Nanotechnology to improve Printing of Cotton with Reactive Dye

KEYWORDS
Nanotechnology, TiO₂, cotton fabric, printing

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ABSTRACT
Thickeners like Guar gum and Sodium Alginate, which are used in printing of cellulose substrate (cotton) with Reactive dye. The results shows that the thickeners can be used safely with TiO₂ in preparing printing paste for coloration of cotton and that also improves fastness properties and wrinkle resistance property of cotton.

Introduction
Reactive printing is not only oldest but also very popular printing method as its reactivity towards cotton substrate. In cotton industries 75 % print goods are based on reactive printing due to its obvious advantages, such as fastness, durability of print.

From the last two decades, the nano particles have become quite popular in various fields. These nano – particles are applied to the textile by padding to impart water repellency, wrinkle resistance, anti bacterial, anti static, soil resistance, UV – protection and improvement in dyeing. From various application of nanotechnology in textile, some imparted by nano treatment are critically highlighted in this paper.

The present study is aimed to use water soluble guar gum and sodium alginate thickeners with TiO₂ nano particles in preparation of printing paste for coloration of cotton to improve fastness and wrinkle resistance properties.

Materials and Methods
Fabric
Mill Scoured and bleached cotton fabric (118 g/m²) plain weave with ends/inch 112 and picks/inch 72 procured from local market and further thoroughly washed, neutralized and air dried.

Dye and chemicals
One commercial Reactive Dye namely Reactive Red C.I. No. 180 was used. Gaur gum (T₁), sodium alginate (T₂), TiO₂ nano particles of 50 nm size, Urea (Mol. Wt. 60), Sodium carbonate (Mol. Wt. 116), Resist salt L were used for making printing paste.

Paste Preparation
Aqueous paste of guar gum and sodium alginate (with desired viscosity for printing) was prepared.

Printing
The printing was prepared using following recipe:-

50 g Reactive Dye
200 g Urea
350 g Thickener Paste (T₁ / T₂)
25, 50 & 100 ppm TiO₂ nano particles
10 g Resist salt L
15 g Anhydrous Sodium carbonate
Z ml water
1000 g

This printing paste was applied on cotton fabric using flat nylon screen. The printed samples were passed through steam ager at 150 °C for 5 minutes for fixation.

Measurement & Analysis
The crease recovery angle of the sample was determined as per AATCC test method 66 – 2003 using B – TEX Engineering crease recovery tester (India).

The printed samples were assessed for K/S values using computer color matching system (Spectrascan 5100 RT Spectrophotometer, Premier Colorsan Instrument, India)

The light fastness of the printed samples was tested on fad – o – meter (B – TEX Engineering, India) after partially exposing the sample to the Xenon arc lamp for 16 h.

The wash fastness of the printed samples was measured according to ISO – 2 test method in launder – o – meter (Digi. Wash, Paramount Scientific Instrument, India)

The rubbing fastness of the printed samples was measured according to AATCC test method 8 (2005).

Result & Discussion
Effect of TiO₂ Concentration on K/S value
The effect of TiO₂ nano particles concentration with thickeners T₁ & T₂ on color strength (K/S) of screen printed cotton fabric is shown in Table – 1. It is clear from the table, as the concentration of TiO₂ nano particles increases the K/S value of the printed fabric also increases. The increase in K/S leads to more fixation of dye that in paste containing thickener (T₁) shows the excellent result as compare to the paste containing thickener (T₂).

Fastness properties
Table – 2 shows the fastness properties of cotton fabric printed using T₁ & T₂ thickeners and TiO₂ nano particles. It is clear from the table that overall fastness properties improve by using TiO₂ nano particles in printing paste. This may be due to the fact that TiO₂ enhances unsaturated site in reactive dye which is responsible for the fixation of reactive dye. The color fastness of washing, rubbing and light is good – very good.

Wrinkle Resistance
The effect of TiO₂ nano particles concentration on crease recovery of printed samples of cotton fabric is shown in Table – 3. Table shows that crease recovery angle increases with increase in TiO₂ concentration.

Conclusion
- Use of TiO₂ in printing of cotton with reactive dye increases color strength and also improves color yield.
- The paste with TiO₂ also improves the crease recovery angles with almost no effect on rigidity of the material.
The overall fastness properties improved by using TiO₂ nano particles in printing paste.

Use of sodium alginate with TiO₂ gives better result compare to guar gum with TiO₂ nano particles in printing paste.

TiO₂ nano particles can be used safely with the appropriate thickeners in printing of cotton with reactive dye.

**Table – 1** Effect of TiO₂ nano particles concentration on K/S of cotton fabric printed using Reactive dye steam aged at 150 °C for 5 minutes

<table>
<thead>
<tr>
<th>TiO₂ concentration (ppm)</th>
<th>Colour Strength (K/S)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>With T₁</td>
</tr>
<tr>
<td>0</td>
<td>4.06</td>
</tr>
<tr>
<td>25</td>
<td>7.29</td>
</tr>
<tr>
<td>50</td>
<td>9.67</td>
</tr>
<tr>
<td>100</td>
<td>10.93</td>
</tr>
</tbody>
</table>

**Table – 2** Fastness Properties Reactive dye printed cotton fabric using TiO₂ in printing paste and steam aged at 150 °C for 5 minutes

<table>
<thead>
<tr>
<th>TiO₂ concentration (ppm)</th>
<th>Light Fastness</th>
<th>Washing Fastness</th>
<th>Rubbing Fastness</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>With T₁</td>
<td>With T₂</td>
<td>With T₁</td>
</tr>
<tr>
<td>0</td>
<td>3</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>25</td>
<td>3</td>
<td>4</td>
<td>3 – 4</td>
</tr>
<tr>
<td>50</td>
<td>3</td>
<td>4 – 5</td>
<td>4</td>
</tr>
<tr>
<td>100</td>
<td>3</td>
<td>4 – 5</td>
<td>4</td>
</tr>
</tbody>
</table>

**Table – 3** Crease Recovery Angle of Reactive dye printed cotton fabric using TiO₂ in printing paste and steam aged at 150 °C for 5 minutes

<table>
<thead>
<tr>
<th>TiO₂ concentration (ppm)</th>
<th>Crease Recovery Angle</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>With T₁</td>
</tr>
<tr>
<td>0</td>
<td>176</td>
</tr>
</tbody>
</table>