BP 25: Physics of self-organization in DNA nanostructures (joint session CPP/BP)

Time: Thursday 12:15–13:00 Location: H13

BP 25.1 Thu 12:15 H13

Synthetic cells: Bottom-up assembly with DNA nanotechnology — •Kerstin Göpfrich[1,2], Kevin Jahnke[1,2], Ilia Platzman[1,2], and Joachim P. Spatz[1,2] — [1]Max Planck Institute for Medical Research, Department of Cellular Biophysics, Jahnstraße 29, D 69120, Heidelberg — [2]Department of Biophysical Chemistry, University of Heidelberg, Im Neuenheimer Feld 253, D 69120 Heidelberg

Bottom-up synthetic biology has been successful at isolating components from cells and reconstituting subcellular functions inside compartments. Progress towards a fully functional synthetic cell, however, requires strategies to recombine and arrange a multitude of components in space and time. We therefore propose to merge two precision technologies, namely microfluidics and DNA nanotechnology, to position and manipulate components in synthetic cells. In particular, we demonstrate that DNA can be used as a near-universal tool for responsive and programmable compartment functionalization. Our method relies on the self-assembly of single-stranded cholesterol-tagged DNA handles, which provide an addressable anchoring point for complementary DNA carrying an arbitrary functional group. Using this DNA handle approach, we demonstrate the stimuli-responsive attachment of reactive groups, DNA nanostructures, microspheres, an actin cortex and even living cells to the periphery of surfactant-stabilized droplets. We further employ DNA to construct functional components, including a pH-responsive DNA-based cytoskeleton mimic, which serves as a stabilizing cortex inside synthetic cells.

BP 25.2 Thu 12:30 H13

DNA-Assembled Plasmonic Waveguides for Nanoscale Light Propagation — •Thorsten-Lars Schmidt — Department of Physics, Kent State University, Kent, OH, USA — cfaed, TU Dresden, Germany

Plasmonic waveguides consisting of metal nanoparticle chains can localize and guide light well below the diffraction limit, but high propagation losses due to lithography-limited large interparticle spacing have impeded practical applications. We previously demonstrated a robust DNA-origami-based self-assembly pipeline of monocrystalline gold nanoparticles. More recently, we demonstrated that this method allows the interparticle spacing to be decreased below 2 nm, thus reducing propagation losses to 0.8 dB per 50 nm at a deep subwavelength confinement of 62 nm ($\sim\lambda/10$). We characterize the individual waveguides with nanometer-scale resolution by electron energy-loss spectroscopy. Light propagation towards a fluorescent nanodiamond is directly visualized by cathodoluminescence imaging spectroscopy on a single-device level, therefore realizing nanoscale light manipulation and energy conversion. Simulations suggest that longitudinal plasmon modes arising from the narrow gaps are responsible for the efficient waveguiding. With this scalable DNA origami approach, micrometer-long propagation lengths could be achieved, enabling applications in information technology, sensing and quantum optics.

BP 25.3 Thu 12:45 H13

Functionalized DNA Origami Nanostructures for Molecular Electronics — •Turkan Bayrak[1], Jingjing Ye[2], Richard Weichelt[3], Amanda Reyes[4], Alexander Eychmüller[3], Enrique Samano[4], Ralf Seidel[2], and Artur Erbe[1] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany. — [2]Peter Debye Institute for Soft Matter Physics, Universität Leipzig, Germany. — [3]Physikalische Chemie, Technische Universität Dresden, Germany. — [4]Centro de Nanociencias y Nanotecnología, Ensenada, México.

The DNA origami method provides a programmable bottom-up approach for creating nanostructures of any desired shape, which can be used as scaffolds for nanoelectronics and nanophotonics device fabrications. Based on this technique, the precise positioning of metallic and semiconducting nanoparticles along DNA nanostructures can be achieved. In this study, various DNA origami nanostructures (nanomolds, nanotubes and nanosheets) are used for the fabrication of nanoelectronic devices. To this end, gold nanoparticles, semiconductor quantum dots/rods are used in/on the DNA origami structures to create nanowires and transistor-like devices. The DNA origami nanowires and transistors were electrically characterized from room temperature (RT) down to 4.2K. Temperature-dependent characterizations of wires were performed in order to understand the dominant conduction mechanisms. Some nanowires showed pure metallic behavior. Transistor like devices showed Coulomb blockade behavior at RT. The study shows that self-assembled DNA structures can be used for nanoelectronic patterning and single electron devices.