Rheological Aspects in Electrospinning to Prepare Polymer Nanofibers

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Electrospinning is a promising technique to produce polymeric fibers with submicron diameters. Different fiber morphologies can be obtained by manipulating the solution properties and processing variables; the former include solution viscosity, conductivity, and surface tension, whereas the latter comprise applied voltage, solution flow rate and tip-to-collector distance. Bead-free fibers are generally produced provided that a semi-dilute solution with entangled chain conformation is used. Solutions with a lower concentration yield fibers with a lower diameter. This phenomenon is associated with the different entanglement density developed in the electrospinning solution. In this work, several polymer solutions are investigated to reveal the impact of chain entanglement. A simple relation is derived as shown in the Figure; $d_f = d_{f,e}(\phi/\phi_e)^{2.49}$, where ϕ and ϕ_e are the solution concentration and entanglement concentration, respectively, and $d_{f,e}$ is the diameter of fibers electrospun from the solution with a concentration of ϕ_e.

In-situ light scattering of electrospinning jet is also discussed to obtain the jet diameter distribution along the straight jet, from which the extension rate is further derived. The extension rate is found to be higher than the terminal relaxation rate of polymer chains. Based on this finding, the dynamically asymmetric polymer solutions may undergo phase separation in the straight jet section during electrospinning.

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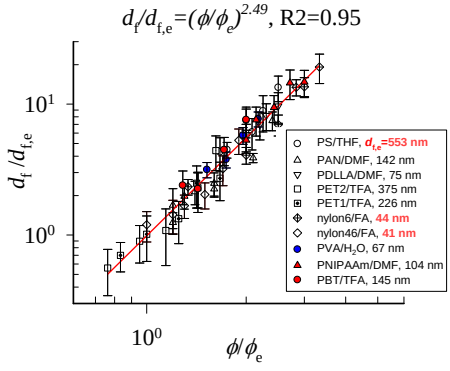

Prof. Chi Wang received his PhD in Polymer Engineering, University of Akron (1992) under the guidance of late Dr. Alan N. Gent. He came back to Taiwan in 1993 and became a full professor in 2000. In 2015, he received the outstanding alumni award from Polymer Engineering Department, Akron U.. He has about 80 SCI publications in the fields of fluid mechanics and solid mechanics of polymers as well as the structure characterization by using synchrotron WAXD/SAXS. His current research focuses on the development of electrospinning process and applications of electrospun fibers.