

PhD Researcher Position:

Walther Lab @ University of Mainz – Germany (www.walther-group.com)

Max Planck Graduate Center between MPI for Polymer Research and JGU

DNA-based Synthetic Cells with Enzymatic Reaction Modules for Active and Adaptive Behavior

Key words: Synthetic Cells, DNA Nanoscience, Active Matter, Enzymes, Computing

Walther Lab. The Walther Lab at JGU Mainz is one of the pioneers in the field of life-like materials and systems at the interface of systems chemistry/chemical reaction networks, DNA nanoscience, polymer materials, and the interface to cells. We are excited to empower systems, materials, and artificial cells with embodied intelligence – chemical and physical – to endow them with the capacity to compute, adapt, learn, or make simple decisions. We are highly international and interdisciplinary, and act as a team to solve complex challenges. Prof. Andreas Walther has received two ERC grants, is a Max Planck Fellow, and a founder of one DFG Cluster of Excellence (> 270 publications in high impact journals, h-index 80).

Project Description:

Building on our pioneering work on DNA-condensate-synthetic cells (see references below), we aim to break new ground in enzymatically active synthetic cells. We are interested in the fundamental engineering of enzymatic activity, in active matter properties such as propulsion, and in dynamic adaptation processes such as learning. Experimental key tasks are:

- Preparation of DNA-based Synthetic Cells and integration of enzymatic reaction modules
- Analysis of enzymatic activity and emergent behavior such as flow and propulsion
- Integration of enzymatic reaction circuits and enzymatic control modules to achieve adaptive systems behavior with a focus on learning such as habituation and sensitization

The project requires candidates to perform quantitative microscopy and establish quantitative interaction-structure-behavior maps to understand how such life-like entities can be formed and modulated in their behavior.

For excellent candidates, we will pursue an association to the Max Planck Graduate Center between the Max Planck Institutes and JGU Mainz to provide you with the widest interdisciplinary networking and career-development opportunities.

We offer:

- a collaborative and interdisciplinary research team with a dedicated mission of making materials and molecular systems intelligent
- a highly engaging and current research topic in excellently equipped lab infrastructures; including all analytical facilities needed for your research
- an inspiring environment with international and ambitious teams
- ample opportunities to develop beyond your core project
- a stimulating local research environment with excellent collaboration possibilities
- support for personal development with attendance to conferences, workshops and soft skill seminars
- excellent and close support of PhD researchers
- possibilities for national and international collaboration

FURTHER READING:

1. Review: W. Chen, J. Fritzen, A. Walther “Phase Separation of Nucleic Acids: Mechanisms, Properties, and Applications” *Angew. Chem. Int. Ed.* e23943 (2026).
2. W. Chen, S. Song, A. Samanta, S. Sethi, C. Drees, M. Kappl, H.-J. Butt, A. Walther “Growing functional artificial cytoskeletons in the viscoelastic confinement of DNA synthetic cells” *Nat. Chem. Eng.* 2, 627 (2025); Highlighted in *Nat. Mater.* DOI: 10.1038/s41563-025-02420-6 (2025); Research Briefing and Behind the Paper *Nat. Chem. Eng.* DOI: 10.1038/s44286-025-00307-6 (2025).

3. W. Chen, B. Dúzs, P. G. Argudo, S. V. Bauer, W. Liu, A. Samanta, S. H. Parekh, M. Bonn, A. Walther “Ballistic Diffusion Fronts in Biomolecular Condensates” *Nat. Nanotechnol.* 20, 1602 (2025).
4. M. Xie, W. Chen, M. de Roy, A. Walther “Constructing synthetic nuclear architectures via transcriptional condensates in a DNA protonucleus” *Nat. Commun.* 16, 8254 (2025).
5. A. Samanta, L. Baranda Pellejero, M. Masukawa, A. Walther “DNA-Empowered Synthetic Cells as Minimalistic Life Forms” *Nat. Rev. Chem.* 8, 454, (2024).
6. W. Liu, C. Lupfer, A. Samanta, A. Sarkar, A. Walther “Switchable Hydrophobic Pockets in DNA Protocells Enhance Chemical Conversion” *J. Am. Chem. Soc.* 145, 7090 (2023).
7. A. Samanta, M. Hörner, W. Liu, W. Weber, A. Walther “Signal-processing and adaptive prototissue formation in metabolic DNA protocells”, *Nat. Commun.* 13, 1 (2022).
8. W. Liu, A. Samanta, J. Deng, C. O. Akintayo, A. Walther “Mechanistic Insights into the Phase Separation Behavior and Pathway-Directed Information Exchange in all-DNA Droplets”, *Angew. Chem. Int. Ed.* 61, e202208951 (2022).
9. A. Samanta, V. Sabatino, T. Ward, A. Walther “Functional and morphological adaptation in DNA protocells via signal processing prompted by artificial metalloenzymes” *Nat. Nanotechnol.* 15, 914 (2020).
10. R. Merindol, S. Loescher, A. Samanta, A. Walther “Pathway-Controlled Formation of Mesostructured all-DNA Microgels and their Superstructures” *Nat. Nanotech.*, 13, 730 (2018). (Cover Article, highlighted in Mirkin et al. *Nat. Nanotech.* 13, 624)

EXPECTED CANDIDATE PROFILE

- highly motivated candidate with a very good degree in Chemistry, Biochemistry, biomaterials or biological sciences.
- Independent and self-responsible work ethic
- Enthusiasm for basic research, creative experimental approaches, and scientific networking
- Excellent English skills and enjoyment of teamwork

Please send your full application as a single PDF file with the subject “DNA Synthetic Cells” containing

- Letter of motivation including a summary of your past research experience and research interests
- A meaningful summary of your Master thesis
- Transcript of records of your Master and Bachelor program.
- Curriculum vitae and list of publications
- One, or if possible, two contacts for reference letters

to both andreas.walther@uni-mainz.de

We look forward to receiving your application!

The position is according to the German salary scale (TVL 13 65%) with full social benefits.

The position is available from July 2026 and applications will be evaluated on a rolling basis until the position is filled. Deadline is End of May 2026.