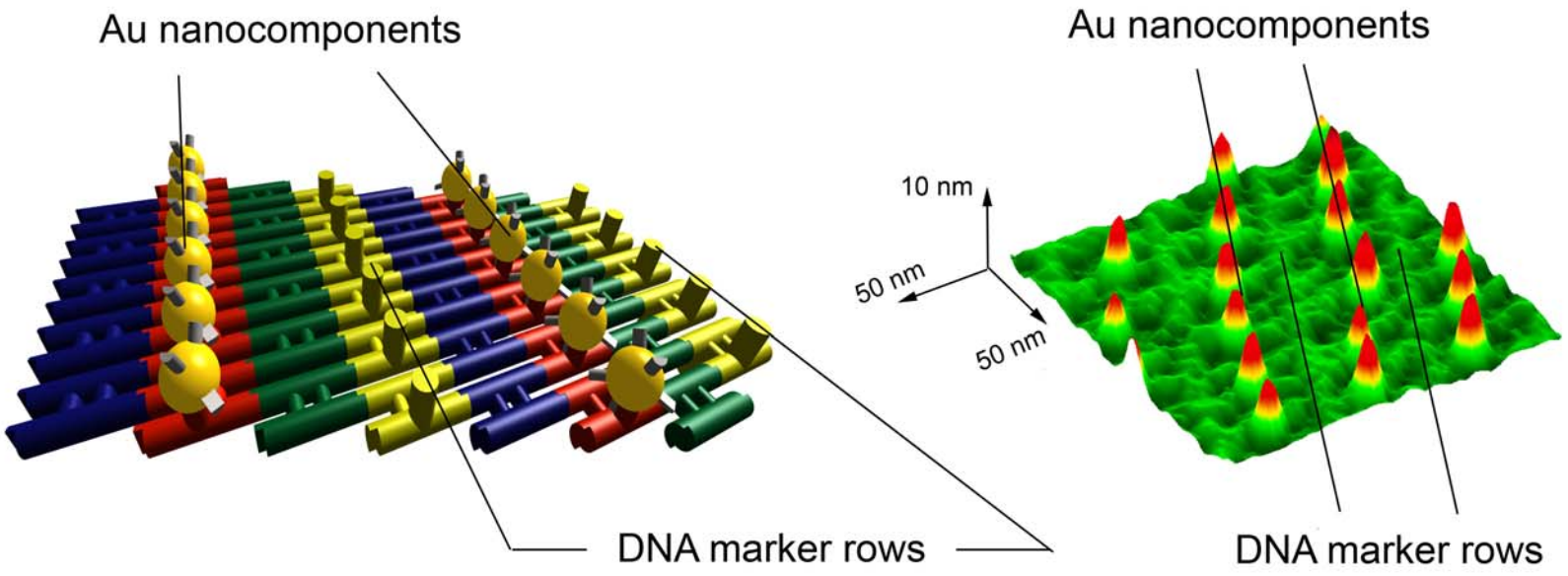
DNA-Based Nanoelectronic Manufacturing Technologies

Richard A. Kiehl

Department of Electrical and Computer Engineering
University of Minnesota, Minneapolis, Minn. USA



The Second U.S.-Korea Forum on Nanotechnology:Nanomanufacturing Research and Education,
Los Angeles, Calif., February 17-18, 2005

acknowledgments

- University of Minnesota

  Richard A. Kiehl (ECE)

  John D. Le (ECE)

  Karin Musier-Forsyth (Chem)

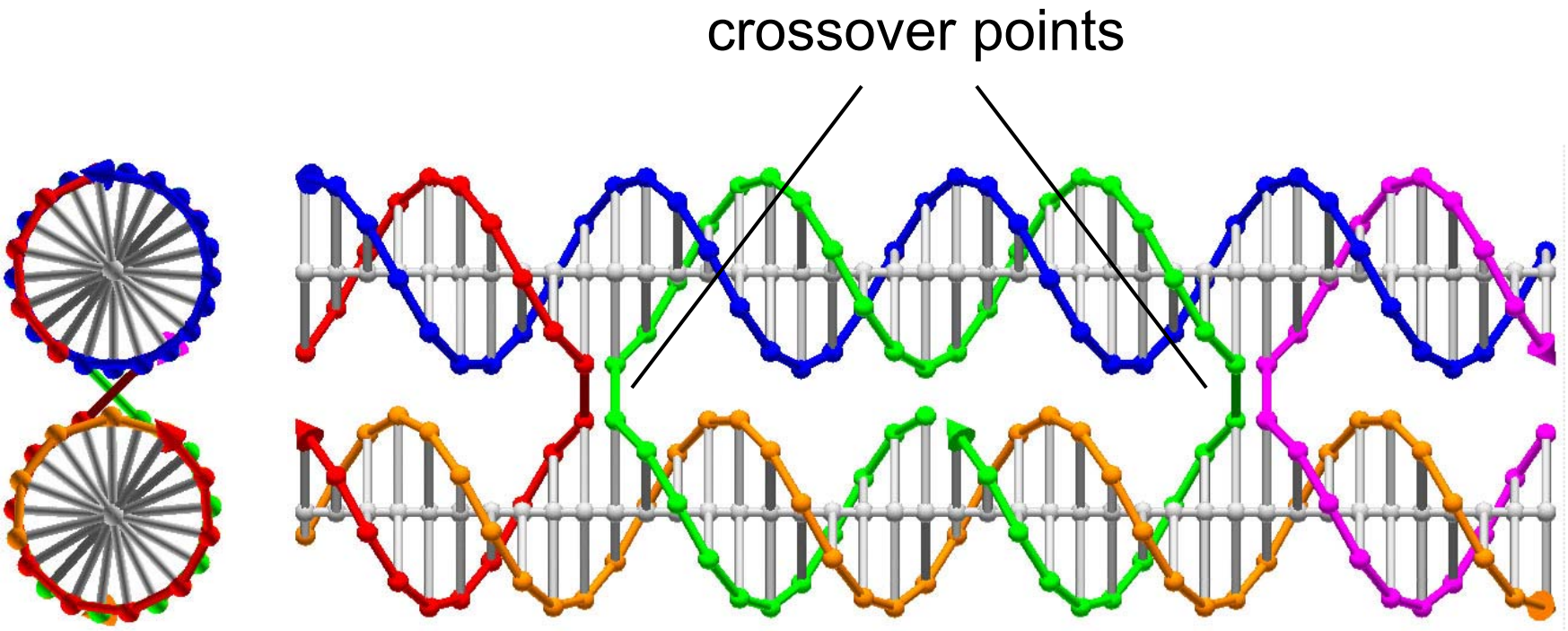
  Yariv Pinto (Chem, ECE)

  T. Andrew Taton (Chem)

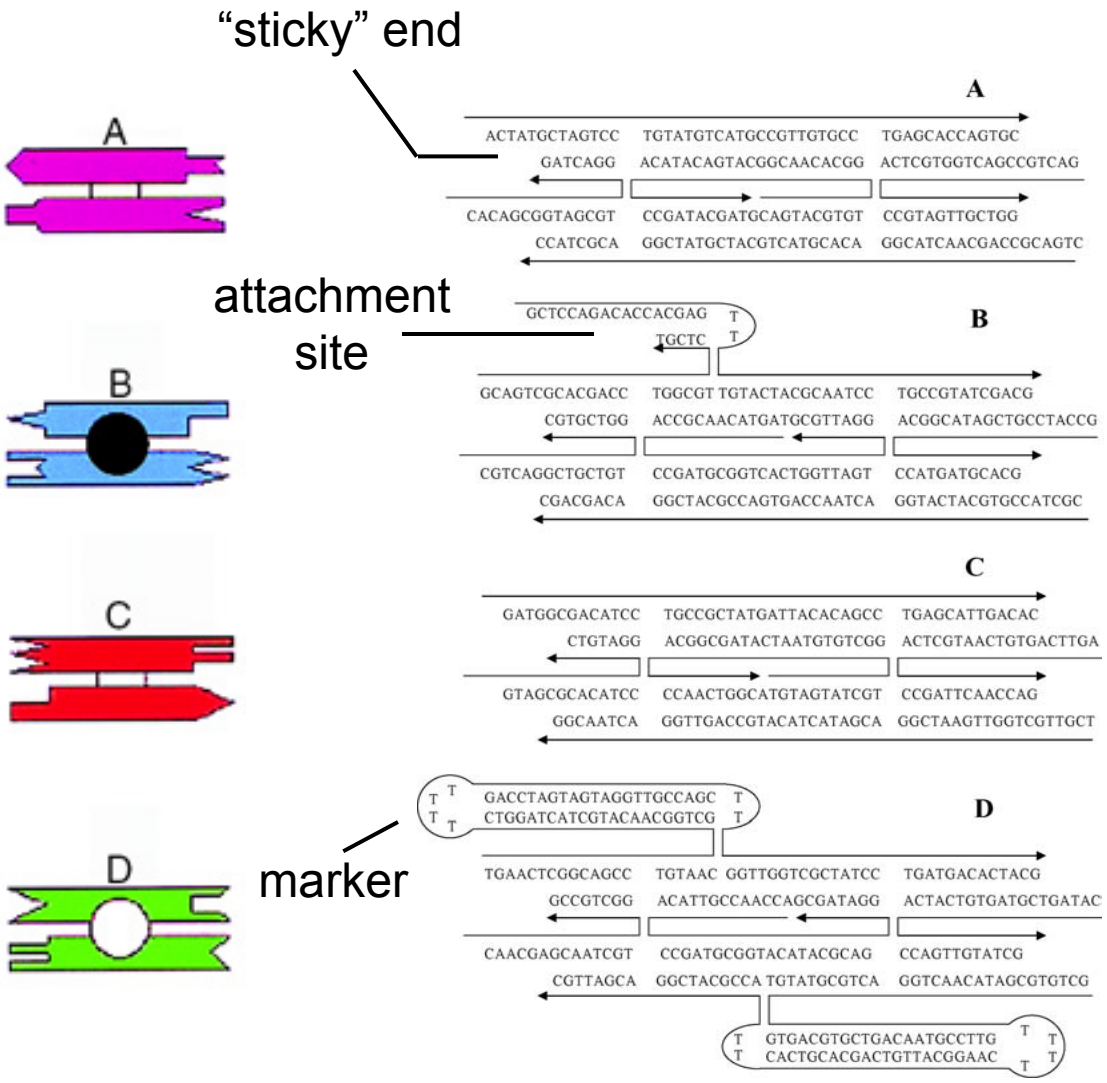
- New York University

  Nadrian C. Seeman (Chem)

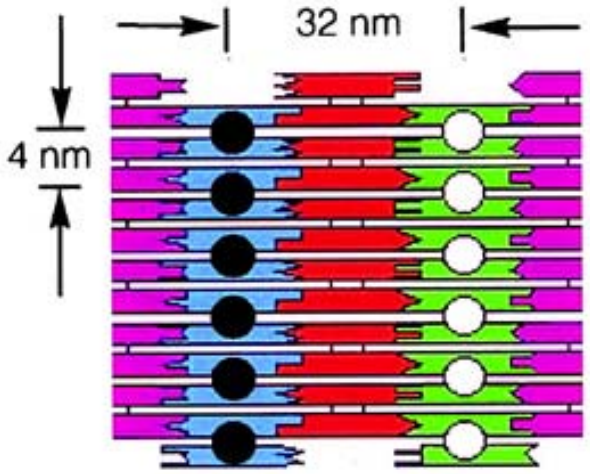
DNA double-crossover molecule



2D DNA scaffolding based on DX molecule “tiles”



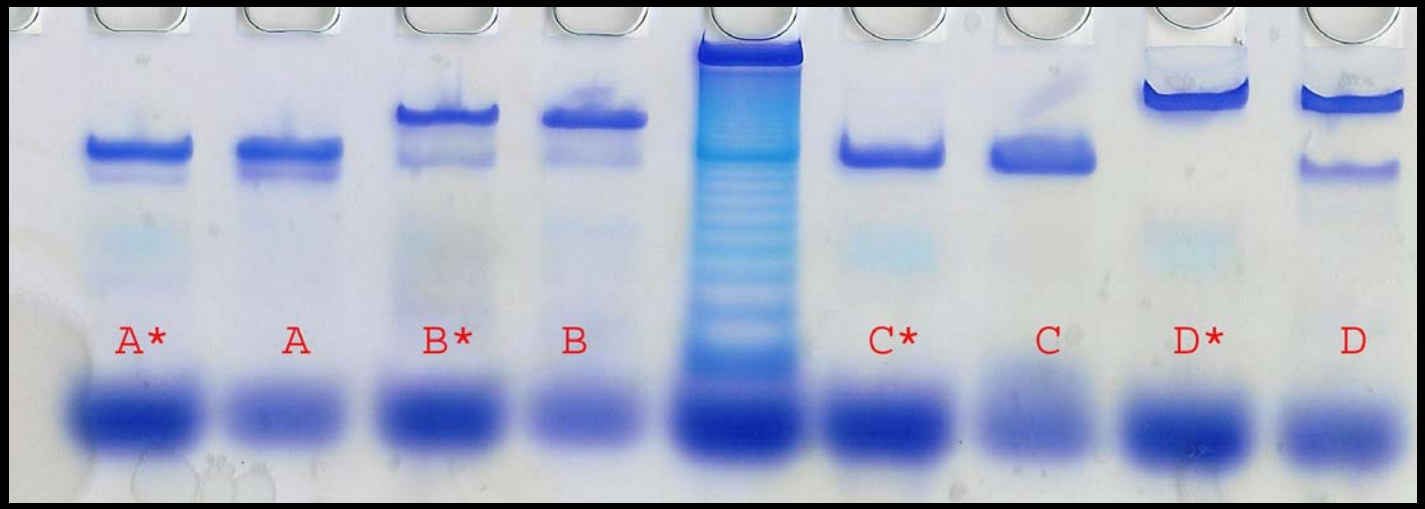
2D DNA crystal



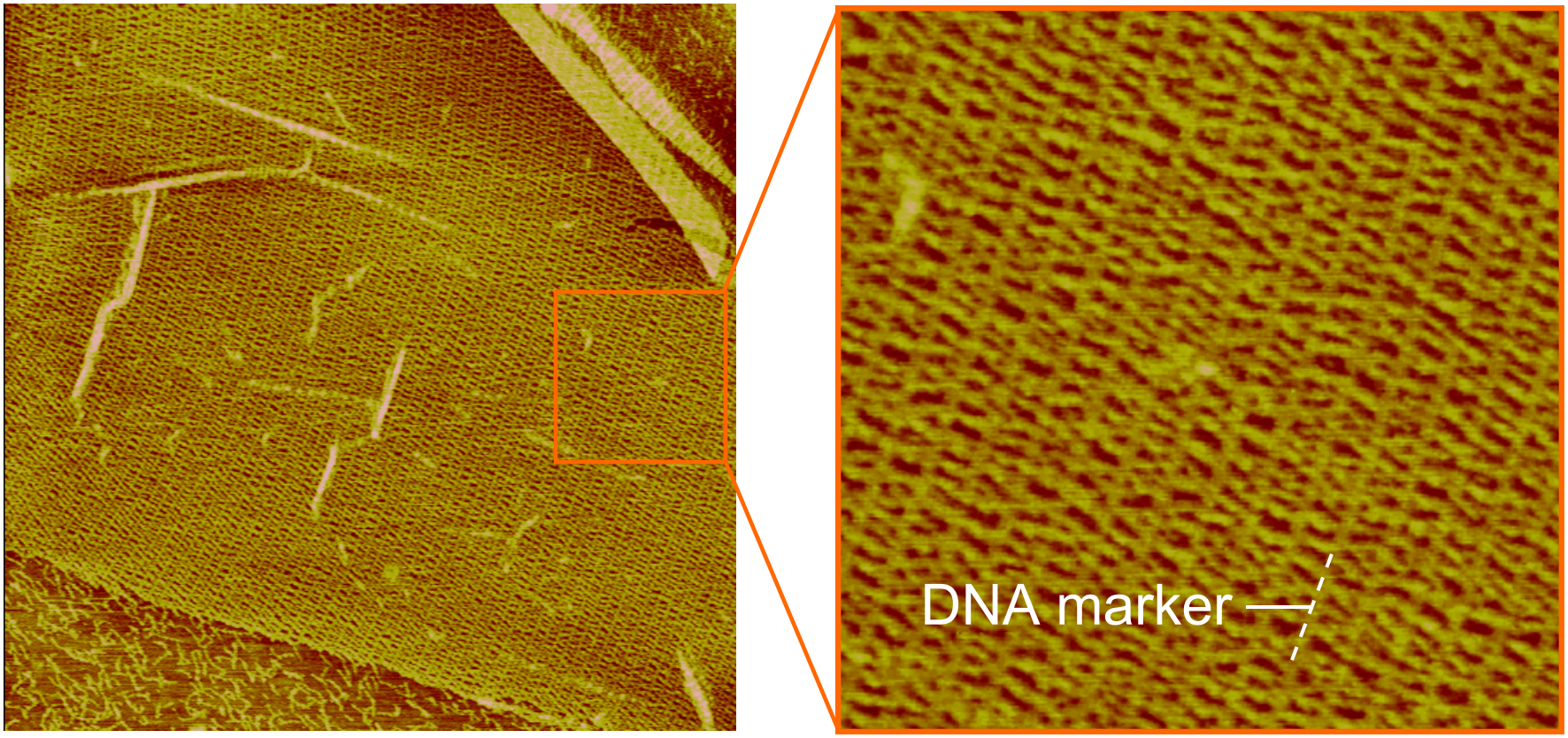
attachment sites

DNA markers

“materials growth technology”: tile analysis by gel electrophoresis



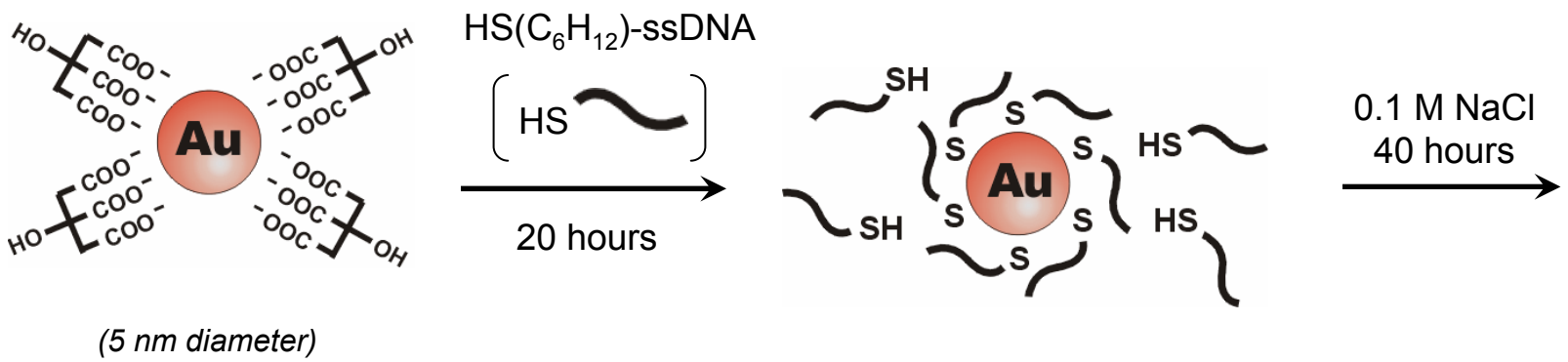
assembly of DNA scaffolding

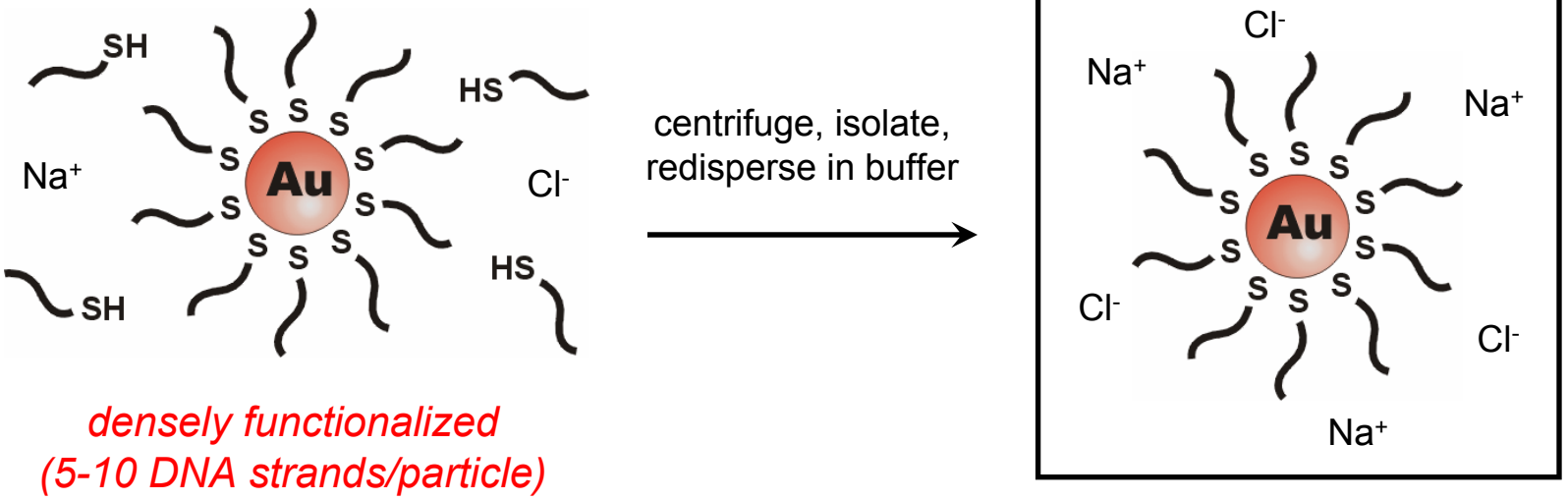


4 μm x 4 μm

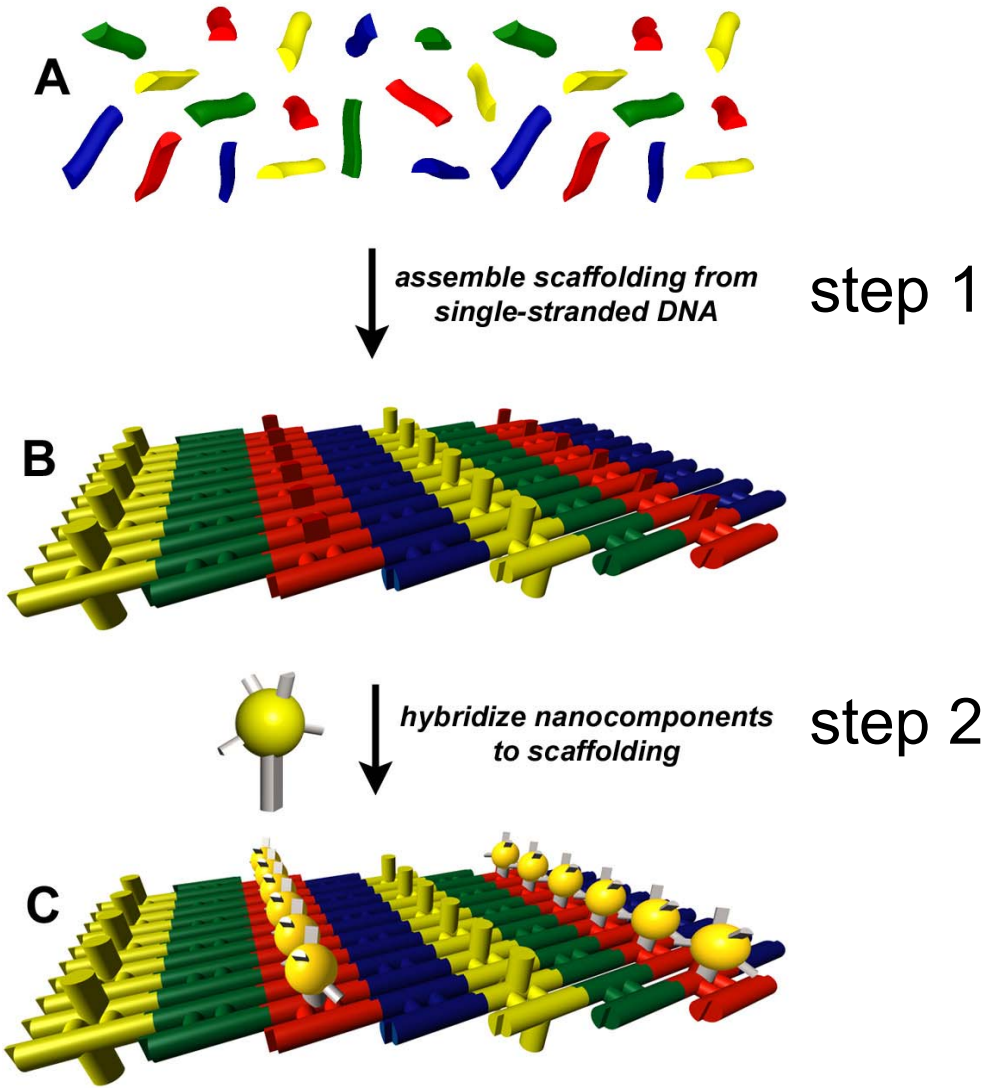
1 μm x 1 μm

“device process technology”: oligoDNA-nanoparticle conjugates



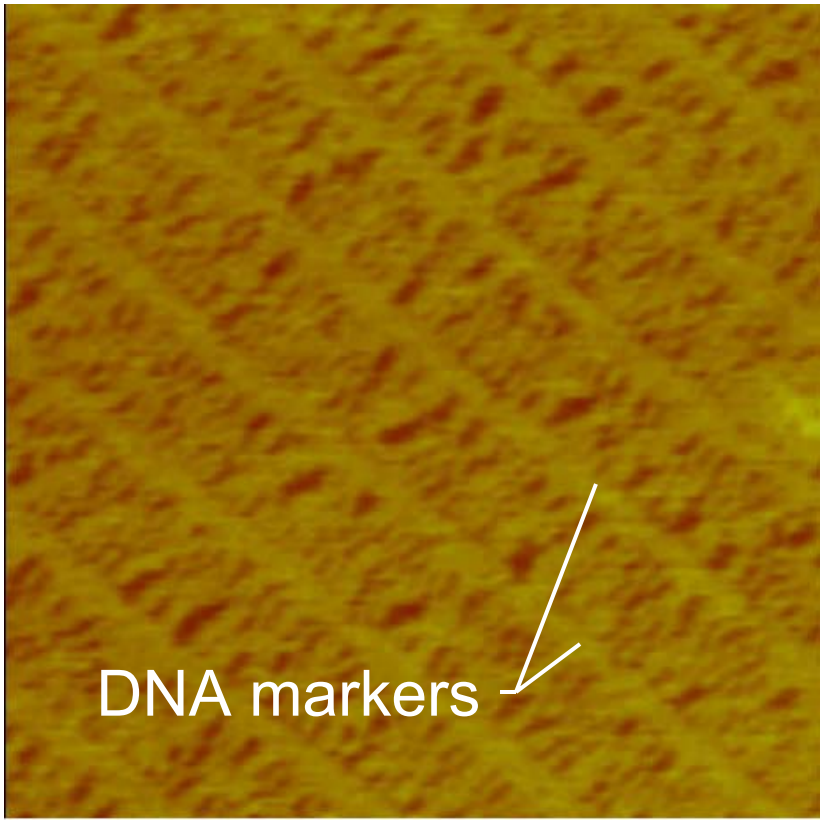


2-step process: scaffolding assembly > component attachment



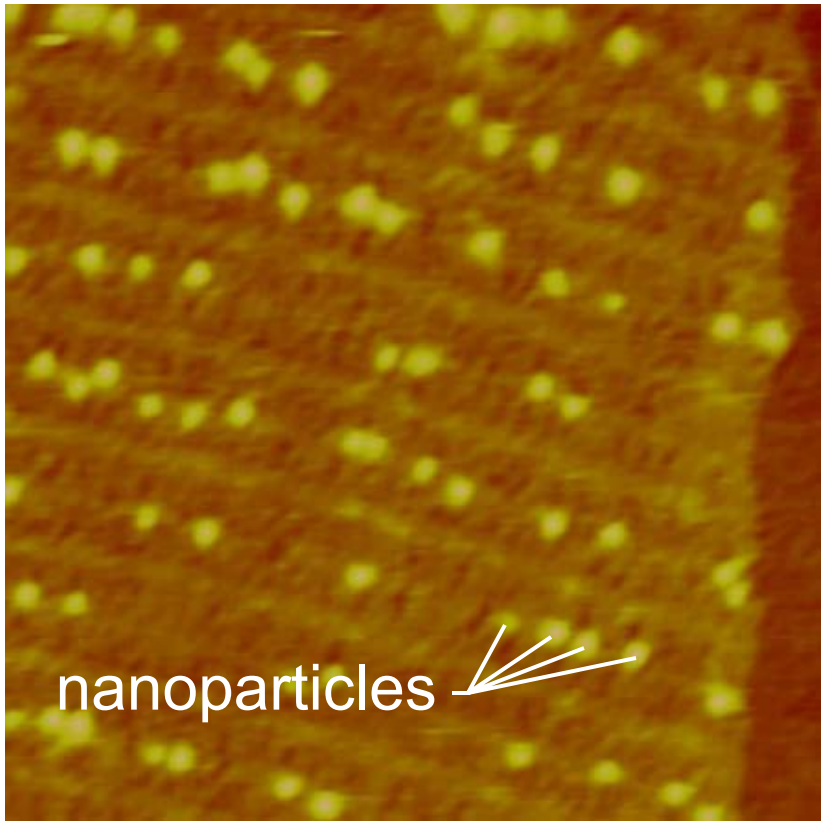
hybridization of nanocomponents to a pre-assembled DNA scaffolding

as-grown DNA crystal



0.5 μm x 0.5 μm

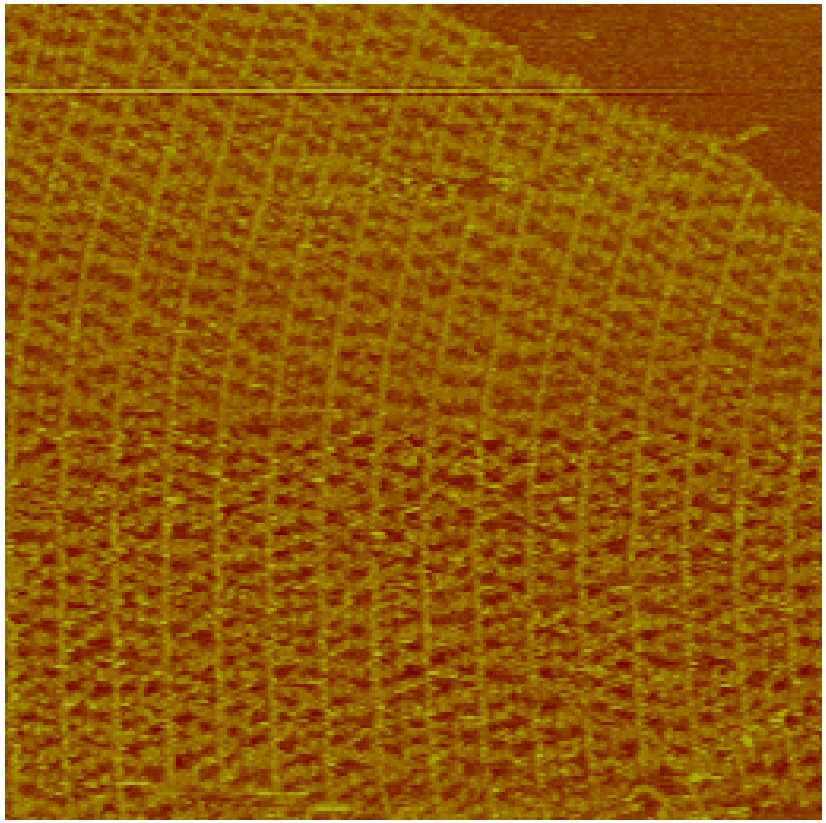
after hybridization



0.5 μm x 0.5 μm

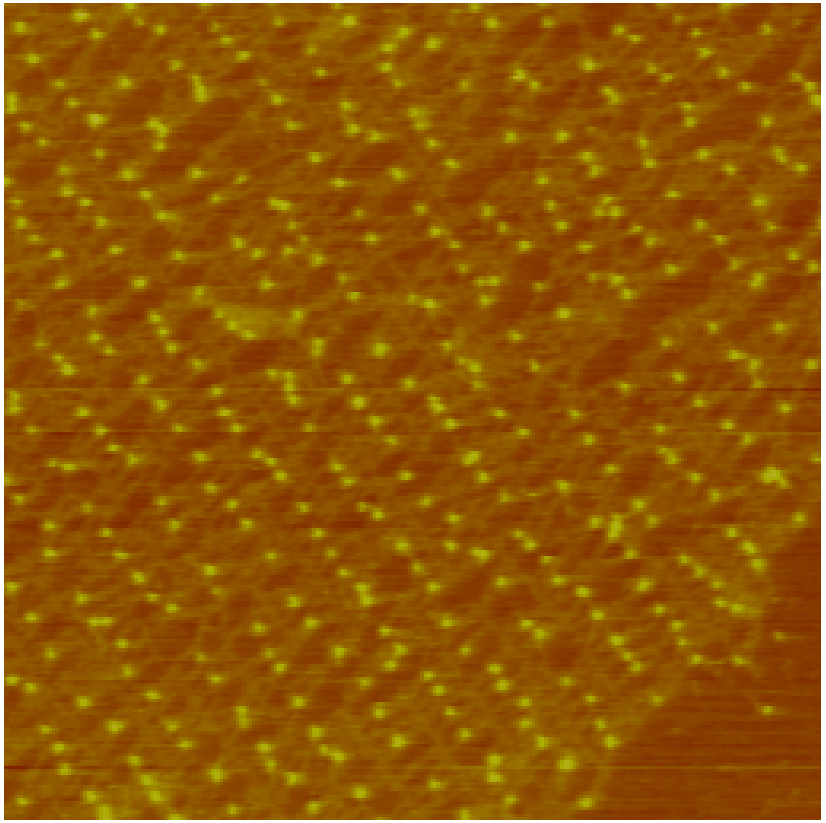
high-yield assembly of nanocomponent arrays

before hybridization



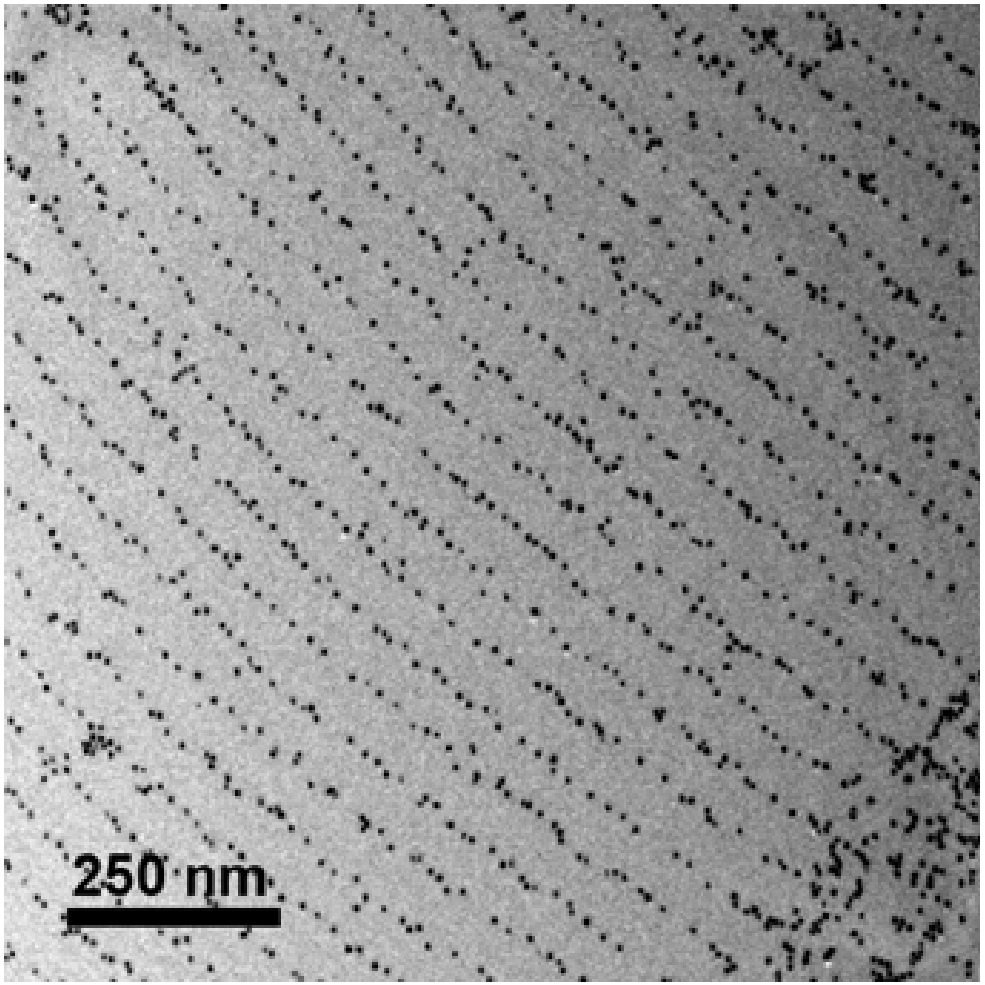
1 μm x 1 μm

after hybridization

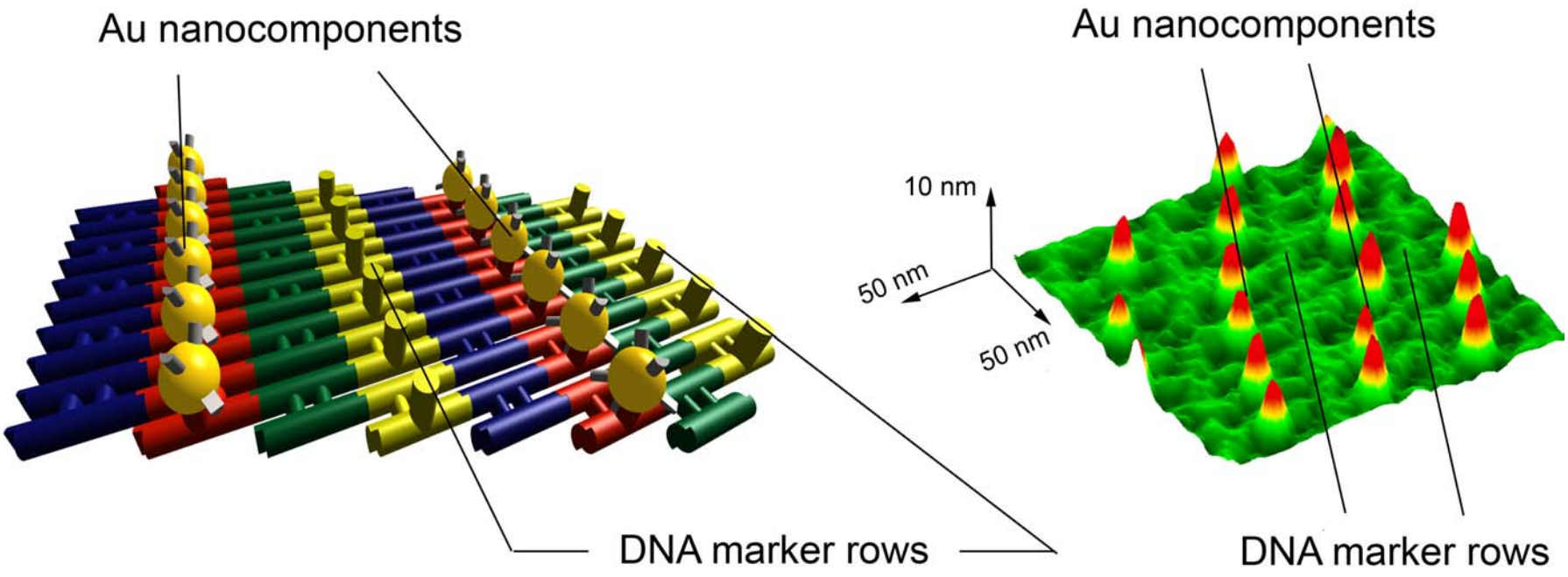


1 μm x 1 μm

TEM image confirming assembly of gold nanoparticles



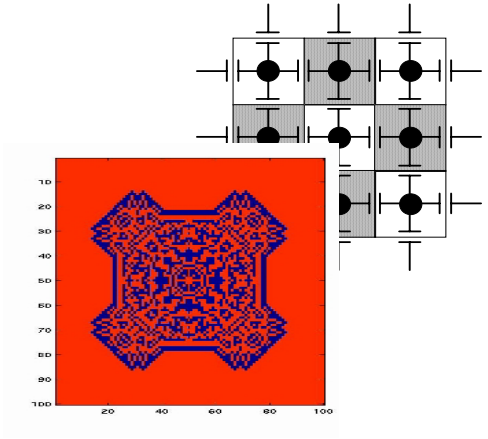
DNA-templated self-assembly of metallic nanocomponent arrays on a surface



J. D. Le, Y. Pinto, N. C. Seeman, K. Musier-Forsyth, T. A. Taton, and R. A. Kiehl, *Nano Lett.* 4, 2343, Dec 2004.

electronics applications: information processing in 2D arrays

tunneling phase logic cellular nonlinear network



periodic pattern selection

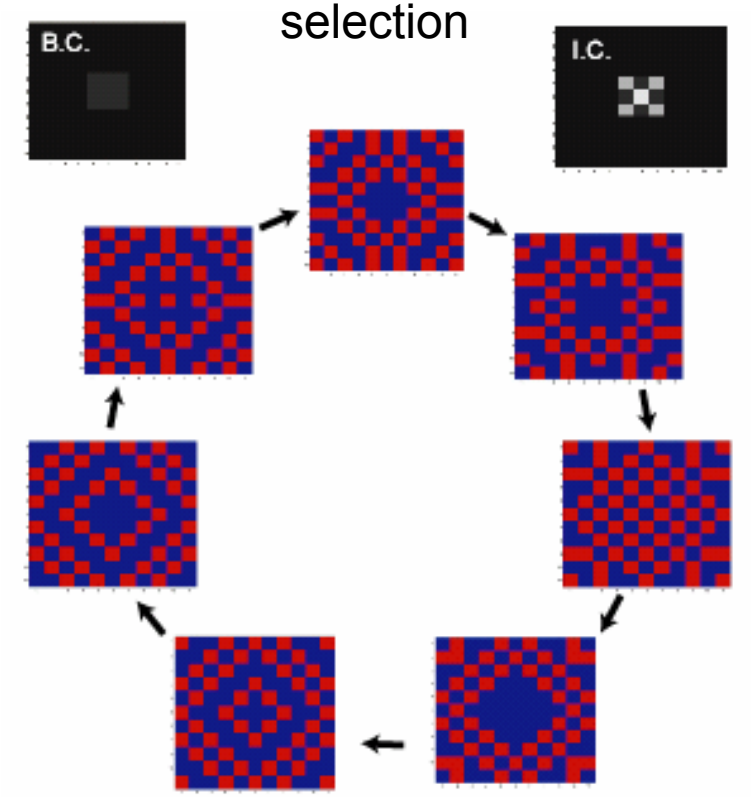
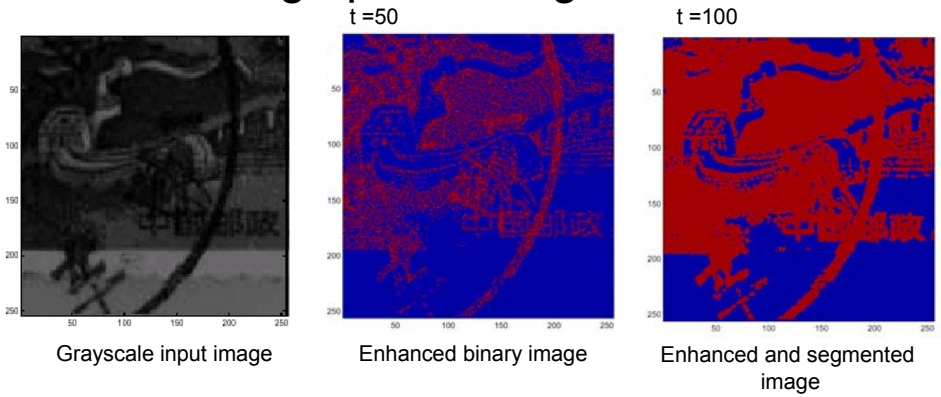


image processing function



Grayscale input image

Enhanced binary image

Enhanced and segmented image

T. Yang, R. A. Kiehl, L. O. Chua, Intl. J. Bifurcation and Chaos 11, 2895 (2001)

conclusion

- First demonstration of hybridization of nanoelectronic components to a pre-assembled 2D DNA scaffolding.

- High-yield assembly of DNA-Au nanocomponent arrays

  Scaffolding: 2D DNA crystal with hybridization sites

  Nanocomponents: oligoDNA-Au conjugates

- Step toward technology for *precision*, *programmable* assembly of nanoelectronic circuitry.