# Self-Assembly via DNA Origami

Si-ping Han[1], Hareem Maune[2], Robert Barish[1†], Paul W. K. Rothemund[1], Erik Winfree[1], Marc W. Bockrath[3] and William A. Goddard, III[1]*

[1] California Institute of Technology, Pasadena, CA
[2] IBM Almaden Research Center, San Jose, CA
[3] University of California Riverside, Riverside, CA
[†] Current address: Wyss Institute, Harvard University, Cambridge, MA

***PI contact: wag@wag.caltech.edu**

Structural DNA nanotechnology allows rational design and self-assembly of geometrically exquisite two and three dimensional nanostructures. We demonstrate two methods for using DNA nanostructures to the guide the assembly of single walled carbon nanotubes (SWNT) into functional nanodevices.

First, we have used DNA origami as a nanoscale breadboard to assemble SWNT cross-junction transistors. In this process, SWNTs are modified with non-covalently attached DNA linkers that present duplex labeling domains for base pairing to complementary single stranded hooks patterned on customized DNA origami. We show that the DNA labeled SWNTs attach to DNA origami at positions and in orientations specified by their labeling sequence. This allows assembly of cross-junction transistors by mixing origami templates with two types of labeled nanotubes. The resulting structures have transistors-like electronic behavior.

Second, we have discovered that structured DNA linkers can assemble solution dispersed (including purified semiconducting) SWNTs into parallel arrays via surface diffusion mediated self-assembly. Duplex portions of the DNA linkers act as spacers to precisely control the inter-nanotube separation distance down to $< 3$ nm, and can serve as scaffolds to position components such as proteins between adjacent parallel nanotubes. The arrays can be assembled on Muskovite mica and DPPC lipid bilayers and transferred to other substrates by stamping.

Our results demonstrate nanoscopically precise and massively parallel assembly of SWNTs in device-like geometries, and suggest avenues and challenges towards reaching truly scalable and practical DNA based nanomanufacturing.