Methods in Multi-Walled Carbon Nanotube Growth, Suspension, and Modifying Area Density

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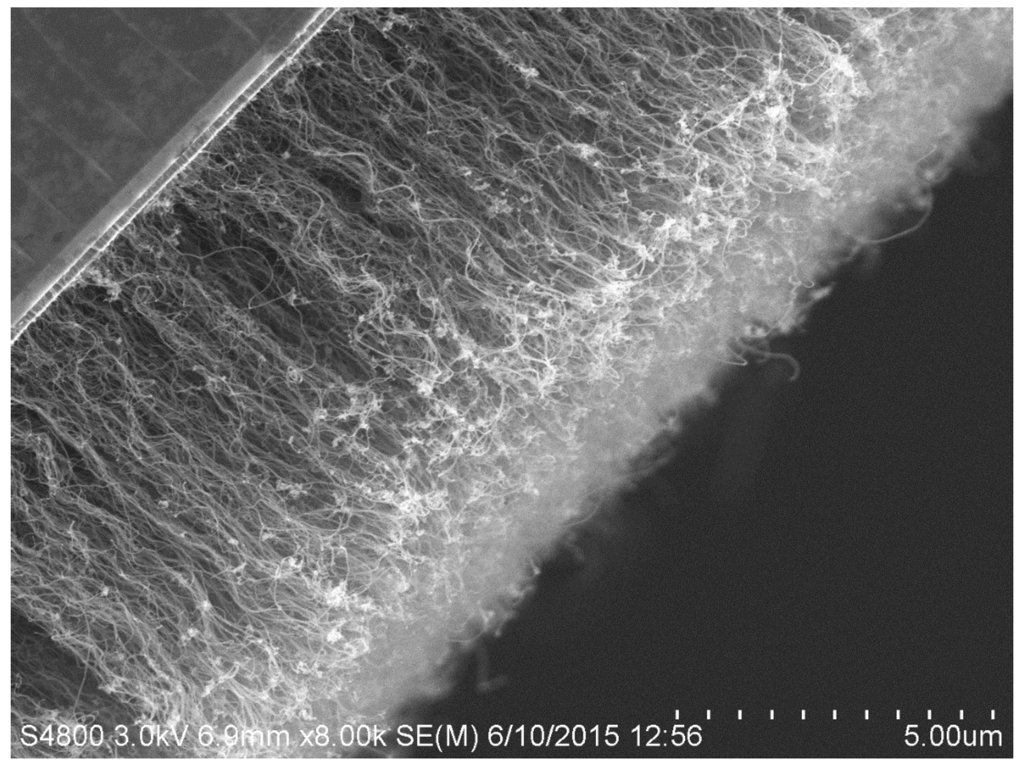
Abstract

Here we present area density results on multi-walled carbon nanotubes (MWCNT's)through modification of their growth temperature, findings on their ability to be suspended and freeze-dried into microspheres, and our work in solving the Discretized Poisson Equation in two dimensions through computer coding.

Background

Carbon nanotubes have many different properties that prove to be very beneficial to society. The property that we were most interested in was their ability to be excellent electrical conductors. We hope to enhance their use as super capacitors by modifying their area density.



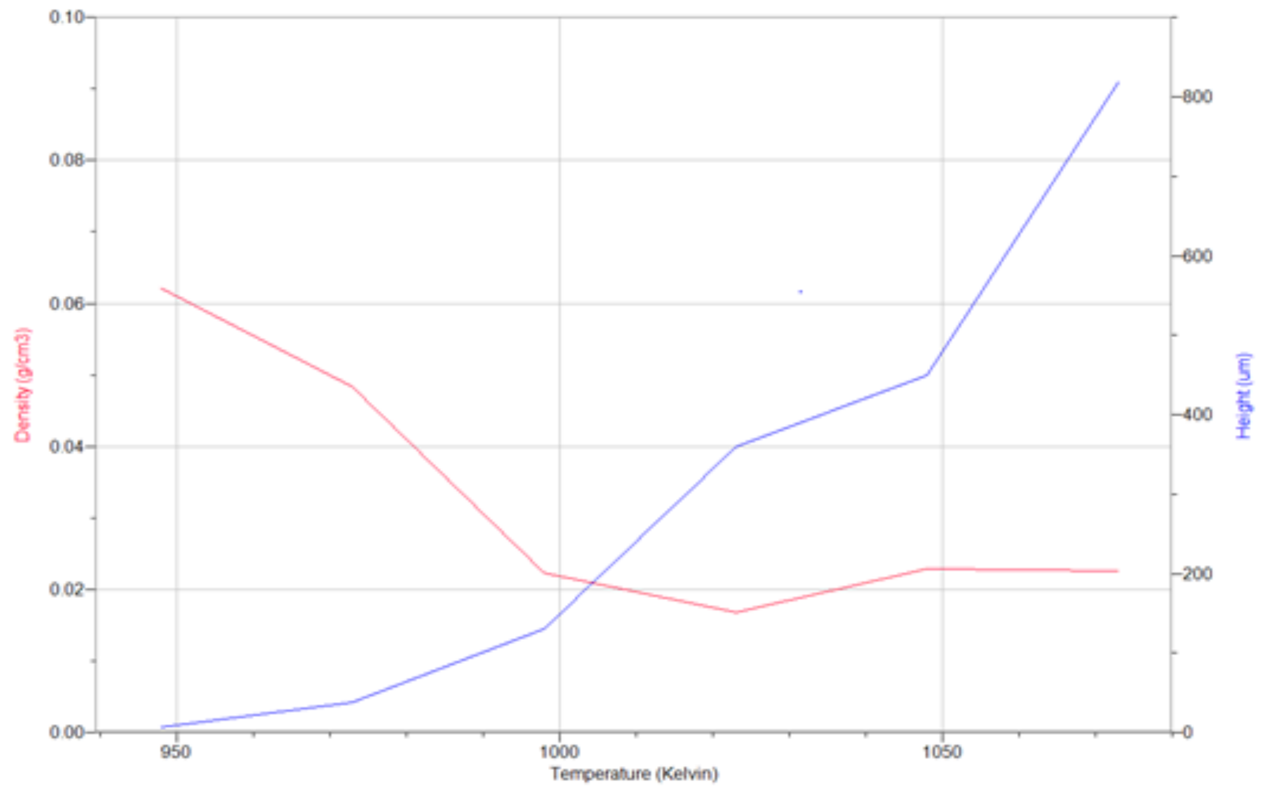
Some of the pore-structure properties of carbon nanotube forests are thought to be linked to their area packing density. Previous experiments have shown some correlation between the temperature at which the carbon nanotubes were grown and the resulting area density.

Microspheres composed of carbon nanotubes can possibly be used as nano-lubricants and high surface area catalysts supports in packed beds. In order to test the conductive power of these microspheres, a reliable method of producing carbon nanotube microspheres must be developed.

Solving the Poisson Equation is necessary to understanding the charges of the carbon nanotubes in their possible application as super capacitors.

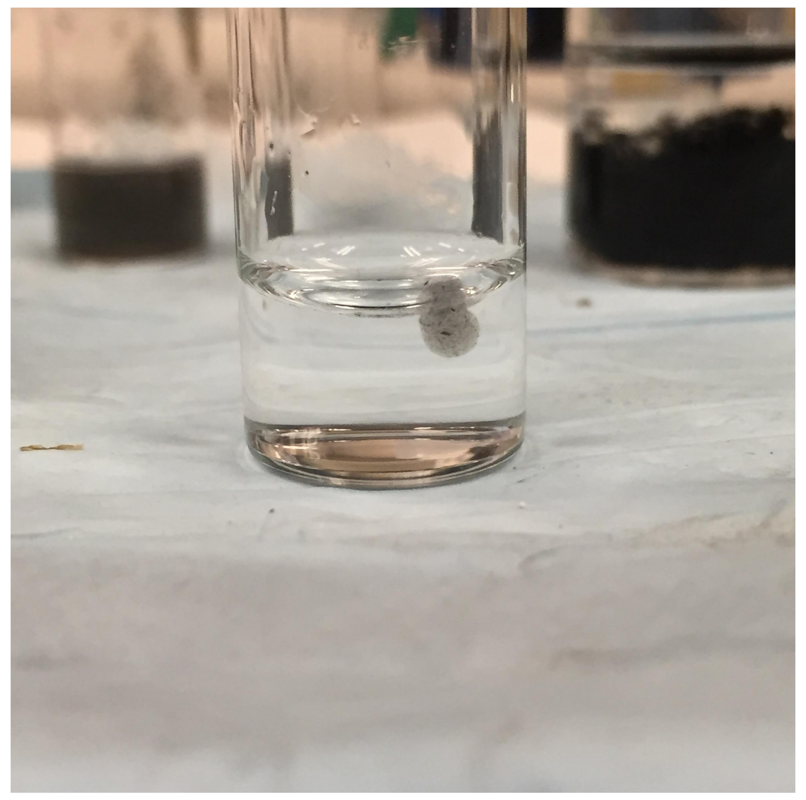
Modifying Area Density

A greater area density is necessary to leverage MWCNT's potential as super-capacitors. As predicted in previous scientific experiments, we expect to find an inverse relationship between growth temperature and area density. However, we also expect to find a positive relationship between the growth rate and the growth temperature. Our experimental findings match previous experiments.



Suspension and Microsphere Formation

Pieces of carbon nanotubes were first dispersed in water and homogenized for thirty minutes to break them into individual tubes. The water was then filtered out and the carbon nanotubes were allowed to dry. The dry carbon nanotubes were then dispersed in ethanol. This carbon nanotube solution was then added to a second solution of chitosan and acetic acid. Once this combined solution was produced, the solution was pipetted into a 1M base to form microspheres. This solution was then freeze-dried .



Solving Poisson's Equation

Solving the Poisson Equation will allow us to understand the MWCNT's as super capacitors. We have successfully solved the one dimensional case and are currently working on solving the two dimensional case of the Poisson Equation as it applies to MWCNT's. We are using Python as our coding method and are discretizing the equations to make them computable. High level programs also discretize the system for solving more elaborate and computationally intensive Poisson Equations.

```
m=5  #size of the matrix +1
R=[0]*(m*m) #array of Charges
#charges not zero
R[4]=-23
R[1]=3
R[21]=20
#starter values for v
v=[1]*(m*m)
for x in range (0,10):
    for i in range (0,4):
        for j in range (0,4):
            if i==0:
```

Conclusions and Next Steps

1. Modification of the area density of carbon nanotubes is possible through the control of their growth temperature.

2. Suspension of carbon nanotubes into microspheres is possible, although the emulsion formed is unstable due to interactions with the container.

3. The Discretized Poisson's Equation in the first dimension is solvable using programming.

4. (In progress): Solving multi-dimensional Poisson's Equations through the use of computer modeling.

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