Supporting Information

Three-Helix Bundle DNA Tiles Self-assemble into 2D Lattice or 1D Templates for Silver Nanowires

By S. H. Park, R. Barish H. Li, , J. H. Reif, G. Finkelstein, H. Yan*, and T. H. LaBean*.

1. Materials and Methods:

Three-Helix bundle Design and Annealing. The DNA base sequences of the 1D-3HB and 2D-3HB tiles were designed with the program SEQUIN [N.C. Seeman, J. Biomol. Struct. Dyns. **8**, 573-581 (1990)] to minimize the chance of sequence symmetry and undesired complementarity. The strand sequences for the molecules used here are given below in Figure S1. Custom oligonucleotides were purchased from Integrated DNA Technology (Coralville, IA) and purified by PAGE. Complexes were formed by mixing a stoichiometric quantity of each strand in 1xTAE/Mg^{++} buffer (20 mM Tris (pH 7.6), 2 mM EDTA, and 12.5 mM $MgCl_2$). The final concentration of DNA was 1.0 μM. Oligo mixtures were cooled slowly from 95ºC to 20ºC by placing the microtubes in 2 L of boiled water in a sealed styrofoam box for 2 days to facilitate hybridization.

AFM Imaging. A 5 μL sample was dropped on freshly cleaved mica and left to adsorb to the surface for 3 minutes, then 30 μL of 1xTAE/Mg^{++} buffer was added onto the mica. Imaging was performed using tapping mode under liquid phase in a fluid cell on a Multimode NanoScope IIIa, using NP-S tips (Veeco Inc.).

Two Step Metallization. 1) First, the 1D-3HB filament was seeded with silver using the glutaraldehyde method. Annealed DNA was incubated with 0.2 % glutaraldehyde in 1xTAE/Mg^{++} buffer on ice for 20 minutes, then at room temperature for 20 minutes, then the sample was loaded into a Slide-A-Lyzer Mini Dialysis unit (Pierce, Rockford, IL) and dialyzed overnight at 4°C in 1 L of 1xTAE/Mg^{++} buffer.

The published method [E. Braun, et al., Nature **391**, 775-778, (1998)] was modified in that the silver seeding was done in aqueous solution for 20 minutes instead of on substrate. Then 10 μL was deposited onto silicon substrate, allowed to absorb for 5-10 minutes; then excess reagent was rinsed off with distilled water, and dried under a stream of nitrogen. Silicon substrate was treated with aminopropyl silane prior to DNA sample deposition for better adhesion to the substrate. 2) In the second step, HQ SILVER^{TM}-EM Formulation (www.nanoprobes.com) was used according to the manufacturer's instructions. One unit of initiator (A) was mixed with one unit of moderator (B) and one unit of activator (C). Then 10 μL of this fresh mixture was pipetted onto the sample and left for 5-10 minutes. Finally excess reagent was rinsed off with distilled water and dried under a stream of nitrogen.

2. Supporting Figures:

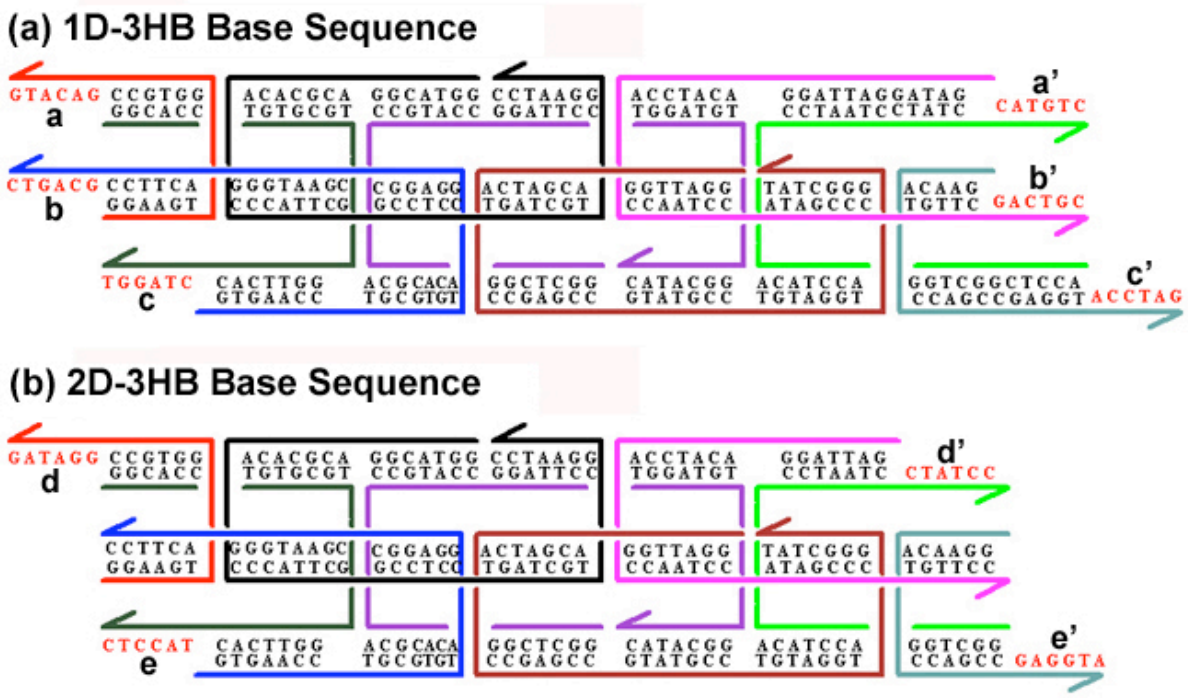

Figure S1. (a) The 1D-3HB strand structure and sequences, (b) the 2D-3HB structure and sequences. The complementary sticky-ends of *a*, *b*, *c*, *d*, and *e* are *a'*, *b'*, *c'*, *d'*, and *e'*, respectively.

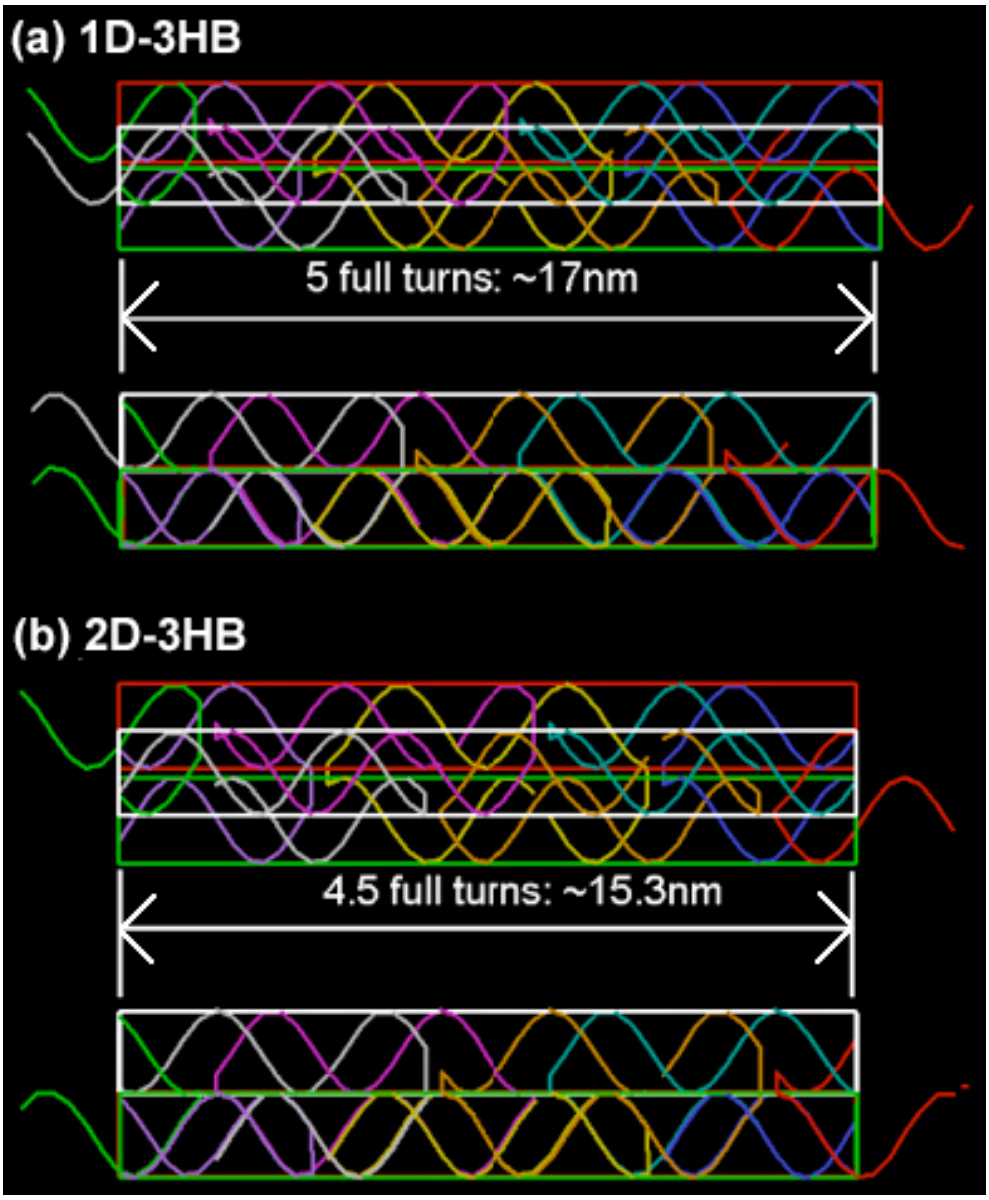

Figure S2. (a) Top view (top) and side view (bottom) schematic drawings of the 1D-3HB tile. The 1D unit tile consists of nine strands illustrated in different colors. Three rectangles — red, white and green — outline duplex DNA domains. In this drawing, five full turns of helix and six crossovers can be seen. (b) Schematic drawings of the 2D-3HB tile show 4.5 full turns of helix and six crossovers.

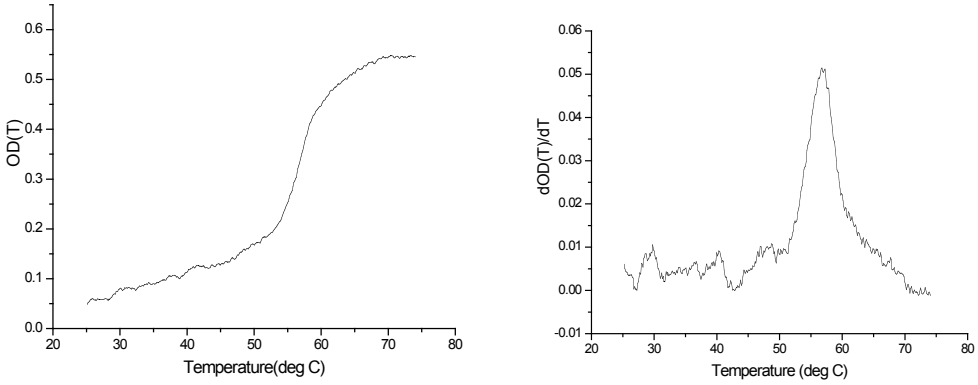

Figure S3. Melting behavior of 3HB tile without sticky ends. The optical density at 260 nm as a function of temperature (left panel). The derivative of the A_{260} data shows several different melting domains with the most significant overall transition at around 57° C (right panel).

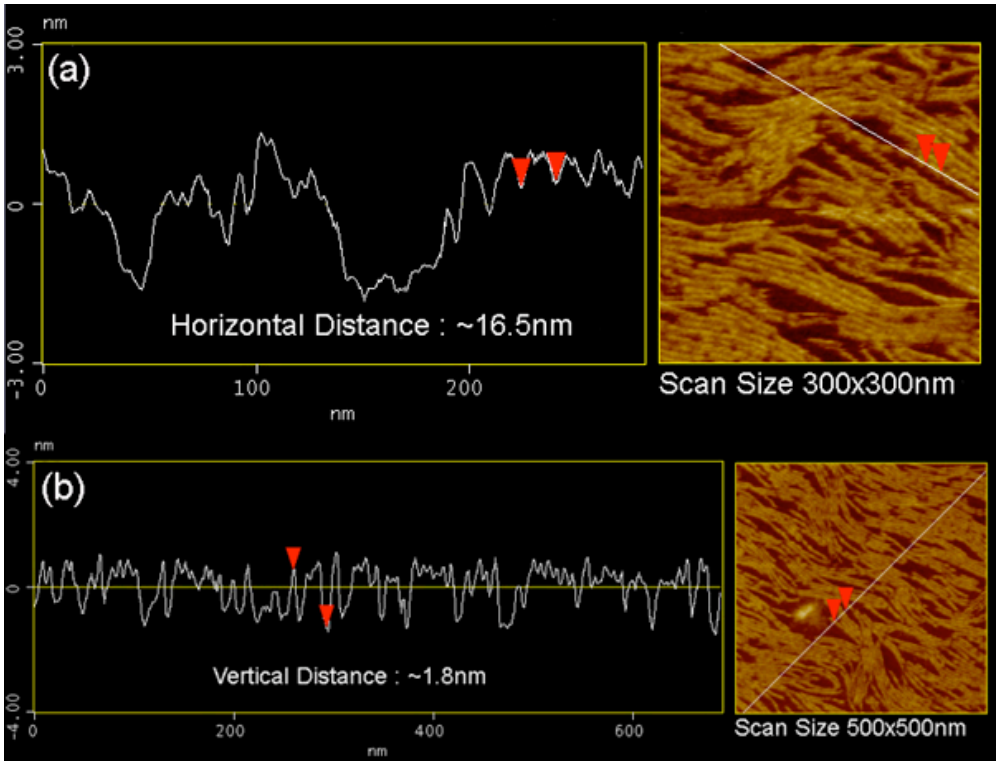

Figure S4. (a) Section profiles from AFM images of the 1D filaments. After formation, we observe horizontal lengths for the unit 1D-3HB tile at about 16.5 nm, in good agreement with the designed structure, ~17.0 nm. (b) Vertical distance (height) of the 1D-3HB filaments is 1.8 ± 0.2 nm.

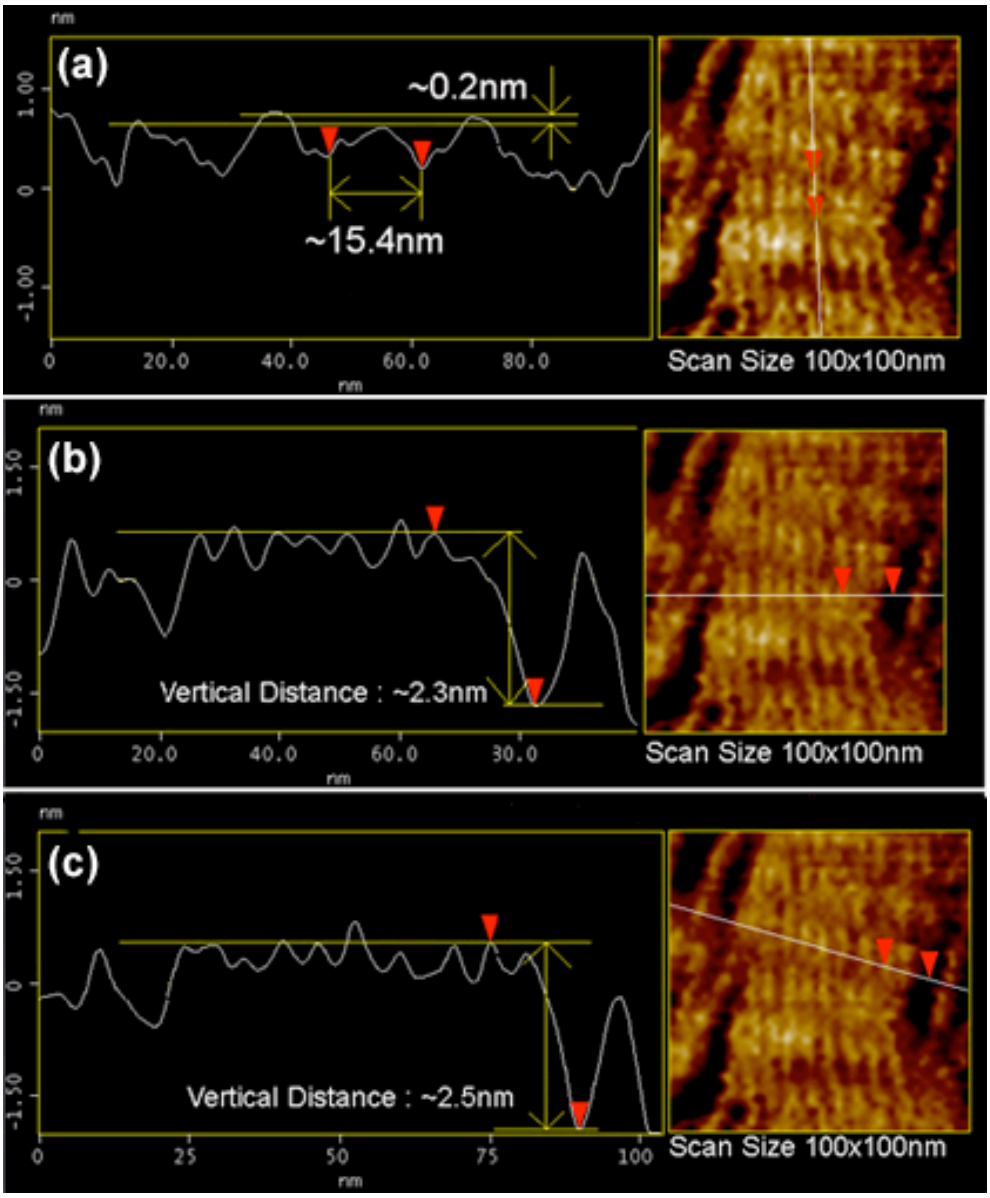

Figure S5. (a) ~ (c) Section profile AFM images of 2D-3HB lattices. Tile heights are ~2.5 nm for upward-facing stripes and ~2.3 nm for downward-facing. Thus, the height difference between alternating stripes is ~0.2 nm, with upward-facing stripes slightly lower. Horizontal unit distance is ~15.4 nm matching the designed distance of ~15.3 nm.