

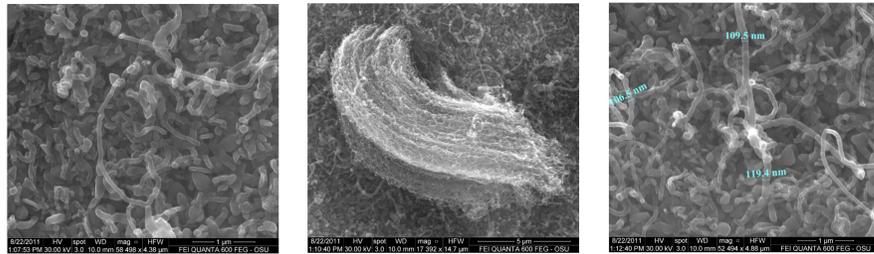
# Oxidation of Methylene Blue in Corona Discharge Microreactor



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## Carbon Nanotubes Before Experiment

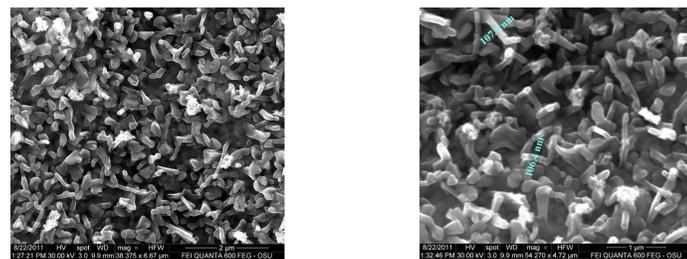
Carbon nanotube growth on pure Titanium reactor pieces. Figure a) shows the average nanotube growth, while Figure b) shows vertically aligned carbon nanotubes. Figure c) shows that the average diameter of the nanotubes is about 100 nm.



a) b) c)

Figures d) and e) show carbon nanotube growth on anodized Titanium. Figure d) shows the average nanotube growth, and Figure e) shows that the average diameter is 100 nm.

The carbon nanotube growth on anodized Titanium was not as advantageous as the growth on pure Titanium. The large amount of TiO<sub>2</sub> may have hindered the carbon nanotube growth.



d) e)

## Anodized Titanium



a) b) c)

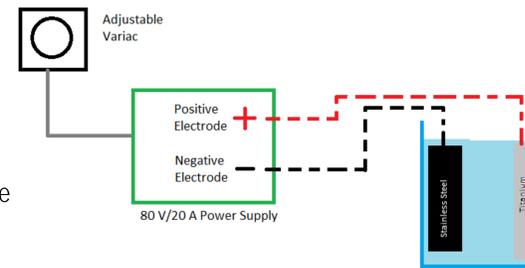


d) e)

Substrate b) at 46.5V, c) at 55.9V, and d) at 68.0V. Substrate e) is the pure, machined Titanium piece.

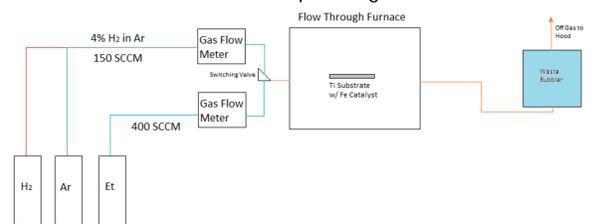
## Anodization Process

The titanium pieces were anodized to prevent oxidation during the reaction. First, an adjustable 80V/20A power supply was connected to a variac. Next, the positive electrode was connected to the titanium piece, and the negative electrode was connected to a stainless steel substrate, both using an alligator clip. Both pieces are then placed in a 5% TSP (trisodium phosphate) solution, ensuring that they are not touching. The variac is then plugged in and set to zero. It is then adjusted to the desired percentage to start the anodization process. Using the percentage, the voltage and current applied can be found.



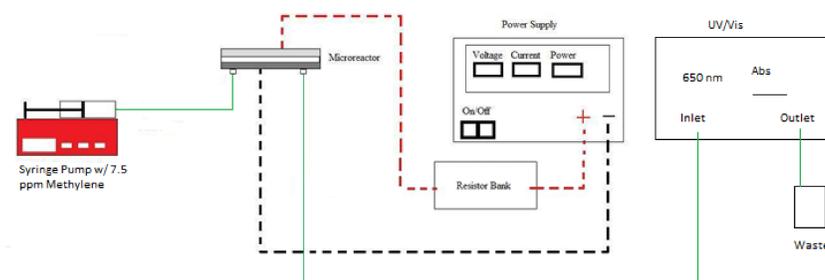
## Carbon Nanotube Synthesis

The cleaned, machined Titanium substrate is put through sonication in acetone. Next, 10 nm of a 99.9% solution of iron is deposited via sputtering. It is then placed in a sealed, quartz reactor tube and the tube is evacuated below 1 torr. A flow of 4% hydrogen in argon mixture is sent through the tube at 150 sccm. The furnace is heated to 775°C at 10°C per minute. The air flow of hydrogen and argon is stopped once the temperature has reached 775°C, and pure ethylene gas is flowed through at 200 sccm and 775°C for 20 minutes. After this time, the heating unit is stopped, and the substrate is allowed to cool under pure argon air flow.

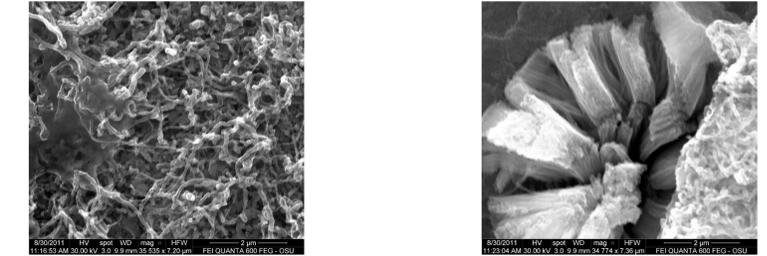


## Experimental Setup

The experiment is set up using a syringe pump, power supply, and UV/Vis instrument. 7.5 ppm methylene blue is pumped into the microreactor, which is connected to the power supply to vary the applied voltage. The solution is then pumped to the UV/Vis, where the absorption wavelength is measured, and then sent to the waste container.

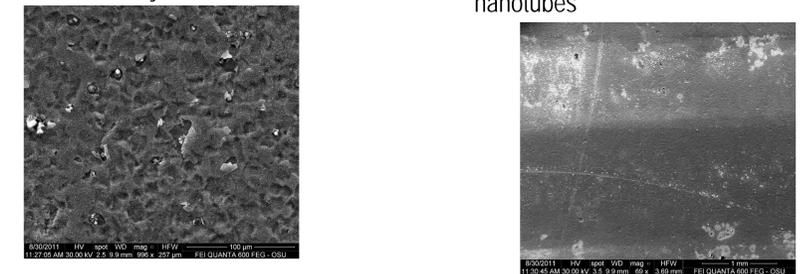


## Carbon Nanotubes After Experiment



Carbon nanotubes are shown to be unaffected by the reaction.

Figure of several vertically aligned nanotubes

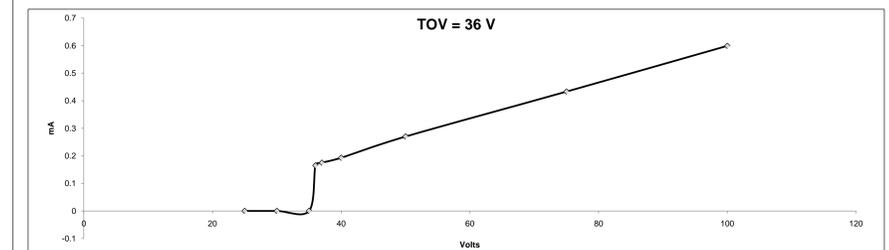


This figure shows the concentration of vertically aligned nanotubes (each 'white spot')

Figure of the microchannel (

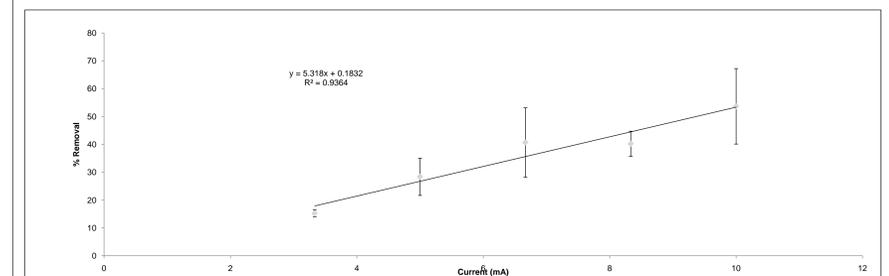
## Results

Figure a) shows the activation point of the microreactor. After about 35V, the system activates and becomes a closed circuit. The current then follows a linear trend.



a)

Figure b) shows percent removal of methylene blue versus the current applied. The current was applied by varying the voltage of the power supply. The graph shows a linear trend between percent removal and current.



b)

## Acknowledgements

This study was supported by the SBI Internship Program.