

## Adam Woolley (Brigham Young University) DNA-templated fabrication of carbon nanotube and metal nanowires:

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Background: A tale of two Y's. In 1910 students tried to construct a 200m tall school logo on the adjacent hill. The logistics were very challenging as the aspect ratio had to be compensated for line of sight. In 2004 we are trying to construct a DNA nano-Y, 20nm across: DNA templated nanocircuits. DNA as a nanofabrication template, 2nm, linear, aligned, specificity (base-pairing) conductivity? Background: negative DNA charge electrostatically attracts cations: reduce to make silver metal nanostructures, 100nm diameter wires. Objectives: probe the early stages of metal deposition, explore nanowire synthesis with metals and carbon nanotubes, overcome specificity and template cleavage problems. Explore more complex DNA-metal assemblies. Macroscale process, nanoscale alignment, uses molecular combing. Clean off silicon surfaces, modify with poly-lysine (1ppm), DNA droplet translation, image with AFM, example was circular single stranded DNA. DNA templated synthesis of Cu nanowires. Treat DNA with  $\text{Cu}^{2+}$ , interacts electrostatically, add ascorbic acid, reduced to Cu metal. Cu metal on DNA is nucleation site for more deposition. Height increases to 20-Å, but only 50% coated with Cu. Nonspecific nanoparticle background. Metallized DNA surfaces: reducing nonspecific background, followed by reduction, causes the background. Try to block nonspecific adsorption sites, with high surface affinity cation. Align DNA, treat with cesium, then add Ag, Cs reduces background of Ag nanowires. Examine backscattered electrons in SEM. Generalized with dsDNA, metallized without  $\text{K}^+$ , Cu nanorods made using  $\text{K}^+$  treatment. Cu nanowire fabrication causes DNA fragmentation. Aqueous  $\text{Cu}^{2+}$  makes hydroxyl radical which cleaves DNA. Got an aprotic solvent to reduce  $\text{OH}^-$ , less cleavage. To increase Cu, Ag density, use a low dielectric solvent. Dimethyl sulfoxide makes greater length, surface masking, length 7- $\mu\text{m}$  long, 7-nm tall. Localization: DNA to surface, then CNT to DNA. DNA is hydrophilic. Use 1 PMA (pyrenemethylamine) aggregate on DNA to get specific localizations of SWNT, 60% were aligned on DNA, covering only 1% of surface. Only 5% of total DNA length is decorated with SWNT. Evaluation of nanowires: Are these DNA templated nanostructures really nanowires? Useful to probe same structure at various stages of synthesis, need to measure electrical characteristic, grow nanowires across electrode arrays, must be planar. Have aligned DNA across electrodes, done metallization, preliminary conductivity measurements, resistance is  $\sim G\Omega$ . Looking to e-beam lithography to go to smaller spaces. Fabrication of more complex architectures: Can we make more complex DNA nanostructure designs? AFM: native DNA, TEM-Ag metallized DNA, optimistic about moving onto more complicated devices.