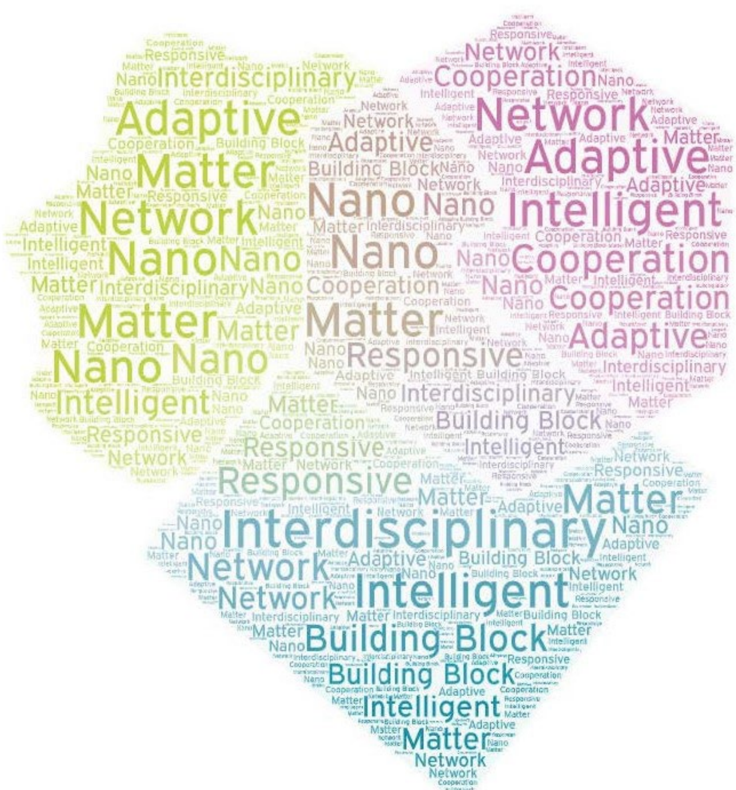
CRC 1459
Fall Colloquium 2024

November 21st 2024 | 3:00pm
Münster, Germany



Booklet of Abstracts

Program

3:00 pm	**Bernd M. Schmidt** HHU Düsseldorf, Institute of Organic Chemistry and Macromolecular Chemistry ***Photoresponsive Macrocycles & Mechanoresponsive Metal-Organic Cages – Influencing Supramolecular Architectures with Stimuli***	*Chair:* *Sebastian Baumert*
4:00 pm	**Ali Sadeghi** University of Twente, The Netherlands ***Additive Manufacturing of Multifunctional Soft Robots: Integrating Sensing and Actuation for Safe and Adaptive Systems***	*Chair:* *Peter Lazarowicz*
5:00 pm	**Networking with Beer & Pretzels**	

Please see our website www.uni-muenster.de/SFB1459/events for updates
or contact crc1459@uni- muenster.de if you have any questions!

Speakers

Dr. Bernd M. Schmidt

Institute of Organic Chemistry und Macromolecular Chemistry
Heinrich-Heine-Universität Düsseldorf
Germany

Dr. Bernd M. Schmidt is a distinguished chemist who began his academic journey at the Freie Universität (FU) Berlin, where he studied chemistry. As a student researcher, he expanded his research horizons at the Institute for Molecular Science in Okazaki, Japan. In 2013, Dr. Schmidt earned his PhD at FU Berlin, where he was part of the Fluorine Chemistry Research Training Group. Following his doctoral work, he completed postdoctoral research at Humboldt University in Berlin and the University of Tokyo.

In 2018, Dr. Schmidt joined Heinrich Heine University Düsseldorf (HHU), where he leads a junior research group. His academic and research excellence has earned him several prestigious awards and distinctions, including: Heisenberg Programme of the German Research Foundation (DFG) (since 2024), Dr. Otto Röhm Memorial Foundation Award (2022), Member of the "Junge Kolleg," North Rhine-Westphalian Academy of Sciences, Humanities and the Arts (since 2020), where he also serves as an elected representative, Humboldt Research Fellowship (2013), Feodor Lynen Research Fellowship (2014–2016), Short-term and long-Term Research Scholarships, and Japan Society for the Promotion of Science (JSPS).

Dr. Bernd M. Schmidt researches simple organic building blocks that arrange themselves into well-defined, complex supermolecules within a short time. This process of association of individual molecules into superordinate structures is of great importance in nature but also in many other areas. In contrast to metal-containing networks, individual pores are formed in organic molecules. It is hoped that the very light porous compounds can be used to bind gases such as carbon dioxide. Dr. Schmidt's research group is working specifically on ultrahydrophobic pores made of fluorinated building blocks. In addition, the group is working on supramolecular systems that can be controlled by external stimuli such as light and ultrasound.

Photoresponsive Macrocycles & Mechanoresponsive Metal-Organic Cages – Influencing Supramolecular Architectures with Stimuli

Dr. Bernd M. Schmidt, HHU Düsseldorf

Both metal coordination and dynamic covalent chemistry allow the synthesis of complex two- and three-dimensional architectures with high selectivity and yields, as the reversible bond formation allows for error correction.[1] We utilised the reversible formation of imines to generate metastable and dissipative dynamic covalent systems, in which light can be used to control the number of monomers in the cyclo-oligomerization. Intriguingly, the irradiation of azobenzene-based trianglimine with red light leads to the dissipative formation of different-sized macrocycles.[2]

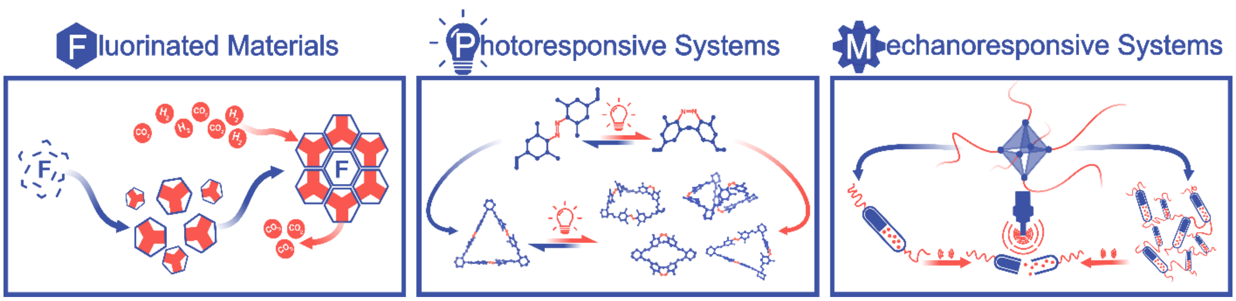


Figure 1. Overview of the current areas of research in the Schmidt group: fluorinated materials, photoswitchable supramolecular assemblies, and ultrasound-induced mechanochemistry in complex systems (from left to right).

By combining metal-mediated self-assembly of organic ligands into a discrete nanoscopic structure with polymer chains on each vertex, we realised the ultrasound-induced disassembly[3] of a cargo-loaded, self-assembled supramolecular $Pd^{II}_6(TPT)_4$ cage, entailing the release of its nanoconfined guests.[4] In addition, we reported bifunctionalized bypridines that can be used to generate metal-organic cage-based hydrogels, combining supramolecular chemistry with soft matter.[5] The encapsulation of guest molecules into supramolecular self-assembled metal-organic cage-crosslinked hydrogels, as well as ultrasound-induced disassembly of the cages with release of their cargo, is presented in addition to their characterization by rheology and small-angle X-ray scattering (SAXS) experiments. The constrained geometries simulating external force (CoGEF) method and barriers using a force-modified potential energy surface (FMPES) suggest that the cage-opening mechanism starts with the dissociation of one pyridine ligand at around 0.5 nN.[5]

[1] a) E. Nieland, J. Voss, B. M. Schmidt, *ChemPlusChem* **2023**, *88*, e202300353, b) T. Kunde, T. Pausch, B. M. Schmidt, *Eur. J. Org. Chem.* **2021**, *43*, 5844.
[2] E. Nieland, J. Voss, A. Mix, B. M. Schmidt, *Angew. Chem. Int. Ed.* **2022**, *61*, e202212745.
[3] R. Küng, R. Göstl, B. M. Schmidt, *Chem. Eur. J.* **2022**, *28*, e202103860.
[4] R. Küng, T. Pausch, D. Rasch, R. Göstl, B. M. Schmidt, *Angew. Chem. Int. Ed.* **2021**, *60,* 13626.
[5] R. Küng, A. Germann, M. Krüsmann, L. P. Niggemann, J. Meisner, M. Karg, R. Göstl, B. M. Schmidt, *Chem. Eur. J.* **2023**, *29*, e202300079.

Dr. Ali Sadeghi

Department of Biomechanical Engineering
Soft Robotics Lab
University of Twente
The Netherlands

Dr. Ali Sadeghi is a leading expert in the field of soft robotics. He earned his Ph.D. with honors (cum laude) in Micro-BioRobotics from Scuola Superiore Sant'Anna in Italy in 2013. His academic journey began in Iran, where he obtained his M.Sc. in Manufacturing & Production Engineering from the University of Tehran (2004) and his B.Sc. from Noshirvani University of Technology (2001).

Dr. Sadeghi initially spent several years in industry before transitioning to academia, serving as a lecturer and researcher at the University of Tehran from 2004 to 2010. During this period, he focused on service robots and polymer micromachining. His passion for soft robotics flourished during his time at the Italian Institute of Technology's Center for Micro-Bio Robotics (2010–2019), where he focused on the design and manufacturing of bio-inspired soft-bodied robots. He is widely recognized for pioneering **Growing Robots**, which utilize additive manufacturing to create robots capable of self-structuring and autonomous movement, drawing inspiration from plant behaviors.

Dr. Sadeghi has served as the Principal Investigator (PI), Work Package (WP) leader, and partner in numerous Dutch, Italian, and EU projects. His work has spanned a wide array of applications for soft robotics in healthcare and environmental monitoring. Some of the notable projects he has contributed to include **GROWMIS**, **PROMETHEUS**, **Holland Hybrid Heart**, **INDEPEND**, **GROWBOT**, **XoSoft**, **SMASH**, and **PLANTOID**.

Dr. Sadeghi's research stands at the intersection of robotics, nature-inspired design, and cutting-edge fabrication technologies, with an emphasis on applying soft robotics to real-world challenges. His group focusses on developing new methods and robotic machines for the additive manufacturing of soft robots. Among the notable achievements of his lab are the development of a soft rubber pellet extruder printer, 3D weaving/printing machines, and a multi-material polymer printer, all contributing to advancing additive manufacturing technologies. His research mainly involves 3D printing of multilateral, hyperelastic, and fiber-reinforced smart polymers. These efforts aim to create advanced soft sensors and proprioceptive soft actuators, suitable for various applications including wearable robotics, healthcare, and environmental monitoring.

Additive Manufacturing of Multifunctional Soft Robots: Integrating Sensing and Actuation for Safe and Adaptive Systems

Dr. Ali Sadeghi, University of Twente, The Netherlands

Soft robotics represents a transformative approach to designing machines that can interact safely with users and their environment. Built from highly flexible, compliant materials, soft robots mimic the properties of biological organisms, making them ideal for applications in healthcare, wearable technology, and bio-inspired systems. These robots offer versatile solutions for tasks requiring adaptability and gentle interaction, from rehabilitation devices to soft robotic hearts and sensorized garments.

Similar to biological systems, soft robots possess multifunctional bodies where the structure itself hosts various integrated functionalities such as sensing, actuation, and adaptability. This inherent complexity requires advanced fabrication techniques capable of producing such multifunctional structures. One of the most promising approaches is additive manufacturing, which allows for the precise layering of multiple materials, each serving distinct roles in the system. At the Soft Robotics Lab, University of Twente, we focus on the additive manufacturing of multi-material soft robotic systems that combine hyperelastic rubbers, continuous fibers, and conductive polymers.

This talk will present some of our recent achievements and the challenges we face in developing these complex, multifunctional soft systems. From fabricating soft sensors, proprioceptive actuators, and electroactive actuators to designing sensorized insoles and prosthetic hands, I will discuss the fabrication techniques, material considerations, and design choices that drive our research, as well as our future directions.

Photographs and images obtained from:

Bernd M. Schmidt and Ali Sadeghi