DNA Origami for plasmonics and fluorescence applications

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This contribution will focus on different applications of the DNA-Origami technique [1] in the fields of plasmonics and fluorescence enhancement. In particular, we employ DNA-Origami as a platform where metallic nanoparticles as well as single organic fluorophores can be organized with nanometer precision in three dimensions. With these hybrid structures we initially study the nanoparticle-fluorophore interaction in terms of the distance-dependent fluorescence quenching [2] and angular dependence around the nanoparticle [3]. Based on these findings, we build highly efficient nano-antennas (figure a) based on 100 nm gold dimers [4-5] which are able to strongly focus light into the sub-wavelength region where the fluorophore is positioned and produce a fluorescence enhancement of more than three orders of magnitude. Using this highly confined excitation field we were able to perform single molecule measurements in solution at concentrations as high as 5 µM in the biologically relevant range (>1µM). Additionally, we report on a controlled increment of the radiative rate of organic dyes in the vicinity of gold nanoparticles with the consequent increment in the number of total emitted photons [6,7]. We also employ the nanoantennas to mediate the fluorophore emission and thus to shift the apparent emission origin. Finally we will discuss how DNA-Origami can also improve the occupation of other photonic structures, the zeromode waveguides (ZMWs). These structures, which consist of small holes in aluminum films can serve as ultra-small observation volumes for single-molecule spectroscopy at high, biologically relevant concentrations and are commercially used for real-time DNA sequencing [8]. To benefit from the single-molecule approach, each ZMW should be filled with one target molecule which is not possible with stochastic immobilization schemes by adapting the concentration and incubation time. We present DNA origami nano-adapters that by size exclusion allow placing of exactly one molecule per ZMW (figure b). The DNA origami nano-adapters thus overcome Poissonian statistics of molecule positioning [9] and furthermore improve the photophysical homogeneity of the immobilized fluorescent dyes [10].

References

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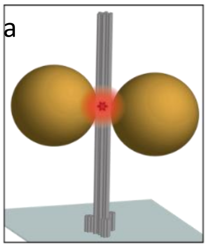
Figures

a



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