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Real-Time Imaging of Electrospinning

Challenge: How to measure what you can't see!!

Real time imaging enables:

- Measurement of parameters like jet velocity, acceleration, and strain rate.
- Understanding of the dynamics of the electrospinning jet instability.
- Understanding of flow behavior and its effect on particulate additives.
- Determination of mechanisms for jet bifurcation.
- Mapping out distribution of charge in the electrospinning jet.

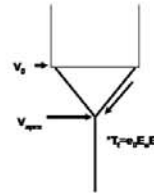
Particulate Motion in the Jet



a. Area of fiber mat directly under the syringe tip

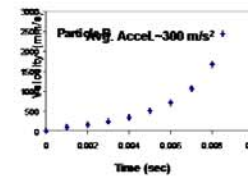
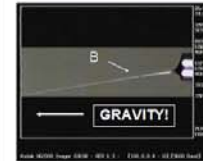
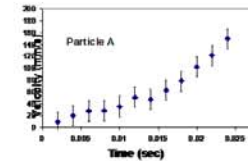
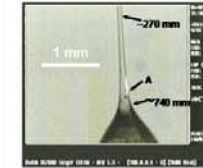


b. Area at the edge of the fiber mat



*Iiyabi, Bailey, Tadros: Nature vol 319, 2, January 1986

Jet Velocity



Cone Shape for Different Spinning Conditions

5 kV - 2.5 ml/hr



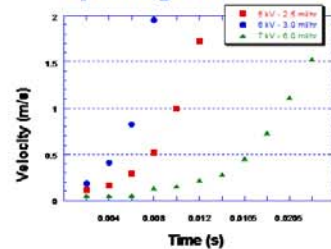
6 kV - 3.0 ml/hr



7 kV - 6.0 ml/hr

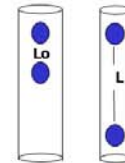


Jet Velocity for Different Spinning Conditions



- Acceleration appears to decrease with increased flow rate and Voltage!!!
- Why?!? Change in ratio of charge density to mass???

Strain Rate



t=0 t=Dt

$$\text{Strain} = \frac{L - L_0}{L_0}$$



Strain Rate = 882 +/- 75 (1/sec)

Conclusions

Key Points!

1. Fiber diameter can be controlled through solution concentration
2. Fiber morphology is HEAVILY affected by solution feed rate and accelerating Voltage
3. Particulates must be smaller than initial jet diameter and well dispersed to be incorporated directly into electrospun mats
4. Jet velocity appears to be highly dependent on solution feed rate and field strength
5. Electrospinning jets can undergo high rates of strain (~800 1/sec) in the linear portion of the jet

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