Malak Jaber, March 13th, 2024

Transient co-assemblies of micron-scale colloids regulated by ATP-fueled reaction networks

Keywords: Transient behavior, Fuel-driven reactions, DNA hybridization, Biomimetic properties, Colloidal particles, Self-assembly.

Who are the corresponding authors and what are their research areas?

Andreas Walther

Ph.D. from Bayreuth University in Germany in 2008, worked on the self-assembly behavior and applications of Janus particles and other soft, complex colloids.

Postdoc at Aalto University (Helsinki, Finland), worked on biomimetic hybrid materials.

Professor for Functional Polymers at the Institute for Macromolecular Chemistry at the Albert-Ludwig's-University in Freiburg

Currently a professor for Macromolecular Materials and Systems at the Department of Chemistry at the Johannes Gutenberg University in Mainz (Germany)

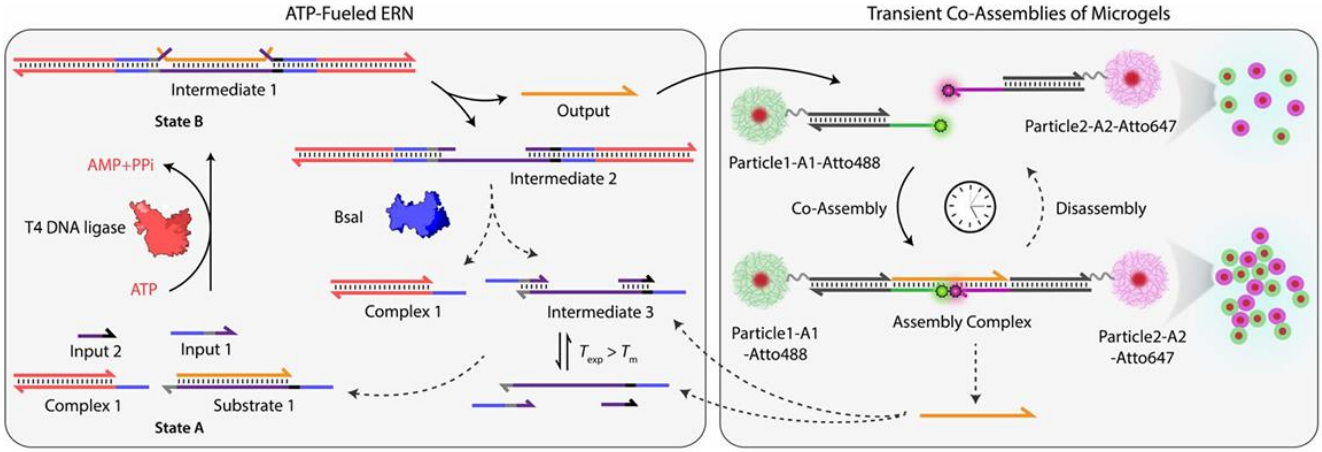
Charu Sharma

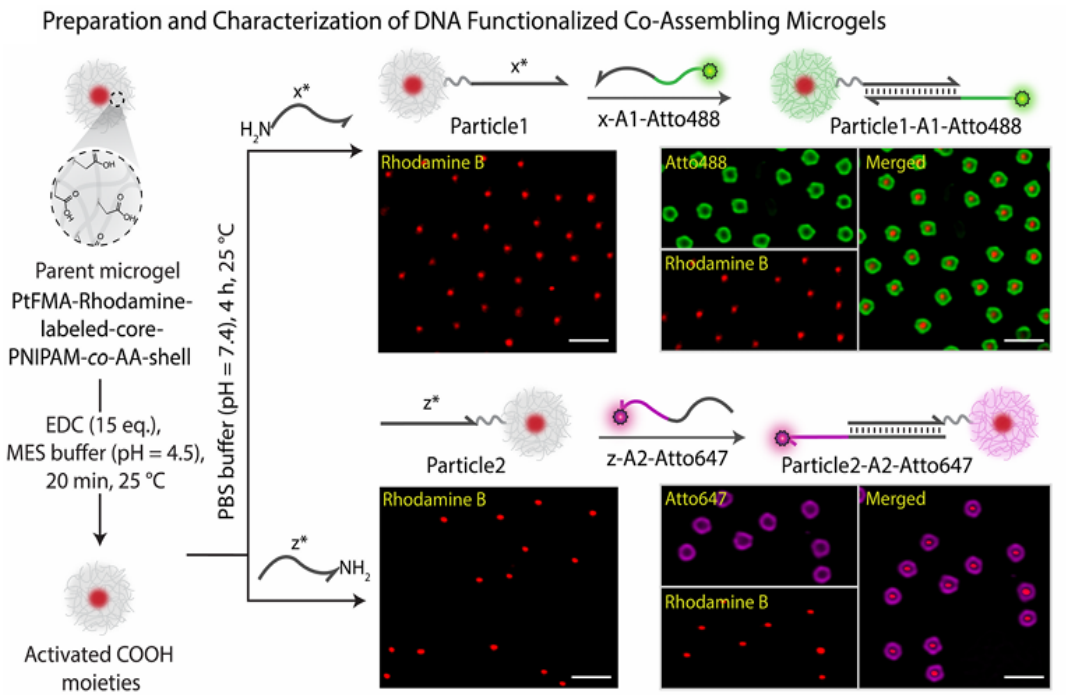
Master's degree in Chemistry at the Indian Institute of Technology Delhi (IIT Delhi) focusing on developing novel methods for synthesizing organic compounds employing Photo-redox Catalysis.

PhD thesis on the autonomous and dynamic feedback-driven self-assembly of bio-hybrid materials in Walther's Lab.

What is the main claim of the article?

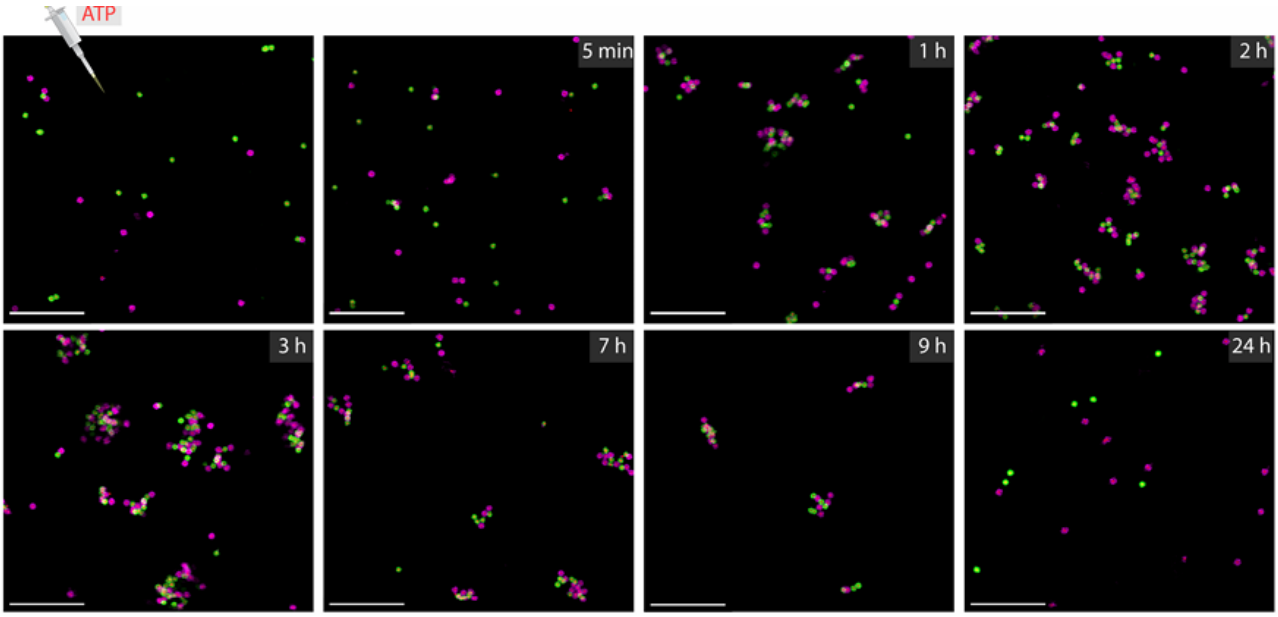
They developed an ATP fuel-driven system where a DNA-based enzymatic reaction network (ERN) couples to micron-sized colloidal particles to achieve a transient co-assembly. The ERN system recovers all components after ATP fuel consumption, generating minimal waste. Due to this, this system can be reactivated for up to three cycles with new fuel.



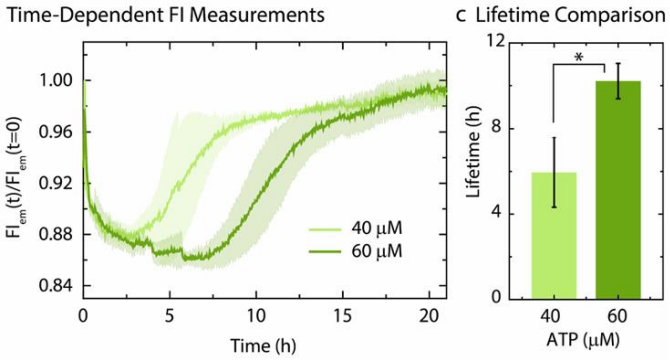


How is it demonstrated?

- *CLSM (Confocal Laser Scanning Microscopy)*



- *Time-dependent FI measurements by FRET (Fluorescence Resonance Energy Transfer)*



What are the typical experimental conditions?

Particle 1- A1-Atto488 and particle 2- A2-ATTO647 at an equimolar concentration of 5 µM are dissolved in 1X NEB CutSmart buffer containing 20 µM Complex 1, 5 µM Substrate 1, 10 µM Input 1 and Input 2 at 37 °C. For the transient system, 0.8 WU µL-1 of T4 DNA ligase and 0.8 U µL-1 of BsaI were used and the system was fueled by 40 µM or 60uM ATP.

Which are the key related papers?

1) *J. Deng and A. Walther, J. Am. Chem. Soc., 2020, 142, 21102 21109. This is a paper that shows how the ERNs are developed to achieve dynamic behavior in systems, by Walther's Team.*

2) *B. G. P. van Ravensteijn, W. E. Hendriksen, R. Eelkema, J. H. van Esch and W. K. Kegel, J. Am. Chem. Soc., 2017, 139, 9763–9766. This paper is related to this field where it demonstrates the first example for the transient clustering of sub-micrometer-sized colloidal particles.*

3) *H.Dehne, A. Reitenbach and A. R. Bausch, Sci. Rep., 2019, 9, 7350. This paper shows the transient assembly of DNA-coated colloids using antagonistic enzymatic CRN of RNA formation and degradation.*

Additional comments, including additional elements of interest

- Reactivating the system for at least three subsequent batches of ATP.
- Only waste accumulated is the amount of AMP and PPi generated from ATP used which will stay below the limit above which these components might affect the MG of the enzyme stability.
- The system is adjustable.
- I didn't quite understand the thermodynamic push provided by the dual migration.