

Chemical Vapour Deposition of Carbon Nanotube in SNF

Proposal

This project proposes to develop one or more recipes for the chemical vapour deposition (CVD) of single-walled carbon nanotubes (CNT) using the FirstNano CVD resources within the SNF. The ability to grow single-walled carbon nanotubes from nanometer sized metal nanoparticles at high temperature in a hydrogen / carbon precursor environment at atmospheric or reduced pressure is a uniquely useful capability for lab users. Specifically, CNTs can be used for demonstrating novel and useful electrical devices and systems¹, unique mechanical and thermal functions², and non-invasive interfaces to complex biological systems³. Precursor chemistries for CVD growth of CNT have been demonstrated and confirmed by several groups, including several at Stanford⁴. This project will create and tune two or more separate turn-key recipes supporting the carbon precursors Methane (CH₄) or Ethanol (C₂H₆O), which will then be available to SNF lab-users. The primary recipe objective will be to obtain CNTs grown horizontally aligned on ST-cut quartz 100mm substrates, which is more difficult than unaligned growth on SiO₂. It is expected this condition will work well for unaligned growth on SiO₂ as well, with the only difference being sample preparation. As a secondary interest to lab users, a vertically aligned CNT growth condition may be explored which requires both distinct sample preparation and a customized optimization of the growth condition.

Objective

1. Develop a standard recipe template for the CVD growth of horizontally-aligned single-walled carbon nanotube on 100mm Quartz in the FirstNano CNT Growth Furnace using methane carbon precursor.
2. Develop a standard recipe template for the CVD growth of horizontally-aligned single-walled carbon nanotube on 100mm Quartz in the FirstNano CNT Growth Furnace using ethanol carbon precursor.

3. Secondary objective: Demonstrate the aligned recipes work on SiO₂ substrates for unaligned growths with minimal growth condition changes.
4. Tertiary objective: Explore vertically-aligned SWCNT forest growth conditions if lab-users are interested.

Timeline

This project is expected to be completed by June 2015, with two REU's expected to conduct research using the tool beginning in mid June. Possibly will morph into EE412 project if course is offered.

Frequency of Review

Bi-weekly status meetings are scheduled with Dr. Michelle Rincon.

Tools required: SEM and AFM characterization in SNL; ASML Lithography, Thermco 4 annealing, and FirstNano CNT CVD Furnace. in SNF.

Materials: 2 Cassettes of ST-cut Quartz wafers (Hoffman Materials).
-\$35 / wafer x 50 = \$1750.

Deliverables:

- Manual for growth and operation, with SOP provided for aligned CNT growth.
- Log and guidelines for regular maintenance
- Summary report containing SEM and AFM characterization of grown CNTs and electrical characterization of FETs fabricated on the grown CNTs from best-known recipes.

References

- [1] Nature, vol. 501, pp 526-530, (2013).
- [2] Nano Letters, vol. 6, No. 1, pp 96-100, (2006).
- [3] Nature, vol. 514, pp 612-615, (2014).
- [4] IEEE Transactions on Nanotechnology, vol. 8, No. 4, pp 498-504 (2009).