PREPARATION AND CHARACTERIZATION OF PVA TWISTED YARNS USING ELECTROSPINNING METHOD

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Extended abstract

Electrospinning is an adaptive and simple method to produce continuous micro- or nanofibers. Nanofibers with outstanding characteristics, such as small diameter, pore network and high surface area to volume ratio, have the potential to significantly improve textile technology and find applications in new areas [1-3]. In typical electrospinning fibers are generally deposited in a random state and form of nonwoven structure. The relatively low mechanical strength and the difficulty in tailoring such fibrous structure with random fiber orientation have limited their applications in many fields. Thus, for many of the textile based applications, the electrospun fibers are required to be produced as a continuous aligned fiber bundles or yarns.

In this study, the preparation and properties of twisted yarns from electrospun polyvinyl alcohol (PVA) fibers by a continuous process is presented [4]. The effect of variability of twist on the final properties of electrospun yarns and corresponding fibers in the yarn structure are investigated and mechanical properties of yarns are also determined as a function of twist rate.

To obtain electrospinnable solutions, PVA was dissolved in distilled water as solvent at a concentration of 7 wt%. To produce continuous twisted fiber yarns, an electrospinning setup consisting of two oppositely charged nozzles was used. In order to investigate the effect of twist amount on the structural and mechanical properties of electrospun yarns, the rotational rate of the twister plate was changed to values of 80, 160, 240 and 320 rpm.

The morphology of the electrospun fibers and yarns was studied using scanning electron microscopy (SEM). The SEM images of electrospun PVA yarns at twist rate of 240 rpm are presented in Figure 1. At different twist rates, uniform and smooth fibers formed and without any bead formation. The statistical analysis revealed that the twist amount had a significant effect on the diameter of the yarns and fibers in the yarn structure. By increasing the twist rate from 80 rpm to 320 rpm, due to the increased tension on the fibers, the mean diameter of the fibers in the yarn structure decreased.
Figure 1. The SEM images of the electrospun PVA yarn at twist rate of 240 rpm

In this work in order to study the thermal behavior of the electrospun yarns and effect of the twist amount on the crystallinity of the fibers, Differential Scanning Calorimetry (DSC) was used. The DSC results showed that by increasing the twist rate due to increasing tension imposed on the fibers and as a result of increasing arrangement of molecular chains in line with the yarn axis, the crystallinity of the fibers in the electrospun yarns increased.

The mechanical properties of PVA electrospun yarns are presented in Table 1. The results of the measurement of mechanical properties of electrospun PVA yarns indicated that by increasing the twist rate the strength and modulus of electrospun yarns decreased slightly while the elongation at break percentage increased.

Table 1. Mechanical properties of PVA electrospun yarns at different twist rates.

<table>
<thead>
<tr>
<th>Yarn twist (rpm)</th>
<th>Tensile Strength (cN/Tex)</th>
<th>Young’s Modulus (cN/Tex)</th>
<th>Elongation at break (%)</th>
</tr>
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<tbody>
<tr>
<td>80</td>
<td>5.30</td>
<td>22.78</td>
<td>156.52</td>
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<td>160</td>
<td>4.97</td>
<td>17.18</td>
<td>203.47</td>
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<tr>
<td>240</td>
<td>4.40</td>
<td>14.18</td>
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<tr>
<td>320</td>
<td>4.24</td>
<td>11.25</td>
<td>304.71</td>
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References


