Patterning Vertical Aligned Single Walled Carbon Nanotubes
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Renewable Energy: a ~massive~ problem
Let’s get Lit... with Si-SWNT Solar Cells!

Single Walled Carbon Nanotube (SWNT) ➔

Vertically Aligned Nanotubes (VA-SWNT) ➔

http://www.photon.t.u-tokyo.ac.jp/index.html

http://cdn2.bigcommerce.com/n-d57o0b/tvhc2xod/product_images/uploaded_images/solar-panels.jpg?t=1416860323
Maruyama-Chiashi Laboratory: University of Tokyo

Liu Ming, me, and metal sputtering machine (above)

Maruyama Group (left)
Lab Photos:

SEM (Scanning Electron Microscopy)

VA-SWNT on 1x1” Si/SiO2 wafer

CVD (Chemical Vapor Deposition)

Water Treatment Method
Research Question:
Can the material properties of VA-SWNTs be improved by patterning the surface and combining the water treatment technique?

Methods:

- Silicon wafer (can also use quartz)
- Dip-coating in Co/Mo (or, sputtering)
- Thin layer of metal catalyst
- CVD growth of VA-SWNTs at 800C with EtOH
- Surface patterning (through stamping)
- Water treatment at 80C for 5s, 25x
- Patterned aligned single walled carbon nanotubes!
Self-Assembled Micro-Honeycomb Network (μHN)

- Lower sheet resistance and higher optical transmittance compared to randomly oriented SWNT film and graphene-Si solar cell.
- High power conversion efficiency – applications in solar cells.
- Transparent conducting film – applications in touchscreens and photovoltaics.

Water Vapor Treatment (exposure to 80°C vapor for 5 seconds, x25)
Micro-scale Patterning using Photolithography

SEM images of a single pattern (two angles)

Microscope images of a three different patterns
Results

Unstamped SWNT after water treatment (left)

Stamped SWNT before treatment (below)

Stamped SWNT after treatment (left)
VA-SWNT Transmittance (200-1500nm)

- NoStampNoWater
- NoStampYesWater
- YesStampNoWater
- YesStampYesWater

%T vs. Wavelength (nm)
Mechanical Pattern Stamping
Next Steps

- Compare sheet resistance for different patterns
- Fabricate and test a hexagonal pattern (similar to naturally forming μHN)
- Test hydrophobic properties of patterned vertically aligned SWNTs