

# Focus Specialization in Micro- und Nanosystems Technologie

**Focus-Coordinator:**  
Prof. Christofer Hierold  
Micro and Nanosystems

May 21<sup>st</sup>, 2024

# Micro- und Nanosystems Technologie everywhere

## Function, Performance, Health and Sustainability



<https://www.nextpit.de/die-besten-smartwatches-2020>



<https://www.nextpit.de/bester-smart-ring-vergleich>



<https://www.rolandberger.com/en/Insights/Publications/Humanoid-robots-From-science-fiction-to-reality.html>



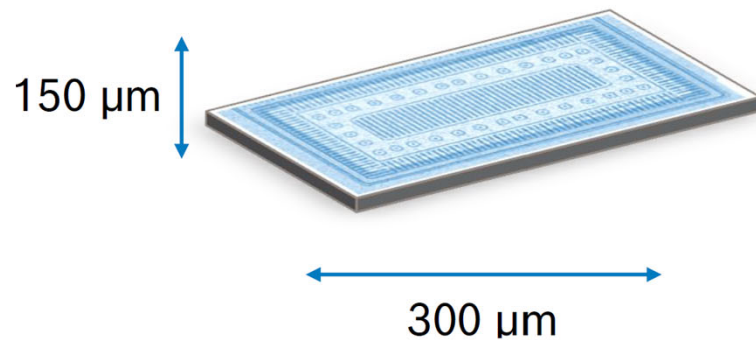
<https://atomica.com/mems-automotive-sensors-drive-the-future-of-mobility/>

# Micro- und Nanosystems Technologie everywhere

## Function, **Performance**, Health and Sustainability

### Pressure Sensor

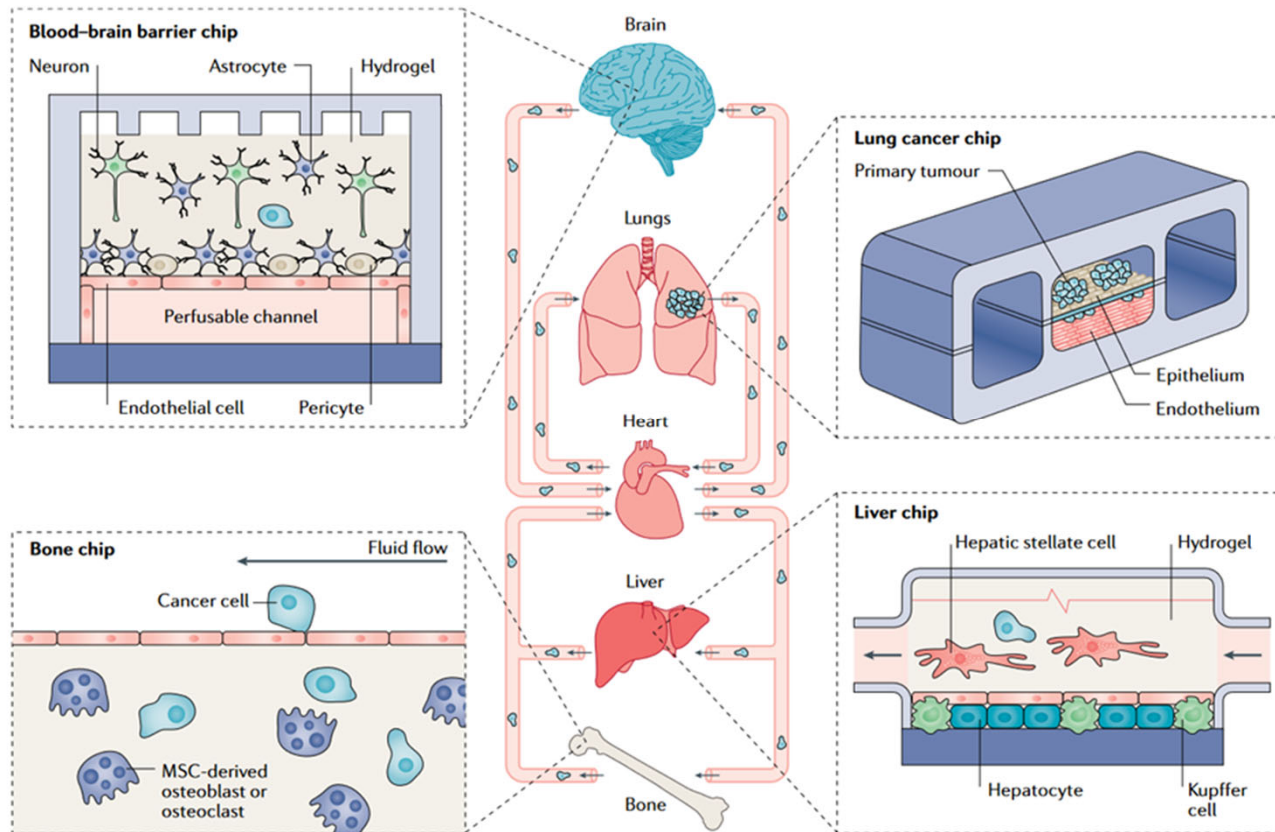
- Resolution: 0.01hPa



Courtesy of Bosch, Stefan Finkbeiner

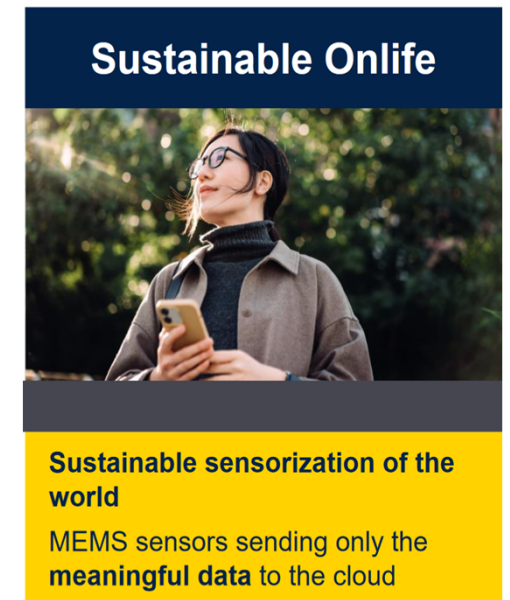
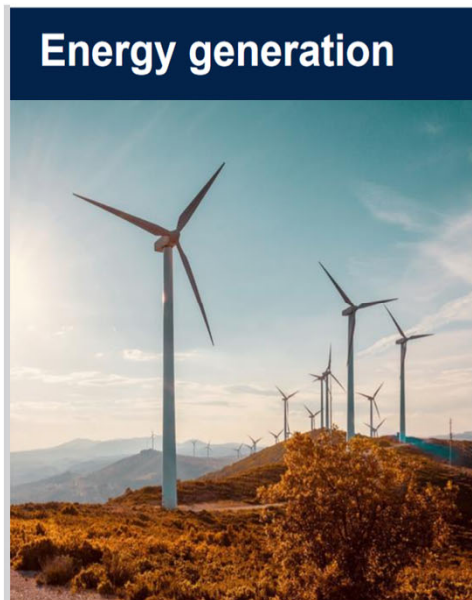
- Overload condition: 100,000hPa
- Range: 7 orders of magnitude

# Micro- und Nanosystems Technologie everywhere Function, Performance, **Health** and Sustainability



Sontheimer-Phelps et al., *Modelling cancer in microfluidic human organs-on-chip*, Nature Reviews Cancer, 2019

# Micro- und Nanosystems Technologie everywhere Function, Performance, Health and **Sustainability**



<https://www.st.com/content/dam/AME/2023/sensors-converge-2023/pdf/sensors-converge-23-sustainable-onlife-keynote-angelici.pdf>

# Automotive Applications

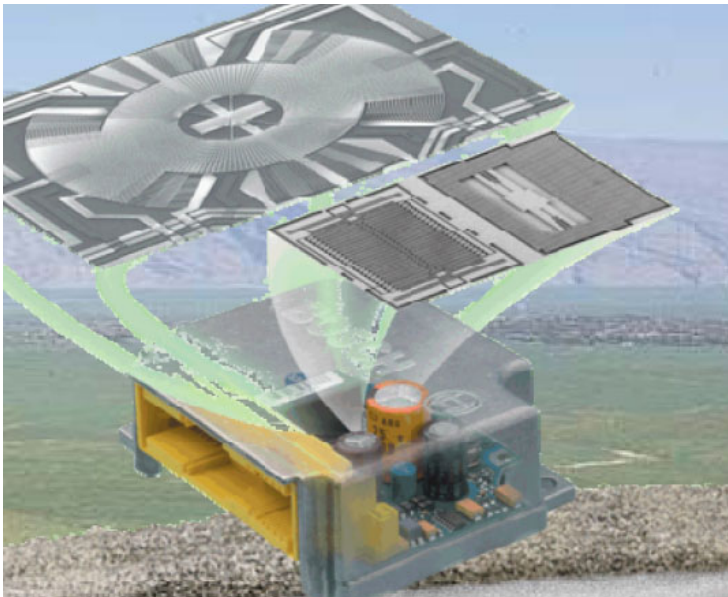


*Courtesy of Dr. Franz Lärmer  
Robert Bosch GmbH*

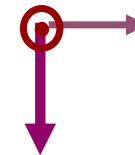


# Coriolis Force

Micromachined resonant sensors exploiting the Coriolis force are mainly used for angular rate sensing (gyroscopes)



$$\vec{F}_s = 2m \vec{v} \times \vec{\Omega}$$



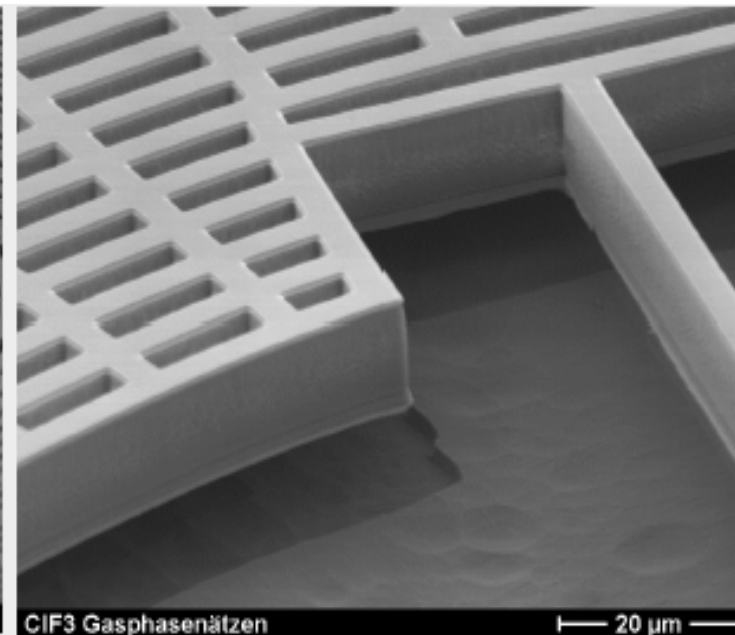
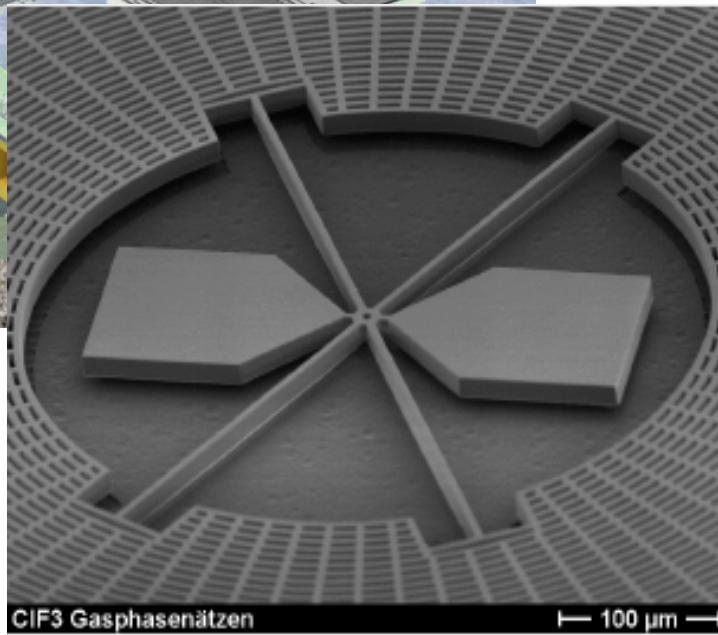
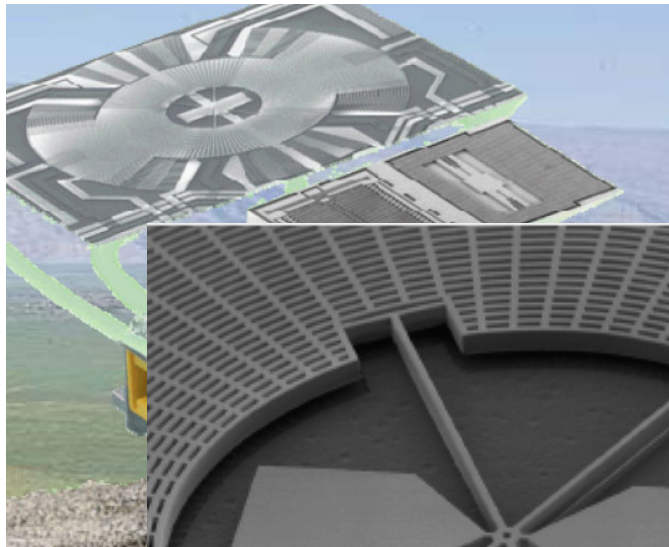
$F_s$ : Coriolis Force

$\Omega$ : Angular rate / yaw rate of the car

$m$ : seismic mass

$v$ : movement of the seismic mass

# Technology for Safety: Sensors, Microsystems or MEMS



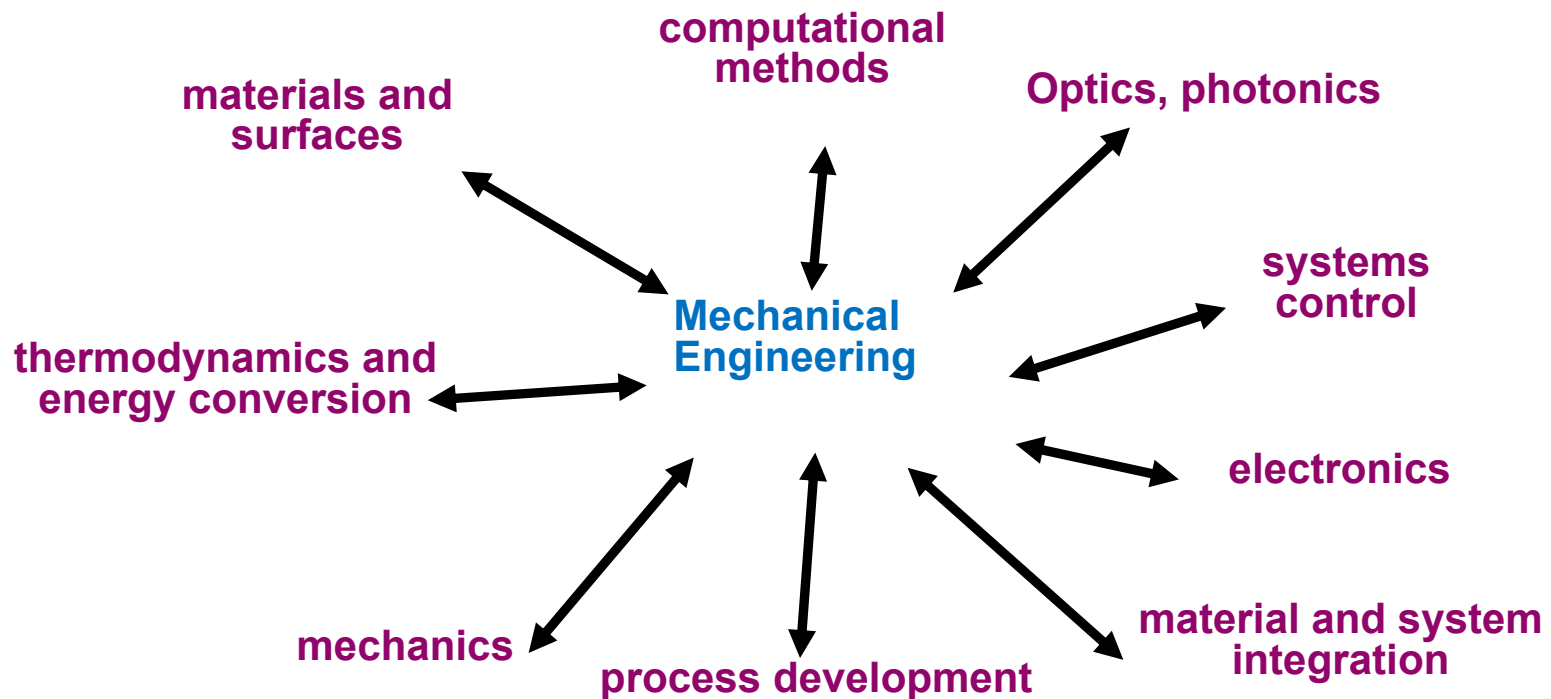


# Micro- und Nanosystems Technologie – Curriculum

LE-Nummer	LE-Titel	Dozierende	Kreditpunkte	Remarks
151-0621-00L	Microsystems I: Process Technology and Integration	HALUSKA Miroslav (H), HIEROLD Christofer (H)	6	
151-0509-00L	Acoustics in Fluid Media: From Robotics to Additive Manufacturing	AHMED Daniel (H)	4	
151-0604-00L	Microrobotics	NELSON Bradley (H)	4	
151-0643-00L	Studies on Micro and Nano Systems		5	
151-0913-00L	Introduction to Photonics	QUIDANT Romain (H), ORTEGA ARROYO Jaime	4	
151-0941-00L	Molecular Health Sensors and Devices	GÜNTNER Andreas (H), GERBER Philipp	4	
227-0145-00L	Solid State Electronics and Optics Information	N. Yazdani, V. Wood	6	NEW
401-0625-01L	Applied Analysis of Variance and Experimental Design	L. Meier	5	NEW
151-0643-00L	Studies on Micro and Nano Systems		5	
151-0172-00L	Microsystems II: Devices and Applications	HIEROLD Christofer (H), ROMAN Cosmin Ioan (H)	6	
151-0540-00L	Experimental Mechanics	CARRARA Pietro (H)	4	
151-0630-00L	Nanorobotics	PANÉ VIDAL Salvador (H)	4	
151-0946-00L	Macromolecular Engineering: Networks and Gels	TIBBITT Mark (H)	4	
151-0952-00L	Nanophotonics: from Fundamentals to Applications	NORRIS David J. (H), QUIDANT Romain (H)	4	

# Micro- und Nanosystems Technologie @ D-MAVT

## Follows an interdisciplinary engineering approach



# Why is an inter-disciplinary education in micro and nanosystems for engineers of great relevance?

... was Sie als Mikrosystemtechniker für uns interessant macht ist die Fähigkeit, auf Systemebene Probleme zu lösen. Dabei müssen vielfach mechanische, elektrotechnische, materialspezifische und viele andere physikalische Effekte berücksichtigt werden.

singgemäß nach ....

Hr. Christoph Tietz, Leiter Platform Engineering,  
Bombardier Transportation AG, Schweiz,  
anlässlich eines Vorstellungsgesprächs

# Micro- und Nanosystems Technologie at D-MAVT

## Professors in D-MAVT

- Daniel Ahmed
- Andreas Güntner
- Inge Herrmann
- Christofer Hierold
- Robert Katzschmann
- Dennis Kochmann
- Brad Nelson
- David Norris
- Salvador Pané i Vidal
- Romain Quidant
- Mark Tibbitt



# Prof. Daniel Ahmed

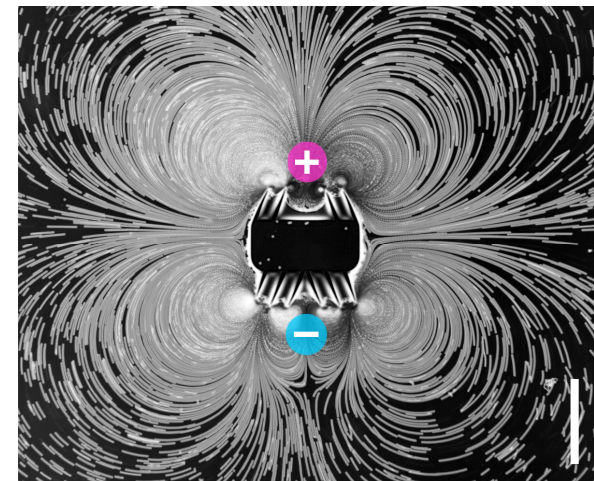
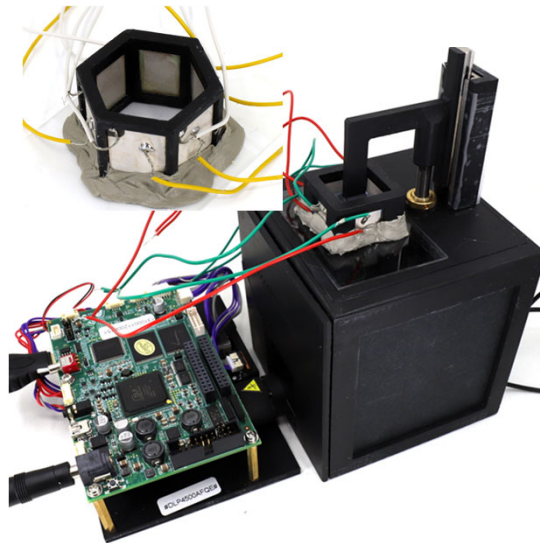
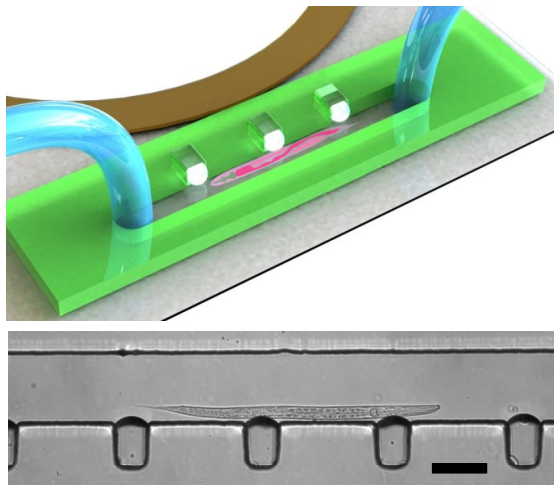
D-MAVT, Institute of Robotics and Intelligent Systems

[www.arsl.ethz.ch](http://www.arsl.ethz.ch)



## Main Research Interests:

- Microfluidics and acoustofluidics devices to manipulate microparticles inside model organisms
- Acoustic 3D printing
- Acoustic-powered micro/nanorobots



# Prof. Andreas Güntner

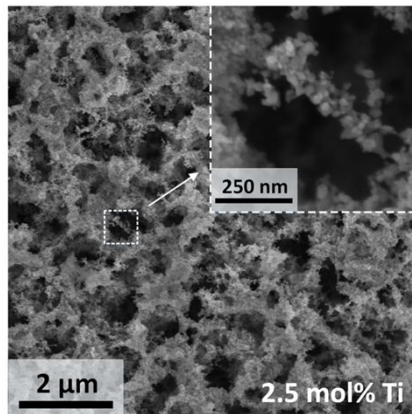
D-MAVT, Human-centered Sensing Laboratory

[www.hsl.ethz.ch](http://www.hsl.ethz.ch)



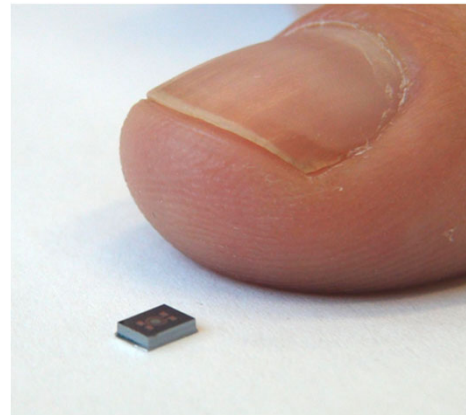
## Main Research Interests:

### Material Design



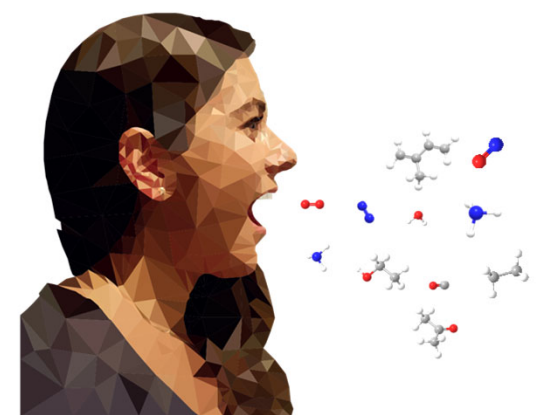
- Nanomaterials
- Thin films
- Process design

### Chemical Sensing



- Solid-gas interaction
- Signal analysis
- Devices
- Wearables

### Application



- Medical breath analysis
- Food safety
- Air quality

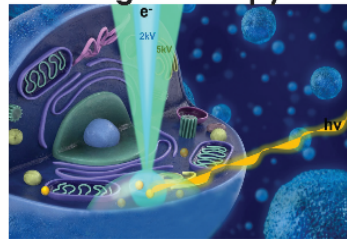
# Prof. Inge K. Herrmann

D-MAVT, Nanoparticle Systems Engineering Laboratory

www.nse.ethz.ch



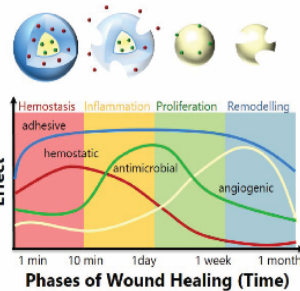
## Nanocrystals for Molecular Labelling & Therapy



with A. Boss (USZ) and L. Plasswilm (KSSG)

Cancer  
Radiotherapy

Simulations  
Chemistry  
Optics  
Med. Physics



## Nanohybrid-based Surgical Adhesives & Next Generation Implants

with M. Constantinescu (Inselspital) and A. Schlegel (USZ), Industrial partners

Materials Design  
Chemistry  
Analytical Imaging  
Preclinical

Bioactive Surgical  
Adhesives & Implants  
(nanoglue.ch)



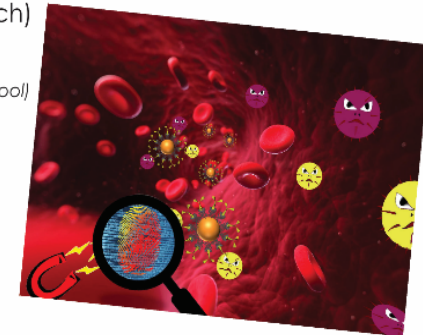
## Nanomagnets for Magnetic Blood Purification

(hemotune.ch)

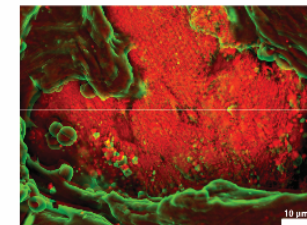
with M. Lattuada (Unifr),  
H. Hug (UniBas) and  
G. Pier (Harvard Med School)

Materials Design  
Magnetism  
Interface Design  
Modelling

Analytical Imaging  
Data Integration



## Mineralomics & Material Biotransformation



Heart disease  
Cancer  
Brain diseases

with S. Bertazzo (UCL)  
D. Obrist (ARTORG)  
B. Thürlimann (KSSG)  
T. Carrel (Inselspital)

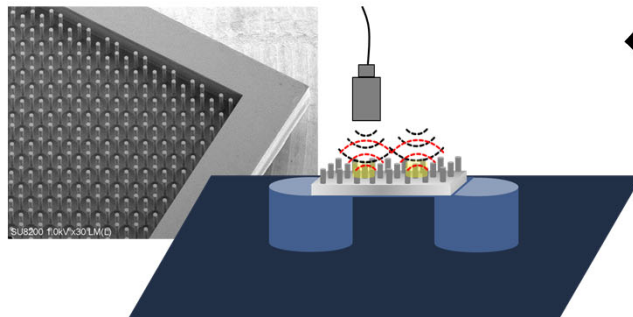
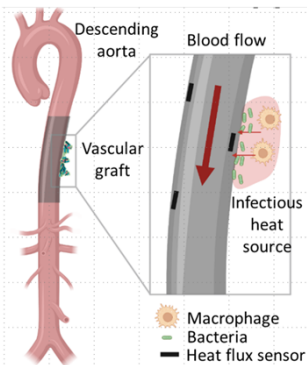


## Main Research Interests:

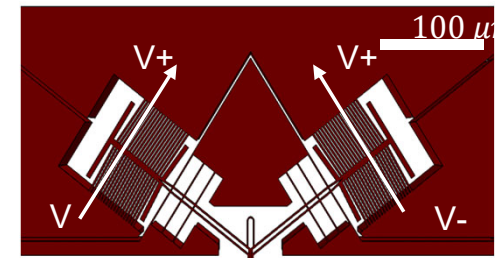
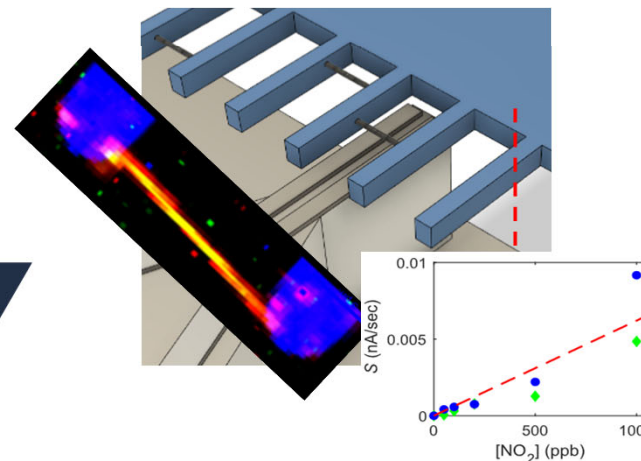
- Advanced microsystems:  
e.g. thermoelectric devices, microsystems for medical applications
- Nanotransducers and nanosensors:  
e.g. ultra low power carbon based sensors



Implants for cardiovascular diseases and infection control



Ultra low power CNT devices and fabrication technology



21.05.2024



# Prof. Robert Katzschmann

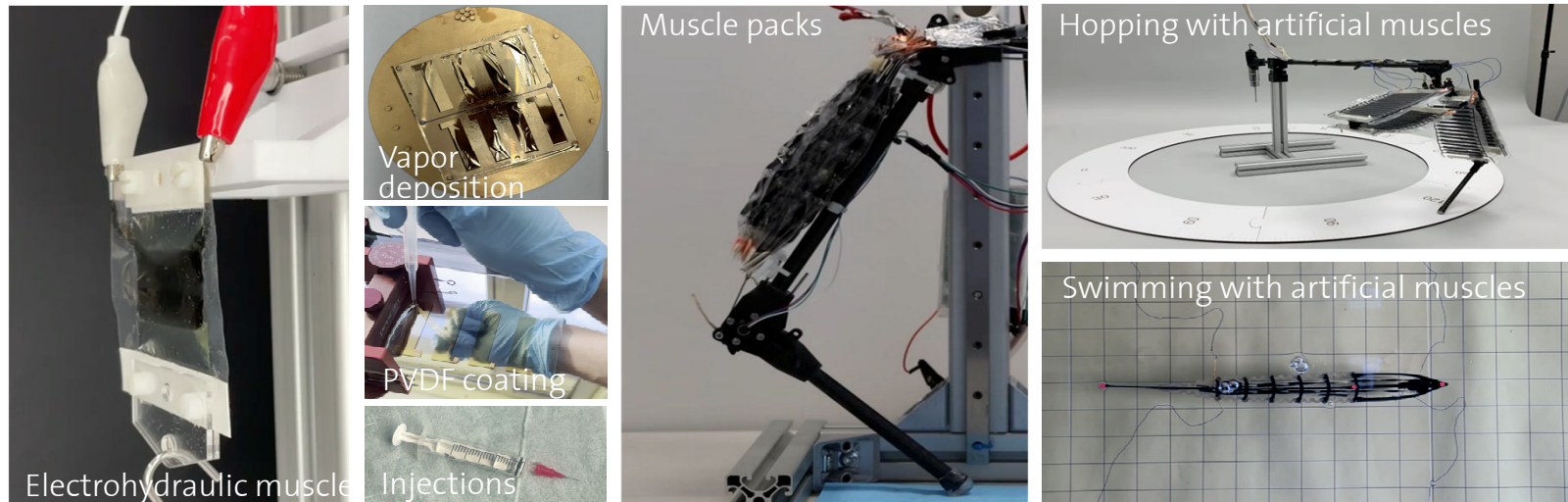
D-MAVT, Soft Robotics Lab

**SoftRobotics**  
Laboratory

[www.srl.ethz.ch](http://www.srl.ethz.ch)



## Electrohydraulic Musculoskeletal Robots



Thomas Buchner, Toshihiko Fukushima, Amirhossein Kazempour, Philip Arm, Stephan Gravert, Elia Varini, Yu Zhang, Manon Prairie, Xingrui Wang, Christoph Keplinger, Robert Katzschmann (in preparation)

# Prof. Dennis M. Kochmann

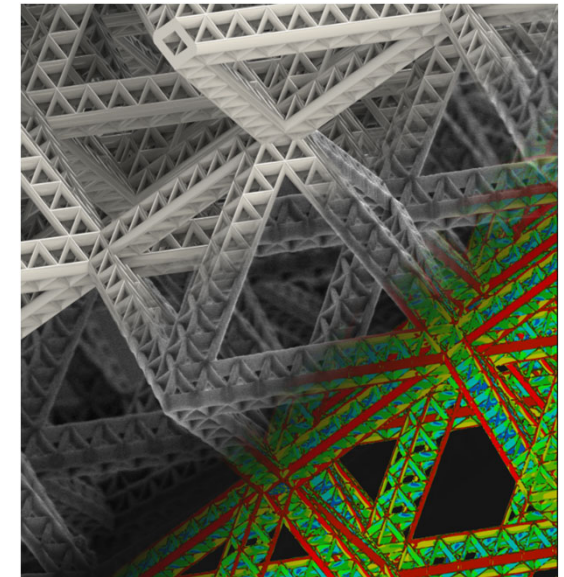
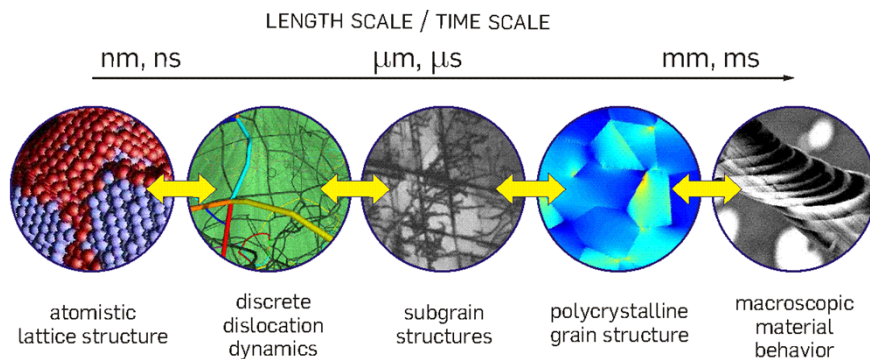
D-MAVT, Mechanics & Materials

[www.mm.ethz.ch](http://www.mm.ethz.ch)



## Main Research Interests:

- modeling across length and time scales: bridging from atoms to devices
- engineered (meta)materials with controllable properties
- materials by design: linking microstructure to properties



# Prof. Brad Nelson

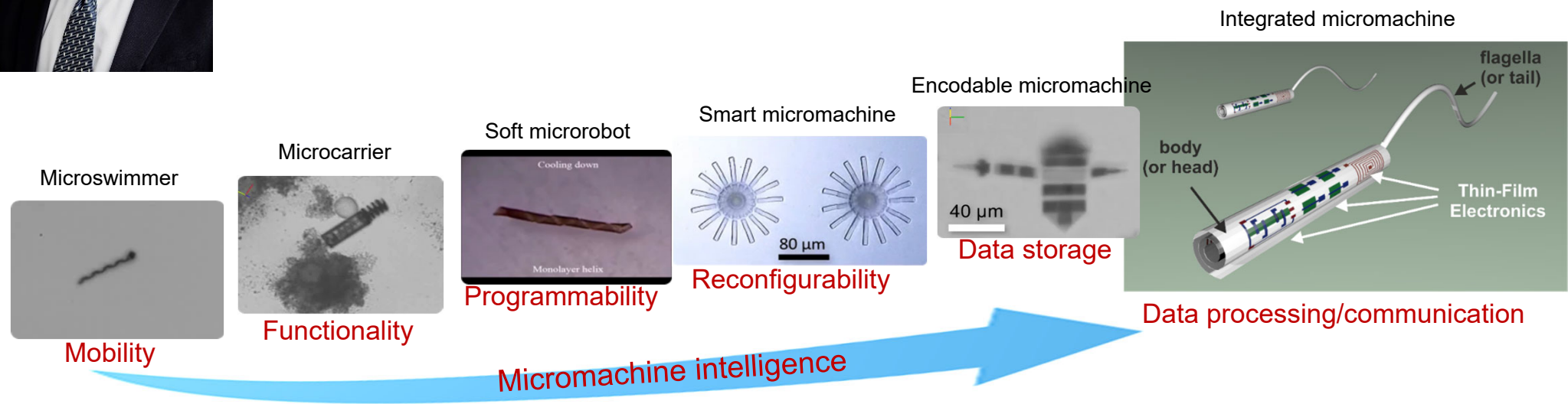
D-MAVT, Institute of Robotics and Intelligent Systems

[www.iris.mavt.ethz.ch](http://www.iris.mavt.ethz.ch)



## Main Research Interests:

- Making sub-mm intelligent machines
- Manipulating sub-mm scale objects



# Prof. David Norris

D-MAVT, Optical Materials Engineering Laboratory

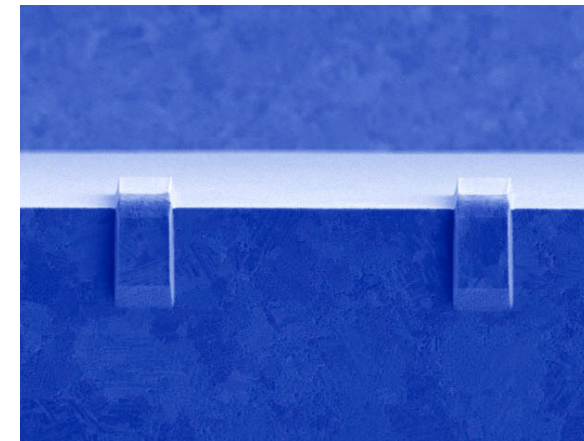
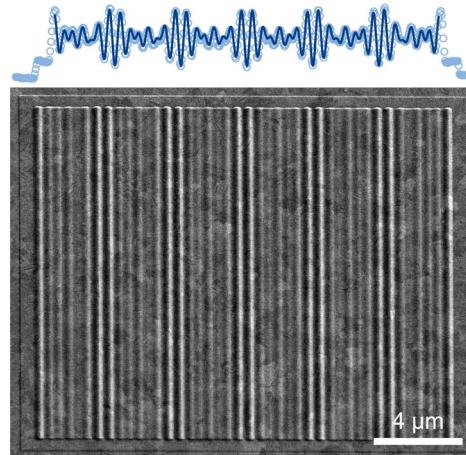


[www.omel.ethz.ch](http://www.omel.ethz.ch)



## Main Research Interests:

- Synthesis / characterization of quantum materials
- Nanophotonics
- Plasmonics



# Prof. Salvador Pané

D-MAVT, Institute of Robotics and Intelligent Systems, Multi-Scale Robotics Lab

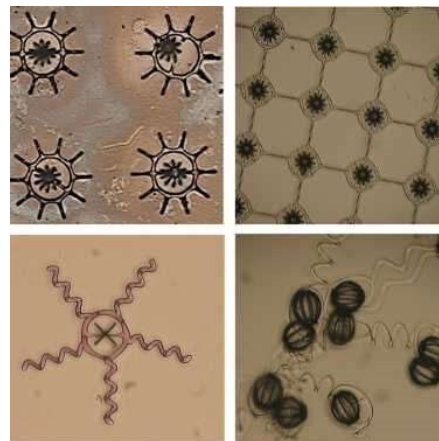
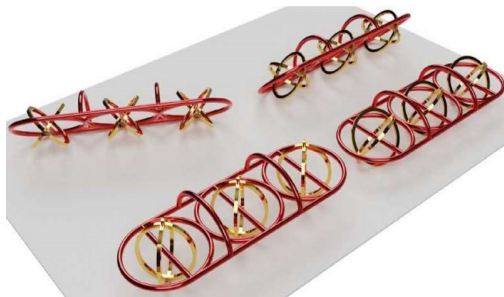
[www.msrl.ethz.ch](http://www.msrl.ethz.ch)



## Main Research Interests:

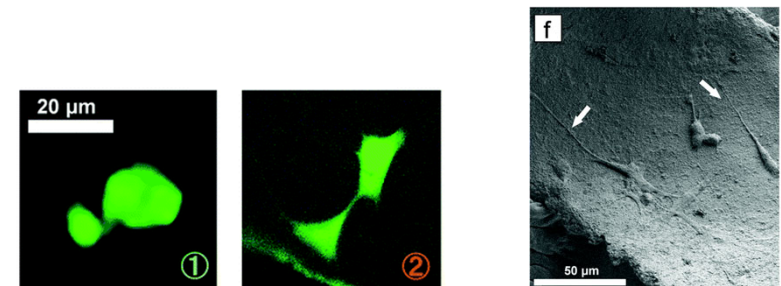
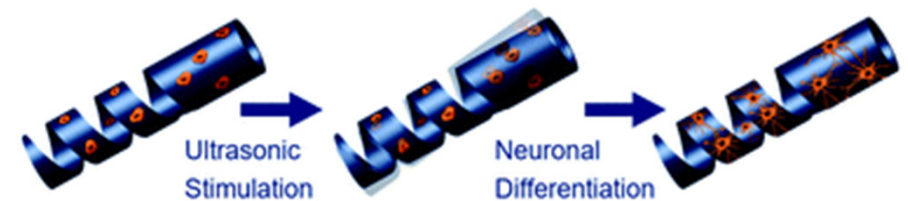
- Development and processing of material for robotics
- Small-scale Robotics for Water Cleaning
- Micro- and nanorobotics for therapeutic delivery and cell stimulation

*Mechanically Interlocked 3D Multimaterial Magnetic Microrobots*



*Nature Communications* (2020). DOI: [10.1038/s41467-020-19725-6](https://doi.org/10.1038/s41467-020-19725-6)

*Soft microrobots for neuron delivery & neuronal differentiation*



*Materials Horizons* (2020). DOI: [10.1039/C9MH00279K](https://doi.org/10.1039/C9MH00279K)

# Prof. Romain Quidant

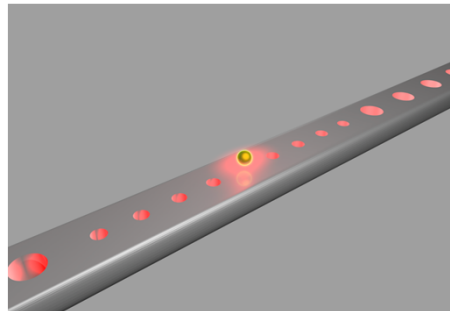
D-MAVT, Nanophotonic Systems Laboratory (NSL)

[www.light.ethz.ch](http://www.light.ethz.ch)



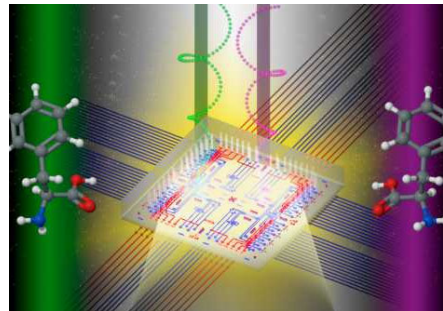
## Main Research Interests

### Optomechanics



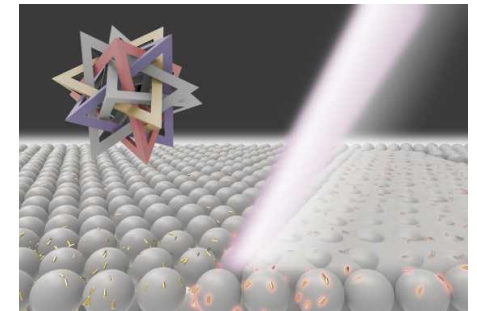
- Optical and electrostatic trapping
- Inertial and force sensing
- Reconfigurable metasurfaces

### Bionanophotonics



- On chip biosensors
- Advanced optical imaging
- Microfluidics

### Microscale heat control



- Hyperthermia
- Reconfigurable planar optics
- Catalysis

# Prof. Mark Tibbitt

D-MAVT, Macromolecular Engineering Laboratory

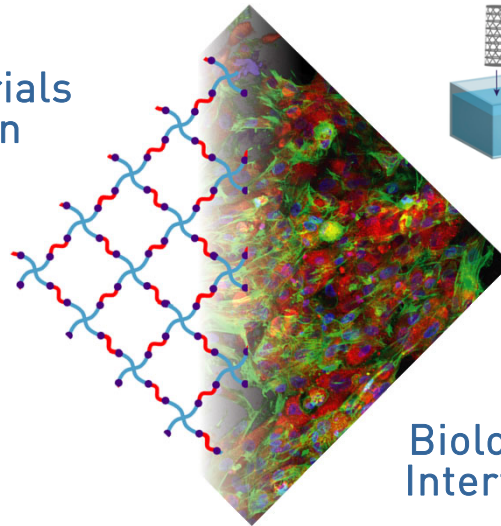
[www.macro.ethz.ch](http://www.macro.ethz.ch)



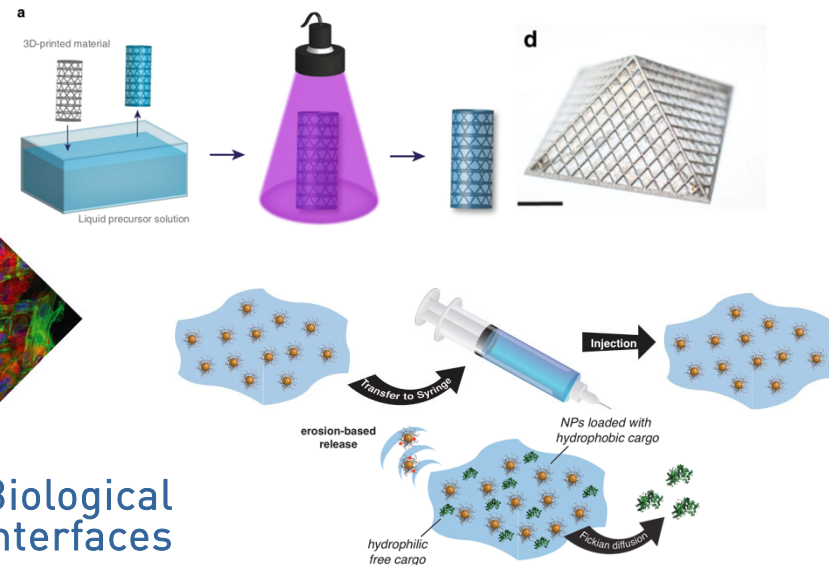
## Main Research Interests:

- Soft materials design with a focus on biomedical applications
- Additive manufacturing of multicomponent biomaterials
- Injectable drug delivery systems

Materials Design



Biological Interfaces



# Focus Specialization in Micro- und Nanosystems Technologie

Please find research topics of all 11 Micro- und Nanosystems Technologie Professors in the downloads

Thank you for your attention

Questions?