DNA Directed Assembly of Nanoparticles Linear Structure For Nanophotonics

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Recently, the optical properties of metallic nanoparticles and their aggregates have attracted great interest. Theoretical computation shows that a self-similar linear chain of several metal nanospheres with progressively decreasing sizes and separations can work as an efficient nanolens[1]. Previously, self-assembled DNA nanostructures have been produced to generate various patterns[2] and also used to organize nanoparticles in 1D or 2D arrays[3, 4, 5, 6]. But linear array of nanoparticles with decreasing sizes and precise control of distance under 10 nm has not been reported. Lithography has been utilized to fabricate nanophotonic structures. But it is very hard to produce nanospheres by top-down methods. Here we describe a method to use a rigid DNA motif (Triple crossover molecule) to organize Au nanoparticles to realize the arrangement.

Stiff triple crossover DNA (TX) motifs have been used to construct 2D or 3D nanostructures[7]. Here we designed a nine-turn long TX motif that is consisted of eight DNA strandsas shown in Fig.1. Three strands are thiol-modified at the 5' end to allow the linkage to Au particles. Au particles with only one piece of DNA attached are individually purified by agarose gel electrophoresis. Three DNA-Au conjugates then hybridize with other five DNA strands without Au linkage. The DNA and nanoparticle hybridization products are analyzed by Gel electrophoresis. Target bands are extracted from the gel and are analyzed by scanning electron microscopy. The total yield of the chain structure is not high (less than 15%), but optimization of stoichiometry among three Au particles linked DNA and other five DNA strands will increase the yield.

Linear chains of different size Au particles with controllable distance were successfully fabricated as shown in Fig.2. The next step will be the characterization of optical signal. A six particle linear chain can be produced by connecting two TX motifs. The same method could apply to other stiff DNA motifs. For example, DNA origami[8] can be use to organize more particles.

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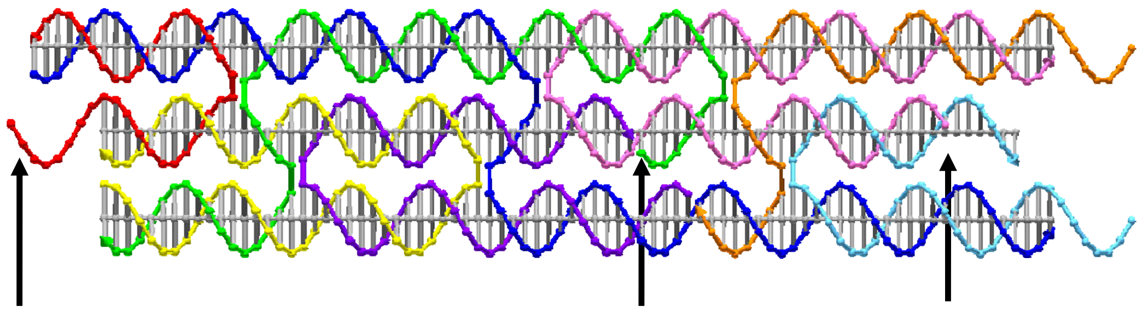

Figure 1, TX motif that is used to organize three different sized Au particles. The black arrows point to the Au particles linkage position. By control the sequence, two of this TX motif can be assembled together to produce a chain of six nanoparticles

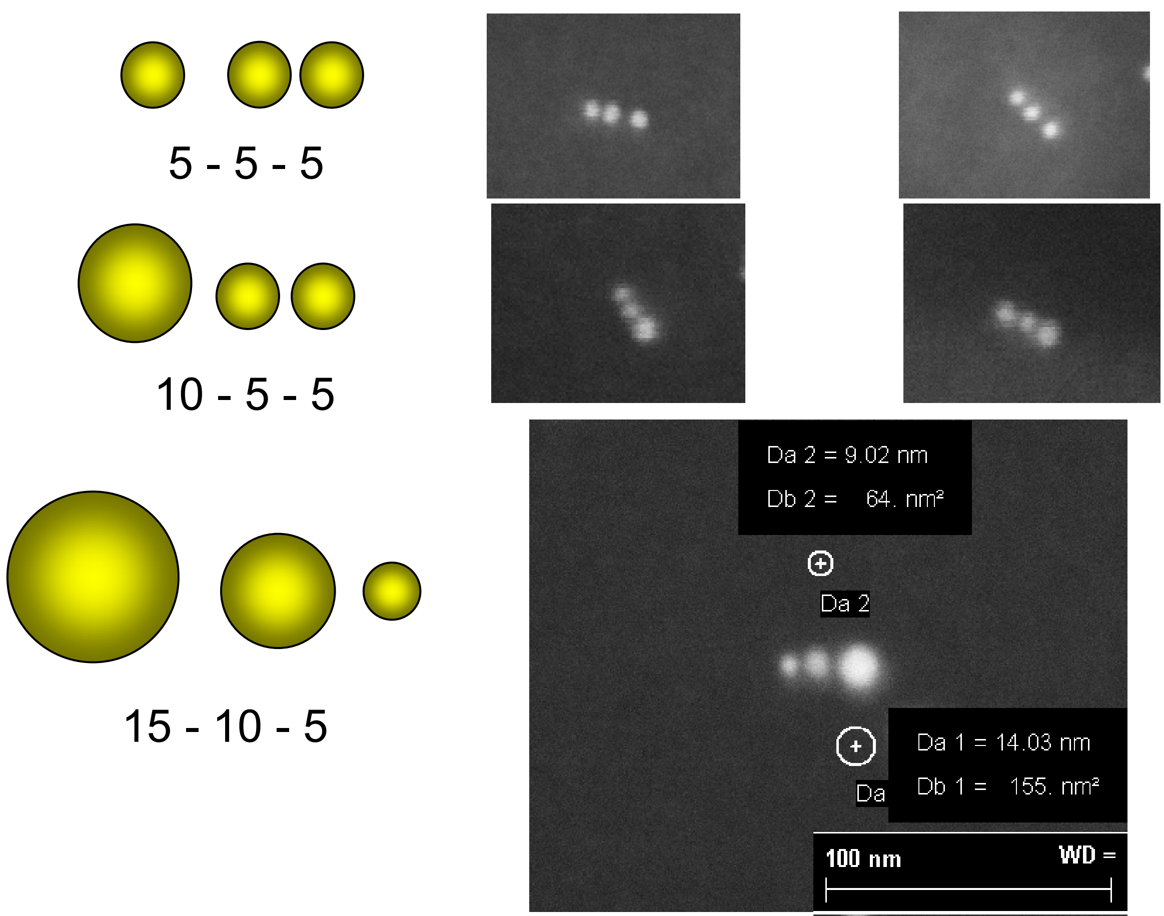

Figure 2, SEM images of chain structure of three Au nanoparticles with different sizes and distances. The sizes of particles chain are labeled on the left of images. Top two structures are organized by regular 6-turn long TX motif. Bottom structure is organized by 9-turn long TX motif shown in Fig.1 to have enough space for 15nm Au particles.