Plasmonic waveguide self-assembly on DNA origami


Center for Advancing Electronics Dresden (cfaed), Technische Universität Dresden, 01062 Dresden, Germany.

The field of plasmonics exploits the interaction of light with nanoscale metallic structures to confine, guide and manipulate light on scales below the diffraction limit, thereby greatly benefiting applications such as quantum photonics, or short-distance optical communication. For example, deep subwavelength plasmonic waveguides fabricated from closely spaced metal nanoparticles have been proposed two decades ago, and were realized by electron beam lithography, a method which is, however, non-scalable. Moreover, it is desirable to attain a more precise control over the metal particle crystallinity, shape, size, positioning and interparticle spacing than that achievable by lithography. To this end, DNA nanotechnology can be used to self-assemble plasmonic structures with superior control. We systematically studied the assembly yield of gold nanoparticles on DNA origami structures as a function of a wide range of parameters such as ionic strength, stoichiometric ratio, oligonucleotide linker chemistry, and assembly kinetics by an automated high-throughput analysis of electron micrographs of the formed heterocomplexes.[1]

Next, we demonstrate energy propagation towards a fluorescent nanodiamond through a nanoparticle waveguide, and thus visually demonstrate the realization of nanometer-precise light manipulation. High-resolution mapping by electron energy loss spectroscopy and cathodoluminescence imaging spectroscopy reveal an efficient in-coupling, propagation and out-coupling of the energy over a distance of 350 nm. Finite-difference time-domain simulations reveal that several plasmon modes contribute to efficient waveguiding. We anticipate that combining DNA origami deposition, interfacing methods, and established microfabrication techniques with our scalable self-assembly approach will enable the construction of complex sub-diffraction plasmonic devices for applications in information technology, sensing and quantum optics.[2]

References
2- arXiv:1712.09141 [physics.optics]

Corresponding author email: Thorsten-Lars.Schmidt@tu-dresden.de