Deposition of Single Walled CNTs Through Electrospay
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Introduction and Mechanism

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 reaches 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.

Experimental Setup

Fig:1 Electrospay setup used for the experiment.

Fig:3 Single walled Carbon Nanotube (SWCNT solution)

Results

By varying flow rate and applied voltage, the electrospray phenomena was achieved using a ring with the needle that acted like a focusing lens. The ring was placed just at the tip of the needle as to avoid spray getting on the ring. We tested the H2SO4 solution filled with dispersed CNTs and we sprayed them at different flow rate settings increasing the voltage until achieving a Taylor cone, and thus electrospray. The two figures below represent the data collected and the observation made during the trials. To achieve a finer spray the flow rate was decreased with a set interval of 0.2 ml/mm. The voltage was adjusted accordingly to form the Taylor cone. A decreasing linear trend was found between voltage and small flow rates.

Flow rate: 1.0 mL/min Voltage: 4.8 ± 0.1 kV Flow rate: 0.05 mL/min Voltage: 5.7 ± 0.1 kV Flow rate: 0.6 mL/min Voltage: 5.6 ± 0.1 kV

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.

References and Acknowledgements

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