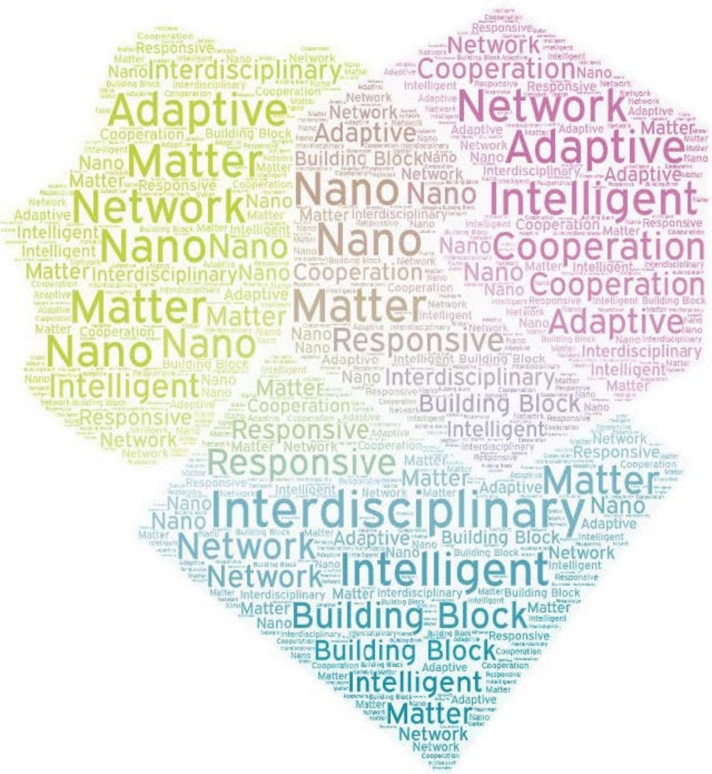
Universität Münster

Center for Soft Nanoscience

CRC 1459 INTELLIGENT MATTER

CRC 1459
Spring Colloquium 2024

May 16th 2024 | 3:00pm
Münster, Germany



Booklet of Abstracts

Program

3:00 pm	**Eva Blasco** IMSEAM, Heidelberg University, Germany ***Designing Intelligent Materials for 4D (Micro)Printing***	*Chair: Sebastian Baumert*
4:10 pm	**Regina Dittmann** Peter Grünberg Institute, Forschungszentrum Jülich, Germany ***From Nanoionic Processes to Neuromorphic Sensing***	*Chair: Niklas Vollmar*
5:20 pm	**Networking with Beer & Pretzels**	

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Speakers

Prof. Dr. Eva Blasco

Institute for Molecular Systems Engineering & Advanced Materials (IMSEAM)
Heidelberg University
Germany

Eva Blasco studied Chemistry at the University of Zaragoza in Spain, where she completed her doctoral studies in 2013. She then moved to the Karlsruhe Institute of Technology (KIT), where she first worked as an Alexander von Humboldt fellow and later as a group leader at the Institute of Nanotechnology. She has been a junior professor at Ruperto Carola since October 2020. Eva Blasco is also a principal investigator in the Excellence Cluster “3D Matter Made to Order” (3DMM2O), a collaboration of Heidelberg University and the KIT. She is now a junior professor at the Institute of Organic Chemistry and the Institute for Molecular Systems Engineering and advanced Materials of Heidelberg University. She received the Outstanding Young Researcher in Polymers Award 2022 of the Spanish Royal Society of Chemistry, a Dr. Hermann Schnell Scholarship 2022 for outstanding young researchers and the Ernst-Haage-Award 2022 for Chemistry.

Eva Blasco’s work is at the interface of organic and macromolecular chemistry and materials sciences. Her projects focus on developing intelligent functional materials for 3D and 4D printing. Taking inspiration from nature, one of her main goals is the incorporation of “life-like” behaviour into synthetic materials by combining stimuli-responsive polymers and 3D printing technologies at the microscale. This method is called 4D microprinting, and the additional fourth dimension refers to the ability of a three-dimensionally printed object to change its properties over time.

Designing intelligent materials for 4D (Micro)Printing

Eva Blasco, IMSEAM, Heidelberg University, Germany

4D printing has become a promising tool for the fabrication of dynamic and adaptive structures. During the last years, promising examples of defined 4D microstructures employing stimuli-responsive materials have been shown using two-photon 3D laser printing. In this lecture, I will present our recent work on the field with emphasis on new responsive materials enabling the preparation of adaptive and structures. In particular, shape memory polymers as well as liquid crystal elastomers have been explored. In the first case, a simple and versatile formulation has been developed enabling complex microstructures with remarkable shape memory properties. Also, multi-responsive structures using photo responsive liquid crystal elastomers, are demonstrated. Furthermore, we have exploited the inclusion of dynamic and living bonds in a printable formulation enabling the creation of microstructures with „life-like" characteristics such as adaptability by tunable shape and mechanical properties. For example, a dramatic increase of the volume (eight times) of the 4D microstructure together with an increase of the Young's Modulus by two orders of magnitude is possible, while maintaining the shape including fine structural details. We envision that this programable materials will open new opportunities for the additive manufacturing of functional devices.

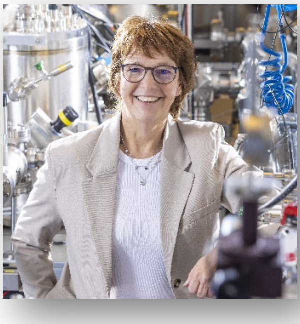
References:

[1] *C. A. Spiegel, M. Hackner, V. P. Bothe, J. P. Spatz, E. Blasco, Adv. Funct. Mater.* ***2022****, 144, 2110580.*

[2] *L.-Y. Hsu, P. Mainik, A. Münchinger, S. Lindenthal, T. Spratte, A. Welle, J. Zaumseil, C. Selhuber-Unkel, M. Wegener, E. Blasco, Adv. Mater. Technol.* ***2022****, 2200801.*

[3] *P. Mainik, L-Y. Hsu, C. W. Zimmer, D. Fauser, H. Steeb, E. Blasco, Adv. Mater. Technol.* ***2023****, 2300727.*

[4] *Y. Jia, C. A. Spiegel, A. Welle, S. Heißler, E. Sedghamiz, M. Liu, W. Wenzel, M. Hackner, J. P. Spatz, M. Tsotsalas, E. Blasco, Adv. Funct. Mater.* ***2022****, 2207826.*



Prof. Dr. Regina Dittmann

Peter Grünberg Insitute
Forschungszentrum Jülich
RWTH Aachen
Germany

Regina Dittmann currently works at the Peter Grünberg Institute (PGI), Forschungszentrum Jülich. Since November 2012, she is professor in the department of electrical engineering and information technology at RWTH Aachen University. She is dealing with the atomically controlled growth of oxide thin films and hetero-structures by pulsed laser deposition. She is an internationally recognized expert in resistive (memristive) switching in thin film devices. The focus of her resent research is the elucidation of switching mechanisms in different oxides by employing scanning probe techniques and X-ray spectromicroscopy.

From Nanoionic Processes to Neuromorphic Sensing

Regina Dittmann, Forschungszentrum Jülich, Germany

Memristive devices based on the valence change mechanism are highly interesting candidates for non-volatile data storage and for hardware representations of synapses and neurons in neuromorphic circuits. Although it has been early proposed that the switching mechanism is based on the field-driven movement of oxygen vacancies within nanosized filaments [1], details of the underlying physical-chemical processes are difficult to access experimentally. However, these details are highly relevant for the kinetics of the devices and the time stability of the resistances states. We employed photoemission electron spectoscopy (PEEM) to study the movement of oxygen vacancies during device operation and after resistance relaxation [2, 3]. By combining PEEM data with simulations of the ionic and electronic transport, we gained a deep understanding of the interplay between oxygen vacancy movement, the modulation of space charge zones and the switching performance.

We use the knowledge to design VCM devices with tailored resistance relaxation [4] to gain spatio-temporal information in a neuromorphic sensing circuit, the time-difference encoder, developed at the University of Groningen [5].

References:

[1] Waser et al., Adv. Mater. 2009
[2] Bäumer et al., Nature Commun. 2015
[3] Bäumer et al., Nature Commun. 2016
[4] J. Hellwig et al., Adv. Funct. Mater. 2024
[5] Schoepe et al, Nature Commun. 2024