Electrospray Applications for Applying CNT Solutions

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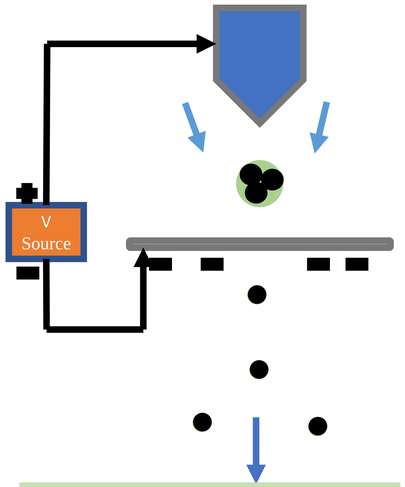
Introduction and Mechanism



Schematic Diagram

Experimental Setup

Electrospray operates by pumping an electrolyte through a capillary and forming a very fine tip of conductive solution, called a Taylor Cone, by applying a high voltage between the capillary containing the conductive liquid and a substrate. The applied electric field induces forces (surface tension and viscoelastic forces) on the fluid that help to retain the hemispherical shape of the droplet. Once the voltage breaches a threshold value the surface tension is overwhelmed, and a charged jet emerges from the Taylor cone. It has been observed that low viscosity fluids break up into particles when an electric field is applied and leave the capillary as very fine mist in electrospray.

Comparison of Standard Coating Methods

	Low Cost	Scalable	Highly Uniform	Material Efficient
Spin Coating	✔	X	✔	X
Dip Coating	✔	✔	X	X
High-Volume Low-Pressure Spray	✔	✔	X	✔
Electrospray	X	✔	✔	✔

CNT Solution

The solution used with the electrospray platform was composed of Singled Walled Carbon nanotubes (CNTs), polyaromatic moieties, and the presence of a strong acid. Carbon nanotubes (CNTs) are an allotrope of carbon that is rolled into cylinders that can be used for a variety of purposes. Concentration of CNT 1.2 mg/mL

Single walled Carbon Nanotube solution

Results

The experiments were performed by varying flow rate and applied voltage. The voltage varied 1000 V to 6000 V. The ring was constant; placed at the level on the needle tip

Voltage Off

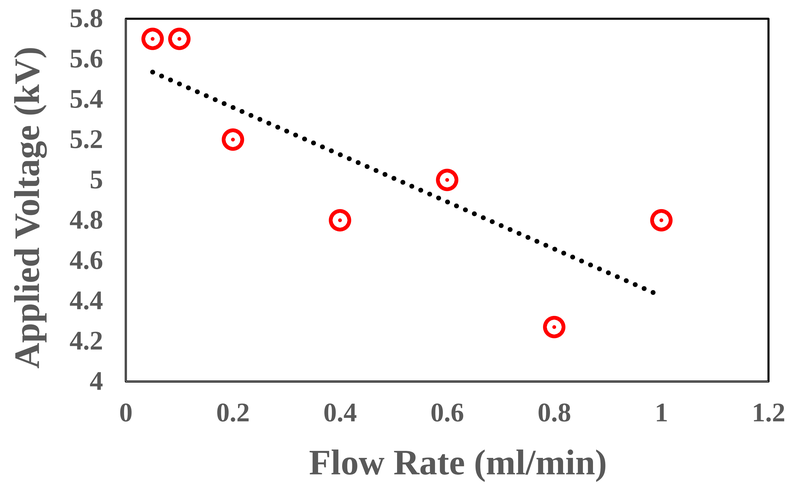
Voltage On

Flow rate: 0.05 mL/min
Voltage: 5.7 ± 0.1 kV

Flow rate: 0.6 mL/min
Voltage: 5.0 ± 0.1 kV

Flow rate: 1.0 mL/min
Voltage: 4.8 ± 0.1 kV

Parameters for Taylor Cone Formation



Discussion

For the given conditions of the concentration of the SWCNTs, the distance between the needle and the ring, the Taylor Cone formation the experiment suggests the need of low voltage at higher flow rate. The voltage of 5.7 ± 0.1 kV required to form a Taylor cone at 0.05 mL/min as compared to 4.8 ± 0.1 kV for 1.0 mL/min.

Conclusion

In conclusion, electrospray is a proven concept. We look next to improving upon the concept by experimenting further with the needle size as well as the changing the voltage and flow rate of our experiment setup to improve the quality of our spray to apply our concept to larger scale applications.

Future Work

Optimization of the set-up for the needle size, and linear stage for the continuous application of the CNTs on the larger scale for a coating which is transparent. The IR camera will be used to test the heating profile when the voltage is applied to the sample.

References and Acknowledgements

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