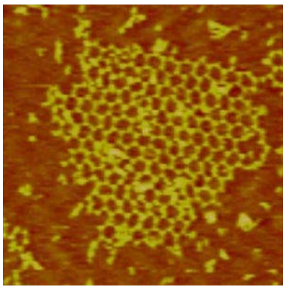
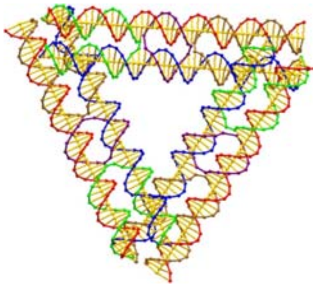
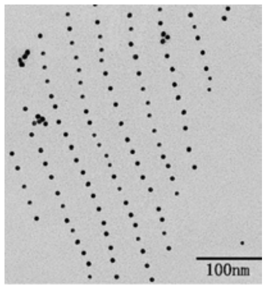
Using structural DNA nanotechnology to organize matter

Nadrian C. Seeman
New York University, U.S.A.

Structural DNA nanotechnology uses branching to produce unusual motifs that can be self-assembled into objects, lattices and devices. The self-assembly process is directed by programmable cohesive interactions between the ends of the helices, typically using single-stranded overhangs called 'sticky ends'. The strength of sticky-ended cohesion is that it produces predictable adhesion combined with known structure. Initial constructions included stick-polyhedra, knots and Borromean rings. These were followed by the self-assembly of two-dimensional arrays built from simple motifs, such as double (DX) and triple (TX) crossover motifs. Recent array components include planar and skewed triangular motifs whose edges are DX molecules. The former leads to honey comb-like arrangements, as shown on the left below. We combine DNA motifs to produce specific structures by using sticky-ended cohesion (below, left).







Three-space-spanning motifs can be developed readily. These are motifs that contain intramolecular vectors that can be used in sticky-ended self-assembly to fill space. Using only two of these directions leads to two-dimensional arrays that have a feature that can be used to organize nanoelectronic components, such as gold nanoparticles. The 3D-DX triangle (middle above) is such a motif. It has been used to produce the array of nanoparticles shown in the transmission electron micrograph at the right above. Note that the spacing in the vertical direction is roughly twice the spacing in the horizontal direction, because only one of the two triangles contains a nanoparticle.

Another 3-space-spanning motif with the potential to organize matter is the 6-helix bundle, This motif (shown in cross-section and laterally) also can be built into a 2D array. The images on the right are an AFM of an array and its autocorrelation function.