Asian Journal of Chemistry; *Vol. 25, No. 4 (2013), 1776-1778*

ASIAN JOURNAL OF CHEMISTRY

http://dx.doi.org/10.14233/ajchem.2013.12798

Effect of Nano TiO_2 Grafting Method on Strength and Dyeing of Cotton Fabric in Presence of Different NaOH Concentrations

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(*Received*: 29 September 2011; *Accepted*: 3 October 2012) AJC-12217

Printing is one of the common processes in textile but not only use for creating dye designees. It can be use for burning designed, *etc*. In this work, two type of cotton fabrics were used; one crosslinked with nano TiO_2 and the other one without nano TiO_2. The treated fabric just printed with NaOH in different concentrations and un-treated fabric printed with NaOH in same concentrations containing nano TiO_2 in its printing pulp. Strength of each type of fabrics investigated and compare with each other and with raw cotton. Dye ability of these fabrics was investigated and the effect of nano TiO_2 grafting method was studied. The results show meaningful difference in strength and dyeability of fabrics between crosslinked and non crosslinked method in difference of different NaOH concentrations.

Key Words: Nano TiO_2, NaOH, Cotton, Dyeing, Printing.

INTRODUCTION

In textile industry more than 70 % of all printed substrates are cellulosic fabrics[1]. The swellability of cellulose fabrics has importance in textile industry[2]. Using sodium hydroxide is a typical treatment for cotton fabrics which improves the fabric luster and wettability, ensures a covering effect for dead cotton, improves dimensional stability and dyeing efficiency[3]. Several methods can be use to apply nano materials on fabrics such as spraying, foaming, padding and transfer printing[4].

In recent years, properties of TiO_2 have gained much attention and a wide range of nanoparticles can be immobilized on fibers, which brings new properties to the final clothing product[5,6]. Putting nano scale materials such as TiO_2 on to fabrics improve their properties such as strength, electrical conductivity, wettability and dyeabilitiy, depending on type and content of nano materials used[7-12].

TiO_2 can exist in both crystalline and amorphous forms.In the case of photocatalytic, amorphous form is inactive. There are three crystalline phases of TiO_2: anatase, rutile and brookite.Anatase and rutile are both tetragonal in structure while the brookite structure is orthorhombic[13]. One way to graft nano TiO_2 on cotton fabric is using crosslink agent (29-311).

The aim of this study is to investigate the effect of NaOH and nano TiO_2 on printing of cotton fabric and its effect on strength and dyeability on cotton fabric.

EXPERIMENTAL

The materials under investigation were cotton fabric that bleached with H_2O_2 and nano TiO_2 supplied by Degussa P25. The used sodium hydroxide prepared in different percentages (Table-1). Eight cotton fabrics prepared. Half of them crosslinked with nano TiO_2 and then printed with different concentration of NaOH. The other 4 samples doesn't crosslinked and just printed with NaOH, which contain nano TiO_2 in its printing pulp. Thus, two kinds of samples with different methods of TiO_2 attachments were prepared.

TABLE-1
SPECIFICATION OF SAMPLES

Sample code	Percent of NaOH (%)	Crosslinked	Percent of nano TiO_2 (%)
A	20	-	1.5
B	30	-	1.5
C	40	-	1.5
D	50	-	1.5
E	20	✓	1.5
F	30	✓	1.5
G	40	✓	1.5
H	50	✓	1.5

Method and characterization: XRD analysis was carried out for crystal phase identification of the TiO_2 samples using a Bruker, D8ADVANCE, Germany; X-ray tube anode: Cu;

wavelength: 1.5406 Å (CuK_α); filter: Ni. Irradiation was done by UV A 400 w lamp. Scanning electron microscopy (Philips, SEM, XL3, Netherland) was used to determine the structure of nano materials on fabric and samples were coated by gold with PVD method. EDX of specimens was prepared coincide of SEM. Strength of fabrics measured by a tearing tester (MESDAN S.P.A [CRE], 7EN9300, SALQ, Italy) in accordance with ISO 5082. Dye adsorption of samples was calculated using absorption spectrophotometer (BYK-Gardner, India-D65 Light Source).

Printing: Two type of cotton fabric (crosslinked with nano TiO_2 and non crosslinked) prepared. For the fabric which treated with nano TiO_2, we print them with 4 percentage of sodium hydroxide and for the non crosslinked fabrics we print them with same percentage of NaOH, which contain nano TiO_2 in printing pulp. Then both type of fabrics neutralized and prepare for strength test and dyeability.

Dyeing: The dyeing behaviour of the Solophenyl Blue 78 (Fig. 1) on treated fabrics was investigated. Prepared cotton fabrics were immersed in the dyebath. Dyeing was started at 20 ºC and the temperature raise by 4 ºC min^{-1} to 100 ºC. Dyeing was continued for 45 min at this temperature and then the fibers were washed with distilled water.

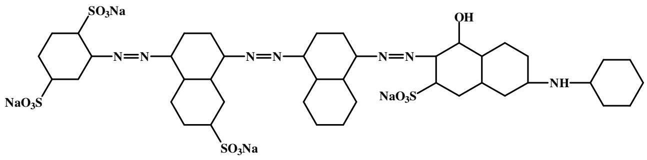

Fig. 1. Structure of solophenyl blue 78

RESULTS AND DISCUSSION

Particle size and crystal phase: The XRD spectra of the nano TiO_2 is shown in Fig. 2. Two peaks of anatase and rutile observed for P25. Quantification analysis showed that the average percentage of anatase and rutile was 84 % and 16 % respectively and the crystal size was 16.6 nm.

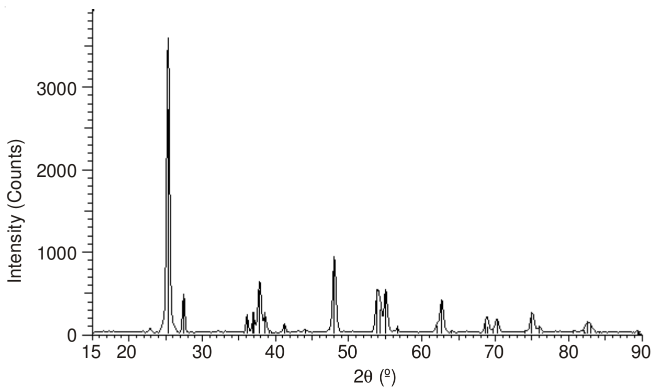

Fig. 2. Spectra of nano TiO_2 and crystal phase percent

SEM, EDX and distribution of nano particles: SEM photos of nano TiO_2 and treated fabrics are illustrated in Figs. 3 and 4. The intensity of electrons was 15 kv. The SEM of nano filled fibers show distribution of nano particles on cotton. By comparing crosslinked and non crosslinked samples, it demonstrates that in crosslonked samples there is more distribution of nano particles. Energy dispersive X-ray microanalysis was employed to establish the chemical identity of the observed particles. It can be clearly seen from the EDX analysis (Table-2) that particles existing on the surface of fibers are titanium dioxide with nearly used percentage. EDX of specimens show the percent of material just on the surface of fibers. Also the SEM is proving that the particle size of nano material is 21 nm.

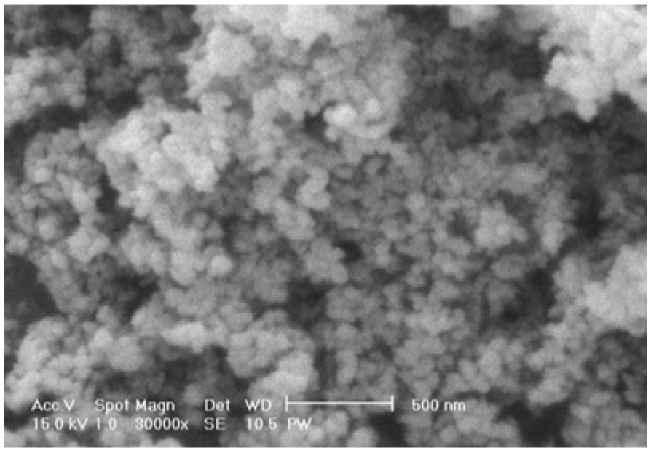

Fig. 3. SEM of nano TiO_2 powder

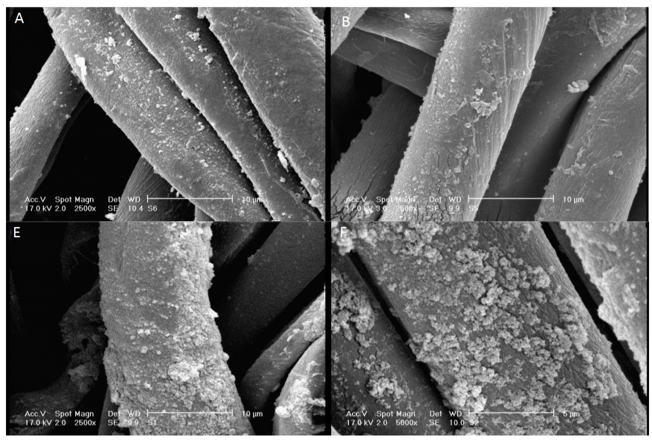

Fig. 4. SEM of treated samples

TABLE-2
COMPARING OF USED AND PRESENT TiO_2

Sample code	TiO_2 by EDX (%)	Used nano TiO_2 (%)
A	1.15	1.5
B	1.47	1.5
C	1.43	1.5
D	1.43	1.5
E	1.45	1.5
F	1.39	1.5
G	1.41	1.5
H	1.39	1.5

Strength property: Five samples from each type of fabrics were prepared in warp direction. Consequently the tearing strength was separately recorded for each sample. Average results of strength test for raw cotton and treated fabrics (using crosslink and non-crosslink) with nano titania are presented in Table-3.

The tearing strength of crosslinked samples are higher that non-crosslinked without any exception. It is introduce due to better coupling of nano TiO_2 in crosslink method. In both

TABLE-3
STRENGTH OF SAMPLES

Sample code	A	B	C	D	E	F	G	H	Raw cotton
Strength (N)	301.809	324.198	340.158	361.349	360.400	361.588	373.976	378.702	350.638

FTABLE-4
ADSORPTION IN WASTEWATER

Sample code	A	B	C	D	E	F	G	H
Abs	0.112	0.110	0.109	0.126	0.136	0.129	0.125	0.143

type of samples, by increasing the concentration of sodium hydroxide, the strength of fabrics increase respectively. It is because of acidic properties of nano $TiO_{2,}$ which neutralizes in high concentration of NaOH. In compare of strength of treated fabrics with raw cotton, it demonstrates that the strength of crosslinked fabrics with nano TiO_2 is higher that raw sample, but in non-crosslinked samples generally it is lower than raw sample (except in higher concentration); maybe it is because of aggregation of nano material on surface of fabric.

Dyeing property: The changes in absorbance of fibers were monitored using an adsorption spectrophotometer. Due to the colouring of fibers provided by crosslink and non crosslink, it can be observed that the dye concentration of crosslinked fabrics are higher than the other one in wastewater (Table-4), so it means that the dye adsorption of fabrics that treated by crosslink agent are lower than the other one. This can because of closing sites of cotton by TiO_2 so that colour groups cannot come over it. On the other hand, by increasing percent of NaOH, adsorption of wastewater reduces and so dye adsorption on fabrics increase except in highest concentration (samples D and H). It can be introduce that by increasing NaOH concentration, swelling of cotton occur and cause to better adsorption.

Conclusion

The objective of this study was to investigate the strength of two type of cotton fabric (crosslinked with nano TiO_2 and non-crosslink) printed by sodium hydroxide under different concentrations. With the exception of the highest NaOH concentration in non-crosslinked sample, strength of non-crosslink treated fabrics are lower than raw sample; but the strength of all crosslinked samples are higher than raw fabric. Also dyeability of both two fabrics increases with increasing of NaOH percentage. In compare of cosslink and non-crosslink samples it delineate that strength of coslinked samples are higher than the other samples and noncrosslinked fabric dyability is higher than crosslinked. So in general, using nano TiO_2 in type of crosslink treatment improves the property of strength and dyeing and sodium hydroxide printing (because of swelling of cotton) causes to improve this ability.

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