Research challenges, future trends and limitations in modeling and simulation of electrospun carbon nanofibers

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Abstract Electrospinning is an efficient and versatile technique which has been attracted great attention in current decades because of providing the nearly simple, easy and low cost to produce nanofibers from polymers or composites. During the recent years some attempts have been made to optimize the uncontrollable electrospinning process in order to create more uniform nanofibers. Modeling and simulation are suitable methods to obtain this approach. In this paper, activated carbon nanofibers were produced during electrospinning of polyacrylonitrile solution, stabilization, carbonization and activation of electrospun nanofibers in optimized conditions, and then mathematical modeling of electrosinning process will be done by focusing on governing equations of electrified fluid jet motion by using FeniCS software. Experimental and theoretical results will be compared with each other in order to estimate the accuracy of the model. The simulation can provide the possibility of predicting essential parameters which affect the electrospinning process.

References

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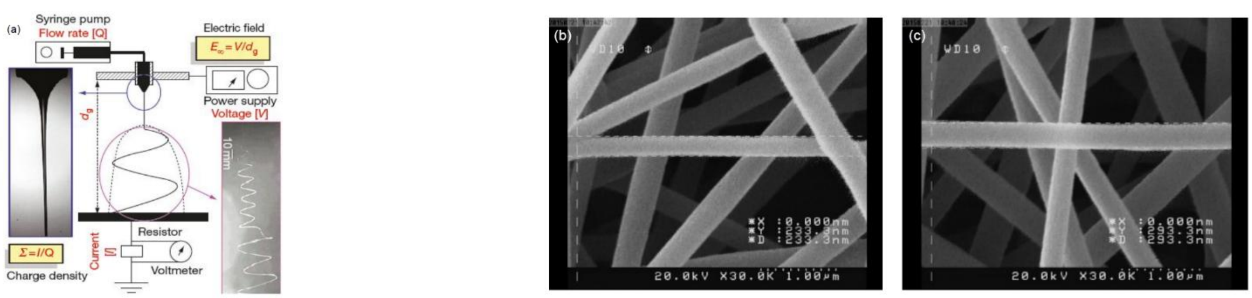
Figures



(a) Schematic diagram of electrospinning showing details of the jetting processes, the whipping instability, as well as the fiber morphologies that can be obtained. The flow rate (Q), the voltage (V) and the distance between the electrodes (dg) are set and the current (I) flowing through the jet is measured. The electric field strength is calculated as V/dg. The quantity Σ=I/Q) is the volumetric charge density. The photograph on the left hand side shows the straight section of the steady jet immediately after it ejects from the conical meniscus. The photograph on the right shows the whipping instability, where the centerline of the jet bends at a characteristic wavelength.

The micrographs (b) and (c) show electrospun polyacrylonitrile nanofibers in optimized conditions (in different voltages).

(b): concentration (11wt %), pumping rate (8µl/min), spinning distance (12cm), voltage (18kv)
(c): concentration (11wt %), pumping rate (8µl/min), spinning distance (12cm), voltage (16kv)