DNA-based assembly of nanoparticles of various shapes and materials into discrete nanostructures

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Metallic nanoparticles possess strong optical properties that depend on their size, shape and composition due to their localized surface plasmon resonance. Moreover, their controlled assembly into discrete hybrid or chiral plasmonic nanostructures can exhibit Fano-like resonances1 or circular dichroism2. In particular, thiolated DNA has been extensively used to self-assemble in solution billions of identical nanostructures with interparticle distances controlled down to the nanometer. However, most reports only focus on the self-assembly of identical nanoparticles. Indeed, because of the different ligands (citrate, CTAB, CTAC, PVP…) and solvents (water, ethanol) used when synthesizing various nanoparticles, they possess different physico-chemical properties, such as zeta potential, which can prevent a controlled self-assembly. Here, we present a rapid way to fabricate and purify hybrid DNA-based assemblies enabling study of the optical properties of individual structures.

The method relies on the use of a central nanocrystal of given morphology. Tethering various quantities of tri-thiolated DNA strands onto the surface of the central nanocrystal and combining these nanoparticles with spheres functionalized with a single complementary DNA strand allows the specific, and self-terminating, assembly of hybrid nanocrystal superstructures. Different nanostructures can be produced in high yield by varying the number of strands tethered on the central nanoparticle. These range from dimers (Figure 1a) to structure with the central nanoparticle fully covered with spheres (Figure 1b), when increasing the DNA coverage. This technique was used to assemble particles of different particle shape such as triangles (Figure 1c) and cubes, and different composition such as silver. Moreover, we will present optical properties of individual structures measured using dark-field spectroscopy and correlated with SEM images.

Overall, this technique will help to synthesize and purify colloidal solutions of hybrid plasmonic structures with novel optical properties.

Figure 1. (a,b) SEM or (c) TEM images of DNA-based discrete assemblies of (a,b) gold bipyramids or (c) triangles (a) attached to a single gold nanosphere or (b,c) fully covered with gold nanospheres. Scale bar is 200 nm.

References
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