Finishing of Nylon/Cotton Fabric with ZnO/TiO₂ Nanocomposite

A. Meftahi, F. salehi, F. Yadegari, S. Alibakhshi, S. Vatandoost, H. Mohammadi

Abstract

Nylon/cotton (NYCO) fabric is one of the most applicable fabrics in producing clothes. Its appropriate properties such as high abrasion resistance and comfort caused to be used in labor cloths, uniform and dressing. Accordingly, in this research NYCO fabric finished with ZnO/ TiO₂ to investigate the improvement of light and washing fastness. Meanwhile we try to expand the application of this fabric in other sections like hospital clothes by adding antibacterial property. Therefore, nano ZnO/TiO₂ in different concentrations (30,40,50 & 60 ppm) was applied and cured to the fabric then handling, color appearance, light and washing fastness and antimicrobial properties were evaluated. SEM was used to assess the distribution of nanocomposite. The results represent considerable improvement in light and washing fastness. In addition there is no change in handling and color appearance. It is also indicated the highest antibacterial property against E.Coli and S. Aureus which was appeared at 60ppm.

1. Introduction

Nylon/Cotton (NYCO) blended fabric has unique properties such as high abrasion resistance and good comfort which make it to be used for cloths with special application, Yang and Yang (2005), Malshe et al. (2012), Chen et al. (2014), Saleh et al. (2012). High strength, chemical and abrasion resistance and good thermal and mechanical

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properties, caused nylon fiber to be used in textile industry, Kim et al. (2001), Song et al. (2005), Hine et al. (2005). In addition cotton fiber with individual properties like softness, good water absorption, excellent dye ability, high compatibility and comfort has significant role in textile and cloth, Bao and Li (2012), Yu et al. (2005), Gorgjanc et al. (2012), Mohsin et al. (2013). Therefore NYCO fabrics have a combination of appropriate properties and cover the disadvantages of each individual fiber. Accordingly, this research attempts to add the antibacterial property via ZnO/TiO₂ nanocomposite and improve light and washing fastness to develop the application of this fabric in medical textile field.

2. Materials & method

Bleached Nylon/Cotton (50/50) blended fabric (Taffeta weave, 250 g/m²) was purchased from Yazdbaugh Co. and Vat/disperse dye from Alvan Sabet Co. was used for dyeing the fabric. All samples were dried and treated with ZnO/TiO₂ nanocomposite which was supplied by Nano Fanavaran Hassun company, Ltd. E.coli (AATCC 11303) as a gram negative and S.aureus (AATCC 6538) as a gram positive bacteria were applied for antibacterial assessment.

NYCO fabric was dyed with vat/disperse dye in a HT-Beam dyeing machine (AHIBA 1000) by liquid ratio of 1:10. NYCO fabric was dyed with vat/disperse dye in a HT-Beam dyeing machine (AHIBA 1000) by liquid ratio of 1:10. In this method a piece of fabric (1 gr) is inserted into vessel of dyeing machine which is filled with water and suitable auxiliaries. List of auxiliaries is summarized in Table 1. Graph of dying process is shown in Fig.1.

Table1. List of auxiliaries for dyeing process.

<table>
<thead>
<tr>
<th>Auxiliaries for disperse dyeing</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Acetic Acid</td>
<td>0.5 gr/lit</td>
</tr>
<tr>
<td>Dispersing Agent (Alcoperse RJL)</td>
<td>1 gr/lit</td>
</tr>
<tr>
<td>Ammonium sulfate</td>
<td>2 gr/lit</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Auxiliaries for vat dyeing</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium Hydro sulfite</td>
<td>1 gr/lit</td>
</tr>
<tr>
<td>Sodium Hydroxide</td>
<td>4cc</td>
</tr>
</tbody>
</table>

In this method acetic acid, dispersing agent and ammonium sulfate are added to the dyeing bath at 50°C and then the temperature is increased up to 130°C, dyeing is continued for 60 minutes in this temperature. In next step, the temperature decreased up to 60°C and Sodium Hydro sulfite and Sodium Hydroxide are added to the dyeing bath. Dyeing process is continued for 60 minutes. At the end of process samples must remain in dyeing bath without tension and then put them in a solution containing 1 L water, 4cc hydrogen peroxide and 1cc acetic acid for 1 minutes and then samples are rinsed and dried at room temperature.

Dyed NYCO fabrics were immersed in 30, 40, 50 and 60 ppm solutions of ZnO/TiO₂ nanocomposite. Treated fabrics were dried at 80 °C for 3 min and then cured at 160 °C for 3 min.
Antibacterial property of samples against S. areus and E. coli are evaluated by ASTM 100 method. Durability of treated samples against light and washing is examined by ISIRI 4084 and ISIRI 4350, respectively. Scanning electron microscopy (SEM) (Philips XL30) was used to determine the morphology and surface of the NYCO fibers.

3. Result and discussion

3.1. Antibacterial property

Fig. 2 and Fig. 3 represented the antibacterial activity of treated fabric. It is shown that by increasing amount of ZnO/TiO$_2$ nanocomposit, the antibacterial activity increased. According to the obtained result, 60 ppm ZnO/ TiO$_2$ nanocomposite has the lowest bacterial growth.

Fig. 2. Comparing Antibacterial properties of (S-0) raw; treated samples with (S-1) 30; (S-2) 40; (S-3) 50; (S-4) 60 ppm ZnO/TiO$_2$ nanocomposite against S. areus.
3.2. **SEM**

Figure 4 showed the surface of Untreated and treated NYCO. As it can be seen in Fig. 4b, the presence of ZnO/TiO₂ nanocomposite is clearly observed.
3.3. Light and washing fastness

Table 2 represented the effect of treatment on light fastness. Untreated and treated specimens with ZnO/ TiO$_2$ nanocomposite are exposed to Xenon arc light for 72 hours. Obtained results indicated that treating samples with ZnO/TiO$_2$ nanocomposite has positive effect on light and washing fastness.

Table 2. Comparing light and washing fastness of untreated and treated NYCO with different amount of ZnO/TiO$_2$ nanocomposite.

<table>
<thead>
<tr>
<th>Amount of ZnO/TiO$_2$ nanocomposite</th>
<th>Light fastness</th>
<th>Washing fastness (staining)</th>
<th>Washing fastness (color change)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw</td>
<td>4-5</td>
<td>4-5</td>
<td>4-5</td>
</tr>
<tr>
<td>Treated with 30ppm</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Treated with 40ppm</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Treated with 50ppm</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Treated with 60ppm</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>

Washing fastness of samples summarized in table 2 and it shows that there is no negative effect on washing fastness of treated fabrics.

4. Conclusion

Blend fabrics have significant role in textile and clothing industries. Among these kind of fabrics, NYCO fabric has unique properties like good abrasion resistance, dye ability and comfort which makes it as appropriate fabric for many application. Consequently improving the fabric properties has been done by applying ZnO/TiO$_2$ nanocomposite. The obtained results represented that ZnO/TiO$_2$ not only caused high antibacterial property but also improve light and washing fastness.

Reference