Using Nanomaterials Treatments to Improve the Performance Characteristics of Garment groups with Special Needs.

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Abstract: Special Needs garments can be classified on the basis of their specified functions. Basically, there are three main functional domains: protective, treatment and caring. This paper investigates the possibility to improve the comfort and functionality of these groups clothing with nanotechnology by assessing all of the above concerns and compare the benefits of nanotechnology with its disadvantages. It will also investigate the role of nanotechnology in improving sustainability. Fabric comfort is determined by its physical and mechanical properties which are being influenced by the finishing treatment. This paper study the effects of nano-silver finishing on the physical and mechanical propertie. Plain weave of 100% cotton fabrics have been finished with five distinct solution concentrations (100,200,300,400 and 500 PPM) and have been compared to the raw fabric. The physical and mechanical properties including air permeability, wrinkle recovery, water vapor permeability, breaking strength, breaking elongation and bending rigidity have been measured. The results illustrated that by increasing the solution concentration of the nano-silver finish, air permeability has been wasted and there is a great difference between nano-finished samples and the unfinished one. Also by increasing the solution concentration, a slight decrease in wrinkle recovery and an irregular decline in water vapor permeability have been observed. Also an irregular increase in thickness and breaking strength has been perceived and a considerable raise in the breaking elongation and bending length in both warp and filling directions was observed. All these consequences have been confirmed by the mean of statistical analysis.

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Key words: Nanotechnology; Cotton; physical and mechanical properties, woven fabric, nano-silver finish

1. Introduction:

The application of nanoparticles to textile materials has attracted considerable interest due to their novel physicochemical properties and their potential applications. However, some of these particles are toxic or poorly effective, which makes them not suitable for applications in medicine, filters, and textiles and for the exclusion of pollution. For example; improving the water-repellent property of the fabric by creating nano-whiskers (hydrocarbons which are 1/1000 size of typical cotton fibers) on the fabric [1]; imparting anti-static properties of textile which can be provided by TiO2, ZnO, antimony-doped tin oxide (ATO) and silane nano sol [1]; increasing the surface energy and thus giving a very high particle retention to filters by the usage of nanofibrous webs on them [2]; employing nano-titanium dioxide and nano-silica to advance the wrinkle resistance of cotton and silk respectively [1]; employing nano-sized TiO2 and ZnO in order to absorb and scatter UV radiation more effectively regarding the larger surface area and blocking ability of so-called particles [2]; covering the cotton fibers in a fuzz of minute whiskers and creating fewer points of contact of dirt, thus the fabric has been rendered super-hydrophobic and the self-cleaning property can be developed in this way [3]; and eventually, anti-bacterial properties can be imparted by using nano-sized silver, titanium dioxide and zinc oxide. In respect to our study nano\-silver particles should be discussed more which they have an extremely large relative surface area, so their contact with bacteria or fungi is increased, thus their bactericidal and fungicidal effectiveness has been vastly improved.

Cotton is a common material for the production of textiles for sport and leisure. It has excellent moisture absorption ability. However, the moist cotton can be easily attacked by bacteria. Decomposed products of body secretions have a characteristic odor [4].In recent research, a good antibacterial effect of nano-sized silver colloidal solution on polymer and textile fabrics was shown [5,6]. The objective of this study was not only the synthesis of silver nanoparticles used microwave radiation as a heating source but also investigate the role of nanotechnology in improving sustainability cotton fabrics and the relationship between the physical & mechanical properties and the content of nano-sized silver on cotton fabric was discussed. Generally, this utilization can be categorized into two main areas: firstly, application of nanofibers and secondly, application of nano-particles in different domains. Here some of these applications can be named. For instance, using of polymeric nanofibers and their composites for drug delivery systems[7], tissue engineering, reinforcement of some composites, transistors, capacitors etc. can be mentioned [8,9].

2.Material and Methods

2.1Material

Fabrics were woven with 100% cotton and plain weave,their complete specifications are demonstrated in table 1.Six different specimens were tested in order to study the effects of nano-silver finishing on the physical and mechanical properties of the fabric. The unfinished sample is labeled 'A' and samples which were finished with five solution concentrations of 100 PPM,200 PPM,300 PPM,400 PPM and 500 PPM are labeled as 'B','C','D','E' and 'F' respectively. Five different concentrations thus have been chosen to identify a trend in changes.

2.2. Treatment condition

In this case, fabrics soaked in 50°c suspensions with five distinct concentrations of nano-silver particles for 30 minutes. Fabrics have been dried in the open air afterward. This kind of finishing is generally called 'exhausting finishing'. PPM stands for particle per million and it is the mass concentration of the batches.

2.3 Methods

The physical and mechanical properties including air permeability**(A.P)**, wrinkle recovery **(W.R)**, water vapor permeability **(W.V.P)**, thickness**(T)**, breaking strength**(B.S)** , breaking elongation**(B.E)** and bending rigidity**(B.R)** have been measured as a testing procedure[10].

Table (1) Constructional Parameters of woven Fabric Samples before treatment

SampleID	Yarn count(Nm)Warp	Yarn count(Nm)Weft	Warp density (ends/cm)	Weft density (picks/cm)	Fabric thickness mm	weave	Fabric weight g/m^2
A	30	25	43	36	0. 36	plain	155.79

3.Results and Discussion

Physical and mechanical properties were tested in this study, Table 2 shows these results.

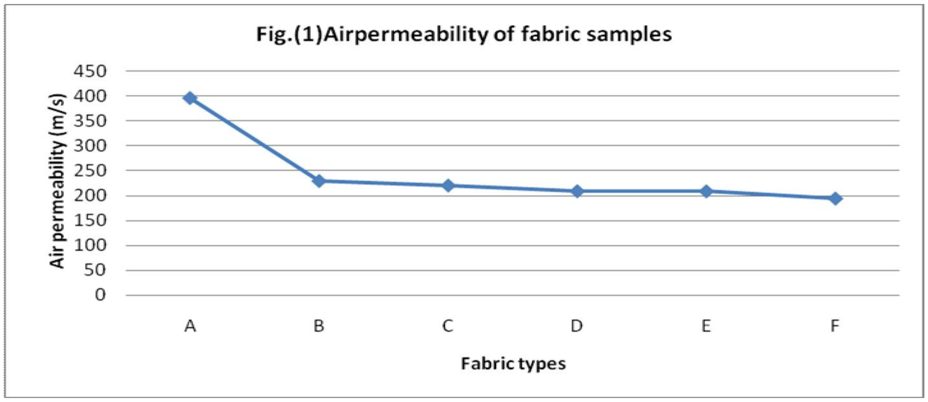
Table (2) Physical &Mechanical Properties of Fabric Samples (A, Raw sample & B - F, Nano-finished samples with different concentrations)

Sa. ID	Physical Properties									Mechanical Properties									
	(A.P)		(W.R)				(W.V.P)%		(T) mm	(B.S)				(B.E)				(B.R)	
			warp		weft					warp		weft		warp		weft		warp	weft
	Ave.	CV %	Ave.	CV %	Ave.	CV %	Ave.	CV %		Ave.	CV %	Ave.	CV %	Ave.	CV %	Ave.	CV %		
A	395.5	7.4	95.2	2.6	116.5	12.3	112	0.24	0.36	403.5	1.85	423.2	2.5	11.2	3.3	13.8	1.9	71.2	72.5
B	229.8	6.6	92.9	8.9	91.5	8.1	111.7	1.28	0.42	407.1	17.4	423.8	18.3	18.3	5.3	25.2	2.1	91.6	96.4
C	220.8	5.6	92.3	5.2	84.6	4.4	111.9	0.07	0.42	439.5	5.35	423.6	18.7	17.8	4.3	24.5	4.4	106	119
D	209.4	5.6	87.7	8.8	85.6	3.9	111.8	0.18	0.42	428	17.9	463.6	5.24	18.9	3.8	26.5	3.5	109	120
E	209.2	4.5	77	5	83.7	3.3	111.4	0.94	0.42	407.8	8.49	424.6	13.1	16.2	4.4	25.9	3.6	126	124
F	194.7	5.6	84.8	6.2	74.6	4.2	98.84	1.18	0.37	387.6	10.6	373.6	16.4	15.73	5.5	21.65	4.5	93.4	105

3.1 Effects of Nano-silver finish on Physical properties

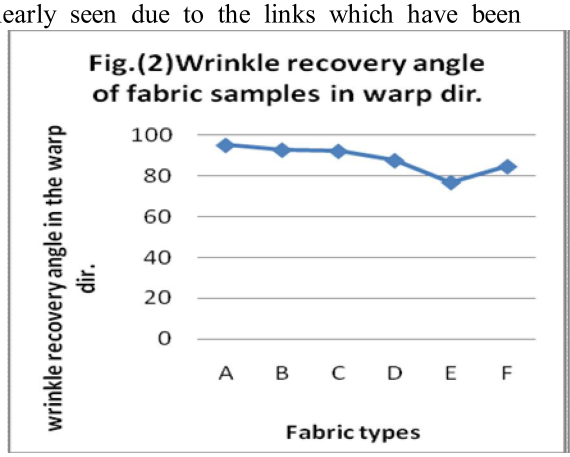
3.1.1 Air permeability

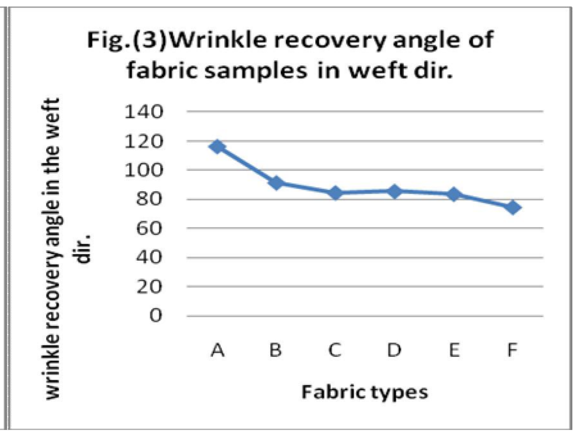
Fig.1 illustrated the results of the air permeability test. It can be clearly seen that there is a severe drop in the air permeability property by applying nano-silver finish on the fabric; also a gradual fall has been occurred by increasing the solution concentration. This has been happened due to the reduced fabric pores which have been padded by nano-silver particles. Since the nano-particles are extremely tiny, increasing the concentration does not have any considerable effect on the air permeability property.



3.1.2 Wrinkle recovery

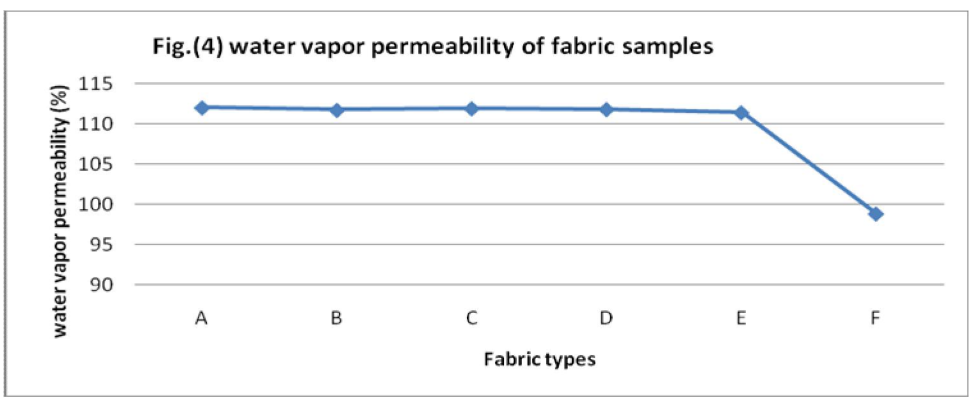
Fig.2 and fig.3 show the test results of wrinkle recovery in the warp and weft directions respectively. The angle of recovery in the warp direction was high degree in sample A and it went down gently in sample E and then rise again in the sample F. A downward trend in wrinkle recovery can be clearly seen due to the links which have been created by nano-silver particles on the fabric, but by increasing solution concentration to 500 PPM the created links decreased. The angle of recovery in the weft direction was high in sample A and there was a moderate drop in this value for the other samples but here, no regular trend can be observed and this can be attributed to the finishing unevenness.





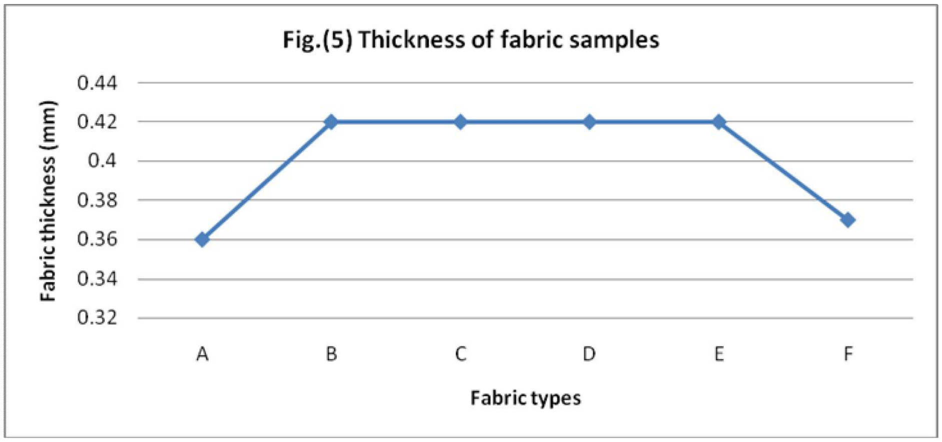
3.1.3 Water vapor permeability (WVP)

Fig.4 shows the WVP% of the fabrics. Generally, it can be concluded that WVP% of nanofinished fabrics are lower than the unfinished one. This result can be justified by the same explanation which was discussed in air permeability. Fabric A had the most WVP% while fabric F had the least WVP% The irregularity caused by the unevenness of finishing process.



3.1.4 Thickness

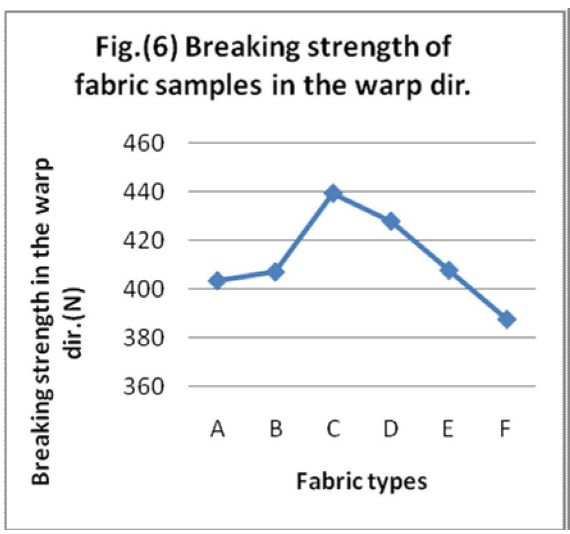
Thickness values of the samples are illustrated in fig.5. It is crystal clear that the thickness values of nano-finished samples are more than the unfinished fabric. More thickness values of the nanofinished fabrics are the result of the yarn swelling phenomena which happens during the finishing process, but by increasing solution concentration to 500 PPM a severe fall has been occurred.This has been happened due to decreasing of yarn swelling.

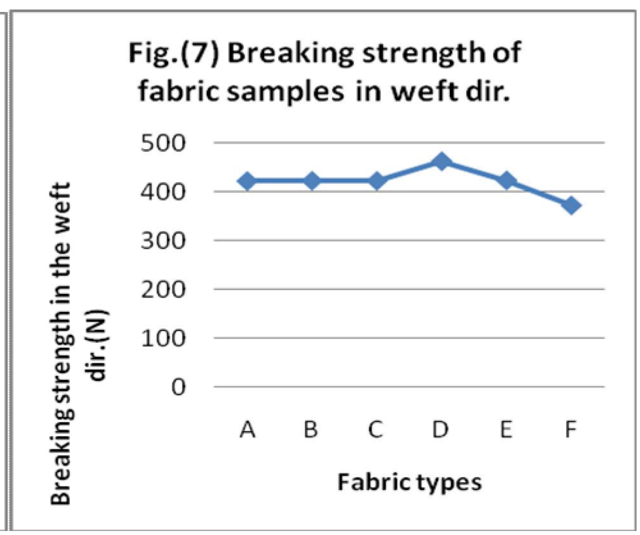


3.2 Effects of nano-silver finish on mechanical properties

3.2.1 Breaking strength

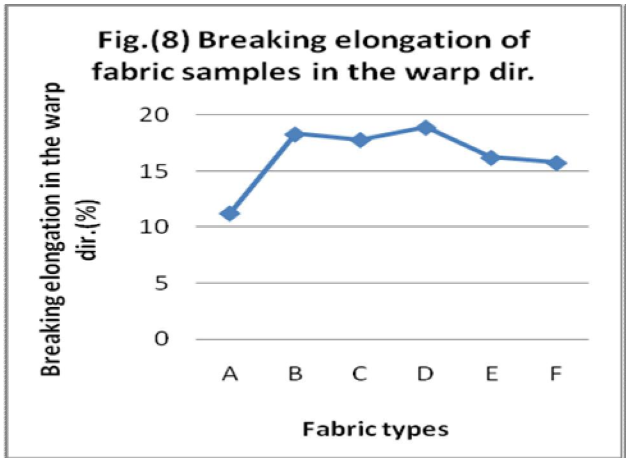
The breaking strength of the fabrics in the warp direction is illustrated in fig.6. Sample F had the least breaking strength and fabric C had the most one. Generally it can be indicated that the breaking strength of nano-finished samples is more than unfinished fabric owing to the linkage formation between fibers and yarns, while there is no exactly trend in this property. Fig.7 shows the breaking strength of the fabrics in the weft direction. The highest breaking strength relates to sample D but no significant difference can be observed between other samples.

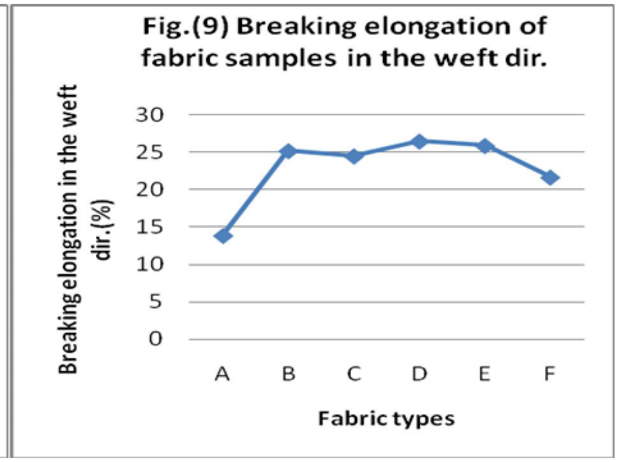




3.2.2 Breaking elongation

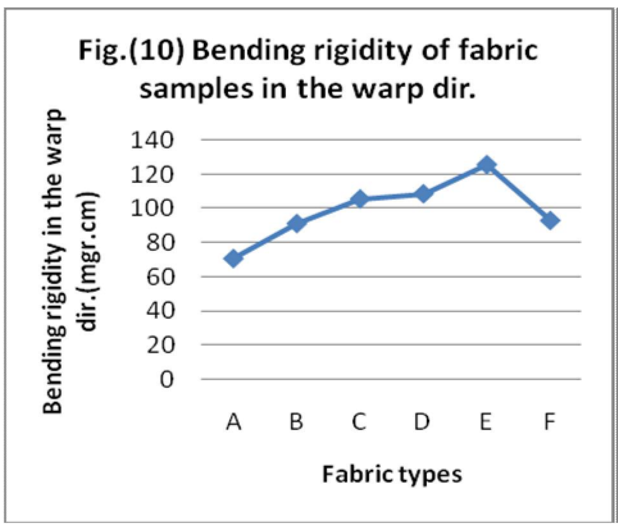
The breaking elongations of samples in warp and weft directions are presented by fig.8 and fig.9. It can be observed that there are considerable differences in the breaking elongation of fabrics between nano-finished and unfinished specimens. This essential distinction is due to consolidation of fibers and yarns by the nano-silver particles.

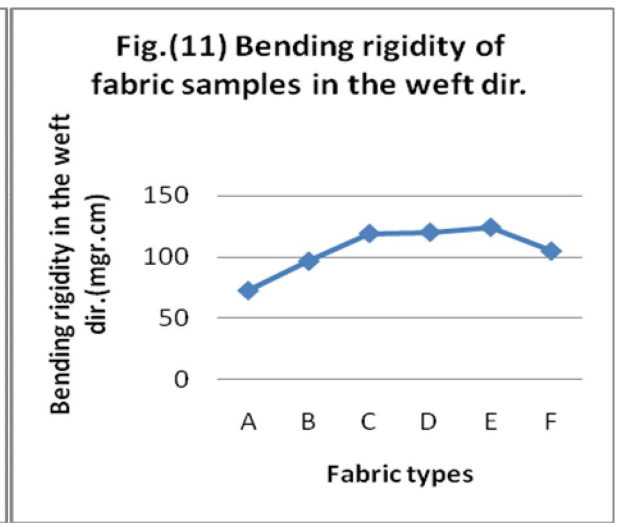




3.2.3 Bending rigidity

Bending rigidity values of samples in the warp and weft directions are shown in fig.10 and fig.11 respectively. Bending rigidity of sample A is 71.2 (mgr.cm) in the warp direction and 72.5 (mgr.cm) in the weft direction. After that the bending rigidity values started to increase and they reached to 126(mgr.cm) in the warp direction and 124(mgr.cm) in the weft direction in sample E. This gradual upward trend is caused by the links which was formed on the yarns and fabrics by nano-silver finishing. But by increasing solution concentration to 500 PPM in sample F a gradual fall has been occurred. This has been happened due to decreasing form of links.





4. Conclusion

Due to special needs garments, cotton fabrics may changed by the the effects of nano-silver finishing on the mechanical and physical properties of them, fabric samples were subjected to the nano-silver finishing process with five different solution concentrations of 100, 200, 300,400 and 500 PPM. The following conclusions have been drawn; nano-silver finishing minimized the air permeability and water vapor permeability of the fabric and this can be attributed to the nano-silver particles which fill the fabric pores; wrinkle recovery angle of the nano-finished fabrics was reduced in both directions because of the generation of links on the fabric by nano-silver particles; Yarn swelling phenomena happens during the finishing process in cotton fabrics which means increment of occupied space by fibers and yarns, and thus rise in the fabric thickness; owing to integration of fibers and yarns by the nano-silver particles, the breaking elongations of fabrics in both warp and weft directions was inclined to applying the nano-silver finishing process, and applying the nano-silver finishing process led to formation of links on the fabric, and consequently bending rigidity of the fabrics was increased in both warp and weft directions. Ultimately,it was noted that increasing the concentration of the solution to 500 PPM, marked a decline in most of the physical and chemical properties of cotton fabrics.

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