Electrospinning of poly(vinyl alcohol)/water solutions with suspended zinc oxide nanoparticles

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Abstract:

Poly(vinyl alcohol) (PVA) is soluble in water. Zinc oxide (ZnO) is widely used for its antibacterial and antimicrobial properties. Given these, one can envisage several biomedical applications for PVA fiber mats with dispersed ZnO nanoparticles. Hence, we have investigated the electrospinning PVA solutions with suspended ZnO nanoparticles. ZnO nanoparticles of three different diameters (20, 70 and 100 nm) were used in the study.

We first determined the frequency dependent complex viscosity of the ZnO (volume fraction = 2 x 10^{-4}) suspended in PVA solutions. As can be seen from Figure 1, the viscosity is essentially independent of the frequency. As the volume fraction is sufficiently low, the viscosity would be expected to be independent of the particle size. However, Figure 1 clearly indicates a progressive increase in the viscosity with decreasing particle size. Following Zhao et al. [1], it is suggested that the underlying reason for this behavior is the aggregation of the nanoparticles and the consequent increase in the effective volume fraction of the suspended phase.

The ZnO suspended PVA solutions were then used to produce fibers using electrospinning. The diameter of the electrospun fibers as a function of electric field strength is shown in Figure 2. At a given field strength, the diameter decreased with an increase in the size of the suspended nanoparticles. We believe this is directly related to the dependence of the viscosity [2] on the ZnO nanoparticle size discussed earlier. Additionally, as expected, increasing the electric field strength leads to a gradual decrease in the diameter of the electrospun fibers. This is in agreement with prior work, for e.g., the results of Park et al. [3].

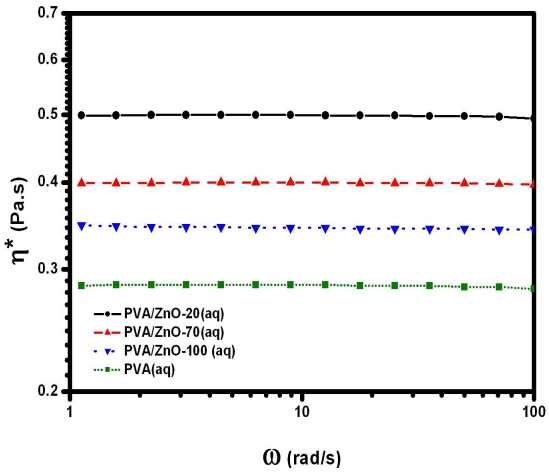

Figure 1 Complex viscosity versus angular frequency for PVA solutions with ZnO particles of three different sizes.

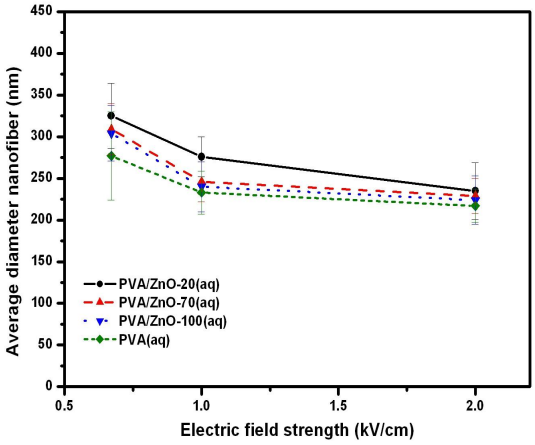

Figure 2 Relationship between the average diameters of electrospun fibers and electric field strength.

Keywords: Poly(vinyl alcohol), Zinc oxide nanoparticles, Viscosity, Electrospinning, Nanofibers.

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