NANOPARTICLE ORGANIZATION AND ADVANCES IN STRUCTURAL DNA NANOTECHNOLOGY

Faisal A. Aldaye and Hanadi F. Sleiman[*]
McGill University, 801 Sherbrooke St. W., Montreal QC H3A 2K6, Canada
hanadi.sleiman@mcgill.ca

One of the central challenges of nanoscience is the organization of functional components according to a deliberately designed pattern, and the ability to modify this pattern at will. Because of its molecular recognition specificity and structural features, DNA presents a unique opportunity to address the above goal. Our research group has been examining the creation of branched DNA molecules containing organic vertices, and the study of their self-assembly into discrete, as well as extended DNA nanostructures.

(a) We discuss a method in which six gold nanoparticles are assembled into a well-defined discrete hexagonal arrangement. The approach involves labeling the individual nanoparticles with DNA containing building blocks that dictate their final location within the constructs.[1]

(b) We also report a straightforward method to selectively organize gold nanoparticles into libraries of discrete and well-defined structures, using a small number of single-stranded, dynamic DNA templates.[2] This approach not only provides the ability to finely control the geometry of the assembly, and the precise position of each nanoparticle, but it also allows for the modification and tuning of these structural features post- assembly. As such, the resulting nanoparticle groupings can undergo structural switching and write/erase functions in response to specific external agents. Access to libraries of precisely positioned particle groupings will allow for the systematic examination of their optical, electronic and catalytic properties as a function of their structure, and will also lead to advances in the use of these particles as components of nanoelectronic and nanophotonic circuitry, plasmonic tools, and surface-enhanced Raman scattering substrates.

(c) As the structural size and complexity of such artificial DNA architectures increases, so will the number of coding DNA sequences that will need to be designed. This inevitably results in overlapping, degenerate sequences that may assemble into undesirable products. We report the first example of guest mediated access to a *single DNA nanostructure*, from building blocks containing identical DNA strands that otherwise generate a complex library of multiple DNA assemblies. This guest template also re-equilibrates every other member of this self-assembled mixture into the same single nanostructure. The addition of a small DNA-binding molecule to alter and refine product outcome in DNA self-assembly not only allows for the incorporation of symmetry to construct more complex systems, but also presents the immediate advantage of auto-correcting errors that may form during the initial self-assembly process. We further applied this approach to predictably construct well-defined one-dimensional DNA fibers extending over tens of microns using two trifunctional DNA building blocks that otherwise generate ill-defined oligomeric networks. Considering the wealth of DNA-binding molecules which can be employed to tune, modify and correct the assembly of DNA structures, this finding promises to lead to significant advances in the field of DNA nanotechnology.

References:

[1] Faisal A. Aldaye and Hanadi F. Slieman, *Angew. Chem. Int. Ed.*, **45** (2006) 2204-2209.

[2] Faisal A. Aldaye and Hanaid F. Sleiman, *J. Am. Chem. Soc.*, **129** (2007) 4130-4131.

Figures:

(a) (b) (c)