sajjad, U.; Arndt, C.; Sindt, S.; Seidler, D.; Thormählen, L.; Selhuber-Unkel, C.; **McCord, J.**: Magnetic bucket brigade transport networks for cell transport, Advanced Materials Technologies, 2300260, (2023), doi: 10.1002/admt.202300260 (open access).

[2] Müller, C.; Durdaut, P.; Holländer, R.B.; Kittmann, A.; Schell, V.; Meyners, D.; Höft, M.; Quandt, E.; **McCord, J.**: Imaging of Love Waves and Their Interaction with Magnetic Domain Walls in Magnetoelectric Magnetic Field Sensors, Advanced Electronic Materials, 8, 2200033, (2022), doi: 10.1002/aelm.202200033 (open access).

[3] Durdaut, P.; Müller, C.; Kittmann, A.; Schell, V.; Bahr, A.; Quandt, E.; Knöchel, R.; Höft, M.; **McCord, J.**: Phase Noise of SAW Delay Line Magnetic Field Sensors, Sensors, 21, (2021) 5631, doi: 10.3390/s21165631 (open access).

[4] Urs, N.O.; Golubeva, E.; Röbisch, V.; Toxværd, S.; Deldar, S.; Knöchel, R.; Höft, M.; Quandt, E.; Meyners, D.; **McCord, J.**: Direct link of specific magnetic domain activities and magnetic noise in modulated magnetoelectric sensors, Physical Review Applied, 13, 024018, (2020), doi: 10.1103/PhysRevApplied.13.024018.

[5] Jovičević Klug, M.; Thormählen, L.; Röbisch, V.; Salzer, S.; Höft, M.; Quandt, E.; Meyners, D.; **McCord, J.**: Antiparallel exchange biased multilayers for low magnetic noise magnetic field sensors, Applied Physics Letters, 114, 192410, (2019), doi: 10.1063/1.5092942.

[6] Holländer, R.B.; Müller, C.; Schmalz, J.; Gerken, M.; McCord, J.: Magnetic domain walls as broadband spin wave and elastic magnetisation wave emitters, Scientific Reports, 8, 13871, (2018), doi: 10.1038/s41598-018-31689-8 (open access).

[7] Sander, D., Valenzuela, S.; Makarov, D.; Marrows, C.; Fullerton, E.; Fischer, P.; **McCord, J.**; Vavassori, P.; Mangin, S.; Pirro, P.; Hillebrands, B.; Kent, A.; Jungwirth, T.; Gutfleisch, O.; Kim, C.; Berger, A.: The 2017 Magnetism Roadmap (Topical Review), J. Phys. D: Appl. Phys., 50, 363001, (2017), doi: 10.1088/1361-6463/aa81a1 (open access).

[8] **McCord, J.**: Progress in magnetic domain observation by advanced magneto-optical microscopy (Topical Review), Journal of Physics D: Applied Physics, 48, 333001, (2015), doi: 10.1088/0022-3727/48/33/333001 (open access).

[9] Fassbender, J.; **McCord, J.**: Magnetic patterning by means of ion irradiation and implantation (Review), Journal of Magnetism and Magnetic Materials, 320, (2008) 579, doi: 10.1016/j.jmmm.2007.07.032.

[10] **McCord J.**; Mattheis, R.; Elefant, D.: Dynamic magnetic anisotropy at the onset of exchange bias, Physical Review B, 70, 094420, (2004), doi: 10.1103/PhysRevB.70.094420.

**Category B**

[1] Schäfer, R.; **McCord, J.**: Magneto-optical Microscopy, in: Franco, V., Dodrill, B. (eds) Magnetic Measurement Techniques for Materials Characterization, Springer, Cham., (2021) 171, doi: 10.1007/978-3-030-70443-8_9.

[2] Fähler, S.; Thomas, M.; Heczko, O.; Buschbeck, J.; **McCord, J.**: Construction element made of a ferromagnetic shape memory material and use thereof, US8786276B2.

[3] **McCord, J.**: Apparatus and method for reduction of side reading effects in lead-overlay and exchange-tab structures, US7140093B2.

[4] Lee, E.; **McCord, J.**; Nikitin, V.: Magnetic head with a vertically laminated back gap structure having magnetic layer thicknesses less than the skin depth, US6909579B2.

[5] Lee, E.; **McCord, J.**: Shield electrical connections for tunnel valve sensors, US6798621B2.

[6] Nikitin, V.; **McCord, J.**; Ramasubramanian, M.: Enhancement of magnetization switching speed in soft ferromagnetic films through control of edge stress anisotropy, US6793961B2.

[7] **McCord, J.**: GMR sensor with end portion magnetization of pinned layer modified to reduce side reading effects, US6906899B2.

[8] Argyle, B.; **McCord, J.**: Laser beam homogenizer, US6672739B1.

[9] Argyle, B., **McCord, J.**: Apparatus and method for measuring magnetization of surfaces, US6593739B1.

[10] Mattheis, R.; **McCord, J.**: Magnetoresistiver Streifenleiter und Magnetfeldsensor zum Erfassen eines Magnetfeldes, DE19737931C1.

## Academic Distinctions

- 2011 Heisenberg Professorship Award from the German Research Foundation (DFG)
- 2001 IBM Stock Options and Invention Achievement Awards

## Data Protection and Consent to the Processing of Optional Data

If you provide voluntary information (marked as optional) in this CV, your consent is required. Please confirm your consent by checking the box below.

[X] **I expressly consent to the processing of the voluntary (optional) information, including "special categories of personal data"[15] in connection with the DFG's review and decision-making process regarding my proposal.** This also includes forwarding my data to the external reviewers, committee members and, where applicable, foreign partner organisations who are involved in the decision-making process. To the extent that these recipients are located in a third country (outside the European Economic Area), I additionally consent to them being granted access to my data for the above-mentioned purposes, even though a level of data protection comparable to EU law may not be guaranteed. For this reason, compliance with the data protection principles of EU law is not guaranteed in such cases. In this respect, there may be a violation of my fundamental rights and freedoms and resulting damages. This may make it more difficult for me to assert my rights under the General Data Protection Regulation (e.g. information, rectification, erasure, compensation) and, if necessary, to enforce these rights with the help of authorities or in court.

I may **revoke** my consent in whole or in part at any time – with effect for the future, freely and without giving reasons – vis-à-vis the DFG (postmaster@dfg.de). The lawfulness of the processing carried out up to that point remains unaffected. Insofar as I transmit "special categories of personal data" relating to third parties, I confirm that the necessary legitimation under data protection law exists (e.g. based on consent).

I have taken note of the DFG's Data Protection Notice relating to research funding, which I can access at www.dfg.de/privacy_policy and I will forward it to such persons whose data the DFG processes as a result of being mentioned in this CV.

[15] Special categories of personal data are those "revealing racial or ethnic origin, political opinions, religious or philosophical beliefs, or trade union membership, and (...) genetic data, biometric data for the purpose of uniquely identifying a natural person, data concerning health or data concerning a natural person's sex life or sexual orientation" (Article 9(1) GDPR).

**Meyners, Dirk, Dr.**

**Personal Data**

| Title, Name, Position, Institution, and ORCID | |
|---|---|
| Title | Dr. |
| First name | Dirk |
| Name | Meyners |
| Current position | Senior Researcher (Akademischer Oberrat) |
| Current institution(s)/site(s), country | Kiel University, Germany |
| Identifiers/ORCID | 0000-0003-2398-4295 |

**Qualifications and Career**

| Stages | Periods and Details |
|---|---|
| Degree programme | 1994 - 2001 Studies of philosophy and physics at the University of Bielefeld, Germany<br><br>10/2001 Diploma in physics 'Domänenuntersuchungen an nanostrukturierten magnetischen Tunnelelementen' (Investigation of domains in nanostructured magnetic tunnel junctions), Prof. G. Reiss |
| Doctorate | 2001 - 2006 PhD study of natural sciences at the University of Bielefeld<br><br>04/2006 Dissertation at the Faculty of Physics at the University of Bielefeld 'Herstellung und Charakterisierung von Logikarrays mit ultrakleinen magnetischen Tunnelelementen' (Fabrication and characterization of logic arrays based on ultra-small magnetic tunnel junctions), Prof. G. Reiss |
| Stages of academic/professional career | Since 2014 Akademischer Oberrat, Inorganic Functional Materials at the Faculty of Engineering of the Christian-Albrechts-Universität zu Kiel (Kiel University), Germany<br><br>Since 2008 Scientific director of the Kieler Nanolabor (Kiel Nanolaboratory)<br><br>2007 - 2014 Akademischer Rat, Inorganic Functional Materials at the Faculty of Engineering of the Kiel University<br><br>2006 - 2007 Research associate at the Center of Advanced European Studies and Research (caesar), Bonn, Germany<br><br>2001 - 2006 Research associate at the Faculty of Physics at the University of Bielefeld |

## Engagement in the Research System

- Member of German Physical Society (Deutsche Physikalische Gesellschaft)
- Member of Deutsche Gesellschaft für Materialkunde

## Scientific Results

### Category A

[1] Schell, V.; Spetzler, E.; Wolff, N.; Bumke, L.; Kienle, L.; McCord, J.; Quandt, E.; **Meyners, D.**: Exchange biased surface acoustic wave magnetic field sensors. Sci. Rep., 13(1) (2023), 8446, doi: 10.1038/s41598-023-35525-6 (open access).

[2] Schlichting, F.; Thormählen, L.; Cipo, J.; **Meyners, D.**; Kersten, H.: Energy-dependent film growth of Cu and NiTi from a tilted DC magnetron sputtering source determined by calorimetric probe analysis. Surface and Coatings Technology, 450 (2022), 129000, doi: 10.1016/j.surfcoat.2022.129000.

[3] Spetzler, B.; Bald, C.; Durdaut, P.; Reermann, J.; Kirchhof, C.; Teplyuk, A.; **Meyners, D.**; Quandt, E.; Höft, G.; Schmidt, G.; Faupel, F.: Exchange biased delta-E effect enables the detection of low frequency pT magnetic fields with simultaneous localization. Sci. Rep., 11(1) (2021), 5269, doi: 10.1038/s41598-021-84415-2 (open access).

[4] Schell, V.; Müller, C.; Durdaut, P.; Kittmann, A.; Thormählen, L.; Lofink, F.; **Meyners, D.**; Höft, M.; McCord, J.; Quandt, E. Magnetic anisotropy controlled FeCoSiB thin films for surface acoustic wave magnetic field sensors. Appl. Phys. Lett., 116(7) (2020), 073503, doi: 10.1063/1.5140562.

[5] Röbisch, V.; Salzer, S.; Urs, N. O.; Reermann, J.; Yarar, E.; Piorra, A.; Kirchhof, C.; Lage, E.; Höft, M.; Schmidt, G. U.; Knöchel, R.; McCord, J.; Quandt, E.; **Meyners, D.**: Pushing the detection limit of thin film magnetoelectric heterostructures. J. Mater. Res. 32(6) (2017), 1009-1019, doi: 10.1557/jmr.2017.58.

[6] Zabel, S.; Kirchhof, C.; Yarar, E.; **Meyners, D.**; Quandt, E.; Faupel, F.: Phase modulated magnetoelectric delta-E effect sensor for sub-nano tesla magnetic fields, Appl. Phys. Lett. 107 (2015) 152402, DOI: 10.1063/1.4932575.

[7] Röbisch, V.; Yarar, E.; Urs, N. O.; Teliban, I.; Knöchel, R.; McCord, J.; Quandt, E.; and **Meyners, D.**: Exchange biased magnetoelectric composites for magnetic field sensor application by frequency conversion, J. Appl. Phys. 117 (2015), 17B513, DOI: 10.1063/1.4913814.

[8] Lage, E.; Woltering, F.; Quandt, E.; **Meyners, D.**: Exchange Biased Magnetoelectric Composites for Vector Field Magnetometers, J. Appl. Phys. 113 (2013), 17C725, doi: 10.1063/1.4798791.

[9] Kirchhof, C.; Krantz, M; Teliban, J.; Jahns, R.; Marauska, S. Wagner, B.; Knöchel, R.; Gerken, M.; **Meyners, D.**; Quandt, E.: Giant magnetoelectric effect in vacuum, Appl. Phys. Lett. 102, (2013), 232905, doi: 10.1063/1.4810750.

[10] Lage, E.; Kirchhof, C.; Hrkac, V.; Kienle, L.; Jahns, R.; Knöchel, R.; Quandt, E.; **Meyners, D.**: Exchange biasing of magnetoelectric composites, Nat. Mater. 11 (6) (2012), 523-529, doi: 10.1038/NMAT3306 (open access).

## Category B

### Patents

[1] Lage, E.; **Meyners, D.**; Quandt, E.: Magnetostrictive Layer System, US20140125332A1 (2012), EP2538235A1 (2011), CN103620435A (2012), WO2012175567A1 (2012).

[2] Hoeink, V.; **Meyners, D.**; Reiss, G.; Schmalhorst, J.; Ehresmann, A.: Reconfigurable magnetic logic circuit arrangement and method for producing and operating such logic devices, US7825686 B2 (2010), EP2171852A1 (2010), CN101803192B (2013), WO2009012755A1 (2009)

### Data Protection and Consent to the Processing of Optional Data

If you provide voluntary information (marked as optional) in this CV, your consent is required. Please confirm your consent by checking the box below.

[X] **I expressly consent to the processing of the voluntary (optional) information, including "special categories of personal data"[16] in connection with the DFG's review and decision-making process regarding my proposal.** This also includes forwarding my data to the external reviewers, committee members and, where applicable, foreign partner organisations who are involved in the decision-making process. To the extent that these recipients are located in a third country (outside the European Economic Area), I additionally consent to them being granted access to my data for the above-mentioned purposes, even though a level of data protection comparable to EU law may not be guaranteed. For this reason, compliance with the data protection principles of EU law is not guaranteed in such cases. In this respect, there may be a violation of my fundamental rights and freedoms and resulting damages. This may make it more difficult for me to assert my rights under the General Data Protection Regulation (e.g. information, rectification, erasure, compensation) and, if necessary, to enforce these rights with the help of authorities or in court.

I may **revoke** my consent in whole or in part at any time – with effect for the future, freely and without giving reasons – vis-à-vis the DFG (postmaster@dfg.de). The lawfulness of the processing carried out up to that point remains unaffected. Insofar as I transmit "special categories of personal data" relating to third parties, I confirm that the necessary legitimation under data protection law exists (e.g. based on consent).

I have taken note of the DFG's Data Protection Notice relating to research funding, which I can access at www.dfg.de/privacy_policy and I will forward it to such persons whose data the DFG processes as a result of being mentioned in this CV.

[16] Special categories of personal data are those "revealing racial or ethnic origin, political opinions, religious or philosophical beliefs, or trade union membership, and (...) genetic data, biometric data for the purpose of uniquely identifying a natural person, data concerning health or data concerning a natural person's sex life or sexual orientation" (Article 9(1) GDPR).

**Murphy, Bridget, Dr.**

**Personal Data**

| Title, Name, Position, Institution, and ORCID | |
|---|---|
| Title | PD Dr |
| First name | Bridget |
| Name | Murphy |
| Current position | Group Leader |
| Current institution(s)/site(s), country | Kiel University, Germany |
| Identifiers/ORCID | 0000-0002-1354-2381 |

**Qualifications and Career**

| Stages | Periods and Details |
|---|---|
| Degree programme | 1987 - 1991 BSc Applied Physics, Dublin City University, Dublin, Ireland.<br>1991 - 1994 MSc Surface science, Dublin City University, Dublin, Ireland |
| Doctorate | 2004 “An X-ray diffraction investigation of the charge density wave transition at the NbSe2 surface” Prof. Dr. Werner Press, Kiel University, Germany |
| Habilitation | 2019 “Investigating Solid State and Liquid Interfaces on the Nanoscale with X-rays” Mentor Prof. Dr Olaf Magnussen, Kiel University, Germany |
| Stages of academic/professional career | Since 2012 LISA Group Leader in the Ruprecht Haensel Laboratory/ Institute of experimental and applied Physics at the Faculty of Faculty of Mathematics and Natural Sciences, Kiel University, Germany<br>2021 - 2022 Deputy Professor, Experimental Physics I., Technical University Dortmund, Germany<br>2010 Visiting Scientist at the Brookhaven National Laboratory, NY, USA<br>2006 - 2012 Assistant to Prof. O. Magnussen, "Habilitandin" / Senior Scientist, Interface Physics, Kiel University, Germany<br>2004 - 2006 Scientific and teaching staff (Post Doc), Kiel University, Germany<br>2004 Visiting scientist at Institut Laue-Langevin (ILL), Grenoble, France<br>2000 - 2004 PhD student Group: Prof. Werner Press, Kiel University, Germany<br>1999 Visiting scientist at the European Synchrotron Radiation |

| | |
|---|---|
| | Source, France<br><br>1997 - 2000 Higher Scientific Officer - First Beamline Scientist at beamline 16.3 Daresbury synchrotron radiation source (high resolution diffraction), Daresbury Laboratory, CCLRC, Cheshire, England<br><br>1994 - 1997 Scientific Officer - Beamline Scientist at SRS-Beamlines 9.4 surface X-ray scattering and 6.3 X-ray Standing Waves, Synchrotron Radiation Source, Daresbury Laboratory, CCLRC, Cheshire, England |

**Supplementary Career Information**

Maternity leave 10/1988 - 01/1989, Parental leave 01/1994 - 09/1994
Maternity leave 09/2011 - 12/2011, Parental leave 12/2011 - 12/2012 free text

**Engagement in the Research System**

- Since 2022 Speaker DAPHNE4NFDI (NFDI Verein)
- Since 2023 Elected Member of NFDI Senate
- Since 2021 Vice Chair European Synchrotron Users Organisation (EUSO)
- 2016 - 2022 Deutsches Elektronen Synchrotron (DESY) Council member
- Since 2020 Member of German Committee for Committee Research with Synchrotron Radiation Resource: Europe
- 2017- 2020 Chair of the German Committee for Committee Research with Synchrotron Radiation

**Scientific Results**

**Category A**

[1] Jordt, P.; Hrkac S.B.; Gröttrup, J.; Davydok, A.; Krywka, C.; Wolff, N.; Kienle, L.; Adelung, R.; Magnussen, O.M.; **Murphy**, **B.M.**: "Local Strain Distribution in ZnO Microstructures Visualized with Scanning Nano X-Ray Diffraction and Impact on Electrical Properties." Advanced Engineering Materials 23, no. 11 (2021): 2100201. doi.org/10.1002/adem.202100201 (open access).

[2] Jordt, P.; Hrkac, S.B.; Gröttrup, J.; Davydok, A.; Krywka, C.; Wolff, N.; Kienle, L.; Adelung, R.; Magnussen, O. M.; **Murphy**, **B.M.**: Local Strain Distribution in ZnO Microstructures Visualized with Scanning Nano X-Ray Diffraction and Impact on Electrical Properties, Advanced Engineering Materials, 2100201 (2021) doi.org/10.1002/adem.202100201 (open access).

[3] Wolff, N.; Jordt, P.; Braniste, T.; Popa, V.; Monaico, E.; Ursaki, V.; Petraru, A.; Adelung, R.; **Murphy, B.M.**; Kienle, L.: "Modulation of electrical conductivity and lattice distortions in bulk HVPE-grown GaN." ECS Journal of Solid State Science and Technology 8, no. 8 (2019): Q141. **DOI** 10.1149/2.0041908jss (open access).

[4] Niklas, N.; Jordt, P.; Jetter, J.; Vogt, H.; Lotnyk, A.; Seemann, K.; Ulrich, S.; Quandt, E.; **Murphy, B.M.;** Kienle, L.: "Nanostabilization of tetragonal distorted FeCo variants in ultra-thin FeCo/TiN multilayer films." Materials Characterization 172 (2021): 110871. https://doi.org/10.1016/j.matchar.2021.110871.

[5] Antonowicz, J.; Zalden, P.; Sokolowski-Tinten, K.; Georgarakis, K.; Minikayev, R.; Pietnoczka, A.; Bertram, F.; Chaika, M.; Chojnacki, M.; Dłużewski, P.; Fronc, K.; Greer, A.L.; Jastrzębski, C.; Klinger, D.; Lemke, Ch.; Magnussen, O.M.; **Murphy, B.M.;** Perumal, K.; Ruett, U.; Warias, J.; Sobierajski, R.: Devitrification of thin film Cu–Zr metallic glass via ultrashort pulsed laser annealing, Journal of Alloys and Compounds, 887(2021) 161437, ISSN 0925-8388.https://doi.org/10.1016/j.jallcom.2021.161437.

[6] Hrkac, S.B.; Koops, C.T.; Abes, M.; Krywka, C.; Müller, M.; Burghammer, M.; Sztucki, M.; Dane, T.; Kaps, S.; Mishra, Y.T.; Adelung, R.; Schmalz, J.; Gerken, M.; Lage, E.; Kirchhof, C.; Quandt, E.; Magnussen, O.M.; **Murphy, B.M.**: Tunable Strain in Magnetoelectric ZnO Microrod Composite Interfaces, ACS Applied Materials & Interfaces 9 (30), (2017) 25571-25577. DOI: 10.1021/acsami.6b15598.

[7] **Murphy, B.M.**; Greve, M.; Runge, B.; Koops, C.T.; Elsen, A.; Stettner, J.; Seeck, O.H.; Magnussen, O.M.: A novel X-ray diffractometer for studies of liquid–liquid interfaces, Journal of Synchrotron Radiation 21, 45-56 (2014). doi.org/10.1107/S1600577513026192.

[8] Diddens, I.; **Murphy, B.M.**; Krisch, M.; Muller, M.: Anisotropic Elastic Properties of Cellulose Measured Using Inelastic X-ray Scattering. Macromolecules, 41, 9755-9759 (2008). doi.org/10.1021/ma801796u.

[9] **Murphy***, **B.M.**; Requardt, H.; Stettner, J.; Serrano, J.; Krisch, M.; Muller, M.; Press, W.: Phonon modes at the 2H-NbSe2 surface observed by grazing incidence inelastic x-ray scattering, Physical Review Letters 95, 256104 (2005). doi.org/10.1103/PhysRevLett.95.256104.

[10] Seeck, O.H.; Deiter, C.; Pflaum, C.; Bertam, F.; Beerlink, A.; Franz, H.; Horbach, J.; Schulte-Schrepping, H.; **Murphy, B.M.**; Greve, M.; Magnussen, O.M.: The high-resolution diffraction beamline P08 at PETRA III. Journal of synchrotron radiation, 19(1), 201230-38. https://doi.org/10.1107/S0909049511047236.

**Category B**

[1] Koops, C. T.; Hrkac, S.B.; Abes, M.; Jordt, P.; Stettner, J.; Petraru, A.; Kohlstedt, H. **et al.**: "Elastic Coupling at Epitaxial Multiferroic Interfaces: In Situ X-Ray Studies of Electric Field Induced Strain." In 4th International Conference on Nanotechnologies and Biomedical Engineering: Proceedings of ICNBME-2019, September 18-21, 2019, Chisinau, Moldova, pp. 187-191. Springer International Publishing, 2020.

[2] Seeck, O.H.; **Murphy, B.M.** eds. X-ray Diffraction: Modern Experimental Techniques. CRC Press, 2015.

## Academic Distinctions

- Since 2018 European Synchrotron Radiation Facility (ESRF) Council, German representative
- 2016-2022 Deuches Elektronen Synchrotron Council member

## Data Protection and Consent to the Processing of Optional Data

If you provide voluntary information (marked as optional) in this CV, your consent is required. Please confirm your consent by checking the box below.

[X] **I expressly consent to the processing of the voluntary (optional) information, including "special categories of personal data"[1] in connection with the DFG's review and decision-making process regarding my proposal.** This also includes forwarding my data to the external reviewers, committee members and, where applicable, foreign partner organisations who are involved in the decision-making process. To the extent that these recipients are located in a third country (outside the European Economic Area), I additionally consent to them being granted access to my data for the above-mentioned purposes, even though a level of data protection comparable to EU law may not be guaranteed. For this reason, compliance with the data protection principles of EU law is not guaranteed in such cases. In this respect, there may be a violation of my fundamental rights and freedoms and resulting damages. This may make it more difficult for me to assert my rights under the General Data Protection Regulation (e.g. information, rectification, erasure, compensation) and, if necessary, to enforce these rights with the help of authorities or in court.

I may **revoke** my consent in whole or in part at any time – with effect for the future, freely and without giving reasons – vis-à-vis the DFG (postmaster@dfg.de). The lawfulness of the processing carried out up to that point remains unaffected. Insofar as I transmit "special categories of personal data" relating to third parties, I confirm that the necessary legitimation under data protection law exists (e.g. based on consent).

I have taken note of the DFG's Data Protection Notice relating to research funding, which I can access at www.dfg.de/privacy_policy and I will forward it to such persons whose data the DFG processes as a result of being mentioned in this CV.

[1] Special categories of personal data are those "revealing racial or ethnic origin, political opinions, religious or philosophical beliefs, or trade union membership, and (...) genetic data, biometric data for the purpose of uniquely identifying a natural person, data concerning health or data concerning a natural person's sex life or sexual orientation" (Article 9(1) GDPR).

**Parchmann, Ilka, Prof. Dr.**

**Personal Data**

| **Title, Name, Position, Institution, and ORCID** | |
|---|---|
| Title | Prof. Dr. |
| First name | Ilka |
| Name | Parchmann |
| Current position | Professor (W3) since 2009 |
| Current institution(s)/site(s), country | Leibniz-Institute for Science and Mathematics Education (IPN), Department of Chemistry Education & Christian-Albrechts-Universität zu Kiel (CAU), Kiel, Germany |
| Identifiers/ORCID | ORCID 0000-0001-9706-9765 |

**Qualifications and Career**

| **Stages** | **Periods and Details** |
|---|---|
| Professor (W3) | 2004 - 2009, University of Oldenburg |
| Associate Professor | 2002 - 2004, IPN and CAU Kiel |
| Research assistant | 1999 - 2002, IPN, Habilitation |
| Second Teachning Degree | 1997 -1999, Staatsexamen Wilhelmshaven |
| PostDoc | 1997 (3 months), University of York, UK |
| Doctorate in Chemistry | 1994 - 1997, PhD studies and degree, University of Oldenburg |
| First teaching Degree | 1988 - 1993, Studies in Chemistry and Biology, University of Oldenburg |

**Engagement in the Research System**

- Member of different committees of academic self-governance
  - Since 2022, speaker of the Alliance for Teacher Education in Schleswig-Holstein
  - Since 2021, Co-speaker of the *Kiel Science Communication Network* (KielSCN)
  - Since 2015, Speaker of the *Kiel Science Outreach Campus* (KiSOC, former Leibniz ScienceCampus)
  - Since 2012 co-leader of the Kieler Forschungswerkstatt and since 2017 of the student research center network (SFZ-SH)
  - 2014 - 2020, Vice-President for Teacher Education, Science Communication and Higher Education at CAU Kiel
  - 2011 - 2015, Visting Professor at the Dep. of Science and Mathematics Education at Umeå
  - 2009 - 2014 Chair of the Division of Chemical Education of EuChemS; 2011 - 2015 Speaker of the German Association for Chemistry and Physics Education (GDCP)
- Reviewing activity for international journals and grant-governing bodies (e.g. International Journal of Science Education, Research in Science and Technology Education, Chemistry Teacher International; BMBF, DFG, ISF)
- Continuous engagement in university teaching at Bachelor and Master levels and in teacher in-service trainings
- Continuous supervision of Master projects

- Supervision and mentoring of doctoral (currently 4) and postdoctoral researchers (currently 5)
- Organizer of symposia, workshops, and meetings (e.g. meetings of the Alliance for Teacher Education SH in 2022 and 2023, Sustainability Congress for school students in 2020, symposium for early-career researchers of the Association for subject-matter education 2018)

**Scientific Results**
**Category A**

[1] Çolakoğlu, J.; Steegh, A.; **Parchmann, I.** (2023): Reimagining informal STEM learning opportunities to foster STEM identity development in underserved learners. Frontiers in Education, 8, [1082747]. DOI: 10.3389/feduc.2023.1082747 (open access).

[2] Siebert, S.; Meurisch, K.; Bernholt, S.; Adelung, R.; **Parchmann, I.** (2023): Vom Wasserläufer zur Forschung: Struktur-Eigenschafts-Beziehungen aus drei Perspektiven. CHEMKON, 30(1), 13-22. DOI: 10.1002/ckon.202000097 (open access).

[3] Krüger, J. T.; Höffler, T. N.; **Parchmann, I.** (2022): Trust in science and scientists among secondary school students in two out-of-school learning activities. International Journal of Science Education, Part B: Communication and Public Engagement, 12(2), 111-125. DOI: 10.1080/21548455.2022.2045380 (open access).

[4] Krüger, J. T.; Höffler, T. N.; Wahl, M.; Knickmeier, K.; **Parchmann, I.** (2022): Two comparative studies of computer simulations and experiments as learning tools in school and out-of-school education. Instructional Science, 50(2), 169-197. DOI: 10.1007/s11251-021-09566-1 (open access).

[5] Broß, C.; Plöger, T.; Enzingmüller, C.; **Parchmann, I.** (2022): Kristalle unter Spannung: Piezoelektrizität als Beispiel für Struktur-Eigenschafts-Beziehungen. CHEMKON, 29(8), 240-246. DOI: 10.1002/ckon.202100024 (open access).

[6] Broß, C.; Enzingmüller, C.; **Parchmann, I.**; Schmidt, G. (2021): Teaching magnetoelectric sensing to secondary school students: Considerations for educational STEM outreach. Sensors, 21(21), [7354]. DOI:10.3390/s21217354 (open access).

[7] Stamer, I.; David, M. A.; Höffler, T.; Schwarzer, S.; **Parchmann, I.** (2021): Authentic insights into science: Scientific videos used in out-of-school learning environments. International Journal of Science Education, 43(6), 868-887. DOI: 10.1080/09500693.2021.1891321 (open access).

[8] Steegh, A.; Höffler, T.; Höft, L.; **Parchmann, I.** (2021): First steps toward gender equity in the chemistry Olympiad: Understanding the role of implicit gender-science stereotypes. Journal of Research in Science Teaching, 58(1), 40-68. DOI: 10.1002/tea.21645 (open access).

[9] Reimann, M.; Herzog, S.; **Parchmann, I.**; Schwarzer, S. (2020): Wirksamkeit der schulischen Vor- und Nachbereitung eines Schülerlaborbesuches. Zeitschrift für Didaktik der Naturwissenschaften, *26*(1), 227-240. DOI: 10.1007/s40573-020-00121-y (open access).

[10] Stamer, I.; Pönicke, H.; Tirre, F.; Laherto, A.; Höffler, T.; Schwarzer, S.; **Parchmann, I**. (2020): Development & validation of scientific video vignettes to promote perception of authentic science in student laboratories. Research in Science & Technological Education, 38(2), 168-184. DOI: 10.1080/02635143.2019.1600491 (open access).

**Category B**

**Journals and Products for Teacher Education and Education Practices with Editorial Board Review**

[1] Sommer, K.; **Parchmann, I.**; Strippel, C. (2023): Forschen und Lernen: Citizen Science für und mit Schüler:innen. Naturwissenschaften im Unterricht - Chemie, 34(194), 2-5.

[2] Lenzer, S.; Menthe, J.; Nehring, A.; **Parchmann, I.** (Hrsg.) (2022): Klimabildung. Naturwissenschaften im Unterricht - Chemie; Band 33, Nr. 191. Friedrich Verlag.

[3] **Parchmann, I.**; Stock, N. (2022): Wie kommen neue Ideen für chemische Reaktionen in die Welt: Einblicke in die Forschungswelt der porösen Materialien. Naturwissenschaften im Unterricht - Chemie, 33(190), 6-8.

[4] Meurisch, K.; Reimers, A.; **Parchmann, I.**; Adelung, R.; Schütt, F. (2022): Funktionale Nanomaterialien: Einblicke in die faszinierenden Möglichkeiten der Nanotechnologie. Naturwissenschaften im Unterricht - Chemie, 33(189), 15-19.

[5] Schwarzer, S.; Wilke, T.; Irmer, E.; **Parchmann, I.** (2022): Nanotechnologie in der Schule: Wie aus einer wissenschaftlichen Entwicklung ein neues Unterrichtsthema wird. Naturwissenschaften im Unterricht - Chemie, 33(189), 2-8.

[6] Herzog, S.; **Parchmann, I.**; Rönnebeck, S.; Adler, R. (2021): Chemiedidaktik trifft Mediendesign: Anwendung fachdidaktischer digitaler Kompetenzen. in M. Kubsch, S. Sorge, J. Arnold, & N. Graulich (Hrsg.), Lehrkräftebildung neu gedacht: Ein Praxishandbuch für die Lehre in den Naturwissenschaften und deren Didaktiken (S. 243-247). https://www.waxmann.com/index.php?eID=download&buchnr=4349#page=243 (open access).

[7] Enzingmüller, C.; Broß, C.; Laumann, D.; **Parchmann, I.**; Schmidt, G. (2021): Magnetfelder am Herzen messen. MNU Journal, 74(2), 149-153.

[8] Sorge, S.**; Parchmann, I.**; Neumann, I. (2020): Forschung zu Lehr-Lern-Laboren: Forschend Lernen im Lehr-Lern-Labor. in Sommer, K.; Wirth, J.; Vanderbeke, M. (Hrsg.), Handbuch Forschen im Schülerlabor: Theoretische Grundlagen, empirische Forschungsmethoden und aktuelle Anwendungsgebiete*,* 159-170. Waxmann.

[9] **Parchmann, I.**; Simon, S.; Apotheker, J. (2020): Engaging learners with chemistry: How can we better understand and design supporting structures and programs?, in Parchmann, I.; Simon, S.; Apotheker. J. (Hrsg.), Engaging learners with chemistry: Projects to stimulate interest and participation (p. 1-15). (Advances in Chemistry Education Series). Royal Society of Chemistry. DOI: 10.1039/9781788016087-00001 (open access).

[10] Herzog, S.; Lüthjohann, F.; Kampschulte, L.; Wilken, M.; Lindmeier, A.; Heinze, A.; **Parchmann, I.** (2020): Cooperating with companies helps to make science education more relevant to school students. in I. Parchmann, S. Simon, & J. Apotheker (Hrsg.),

Engaging learners with chemistry: Projects to stimulate interest and participation (S. 89-113). (Advances in Chemistry Education Series). Royal Society of Chemistry. https://doi.org/10.1039/9781788016087-00089.

**Academic Distinctions**

- 2018 Honorary Doctor, Umea University, Sweden
- 2011 Polytechnik Award for Chemie im Kontext, Polytechnical Society Frankfurt
- 2010 Erhard Friedrich Award for an outstanding scientist, Association for achdidaktik (GFD)
- 2008 Teaching award for the best module (together with school teachers), University of Oldenburg
- 1996 Manfred and Wolfgang Flad Award, German Chemical Society, Division of Chemistry Education

**Data Protection and Consent to the Processing of Optional Data**

If you provide voluntary information (marked as optional) in this CV, your consent is required. Please confirm your consent by checking the box below.

[**X**] **I expressly consent to the processing of the voluntary (optional) information, including "special categories of personal data"[1] in connection with the DFG's review and decision-making process regarding my proposal.** This also includes forwarding my data to the external reviewers, committee members and, where applicable, foreign partner organisations who are involved in the decision-making process. To the extent that these recipients are located in a third country (outside the European Economic Area), I additionally consent to them being granted access to my data for the above-mentioned purposes, even though a level of data protection comparable to EU law may not be guaranteed. For this reason, compliance with the data protection principles of EU law is not guaranteed in such cases. In this respect, there may be a violation of my fundamental rights and freedoms and resulting damages. This may make it more difficult for me to assert my rights under the General Data Protection Regulation (e.g. information, rectification, erasure, compensation) and, if necessary, to enforce these rights with the help of authorities or in court.

I may **revoke** my consent in whole or in part at any time – with effect for the future, freely and without giving reasons – vis-à-vis the DFG (postmaster@dfg.de). The lawfulness of the processing carried out up to that point remains unaffected. Insofar as I transmit "special categories of personal data" relating to third parties, I confirm that the necessary legitimation under data protection law exists (e.g. based on consent).

I have taken note of the DFG's Data Protection Notice relating to research funding, which I can access at www.dfg.de/privacy_policy and I will forward it to such persons whose data the DFG processes as a result of being mentioned in this CV.

[1] Special categories of personal data are those "revealing racial or ethnic origin, political opinions, religious or philosophical beliefs, or trade union membership, and (...) genetic data, biometric data for the purpose of uniquely identifying a natural person, data concerning health or data concerning a natural person's sex life or sexual orientation" (Article 9(1) GDPR).

**Quandt, Eckhard, Prof. Dr.**

**Personal Data**

| Title, Name, Position, Institution, and ORCID | |
|---|---|
| Title | Prof. Dr.-Ing. |
| First name | Eckhard |
| Name | Quandt |
| Current position | Professor (W3) |
| Current institution(s)/site(s), country | Kiel University, Germany |
| Identifiers/ORCID | 0000-0002-2314-5179 |

**Qualifications and Career**

| Stages | Periods and Details |
|---|---|
| Degree programmes | 1979 - 1980 Studies of Mathematics and Physics, Kiel University<br>1980 - 1986 Studies of Physics, Technische Universität Berlin, Germany |
| Doctorate | 1990 Optical Institute, Technische Universität Berlin, Germany |
| Stages of academic/professional career | Since 2020 Vice President of Kiel University<br>Since 2006 Professor (W3) for Inorganic Functional Materials at the Faculty of Engineering of the Kiel University<br>2000 Habilitation, Faculty of Mechanical Engineering, Universität Karlsruhe<br>1999-2006 Research Group Leader at the Center of Advanced European Studies and Research (caesar), Bonn<br>1996 -1999 Research Group Leader at the Forschungszentrum Karlsruhe, Institute for Materials Research I<br>1991-1996 Scientist at the (Kern) Forschungszentrum Karlsruhe, Institute for Materials Research I<br>1986-1991 Scientific Assistant at the Optical Institute of the TU Berlin |

**Engagement in the Research System**

- Member of the Senate Competition Committee (SAW) of the Leibniz Association (since 2023)
- Member of the Scientific Advisory Board of the Department Life, Light and Matter (LLM) of the University Rostock, Germany (since 2018)
- Speaker of the DFG Collaborative Research Centre SFB 1261 "Magnetoelectric Sensors: From Composite Materials to Biomagnetic Diagnostics (2016 - 2021)
- Dean of the Faculty of Engineering of the CAU (2014 - 2016)

- Member of the review board “Materials Science” of the DFG (2012 - 2020)
- Chairman of the Board of Trustees of the Fraunhofer Institute for Silicon Technology (ISIT), Itzehoe, Germany (since 2011)
- Speaker of the DFG Collaborative Research Centre SFB 855 "Magnetoelectric Composites – Future Biomagnetic Interfaces “(2010 - 2014)
- Member of the Executive Board and Speaker of the Advisory Board of the Deutsche Gesellschaft für Materialkunde (DGM) (2008 - 2014)

**Scientific Results**

**Category A**

[1] Dengiz, D.; Goldbeck, H.; Curtis, S. M.; Bumke, L.; Jetter, J.; **Quandt, E.**: Shape Memory Alloy Thin Film Auxetic Structures, Advanced Materials Technologies 2023, 2201991, DOI: 10.1002/admt.202201991(open access).

[2] Gu, H.; Rohmer, J.; Jetter, J.; Lotnyk, A.; Kienle, L.; **Quandt, E.**; James, R.D.: Exploding and weeping ceramics, Nature 599, 416–420 (2021), doi.org/10.1038/s41586-021-03975-5 (open access).

[3] Velvaluri, P.; Pravdivtseva, M. S.; Berg, P.; Wodarg, F.; Lima de Miranda, R.; Hövener, J.-B.; Jansen, O.; **Quandt, E.**: Thin-Film Patient-Specific Flow Diverter Stents for the Treatment of Intracranial Aneurysms, Advanced Materials Technologies 6 (2021), 2100384, DOI: 10.1002/admt.202100384 (open access).

[4] Schell, V., Müller, C.; Durdaut, P.; Kittmann, A.; Thormählen, L.; Lofink, F.; Meyners, D.; Höft, M.; McCord, J.; **Quandt, E.**: Magnetic anisotropy controlled FeCoSiB thin films for surface acoustic wave magnetic field sensors, Appl. Phys. Lett. 116 (2020), 073503, https://doi.org/10.1063/1.5140562.

[5] Jessen, LK., Zamponi, C., Willumeit-Römer, R.; **Quandt, E.**: Magnetron sputtered freestanding MgAg films with ultra-low corrosion rate, Acta Biomaterialia 98 (2019), 81-87; DOI: 10.1016/j.actbio.2019.05.060 (open access).

[6] Hayes, P.; Klug, M. J.; Toxværd, S.; Durdaut, P.; Schell, V.; Teplyuk, A.; Burdin, D.; Winkler, A.; Weser, R.; Fetisov, Y., Höft, M.; Knöchel, R.; McCord, J.; **Quandt, E.**: Converse Magnetoelectric Composite Resonator for Sensing Small Magnetic Fields, Scientific Reports 9 (2019),16355, DOI:10.1038/s41598-019-52657-w (open access).

[7] Kittmann, A.; Durdaut, P.; Zabel, S.; Reermann, J.; Schmalz, J.; Spetzler, B.; Meyners, D.; Sun, N.X.; McCord, J.; Gerken, M.; Schmidt, G.; Höft, M.; Knöchel, R.; Faupel, F.; **Quandt, E.**: Wide Band Low Noise Love Wave Magnetic Field Sensor System, Scientific Reports (2018), 8:278, DOI: 10.1038/s41598-017-18441-4 (open access).

[8] Chluba, C.; Ge, W.; Lima de Miranda, R.; Strobel, J.; Kienle, L.; **Quandt, E.**; Wuttig, M.: Ultralow-fatigue shape memory alloy films, Science 348 (2015), 1004-1007, DOI: 10.1126/science.1261164 (open access).

[9] Lage, E.; Kirchhof, C.; Hrkac, V.; Kienle, L.; Jahns, R.; Knöchel, R.; **Quandt, E.** und Meyners, D.: Exchange biasing of magnetoelectric composites, Nature Materials 11 (2012), 523-529, DOI: 10.1038/NMAT3306 (open access).

[10] Bechtold, C.; Buschbeck, J.; Lotnyk, A.; Erkartal, B.; Hamann, S.; Zamponi, C.; Schultz, L.; Ludwig, A.; Kienle, L.; Fähler, S. and **Quandt, E.**: Artificial Single Variant Martensite in Freestanding Fe70Pd30 Films Obtained by Coherent Epitaxial Growth, Advanced Materials 22 (2010), 2668–2671, DOI: 10.1002/adma.201000599.

**Category B**

**Relevant patents**

[1] Toxvaerd, S.; Knöchel, R.; Thormaehlen, L.; **Quandt, E.**: Mikrowellenresonator-Magnetfeldmessvorrichtung sowie Magnetfeldmessverfahren, DE102018110511B3, EP3788390A1, WO2019210900A1, US2021231757A1.

[2] Hayes, P.; Toxvaerd, S.; Knöchel, R.; **Quandt, E.**: Messvorrichtung für schwache, langsam veränderliche Magnetfelder, insbesondere für biomagnetische Felder DE102019116779B3, EP3987300A1, US2022291302A1, WO2020253908A1.

[3] **Quandt, E.**; Kittmann, A.; Zabel, S.; Yarar, E.; Faupel, F.; Knöchel, R.; Höft, M.; Durdaut, P: Sensorelement für Magnetfelder mit hoher Frequenzbandbreite, DE102016123274B4, EP3548909B1, US11137457B2, WO2018099506A1.

[4] Hayes, P.; Piorra, A.; Knöchel, R.; **Quandt, E.**: Magnetoelektrische Magnetfeldmessung mit Frequenzumsetzung, EP3104186B1, JP6676663B2, KR20180016538A, US10613159B2, WO2016198042A1.

[5] Piorra, A; **Quandt, E.**: Magnetoelektrischer Sensor und Verfahren zu seiner Herstellung, EP2717343B1, CN104737316B, JP6049895B2, KR101744107B1, US9841472B2, WO2014056842A1.

[6] Jahns, R.; Knöchel, R.; **Quandt, E.**: Verfahren zur Magnetfeldmessung mit magnetoelektrischen Sensoren, DE102011008866A1, CN103460067B, EP2635913B1, JP5946471B2, KR101813086B1, US9383417B2.

[7] Lage, E.; Meyners, D.; **Quandt, E.**: Magnetostriktives Schichtsystem, EP000002538235B1, WO2012097796A8.

[8] **Quandt, E.**; Bechtold, Chr.; Chemnitz, St.; Thede, C.; Teliban, J.: Verfahren zur Bestimmung mechanischer Eigenschaften magnetostriktiver Materialien, DE102010005550A1, WO2011088823A3, EP2526434B1.

[9] **Quandt, E.**; Frommberger M.; Tewes, M.; Hartung, W.; Losehand, R.; McCord, J.: Magnetische Schichten mit gekreuzten Anisotropien, DE102004063497A1.

[10] **Quandt, E.**; Stein, S.: Magnetischer Vektorsensor, DE102004062698A1.

**Academic Distinctions**

- SIM Distinction Award, First International Symposium on Integrated Magnetics 2023 (iSIM 2023), Sendai, Japan
- Petersen Innovations-Transfer-Preis 2018 (with Rodrigo Lima de Miranda) in 2018
- Member of the German National Academy of Science and Engineering (acatech) (since 2012)
- 1st prize of the “Ideenwettbewerb Gesundheitswirtschaft Schleswig-Holstein” (with Rodrigo Lima de Miranda) in 2009

- Georg-Sachs-Preis, Deutsche Gesellschaft für Materialkunde in 1996
- Förderpreis Deutsche Gesellschaft für Elektronenmikroskopie (DGE) (with Stephan la Barre) in 1991
- Member of the Studienstiftung des deutschen Volkes (1983 - 1986)

## Data Protection and Consent to the Processing of Optional Data

If you provide voluntary information (marked as optional) in this CV, your consent is required. Please confirm your consent by checking the box below.

[X] **I expressly consent to the processing of the voluntary (optional) information, including "special categories of personal data"[19] in connection with the DFG's review and decision-making process regarding my proposal.** This also includes forwarding my data to the external reviewers, committee members and, where applicable, foreign partner organisations who are involved in the decision-making process. To the extent that these recipients are located in a third country (outside the European Economic Area), I additionally consent to them being granted access to my data for the above-mentioned purposes, even though a level of data protection comparable to EU law may not be guaranteed. For this reason, compliance with the data protection principles of EU law is not guaranteed in such cases. In this respect, there may be a violation of my fundamental rights and freedoms and resulting damages. This may make it more difficult for me to assert my rights under the General Data Protection Regulation (e.g. information, rectification, erasure, compensation) and, if necessary, to enforce these rights with the help of authorities or in court.

I may **revoke** my consent in whole or in part at any time – with effect for the future, freely and without giving reasons – vis-à-vis the DFG (postmaster@dfg.de). The lawfulness of the processing carried out up to that point remains unaffected. Insofar as I transmit "special categories of personal data" relating to third parties, I confirm that the necessary legitimation under data protection law exists (e.g. based on consent).

I have taken note of the DFG's Data Protection Notice relating to research funding, which I can access at www.dfg.de/privacy_policy and I will forward it to such persons whose data the DFG processes as a result of being mentioned in this CV.

[19] Special categories of personal data are those "revealing racial or ethnic origin, political opinions, religious or philosophical beliefs, or trade union membership, and (...) genetic data, biometric data for the purpose of uniquely identifying a natural person, data concerning health or data concerning a natural person's sex life or sexual orientation" (Article 9(1) GDPR).

**Rieger, Robert, Prof. Dr.**

**Personal Data**

| **Title, Name, Position, Institution, and ORCID** | |
|---|---|
| Title | Prof. Dr. |
| First name | Robert |
| Name | Rieger |
| Current position | Professor (W2) |
| Current institution(s)/site(s), country | Kiel University, Germany |
| Identifiers/ORCID | 0000-0002-4436-0804 |

**Qualifications and Career**

| **Stages** | **Periods and Details** |
|---|---|
| Degree programme | Electronics Engineering with Medical Electronics, 1998-2000, University of Kent at Canterbury, U.K. |
| Doctorate | 2004, Prof. Dr. Andreas Demosthenous, Ph.D. in Electronic and Electrical Engineering, University College London (UCL), U.K. |
| Stages of academic/professional career | Since 2018, Professor (W2), Kiel University, Germany.<br>2013 - 2018, Full Professor, National Sun Yat-Sen University, Taiwan.<br>2015 - 2018, Joint Professor – Institute of Medical Science & Technology, National Sun Yat-Sen University, Taiwan.<br>2010 - 2013, Associate Professor, National Sun Yat-Sen University, Taiwan.<br>2006 - 2010, Assistant Professor, National Sun Yat-Sen University, Taiwan.<br>2004 - 2005, Design Engineer, austriamicrosystems AG, Industry & Medical Business Unit, Switzerland.<br>2002 - 2004, Research Assistant, University of Bath, Microelectronics Lab, U.K.<br>2000 - 2002, Research Assistant, University College London (UCL), Analogue Electronics Group, U.K.<br>1998 Engineer, Xanavi Informatics Corporation, Japan.<br>1997 - 1999, Intermediate Diploma in Electrical Engineering, Chemnitz University of Technology, Germany. |

**Engagement in the Research System**

- Editor-in-Chief for Digital Media (AEiC) for IEEE Transactions on Biomedical Circuits & Systems (TBCAS)
- Member of the Scientific Advisory Board of the Rostock Centre for Interdisciplinary Implant Research (ROCINI)
- Associate Editor for IEEE Transactions on Biomedical Circuits & Systems (TBCAS)
- Associate Editor for IEEE Transactions on Circuits and Systems I - Regular Papers (TCAS-I)
- Chairman of the IEEE EMBS Tainan Chapter (2007-2009)
- Member of the IEEE VLSI Systems and Applications Technical Committee (VTA-TC)
- Member of the IEEE Technical Committee CAS Education and Outreach (CASEO)
- Member of the IEEE Technical Committee on Biomedical Circuits and Systems (BioCAS-TC)
- Technical Committee Member Bureau of Standards, Metrology & Inspection (BSMI), Ministry of Economic Affairs, Taiwan (2008-2017)
- DAAD Scholarship Selection Committee (2008)
- Special Issue journal guest editor for IEEE Transactions on Circuits and Systems - II (TCAS2) SI on the 2021 IEEE International Symposium on Circuits and Systems, TCAS2 SI on Bioelectronic Circuits for Enhanced Diagnosis and Therapy, MDPI Electronics SI on Integrated electronic circuits and systems for unobtrusive biomedical sensing.
- Technical Program Committee Member and Track Chair for the 2nd International Conference on Information Technology, Advanced Mechanical and Electrical Engineering (ICITAMEE), Indonesia
- 2020 Technical Program Committee Member for the 10th Electrical Power, Electronics, Controls, Communications, and Informatics Seminar (EECCIS), Indonesia
- 2017 Organizing Committee Member of the International Workshop for B4G/5G Mobile Broadband Communications, Taiwan
- 2015 Track Co-Chair for IEEE International Conference on Circuits and Systems (ISCAS) 2015, Live Demo Track
- 2011 Local Arrangements Chair, IEEE ICICDT 2011, Kaohsiung, Taiwan
- 2010 Technical Program Committee Member for IEEE Asia Pacific Conference on Circuits and Systems
- 2007 - 2014 Technical Program Committee Member for the IEEE BioCAS and ISCAS conference series
- Organizing Committee Member for the 18th Symposium on VLSI Design and CAD, Taiwan
- Publicity Chair for the 18th Symposium on VLSI Design and CAD, Taiwan

## Scientific Results

### Category A

[1] Spetzler, B.; Wiegand, P.; Durdaut, P.; Höft, M.; Bahr, A.; **Rieger, R.**; Faupel, F.: Modeling and Parallel Operation of Exchange-Biased Delta-E Effect Magnetometers for Sensor Arrays, Sensors, 21(22), (2021) 7594, doi: 10.3390/s21227594 (open access).

[2] Simmich, S.; Bahr, A.; **Rieger, R.**: Noise Efficient Integrated Amplifier Designs for Biomedical Applications, Electronics – Special Issue on Analog Microelectronic Circuit Design and Applications, 10(13), (2021) 1522, doi: 10.3390/electronics10131522 (open access).

[3] **Rieger, R.**; Rif'an, M.: Integrated ExG, Vibration and Temperature Measurement Front-End for Wearable Sensing, IEEE Trans. Circuits Syst. I - Reg. Papers, 65(8), (2018) 2422–2430, doi: 10.1109/TCSI.2017.2785863 (open access).

[4] **Rieger, R.**; Sulistiyanto, N.: Integrated Circuit for Superregenerative Low-Frequency Amplification, IEEE Trans. Circ. Syst. II: Express Briefs, 65(1), (2018) 31–35, doi: 10.1109/TCSII.2017.2672782 (open access).

[5] **Rieger, R.**: Signal-Folding for Range-Enhanced Acquisition and Reconstruction, IEEE Trans. Circuits Syst. I - Reg. Papers, 62(10), (2015) 2617–2625, doi: 10.1109/TCSI.2015.2476317 (open access).

[6] Deng, S.-L.; **Rieger, R.**; Lin, Y.-B.: Programmable ExG Biopotential Front-end IC for Wearable Applications, IEEE Trans. Biomed. Circuits Syst., 8(4), (2014) 543–551, doi: 10.1109/TBCAS.2013.2285567 (open access).

[7] **Rieger, R.**; Taylor, J.: A Switched-Capacitor Front-End for Velocity-Selective ENG Recording, IEEE Trans. Biomed. Circuits Syst., 7(4), (2013) 480–488, doi: 10.1109/TBCAS.2012.2226719 (open access).

[8] **Rieger, R.**; Deng, S.-L.: Double-differential Recording and AGC Using Microcontrolled Variable Gain ASIC, IEEE Trans. Neural Syst. Rehabil. Eng., 21(1), (2013) 47–54, doi: 10.1109/TNSRE.2012.2213842 (open access).

[9] **Rieger, R.**: Variable-gain, Low-noise Amplification for Sampling Front-Ends, IEEE Trans. Biomed. Circuits Syst., 5(3), (2011) 253–261, doi: 10.1109/TBCAS.2010.2104320 (open access).

[10] **Rieger, R.**; Taylor, J.: An Adaptive Sampling System for Sensor Nodes In Body Area Networks, IEEE Trans. Neural Syst. Rehabil. Eng., 17(2), (2009) 183–189, doi: 10.1109/TNSRE.2009.2015199 (open access).

### Category B

[1] **Rieger, R.**: Physiological signal acquisition apparatus capable of monitoring abnormal current and method thereof, TWI527561B.

[2] Sun, Y.; **Rieger, R.**: Apparatus for memristor/neuron emulation and testing, US8,990,137 B2.

[3] **Rieger, R.**: Combined digital output system, TWI448071B, US8,593,316 B2.

[4] **Rieger, R.**: Piezo-Electric Transducer System and Signal Processing Method Thereof, TWI446134B.

[5] **Rieger, R.**: Integrated Low Noise Sampling Amplifier, TWI377782B.

[6] **Rieger, R.**: On-Body Sensing System with bi-directional signal communication, TWI364270B.

[7] **Rieger, R.**: Dynamic Range Extension System for Amplifier-Digitizer, TWI346450B.

[8] **Rieger, R.**: Sampling Control System and Method for A/D Converter, TWI327825B.

### Academic Distinctions

- 2014 IEEE Tainan Section Macronix Award 'in recognition of outstanding contributions to advances of circuit design for wearable and implantable biomedical applications'
- 2014 - 2015 NSYSU Academic Research Excellence Award
- 2000 Pfizer Prize for Biomedical Engineering, U.K.

### Data Protection and Consent to the Processing of Optional Data

If you provide voluntary information (marked as optional) in this CV, your consent is required. Please confirm your consent by checking the box below.

[X ] **I expressly consent to the processing of the voluntary (optional) information, including "special categories of personal data"[1] in connection with the DFG's review and decision-making process regarding my proposal.** This also includes forwarding my data to the external reviewers, committee members and, where applicable, foreign partner organisations who are involved in the decision-making process. To the extent that these recipients are located in a third country (outside the European Economic Area), I additionally consent to them being granted access to my data for the above-mentioned purposes, even though a level of data protection comparable to EU law may not be guaranteed. For this reason, compliance with the data protection principles of EU law is not guaranteed in such cases. In this respect, there may be a violation of my fundamental rights and freedoms and resulting damages. This may make it more difficult for me to assert my rights under the General Data Protection Regulation (e.g. information, rectification, erasure, compensation) and, if necessary, to enforce these rights with the help of authorities or in court.

I may **revoke** my consent in whole or in part at any time – with effect for the future, freely and without giving reasons – vis-à-vis the DFG (postmaster@dfg.de). The lawfulness of the processing carried out up to that point remains unaffected. Insofar as I transmit "special categories of personal data" relating to third parties, I confirm that the necessary legitimation under data protection law exists (e.g. based on consent).

I have taken note of the DFG's Data Protection Notice relating to research funding, which I can access at www.dfg.de/privacy_policy and I will forward it to such persons whose data the DFG processes as a result of being mentioned in this CV.

[1] Special categories of personal data are those "revealing racial or ethnic origin, political opinions, religious or philosophical beliefs, or trade union membership, and (...) genetic data, biometric data for the purpose of uniquely identifying a natural person, data concerning health or data concerning a natural person's sex life or sexual orientation" (Article 9(1) GDPR).

**Schmidt, Gerhard, Prof. Dr.**

**Personal Data**

| Title, Name, Position, Institution, and ORCID | |
|---|---|
| Title | Prof. Dr.-Ing. |
| First name | Gerhard |
| Name | Schmidt |
| Current position | Professor (W3) |
| Current institution(s)/site(s), country | Kiel University, Germany |
| Identifiers/ORCID | 0000-0002-6128-4831 |

**Qualifications and Career**

| Stages | Periods and Details |
|---|---|
| Degree programme | Studies of Electrical Engineering (with focus on Information Engineering), 1991 – 1996, Technische Universität Darmstadt, Germany |
| Doctorate | 2001, Prof. Dr.-Ing. Eberhard Hänsler, Technische Universität Darmstadt, Germany |
| Stages of academic/professional career | Since 2010 Professor (W3) for “Digital Signal Processing and System Theory” at the Faculty of Engineering of the CAU Kiel<br>2009 - 2010 Head of the department "Acoustic Speech Enhancement" at SVOX Deutschland GmbH, Ulm<br>2009 - 2010 Part-time professor (1/4 W3) at the Technische Universität Darmstadt, for the topic "Speech and Audio Signal Processing" (in parallel to the industry position at Harman/Becker and SVOX)<br>2001 - 2009 Research engineer at Harman/Becker Automotive Systems GmbH in Ulm (former name Temic SDS GmbH), since 2007 research group leader of the team "Acoustic Signal Processing"<br>1996 - 2001 Scientific assistant at the chair “Signal Theory” at Technische Universität Darmstadt |

**Engagement in the Research System**

- Liaison lecturer of the German National Academic Foundation (since 2021)
- Head of the ITG specialist group "Signal Processing and Machine Learning" (since 2020)
- Member of the senate of Kiel University (since 2022)
- Member of the convention of the faculty of engineering (since 2017)

## Scientific Results

### Category A

[1] Hoffmann, J.; Roldan-Vasco, S.; Krüger, K.; Niekiel, F.; Hansen, C.; Maetzler, W.; Orozco-Arroyave, J.; **Schmidt, G.**: Pilot Study: Magnetic Motion Analysis for Swallowing Detection Using MEMS Cantilever Actuators, Sensors, 23(7), (2023) 3594, doi: 10.3390/s23073594 (open access).

[2] Elzenheimer, E.; Hayes, P.; Thormählen, L.; Engelhardt, E.; Zaman, A.; Quandt, E.; Frey, N.; Höft, M.; **Schmidt, G.**: Investigation of Converse Magnetoelectric Thin Film Sensors for Magnetocardiography, IEEE Sensors Journal, 23 (6), (2023) 5660-5669, doi: 10.1109/JSEN.2023.3237910.

[3] Reermann, J.; Elzenheimer, E.; **Schmidt, G.**: Real-time Biomagnetic Signal Processing for Uncooled Magnetometers in Cardiology, IEEE Sensors Journal, 15(10), (2019) 4237-4249, doi: 10.1109/JSEN.2019.2893236.

[4] Elzenheimer, E.; Bald, C.; Engelhardt, E.; Hoffmann, J.; Hayes, P.; Arbistin, J.; Bahr, A.; Quandt, E.; Höft, M.; **Schmidt, G.**: Quantitative Evaluation for Magnetoelectric Sensor Systems in Biomagnetic Diagnostics, Sensors, 22(3), (2022) 1018, doi: 10.3390/s22031018 (open access).

[5] Broß, C.; Enzingmüller, C.; Parchmann, I.; **Schmidt, G.**: Teaching Magnetoelectric Sensing to Secondary School Students – Considerations for Educational STEM Outreach, Sensors, 21(21), (2021) 735, doi: 10.3390/s21217354 (open access).

[6] Bald, C.; **Schmidt, G.**: Processing Chain for Localization of Magnetoelectric Sensors in Real Time, Sensors, 21, (2021) 5675, doi: 10.3390/s21165675 (open access).

[7] Elzenheimer, E.; Laufs, H.; Schulte-Mattler, W.; **Schmidt, G.**: Magnetic Measurement of Electrically Evoked Muscle Responses with Optically Pumped Magnetometers, IEEE Transactions on Neural Systems and Rehabilitation Engineering, (2020), doi: 10.1109/TNSRE.2020.2968148.

[8] Elzenheimer, E.; Laufs, H.; Schulte-Mattler, W.; **Schmidt, G.**: Signal Modeling and Simulation of Temporal Dispersion and Conduction Block in Motor Nerves**,** IEEE Transactions on Biomedical Engineering, (2019), doi: 10.1109/TBME.2019.2954592.

[9] Spetzler, B.; Kirchhof, C.; Reermann, J.; Durdaut, P.; Höft, M.; **Schmidt, G.**; Quandt, E.; Faupel, F.: Influence of the Quality Factor on the Signal-to-noise Ratio of Magnetoelectric Sensors Based on the Delta-E Effect, Appl. Phys. Lett., 114, (2019) 183504, doi: 10.1063/1.5096001 (open access).

[10] Reermann, J.; Durdaut, P.; Salzer, S.; Demming, T.; Piorra, A.; Quandt, E.; Frey, N.; Höft, M.; **Schmidt, G.**: Evaluation of Magnetoelectric Sensor Systems for Cardiological Applications, Measurement, Elsevier, 116, (2018) 230-238, doi: 10.1016/j.measurement.2017.09.047.

### Category B

[1] **Schmidt, G.**; Bergholz, R.; Quandt, E.; Sun, N.; Klinkenbusch, L.; Bald, C.; Schmidt, T.: Vorrichtung zur Posenschätzung eines magnetfeldmessenden Objekts, (2023) patent application DE 10 2023 116 342.6.

### Academic Distinctions

- 2002 Price of the Ernst-Ludwigs-Hochschulgesellschaft for excellent scientific performances
- 1998 Price (Förderpreis) of the Mannesmann-Mobilfunk Stiftung for applied research in the area of communication

### Data Protection and Consent to the Processing of Optional Data

If you provide voluntary information (marked as optional) in this CV, your consent is required. Please confirm your consent by checking the box below.

[X] **I expressly consent to the processing of the voluntary (optional) information, including "special categories of personal data"[21] in connection with the DFG's review and decision-making process regarding my proposal.** This also includes forwarding my data to the external reviewers, committee members and, where applicable, foreign partner organisations who are involved in the decision-making process. To the extent that these recipients are located in a third country (outside the European Economic Area), I additionally consent to them being granted access to my data for the above-mentioned purposes, even though a level of data protection comparable to EU law may not be guaranteed. For this reason, compliance with the data protection principles of EU law is not guaranteed in such cases. In this respect, there may be a violation of my fundamental rights and freedoms and resulting damages. This may make it more difficult for me to assert my rights under the General Data Protection Regulation (e.g. information, rectification, erasure, compensation) and, if necessary, to enforce these rights with the help of authorities or in court.

I may **revoke** my consent in whole or in part at any time – with effect for the future, freely and without giving reasons – vis-à-vis the DFG (postmaster@dfg.de). The lawfulness of the processing carried out up to that point remains unaffected. Insofar as I transmit "special categories of personal data" relating to third parties, I confirm that the necessary legitimation under data protection law exists (e.g. based on consent).

I have taken note of the DFG's Data Protection Notice relating to research funding, which I can access at www.dfg.de/privacy_policy and I will forward it to such persons whose data the DFG processes as a result of being mentioned in this CV.

[21] Special categories of personal data are those "revealing racial or ethnic origin, political opinions, religious or philosophical beliefs, or trade union membership, and (...) genetic data, biometric data for the purpose of uniquely identifying a natural person, data concerning health or data concerning a natural person's sex life or sexual orientation" (Article 9(1) GDPR).

**Schröder, Stefan, Dr.**

**Personal Data**

| Title, Name, Position, Institution, and ORCID | |
|---|---|
| Title | Dr.-Ing. |
| First name | Stefan |
| Name | Schröder |
| Current position | Post-doc, subgroup leader (temporary contract) |
| Current institution(s)/site(s), country | Kiel University, Germany |
| Identifiers/ORCID | 0000-0001-9996-2637 |

**Qualifications and Career**

| Stages | Periods and Details |
|---|---|
| Degree programme | 2009 - 2015 Studies of Materials Science and Engineering, Kiel University, Germany |
| Doctorate | 2021 Prof. Dr.rer.nat. Franz Faupel, Kiel University, Germany |
| Stages of academic/professional career | Since 2021 Post-doc, group leader “Functional CVD Polymers” at Kiel University, Germany<br>2017 Department of chemical engineering, Gleason group (Prof. Dr. Karen K. Gleason), Massachusetts Institute of Technology, USA<br>2015 - 2021 Graduate student at the chair “Multicomponent Materials” (Prof. Dr. Franz Faupel) at Kiel University, Germany |

**Scientific Results**

**Category A**

[1] **Schröder, S.**; Ababii, N.; Brînză, M.; Magariu, N.; Zimoch, L.; Bodduluri, M. T.; Strunskus, T.; Adelung, R.; Faupel, F.; Lupan, O.: Tuning the Selectivity of Metal Oxide Gas Sensors with Vapor Phase Deposited Ultrathin Polymer Thin Films, Polymers, 15 (3), (2023) 524, doi: 10.3390/polym15030524 (open access).

[2] Barg, I.; Kohlmann, N.; Rasch, F.; Strunskus, T.; Adelung, R.; Kienle, L.; Faupel, F.; **Schröder, S.**; Schütt, F.: Strain-Invariant, Highly Water Stable All-Organic Soft Conductors Based on Ultralight Multi-Layered Foam-Like Framework Structures, Advanced Functional Materials, 33(21), (2023) 2212688, doi: 10.1002/adfm.202212688 (open access).

[3] **Schröder, S.**; Ababii, N.; Lupan, O.; Drewes, J.; Magariu, N.; Krüger, H.; Strunskus, T.; Adelung, R; Hansen, S.; Faupel, F.: Sensing Performance of CuO/Cu2O/ZnO: Fe Heterostructure Coated with Thermally Stable Ultrathin Hydrophobic PV3D3 Polymer Layer for Battery Application, Materials Today Chemistry, 23, (2022) 100642, doi: 10.1016/j.mtchem.2021.100642.

[4] **Schröder, S.**; Hinz, A. M.; Strunskus, T.; Faupel, F.: Molecular Insight into Real-Time Reaction Kinetics of Free Radical Polymerization from the Vapor Phase by In-Situ Mass Spectrometry, The Journal of Physical Chemistry A, 125(7), (2021) 1661, doi: 10.1021/acs.jpca.0c11180.

[5] **Schröder, S.**; Polonskyi, O.; Strunskus, T.; Faupel, F.: Nanoscale Gradient Copolymer Films via Single-Step Deposition from the Vapor Phase, Materials Today, 37, (2020) 35, doi: 10.1016/j.mattod.2020.02.004.

[6] Burk, M. H.; **Schröder, S.**; Moormann, W.; Langbehn, D.; Strunskus, T.; Rehders, S.; Herges, R.; Faupel, F.: Fabrication of Diazocine-Based Photochromic Organic Thin Films via Initiated Chemical Vapor Deposition, Macromolecules, 54 (4), (2020) 1164, doi:10.1021/acs.macromol.9b02443.

[7] **Schröder, S.**; Strunskus, T.; Rehders, S.; Gleason, K. K.; Faupel, F.: Tunable polytetrafluoroethylene electret films with extraordinary charge stability synthesized by initiated chemical vapor deposition for organic electronics applications, Scientific Reports, 9 (1), (2019) 2237, doi: 10.1038/s41598-018-38390-w (open access).

[8] Aktas, O. C.; **Schröder, S.**; Veziroglu, S.; Ghori, M. Z.; Haidar, A.; Polonskyi, O.; Strunskus, T.; Gleason, K.; Faupel, F.: Superhydrophobic 3D Porous PTFE/TiO2 Hybrid Structures, Advanced Materials Interfaces, 6 (4), (2019), 1801967, doi: 10.1002/admi.201801967 (open access).

[9] Mintken, M.; Schweichel, M.; **Schröder, S.**; Kaps, S.; Carstensen, J.; Kumar Mishra, Y.; Strunskus, T.; Faupel, F.; Adelung, R.: Nanogenerator and piezotronic inspired concepts for energy efficient magnetic field sensors, Nano Energy, 56, (2019) 420, doi: 10.1016/j.nanoen.2018.11.031.

[10] Hirschberg, R. E.; Scharnberg, M.; **Schröder, S.**; Rehders, S.; Strunskus, T.; Faupel, F.: Electret films with extremely high charge stability prepared by thermal evaporation of Teflon AF, Organic Electronics, 57, (2018) 146, doi: 10.1016/j.orgel.2018.02.040.

### Category B

None

### Academic Distinctions

- 2022 Best PhD thesis 2021 award for the Faculty of Engineering

### Data Protection and Consent to the Processing of Optional Data

If you provide voluntary information (marked as optional) in this CV, your consent is required. Please confirm your consent by checking the box below.

[X] **I expressly consent to the processing of the voluntary (optional) information, including "special categories of personal data"[1] in connection with the DFG's review and decision-making process regarding my proposal.** This also includes forwarding my data to the external reviewers,

[1] Special categories of personal data are those "revealing racial or ethnic origin, political opinions, religious or philosophical beliefs, or trade union membership, and (...) genetic data, biometric data for the purpose of uniquely identifying a natural person, data concerning health or data concerning a natural person's sex life or sexual orientation" (Article 9(1) GDPR).

committee members and, where applicable, foreign partner organisations who are involved in the decision-making process. To the extent that these recipients are located in a third country (outside the European Economic Area), I additionally consent to them being granted access to my data for the above-mentioned purposes, even though a level of data protection comparable to EU law may not be guaranteed. For this reason, compliance with the data protection principles of EU law is not guaranteed in such cases. In this respect, there may be a violation of my fundamental rights and freedoms and resulting damages. This may make it more difficult for me to assert my rights under the General Data Protection Regulation (e.g. information, rectification, erasure, compensation) and, if necessary, to enforce these rights with the help of authorities or in court.

I may **revoke** my consent in whole or in part at any time – with effect for the future, freely and without giving reasons – vis-à-vis the DFG (postmaster@dfg.de). The lawfulness of the processing carried out up to that point remains unaffected. Insofar as I transmit “special categories of personal data” relating to third parties, I confirm that the necessary legitimation under data protection law exists (e.g. based on consent).

I have taken note of the DFG’s Data Protection Notice relating to research funding, which I can access at www.dfg.de/privacy_policy and I will forward it to such persons whose data the DFG processes as a result of being mentioned in this CV.

**Spetzler, Benjamin, Dr.**

**Personal Data**

| **Title, Name, Position, Institution, and ORCID** | |
|---|---|
| Title | Dr.-Ing. |
| First name | Benjamin |
| Name | Spetzler |
| Current position | Postdoctoral researcher (current contract ends March 2025) |
| Current institution(s)/site(s), country | Ilmenau University of Technology, Germany |
| Identifiers/ORCID | 0000-0003-4255-5947 |

**Qualifications and Career**

| **Stages** | **Periods and Details** |
|---|---|
| Degree programme | 2011 – 2016 Studies of Materials Science and Engineering, Kiel University, Germany |
| Doctorate | 2021 Prof. Dr. rer. nat. Franz Faupel, Kiel University, Germany |
| Stages of academic/professional career | Since 2022 Postdoctoral researcher for “Computational Materials and Devices” at the Chair of Micro- and Nanoelectronic Systems, Prof. Martin Ziegler, Ilmenau University of Technology<br>2017 - 2021 Doctoral researcher at the Chair of Multicomponent Materials on ΔE-effect magnetic field sensors, Prof. Faupel, Kiel University, Germany<br>2015 - 2017 Laboratory assistant at the Chair of Multicomponent Materials, Prof. Faupel, Kiel University, Germany<br>2013 - 2015 Laboratory assistant at the Chair of Biocompatible Nanomaterials, Prof. Selhuber-Unkel, Kiel University, Germany<br>2013 - 2014 Laboratory assistant at the Institute of Experimental and Applied Physics, Kiel University, Germany<br>2009 - 2011 Laboratory assistant at ICP-Analytik, Preetz, Germany |

**Scientific Results**

**Category A**

[1] **Spetzler, B.**; Bald, C.; Durdaut, P.; Reermann, J.; Kirchhof, C.; Teplyuk, A.; Meyners, D.; Quandt, E.; Höft, M.; Schmidt, G.; Faupel, F.: Exchange biased delta-E effect enables the detection of low frequency pT magnetic fields with simultaneous localization, Scientific Reports, 11(1), (2021) 5269, doi: 10.1038/s41598-021-84415-2 (open access).

[2] Kittmann, A.; Durdaut, P.; Zabel, S.; Reermann, J.; Schmalz, J.; **Spetzler, B.**; Meyners, D.; Sun, N. X.; McCord, J.; Gerken, M.; Schmidt, G.; Höft, M.; Knöchel, R.; Faupel, F.; Quandt, E.: Wide band low noise Love wave magnetic field sensor system, Scientific Reports, 8(1), (2018) 278, doi: 10.1038/s41598-017-18441-4 (open access).

[3] Spetzler, B.; Kirchhof, C.; Reermann, J.; Durdaut, P.; Höft, M.; Schmidt, G.; Quandt, E.; Faupel, F.: Influence of the quality factor on the signal to noise ratio of magnetoelectric sensors based on the delta-E effect, Applied Physics Letters, 114(18), (2019) 183504, doi: 10.1063/1.5096001.

[4] **Spetzler, B.**; Golubeva, E. V.; Müller, C.; McCord, J.; Faupel, F.: Frequency dependency of the delta-E effect and the sensitivity of delta-E effect magnetic field sensors, Sensors, 19(21), (2019) 4769, doi:10.3390/s19214769 (open access).

[5] **Spetzler, B.**; Kirchhof, C.; Quandt, E.; McCord, J.; Faupel, F.: Magnetic sensitivity of bending-mode delta-E effect sensors, Physical Review Applied, 12(6), (2019) 064036, doi: 10.1103/PhysRevApplied.12.064036

[6] **Spetzler, B.**; Golubeva, E. V.; Friedrich, R.-M.; Zabel, S.; Kirchhof, C.; Meyners, D.; McCord, J.; Faupel, F.: Magnetoelastic coupling and delta-E effect in magnetoelectric torsion mode resonators, Sensors, 21(6), (2021) 2022, doi: 10.3390/s21062022 (open access).

[7] **Spetzler, B.**; Su, Jingxiang, Friedrich, R.-M.; Niekiel, F.; Fichtner, S.; Lofink, F.; Faupel, F.: Influence of the piezoelectric material on the signal and noise of magnetoelectric magnetic field sensors based on the delta-E effect, APL Materials, 9(3), (2021) 031108, doi: 10.1063/5.0042448 (open access).

[8] Matyushov, A. D.; **Spetzler, B.**; Zaeimbashi, M.; Zhou, J.; Qian, Z.; Golubeva, E. V.; Tu, C.; Guo, Y.; Chen, B. F.; Wang, D.; Will-Cole, A.; Chen, H.; Rinaldi, M.; McCord, J.; Faupel, F.; Sun, N. X.: Curvature and stress effects on the performance of contour-mode resonant $\Delta$E effect magnetometers, Advanced Materials Technologies, 6(9), (2021) 2100294, doi: 10.1002/admt.202100294.

[9] Lukat, N.; Friedrich, R.-M.; **Spetzler, B.**; Kirchhof, C.; Arndt, C.; Thormählen, L.; Faupel, F.; Selhuber-Unkel, C.: Mapping of magnetic nanoparticles and cells using thin film magnetoelectric sensors based on the delta-E effect, Sensors and Actuators A: Physical, 309, (2020) 112023, doi: 10.1016/j.sna.2020.112023.

[10] **Spetzler, B.**; Wiegand, P.; Durdaut, P.; Höft, M.; Bahr, A.; Rieger, R.; Faupel, F.: Modeling and parallel operation of exchange-biased delta-E effect magnetometers for sensor arrays, Sensors, 21(22), (2021) 7594, doi: 10.3390/s21227594 (open access).

**Academic Distinctions**

- 2022 INNOMAG e.V. dissertation prize of the German Physical Society (DPG) for „outstanding research as part of a doctoral thesis and their excellent communication in words and writing”
- 2022 Doctoral thesis award of the Kiel Nano, Surface and Interface Science (KiNSIS) for the best dissertation in the field of engineering
- 2018 Grant of the IEEE Magnetic Society for attending the IEEE Summer School on Magnetism at Universidad San Francisco de Quito, Quito (Equador)

**Data Protection and Consent to the Processing of Optional Data**

If you provide voluntary information (marked as optional) in this CV, your consent is required. Please confirm your consent by checking the box below.

[X] **I expressly consent to the processing of the voluntary (optional) information, including "special categories of personal data"[23] in connection with the DFG's review and decision-making process regarding my proposal.** This also includes forwarding my data to the external reviewers, committee members and, where applicable, foreign partner organisations who are involved in the decision-making process. To the extent that these recipients are located in a third country (outside the European Economic Area), I additionally consent to them being granted access to my data for the above-mentioned purposes, even though a level of data protection comparable to EU law may not be guaranteed. For this reason, compliance with the data protection principles of EU law is not guaranteed in such cases. In this respect, there may be a violation of my fundamental rights and freedoms and resulting damages. This may make it more difficult for me to assert my rights under the General Data Protection Regulation (e.g. information, rectification, erasure, compensation) and, if necessary, to enforce these rights with the help of authorities or in court.

I may **revoke** my consent in whole or in part at any time – with effect for the future, freely and without giving reasons – vis-à-vis the DFG (postmaster@dfg.de). The lawfulness of the processing carried out up to that point remains unaffected. Insofar as I transmit "special categories of personal data" relating to third parties, I confirm that the necessary legitimation under data protection law exists (e.g. based on consent).

I have taken note of the DFG's Data Protection Notice relating to research funding, which I can access at www.dfg.de/privacy policy and I will forward it to such persons whose data the DFG processes as a result of being mentioned in this CV.

[23] Special categories of personal data are those "revealing racial or ethnic origin, political opinions, religious or philosophical beliefs, or trade union membership, and (...) genetic data, biometric data for the purpose of uniquely identifying a natural person, data concerning health or data concerning a natural person's sex life or sexual orientation" (Article 9(1) GDPR).

**Wulfinghoff, Stephan, Prof. Dr.**

**Personal Data**

| Title, Name, Position, Institution, and ORCID | |
|---|---|
| Title | Prof. Dr.-Ing. |
| First name | Stephan |
| Name | Wulfinghoff |
| Current position | Professor (W2) |
| Current institution(s)/site(s), country | Kiel University, Germany |
| Identifiers/ORCID | 0009-0002-4929-7768 |

**Qualifications and Career**

| Stages | Periods and Details |
|---|---|
| Degree programme | 2003-2008 Studies of theoretical mechanical engineering, Universität Karlsruhe (TH), Germany |
| Doctorate | 2014 Prof. Böhlke, Karlsruher Institute of Technology, Germany |
| Stages of academic/professional career | Since 2018 Professor (W2) for "Computational Material Science" at the Faculty of Engineering of the CAU Kiel<br>2015 - 2018 Junior Research Group Leader at Aachen Institute for Advanced Study in Computational Engineering Science (AICES)<br>2014 - 2018 Chief Engineer and Group Leader, Institute of Applied Mechanics (Prof. Reese) at the Faculty of Civil Engineering of RWTH Aachen<br>2009 - 2014 Scientific assistant at the Institute of Engineering Mechanics at the Faculty of Mechanical Engineering of Karlsruher Institute für Technologie |

**Supplementary Career Information**

11/2022-03/2023 part-time parental leave (50%), 4 months

**Engagement in the Research System**

- Member program committee of DFG-priority program SPP 2206, "Cooperative Multistage Multistable Microactuator Systems" (since 2021)
- Member of NFDI-MatWerk – National Research Data Infrastructure for Materials Science & Engineering (since 2021)
- Representative Member of Convention at the Technical Faculty at Christian-Albrechts-University zu Kiel (since 2020)
- Member of KiNSIS –Kiel Nano, Surface and Interface Science at Christian-Albrechts-Universität zu Kiel (since 2019)

**Scientific Results**

**Category A**

[1] Dorn, C.; **Wulfinghoff, S.**: A Magneto-Mechanically Coupled Material Model for Magnetic Sensor Investigation, Proc. Appl. Math. Mech., 22 (1), (2023), doi: 10.1002/pamm.202200008 (open access)

[2] Dorn, C.; **Wulfinghoff, S.**: Computational Micro-Magneto-Mechanics – Application to Thin Film Composites, ECCOMAS Congress 2022, (2023), doi: 10.23967/eccomas.2022.068 (open access)

[3] Dorn, C.; **Wulfinghoff, S.**: Computing Magnetic Noise with Micro-Magneto-Mechanical Simulations, IEEE Transaction on Magnetics, 59 (2), (2023) 1-4, doi: 10.1109/TMAG.2022.3212764

[4] Sielenkämper, M.; **Wulfinghoff, S.**: A thermomechanical finite strain shape memory alloy model and its application to bistable actuators, Acta Mech, 233, (2022) 3059-3094, doi 10.1007/s00707-022-03236-0 (open access).

[5] **Wulfinghoff, S.**; Cavaliere, F.; Reese, S.: Model order reduction of nonlinear homogenization problems using a Hashin-Shtrikman type finite element method, Comp. Method. Appl. M., 330, (2018) 149-179, doi: 10.1016/j.cma.2017.10.019

[6] **Wulfinghoff, S.**; Fassin, M.; Reese, S.: A damage growth criterion for anisotropic damage models motivated from micromechanics, Int. J. Sol. Struc., 121, (2017) 21-32, doi 10.1016/j.ijsolstr.2017.04.038 (open access)

[7] Kilicar, Y.; Vladimirov, I.N.; **Wulfinghoff, S.**; Reese, S.; Demir, O.K.; Weddeling, C.; Tekkaya, A.E.; Engelhardt, M.; Klose, C.; Maier, H.J.; Rozgić, M.; Stiemer, M.: Finite element analysis of combined forming processes by means of rate dependent ductile damage modelling, Int. J. Mater. Form., 10, (2017) 73-84, doi: 10.1007/s12289-015-1278-z

[8] Kilicar, Y.; Demir, O.K.; Engelhardt, M.; Rozgić, M.; Vladimirov, I.N.; **Wulfinghoff, S.**; Weddeling, C.; Gies, S.; Klose, C.; Reese, S.; Tekkaya, A.E.; Maier, H.J.; Stiemer, M.: Experimental and numerical investigation of increased formability in combined quasi-static and high-speed forming processes, J. Mater. Process. Tech., 237, (2016) 254-269, doi: 10.1016/j.jmatprotec.2016.06.007

[9] Kochmann, J.; **Wulfinghoff, S.**; Reese, S.; Mianroodi, J.R.; Svendsen, B.: Two-scale FE-FFT- and phase-field-based computational modeling of bulk microstructural evolution and macroscopic material behaviour, Comp. Method. Appl. M., 305, (2016) 89-110, doi: 10.1016/j.cma.2016.03.001

[10] **Wulfinghoff, S.**; Bayerschen, E.; Böhlke, T.: A gradient plasticity grain boundary yield theory, Int. J. Plast., 51, (2013) 33-46, doi 10.1016/j.ijplas.2013.07.001

**Academic Distinctions**

- 2016 Theodore von Kármán Fellowship for research stay (2 months) at University of Pennsylvania (Prof. Ponte-Castañeda) as part of excellence initiative at RWTH Aachen
- 2016 RWTH-Start Up as part of excellence initiative at RWTH Aachen for “Computational Methods for Microscale Plasticity”
- 2009 Redtenbacher-Price at University Karlsruhe (TH) for best diploma at faculty of mechanical engineering

- 2007 Strömungsmechanik-Preis for best student work at faculty of fluid mechanics

**Data Protection and Consent to the Processing of Optional Data**

If you provide voluntary information (marked as optional) in this CV, your consent is required. Please confirm your consent by checking the box below.

[X] **I expressly consent to the processing of the voluntary (optional) information, including "special categories of personal data"[1] in connection with the DFG's review and decision-making process regarding my proposal.** This also includes forwarding my data to the external reviewers, committee members and, where applicable, foreign partner organisations who are involved in the decision-making process. To the extent that these recipients are located in a third country (outside the European Economic Area), I additionally consent to them being granted access to my data for the above-mentioned purposes, even though a level of data protection comparable to EU law may not be guaranteed. For this reason, compliance with the data protection principles of EU law is not guaranteed in such cases. In this respect, there may be a violation of my fundamental rights and freedoms and resulting damages. This may make it more difficult for me to assert my rights under the General Data Protection Regulation (e.g. information, rectification, erasure, compensation) and, if necessary, to enforce these rights with the help of authorities or in court.

I may **revoke** my consent in whole or in part at any time – with effect for the future, freely and without giving reasons – vis-à-vis the DFG (postmaster@dfg.de). The lawfulness of the processing carried out up to that point remains unaffected. Insofar as I transmit "special categories of personal data" relating to third parties, I confirm that the necessary legitimation under data protection law exists (e.g. based on consent).

I have taken note of the DFG's Data Protection Notice relating to research funding, which I can access at www.dfg.de/privacy_policy and I will forward it to such persons whose data the DFG processes as a result of being mentioned in this CV.

[1] Special categories of personal data are those "revealing racial or ethnic origin, political opinions, religious or philosophical beliefs, or trade union membership, and (...) genetic data, biometric data for the purpose of uniquely identifying a natural person, data concerning health or data concerning a natural person's sex life or sexual orientation" (Article 9(1) GDPR).

## 4. External Scientists – Cooperation Partners of the Last Three Years

### A1: McCord / Meyners

| Name | Institution |
|---|---|
| Berger, Andreas, Dr. | nanoGUNE, San Sebastian, Spain |
| Cardoso de Freitas, Susana, Prof. Dr. | INESC Microsistemas e Nanotecnologias, Lisbon, Portugal |
| van Dijken, Sebastiaan, Prof. Dr. | Aalto University, Aalto, Finland |
| Fassbender, Jürgen, Prof. Dr. | HZDR, Dresden, Germany |
| González, Jesús, Prof. Dr. | ICMM, Madrid, Spain |
| Kersten, Holger, Prof. Dr. | Christian-Albrechts-Universität zu Kiel, Kiel, Germany |
| Kläui, Mathias, Prof. Dr. | Universität Mainz, Mainz, Germany |
| Makarov, Denys, Prof. Dr. | HZDR, Dresden, Germany |
| Lopez-Diaz, Luis, Prof. Dr. | University of Salamanca, Salamanca, Spain |
| Münzenberg, Markus, Prof. Dr. | Universität Greifswald, Greifswald, Germany |
| Munnik, Frans, Dr. | HZDR, Dresden, Germany |
| Padmore, Howard, Dr. | ALS, Berkeley, USA |
| Podgornik, Bojan, Dr. | IMT, Ljubljana, Slowenia |
| Ravelosona, Dauphine, Dr. | CNRS, Université Paris-Saclay, Paris, France |
| Rohwerder, Michael, Dr. | MPIE, Düsseldorf, Germany |
| Schäfer, Rudolf, Prof. Dr. | IFW Dresden, Dresden, Germany |
| Sun, Nian X., Prof. Dr. | Northeastern University, Boston, USA |
| Varga, Rastislav, Prof. Dr. | Safarik University, Kosice, Slovakia |
| Thiaville, André, Dr. | University Paris-Sud, Orsay, France |

### A2: Adelung / Ameri / Schröder

| Name | Institution |
|---|---|
| Calzolari, Arrigo, Dr. | CNR Istituto Nanoscienze, Modena, Italy |

### A4: Rieger / Spetzler

| Name | Institution |
|---|---|
| Calzolari, Arrigo, Dr. | CNR Istituto Nanoscienze, Modena, Italy |
| Cash, Sydney, Dr. | Massachusetts General Hospital, USA |
| Dy, Jennifer, Prof. Dr. | Northeastern University, USA |
| Emam, Shadi, Dr. | Northeastern University, USA |
| Farrell, Patricio, Dr. | WIAS, Berlin, Germany |
| Ferreira Da Costa, Maxime, Dr. | University of Southern California, USA |
| Hennig, Eckhard, Prof. Dr. | University of Reutlingen, Germany |
| Hersam, Mark, Prof. Dr. | Northwestern University, Evanston, USA |
| Kahmen, Gerhard, Prof. Dr. | IHP Leibniz Institut für innovative Mikroelektronik, Germany |
| Kuhtz-Buschbeck, Johann, Prof. Dr. | University Hospital Schleswig-Holstein, |

| | |
|---|---|
| | Germany |
| Li, Yiahe, Dr. | Northeastern University, USA |
| Luban, Jeremy, Prof. Dr. | University of Massachusetts, USA |
| Margraf, Nils G., PD Dr. | University Hospital Schleswig-Holstein, Germany |
| Menzel, Stephan, Dr. | Forschungszentrum Jülich, Jülich, Germany |
| Mitra, Urbashi, Prof. Dr. | University of Southern California, USA |
| Nasrollapour, Mehdi, Dr. | Northeastern University, USA |
| Ochs, Karlheinz, Prof. Dr. | Ruhr-University Bochum, Germany |
| Pagsuyoin, Sheree, Prof. Dr. | University of Massachusetts, USA. |
| Rinaldi, Matteo, Prof. Dr. | Northeastern University, Boston, USA |
| Robbins, Gregory, Dr. | Massachusetts General Hospital, USA |
| Rojjanapinun, Akarapan, Dr. | University of Massachusetts, USA |
| Rubiola, Enrico, Prof. Dr. | Université de Franche Comté, Besancon, France |
| Shi, Xiaoling, Dr. | Winchester Technologies LLC, USA |
| Sun, Nian X., Prof. Dr. | Northeastern University, USA |
| Sun, Xin, Dr. | Northeastern University, USA |
| Taylor, John, Prof. Dr. | University of Bath, U.K. |
| Wang, Jennifer, Prof. Dr. | University of Massachusetts, USA |
| Wenger, Christian, Prof. Dr. | IHP, Frankfurt (Oder), Germany |
| Zulqarnain, Khan, Dr. | Northeastern University, USA |

**A6: Kienle / Murphy**

| Name | Institution |
|---|---|
| Ambacher, Oliver, Prof. Dr. | Universität Freiburg, Germany |
| Barcikowski, Stephan, Prof. Dr. | Universität Duisburg-Essen, Germany |
| Davydok, Anton, Prof. Dr. | Hereon, Germany |
| Johnson, Dave, Prof. Dr. | University of Oregon, USA |
| Koch, Christoph, Prof. Dr. | HU Berlin, Germany |
| Krywka, Christina, Dr. | Hereon, Germany |
| Kübel, Christian, Prof. Dr. | Technische Universität Darmstadt and KIT, Germany |
| Maldonado, Stephen, Prof. Dr. | University of Michigan, USA |
| Ocko, Ben, Prof. Dr. | Brookhaven National Laboratory, USA |
| Popescu, Radian, Dr. | Universität Karlsruhe, Germany |
| Rübhausen, Matthias, Prof. Dr. | TU Hamburg-Harburg, Germany |
| Schreiber, Frank, Prof. Dr. | Universität Tübingen, Germany |
| Shpyrko, O. G., Prof. Dr. | University of California, San Diego, USA |
| Sprung, Michael, Prof. Dr. | DESY, Germany |
| Thompson, Paul, Prof. Dr. | European Synchrotron Radiation Facility, France |
| Weber, Frank, Prof. Dr. | Universität Karlsruhe, Germany |

**A7: Quandt**

| Name | Institution |
|---|---|
| Abshagen, Jan, Dr. | WTD 71, Eckernförde, Germany |
| Budhani, Ramseh C., Prof. Dr. | Morgan State University, Baltimore, USA |
| Greer, Julia R., Prof. | Caltech, Pasadena, USA |
| Gunnæs, Anette E., Prof. | University of Oslo, Oslo, Norway |
| Jalan, Bharat, Prof. | University of Minnesota, Minneapolis, USA |
| James, David, Prof. | University of Minnesota, Minneapolis, USA |
| Kohl, Manfred, Prof. Dr. | KIT, Karlsruhe, Germany |
| Lanceros-Méndez, Senentxu, Prof. | Universidade do Minho, Braga, Portugal |
| Lazarus, Nathan, Prof. | University of Delaware, Newark, DE, USA |
| Lima de Miranda, Rodrigo, Dr. | Acquandas GmbH, Kiel, Germany |
| Martins, Paulo, Prof. | Universidade do Minho, Braga, Portugal |
| Medarde, Maria Luisa, Dr. | Paul Scherrer Institute, Villigen, Switzerland |
| Mönch, Stefan, Dr. | Fraunhofer-Institut für Angewandte Festkörperphysik IAF, Freiburg, Germany |
| Page, Michael R., Dr. | Air Force Research Laboratory, Wright-Patterson Air Force Base, USA |
| Plucinsky, Paul, Prof. | University of Southern California, Los Angeles, USA |
| Priya, Shashank, Prof. | University of Minnesota, Minneapolis, USA |
| Seemann, Klaus, Dr. | KIT, Karlsruhe, Germany |
| Srinivasan, Gopalan, Prof. | Oakland University, Rochester, USA |
| Sun, Nian, Prof. Dr. | Northeastern University, Boston, MA, USA |
| Ulrich, Anne S., Prof. | KIT, Karlsruhe, Germany |
| van Dijken, Sebastiaan, Prof. | Aalto University School of Science, Aalto, Finland |
| Zukauskaite, Agne, Dr. | Fraunhofer-Institut für Angewandte Festkörperphysik IAF, Freiburg, Germany |

**A8: Gerken**

| Name | Institution |
|---|---|
| Condorelli, Gerolama, Prof. Dr. | University of Naples “Federico II”, Italy |
| De La Rue, Richard, Prof. Dr. | University of Glasgow, U.K. |
| Fiutowsk, Jacek, Prof. Dr. | University of Southern Denmark, Denmark |
| Gams, Matjaz, Prof. Dr. | Jozef Stefan Institute, Slovenia |
| Hajjaji, Nawale, Dr. | Oscar Lambret Cancer Center, France |
| Hallil, Hamida, Dr. | University of Bordeaux, France |
| Heidari, Hadi, Dr. | University of Glasgow, U.K. |
| Herzig, Hans Peter, Prof. Dr. | EPFL Lausanne, Switzerland |
| Horvath, Robert, Prof. Dr. | Hungarian Academy of Sciences, Hungary |
| Hosseini, Ensieh, Dr. | Durham University, U.K. |
| Kunstmann, Casper, Prof. Dr. | University of Southern Denmark, Denmark |
| Lefeuvre, Elie, Prof. Dr. | University of Saclay, France |
| Leissner, Till, Prof. Dr. | University of Southern Denmark, Denmark |

| | |
|---|---|
| Lindvold, Lars, Prof. Dr. | DTU, Denmark |
| Madsen, Morten, Prof. Dr. | University of Southern Denmark, Denmark |
| Nazarpour, Kianoush, Prof. Dr. | Newcastle University, Newcastle upon Tyne, U.K. |
| Quintavalle, Cristina, Dr. | Centro Nazionale delle Ricerche, Italy |
| Rahlves, Maik, Prof. Dr. | Universität Lübeck, Germany |
| Rubahn, Horst-Günter, Prof. Dr. | University of Southern Denmark, Denmark |
| Salzet, Michel, Prof. Dr. | University of Lille, France |
| Talbi, Abdelkrim Prof. Dr. | Universités Centrale Lille, France |
| Trerotola, Marco, Prof. Dr. | University of Chieti-Pescara, Italy |

### A9: Quandt / Lofink

| Name | Institution |
|---|---|
| Calzolari, Arrigo, Dr. | CNR Istituto Nanoscienze, Modena, Italy |

### A10: McCord / Wulfinghoff

| Name | Institution |
|---|---|
| Calzolari, Arrigo, Dr. | CNR Istituto Nanoscienze, Modena, Italy |

### B1: Höft / Rieger

| Name | Institution |
|---|---|
| Calzolari, Arrigo, Dr. | CNR Istituto Nanoscienze, Modena, Italy |

### B2: Bergholz, Ellrichman, Schmidt

| Name | Institution |
|---|---|
| Abshagen, Jan, Dr. | WTD71, Germany |
| Abut, Hüseyin, Prof. Dr. | San Diego State University, CA, USA |
| Arlt, Alexander, Prof. Dr. | University Hospital Oldenburg, Oldenburg, Germany |
| Christensen, Sören, Prof. Dr. | Kiel University, Germany |
| Dössel, Olaf, Prof. Dr. | Karlsruhe Institute of Technology, Germany |
| Hansen, John H. L., Prof. Dr. | University of Texas, Dallas, USA |
| Heidari, Hady, Prof. Dr. | University of Glasgow, Scotland |
| Huber, Robert, Prof. Dr. | Institute Biomedical Optics, University Lübeck, Lübeck, Germany |
| Krebs, Thomas Franz, Dr. med. | Ostschweizer Kinderspital, St. Gallen, Switzerland |
| Lambert, Jacob, Dr. | Nagoya University, Japan |
| Meledeth, Christy, Dr. | Kepler University Hospital Linz, Austria |
| Metzger, Florian, Prof. Dr. | University of Tübingen, Germany |
| Oronzco Arroyave, Juan Rafrael, Prof. Dr. | University of Antioquia, Colombia |

| | |
|---|---|
| Repici, Alessandro, Prof. Dr. | Humanitas University Medical School, Milano, Italy |
| Rösch, Thomas, Prof. Dr. | University Clinic Hamburg-Eppendorf, Hamburg, Germany |
| Sander-Thömmes, Tilmann, Dr. | PTB, Berlin, Germany |
| Schilling, Meinhard, Prof. Dr. | Technische Universität Braunschweig, Germany |
| Schulte-Mattler, Wilhelm, Prof. Dr. | University of Regensburg, Germany |
| Sun, Nian, Prof. Dr. | Northeastern University, Boston, MA, USA |
| Takeda, Kazuya, Prof. Dr. | Nagoya University, Japan |
| von Thaler, Anna-Katharina, Dr. | University Hospital of Tübingen, Germany |
| Zimmermann, Milan, Dr. | University of Tübingen, Germany |

**B10: Frey, Schmidt**

| Name | Institution |
|---|---|
| Abshagen, Jan, Dr. | WTD71, Germany |
| Abut, Hüseyin, Prof. Dr. | San Diego State University, CA, USA |
| Bauersachs, Johann, Prof. Dr. | Hannover Medical School, Germany |
| Christensen, Sören, Prof. Dr. | Kiel University, Germany |
| Dössel, Olaf, Prof. Dr. | Karlsruhe Institute of Technology, Germany |
| Friedrich, Matthias, Prof. Dr. | McGill University, Montreal, Canada |
| Graf, Markus, Prof. Dr. | Heilbronn University of Applied Sciences, Germany |
| Hansen, John H. L., Prof. Dr. | University of Texas, Dallas, USA |
| Heidari, Hady, Prof. Dr. | University of Glasgow, Scotland |
| Kelm, Malte, Prof. Dr. | University of Düsseldorf, Germany |
| Kirchhoff, Paulus, Prof. Dr. | University of Hamburg, Germany |
| Krebs, Thomas Franz, Dr. med. | Ostschweizer Kinderspital, St. Gallen, Switzerland |
| Lambert, Jacob, Dr. | Nagoya University, Japan |
| Meledeth, Christy, Dr. | Kepler University Hospital Linz, Austria |
| Metzger, Florian, Prof. Dr. | University of Tübingen, Germany |
| Olson, Eric N, Prof. Dr. | UTSW, Dallas, TX, USA |
| Oronzco Arroyave, Juan Rafrael, Prof. Dr. | University of Antioquia, Colombia |
| Sander-Thömmes, Tilmann, Dr. | PTB, Berlin, Germany |
| Schilling, Meinhard, Prof. Dr. | Technische Universität Braunschweig, Germany |
| Schulte-Mattler, Wilhelm, Prof. Dr. | University of Regensburg, Germany |
| Sun, Nian, Prof. Dr. | Northeastern University, Boston, MA, USA |
| Takeda, Kazuya, Prof. Dr. | Nagoya University, Japan |
| von Thaler, Anna-Katharina, Dr. | University Hospital of Tübingen, Germany |
| Thiele, Holger, Prof. Dr. | University of Leipzig, Germany |
| Zimmermann, Milan, Dr. | University of Tübingen, Germany |

**B11(N): Bergholz, Schmidt**

| Name | Institution |
|---|---|

| | |
|---|---|
| Abshagen, Jan, Dr. | WTD71, Germany |
| Abut, Hüseyin, Prof. Dr. | San Diego State University, CA, USA |
| Christensen, Sören, Prof. Dr. | Kiel University, Germany |
| Dössel, Olaf, Prof. Dr. | Karlsruhe Institute of Technology, Germany |
| Hansen, John H. L., Prof. Dr. | University of Texas, Dallas, USA |
| Heidari, Hady, Prof. Dr. | University of Glasgow, Scotland |
| Krebs, Thomas Franz, Dr. med. | Ostschweizer Kinderspital, St. Gallen, Switzerland |
| Lambert, Jacob, Dr. | Nagoya University, Japan |
| Meledeth, Christy, Dr. | Kepler University Hospital Linz, Austria |
| Metzger, Florian, Prof. Dr. | University of Tübingen, Germany |
| Oronzco Arroyave, Juan Rafrael, Prof. Dr. | University of Antioquia, Colombia |
| Sander-Thömmes, Tilmann, Dr. | PTB, Berlin, Germany |
| Schilling, Meinhard, Prof. Dr. | Technische Universität Braunschweig, Germany |
| Schulte-Mattler, Wilhelm, Prof. Dr. | University of Regensburg, Germany |
| Sun, Nian, Prof. Dr. | Northeastern University, Boston, MA, USA |
| Takeda, Kazuya, Prof. Dr. | Nagoya University, Japan |
| von Thaler, Anna-Katharina, Dr. | University Hospital of Tübingen, Germany |
| Zimmermann, Milan, Dr. | University of Tübingen, Germany |

**B12(N): Altintas, Gerken, Gundlach**

| **Name** | **Institution** |
|---|---|
| Arlt, Alexander, Prof. Dr. | Klinikum Oldenburg AöR, Germany |
| Barrio, Pablo, Dr. | Clinic Hospital, Barcelona, Spain |
| Biedermann, Frank, Dr. | Karlsruhe Institute of Technology, Germany |
| Bölter, Nico, Dr. | Technical University Munich, Germany |
| Haupt, Karsten, Prof. Dr. | Université de Technologie de Compiègn, France |
| Elbuken, Caglar, Prof. Dr. | University of Oulu, Finland |
| Marrazza, Giovanni, Prof. Dr. | University of Florence, Italy |
| Meinhardt, Christian, Dr. | Klinikum Oldenburg AöR, Germany |
| Merkoci, Arben, Prof. Dr. | ICN2 Barcelona, Spain |
| Nitsche, Andreas, Prof. Dr. | Robert Koch Institute, Germany |
| Osterrieder, Klaus, Prof. Dr. | Frei University of Berlin, Germany |
| Piletsky, Sergey, Prof. Dr. | University of Leicester, the UK |
| Schmitt, Clemens, Prof. Dr. | Charité – Berlin University of Medicine, Germany |
| Schneeweis, Christian, M.Sc. | Technical University Munich, Germany |
| Schneider, Günter, Prof. Dr. | University Medical Center Göttingen, Germany |
| Schomäcker, Reinhard, Prof. Dr. | Technical University of Berlin, Germany |
| Schröck, Alexandra, Dr. | Kantonsspital Aarau, Switzerland |
| Schwarz, Karin, Prof. Dr. | Kiel University, Germany |
| Süssmuth, Roderich, Prof. Dr. | Technical University of Berlin, Germany |
| Weinmann, Wolfgang, Prof. Dr. | University of Bern, Switzerland |
| Wurst, Friedrich Martin, Prof. Dr. | University of Basel, Switzerland |

| | |
|---|---|
| Yegles, Michel, Prof. Dr. | Forensic Toxicology, Dudelange, Luxembourg |

### B13(N): Ellrichmann / Lofink

| Name | Institution |
|---|---|
| Calzolari, Arrigo, Dr. | CNR Istituto Nanoscienze, Modena, Italy |

### SOP: Enzingmüller / Parchmann

| Name | Institution |
|---|---|
| Calzolari, Arrigo, Dr. | CNR Istituto Nanoscienze, Modena, Italy |

### IRTG: Gerken / Maetzler / McCord

| Name | Institution |
|---|---|
| Calzolari, Arrigo, Dr. | CNR Istituto Nanoscienze, Modena, Italy |

### Z1: Meyners / Godjka

| Name | Institution |
|---|---|
| Calzolari, Arrigo, Dr. | CNR Istituto Nanoscienze, Modena, Italy |

### Z2: Höft / Rieger

| Name | Institution |
|---|---|
| Calzolari, Arrigo, Dr. | CNR Istituto Nanoscienze, Modena, Italy |

**SOP: Enzigmüller, Parchmann**

| Name | Institution |
|---|---|
| Baram-Tsabari, Ayelet, Prof. Dr. | Technion, Israel |
| Barel-Ben David, Yael, Dr. | Technion, Israel |
| Blonder, Ron, Prof. Dr. | Weizmann Institute of Science, Rehovot, Israel |
| Bosch, Thomas, Prof. Dr. | CAU Kiel, Germany |
| Duscher, Tom, Prof. Dr. | Muthesius Kunsthochschule, Kiel, Germany |
| Hendriks, Friederike, Dr. | Technische Universität Braunschweig, Germany |
| Jeffrey, Nordine, , Prof. Dr. | University of Iowa, USA |
| Kremer, Kerstin, Prof. Dr. | Justus-Liebig-Universität Gießen, Germany |
| Laumann, Daniel, Dr. | Westfälische Wilhelms-Universität Münster, Germany |
| Menthe, Jürgen, Prof. Dr. | Universität Hildesheim, Germany |
| Nehring, Andreas, Prof. Dr. | Leibniz Universität Hannover, Germany |
| Priemer, Burkhard, Prof. Dr. | HU Berlin, Germany |
| Schulenburg, Hinrich, Prof. Dr. | CAU Kiel, Germany |
| Schwarzer, Stefan, Prof. Dr. | Eberhard-Karls-Universität Tübingen, Germany |
| Sommer, Katrin, Prof. Dr. | Ruhr-Universität Bochum, Germany |
| Storksdiek, Martin | Oregon State University, USA |
| Wilcke, Timm, Prof. Dr. | Universität Jena, Germany |

# 5. Expected Financial Requirements from 2024 until 2028

## 5.1 Yearly expenses of all Projects for staff, material expenses and investments

### Yearly expenses of all Projects for staff, material expenses and investments

| | 2024/2 | 2025 | 2026 | 2027 | 2028/1 | Sum |
|---|---|---|---|---|---|---|
| **Staff appropriations** | | | | | | |
| **Material expenses** | | | | | | |
| **Investments** | | | | | | |
| **Sum** | | | | | | |

### Itemized List of Larger Equipment (>50.000 EUR)

| Description of Equipment | Year of acquisition | Expected purchasing prize |
|---|---|---|
| | | |

All sums in Euro