Towards plasmonic waveguides self-assembled on DNA scaffolds

*Fatih N. Gür, Michael Matthies, Nayan Agarval, Jingjing Ye, Thorsten L. Schmidt**

Center for Advancing Electronics Dresden, TU Dresden, 01062 Dresden (Germany).
Thorsten-Lars.Schmidt@tu-dresden.de

Optical data transmission has replaced electronic data transmission for distances longer than a few meters as it is orders of magnitudes faster. It is however challenging to realize optical short-range communication inside computer chips or between microelectronic components. A major problem is the size incompatibility of micrometer to millimeters big optical components such as glass fibers and modulators into nanometer-sized microelectronic structures. Nanophotonic components such as plasmonic waveguides[1] may help to decrease the size of optical components below the refraction limit. It is however challenging to mass produce such plasmonic structures with top-down approaches like electron-beam lithography.
Bottom-up self-assembly reactions on the other hand are fully scalable. Deoxyribonucleic acid (DNA) has been developed into arguably the most controllable material for building artificial nanometer-sized objects of almost arbitrary shapes.[2] Heteroelements such as gold nanoparticles, quantum dots and fluorescent particles can be arranged more precisely on DNA scaffolds than with any other technology by functionalizing certain oligonucleotides and hybridizing them by Watson-Crick base pairing to complementary sequences on DNA origami. Here present our efforts towards building a DNA-based plasmonic waveguide through self-assembly. As a proof of concept we show the synthesis of gold nanoparticle chains with high yields on so-called 6-helix bundles. We investigate factors that influence the assembly yield of waveguides, new triangulated architectures and novel synthesis methods.

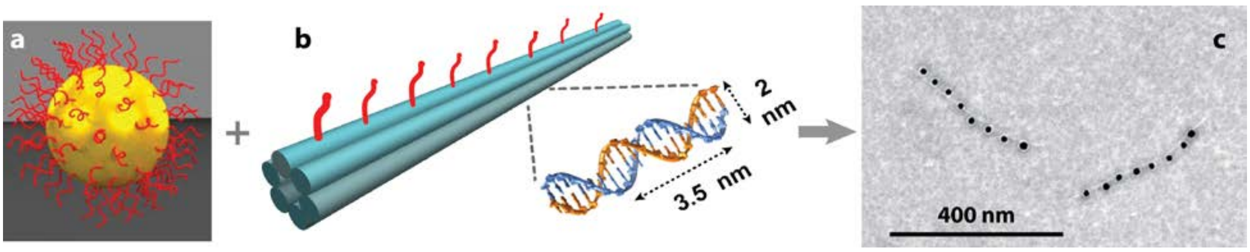

Figure 1: *Self-assembled plasmonic waveguides.* ***a)*** *Gold nanoparticles are conjugated to single-stranded oligonucleotides.* ***b)*** *A so-called 6-helix bundle DNA origami structure carries single-stranded extensions complementary to the ones on gold nanoparticles.* ***c)*** *TEM image of the self-assembled complexes.*

[1] Maier, S. A. et al. Local detection of electromagnetic energy transport below the diffraction limit in metal nanoparticle plasmon waveguides. Nat Mater 2, 229–232 (2003).
[2] 1.Zhang, F., Nangreave, J., Liu, Y. & Yan, H. Structural DNA Nanotechnology: State of the Art and Future Perspective. J. Am. Chem. Soc. 136, 11198–11211 (2014).