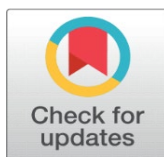


VALUE ADDITION ON COTTON FABRIC USING PLASMA TREATMENT AND PIGMENT PRINTING

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Received 04 March 2023
Accepted 05 April 2023
Published 17 April 2023

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DOI
[10.29121/granthaalayah.v11.i3.2023.5111](https://doi.org/10.29121/granthaalayah.v11.i3.2023.5111)

Funding: This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

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ABSTRACT

Cotton is the king of textile industry. It is the most trendy, versatile, and eco-friendly fabric. This material is most desired fabric by the consumers. It has many good properties as it has good heat conductivity, absorption, strength, etc. it is used in vast gamut of products like apparel, home-furnishing, industries, medical, auto mobiles, etc. it can be blended with other natural as well as synthetic fibers like wool, silk, polyester, acrylic, nylon and many more. In today's world there are various new technologies coming up every day, one of which is plasma technology which is slowly capturing the textile industries. Many researches are done and still continuing on plasma technology. In this study the researcher has tried to apply plasma treatment on to the cotton fabric to modify the surface property of the same. This dielectric plasma treatment was given on varying time period like 15min, 30min, 45min, 1hr, 1 1/2hr and 2hr. After plasma treatment the samples were undergone for pigment printing with water base and without water base printing paste. The same printing was also done on unmodified cotton sample to have a comparison between modified and unmodified samples. The results were compared on the basis of few tests like rub fastness (dry and wet), wash fastness and UV protection test. In this research it has been observed that plasma treated i.e., modified samples were having better fastness to dry and wet rub and wash fastness and UV protection of treated fabric after printing was increased. This study also shows that even 15min and 30min of treatment improves the fastness property of the cotton fabric so in concern of energy usage, treatment can be given for less time duration to have better quality products. UV protection of the fabric can be increased by printing with without water-based pigment printing with 1hr of plasma treatment which on the basis of the results said to be the optimum time of treatment

Keywords: Cotton Fabric, Plasma Technology, Water Based Pigment Printing, Without Water Based Pigment Printing, UV Transmittance

1. INTRODUCTION

COTTON FIBER: Cotton is used more than any other fabric across the world in our day to day lives. It is been cultivated since 5000B.C. which was discovered in Mexico. Cotton is a cellulosic fiber which contains 80- 90% of cellulose and 6-8% Water other than these it has fat, protein, hemicellulose, pectin, and ash. Cotton is a biodegradable fabric because of which it is called as an eco-friendly fabric also. It is best suited for summers as it has an excellent absorbing property and stays cool in hot weather. [Deepa & Goyal \(2013\)](#)

PROPERTIES

Cotton has good strength, heat conductivity, absorbency but it also has poor elasticity, resiliency and darpeability, Cotton does not get affected by soap or detergents. For bleaching hydrogen peroxide and sodium perborate are the common bleaches used on cotton. Cotton is the highly shrinking fabric hence it requires high temperature for ironing. Cotton is damaged by strong acids like sulphuric acid, nitric acid. Organic acids do not harm the cotton fabric. Alkalis do not have any effect on cotton but hot alkalis attack on cotton fibers. [Sapkale et al. \(2006\)](#)

2. PLASMA TECHNOLOGY

Plasma is a fourth state of matter, in addition to the three basic states of matter, which are solid, liquid, and gas. Plasma is formed by adding energy to a gas, causing electrons to leave its atoms, a process known as ionization. As a result, negatively charged electrons and positively charged ions are produced. These electrons and ions have a strong reaction to electric and magnetic forces. Plasma is a superior electrical conductor than copper. Plasma is extremely hot because it needs a very high temperature to destroy the connections between electrons and atom nuclei. It also has a lot of pressure. [Dixit et al. \(2014\)](#)

Plasma processes are classified into two types: low density and high density, based on electron temperature vs. electron density. Plasma treatment has an increased interest in textile industry and used in medical, biomedical, automobiles, electronic, semiconductors, etc. past researches on plasma have concluded that plasma treatment shows improvement in wetability, shrink resistance of wool, dyeability, printability, coating, and washability, dyeing rates of polymers and improved colour fastness and wash fastness of the fabric.

Different techniques of plasma treatment:

- Glow discharge
- Corona discharge
- Dielectric-barrier discharge
- Atmospheric pressure plasma jet (APPJ)

[Kiron \(2014\)](#)

Functions of plasma treatment on fabric:

- 1) Anti-felting of Woolens Fabrics.
- 2) Hydrophilic Enhancement for Improving Wetting and Dyeing.
- 3) Hydrophilic Enhancement for Improving Adhesive Bonding.
- 4) Hydrophobic Enhancement of Water and Oil-repellant Textiles.
- 5) Facilitating the Removal of Sizing Agents.
- 6) Scouring of Cotton, Viscose, Polyester and Nylon Fabrics.
- 7) Anti-bacterial Fabrics by Silver Particles Deposition with Plasma Aid.
- 8) Durable Antistatic Properties using PU-Resin and Plasma Processing.
- 9) Electro-conductivity of Textile Yarns by Surface Plasma Deposition. [Kiron \(2014\)](#)

3. PIGMENT PRINTING

Pigments are synthetic organic materials it is done to produce attractive designs in the fabric surface. Pigment printing is done with binders as the pigment does not have any affinity to the cotton fabric. Binders are the film the pigment and fabric surface together.

There are two types of pigment printing: 1. Water based 2. Without water base
The process of pigment printing:

Pre- treatment → printing → drying → curing.

4. PURPOSE OF STUDY

Aim: To enhance the aesthetic value of plasma treated cotton fabric using pigment printing.

Objectives:

- 1) To modify the surface property of cotton fabric using plasma technology.
- 2) To enhance the aesthetic value of modified and unmodified cotton fabric using pigment printing.
- 3) To evaluate the properties of modified and unmodified cotton fabric.

5. METHODOLOGY

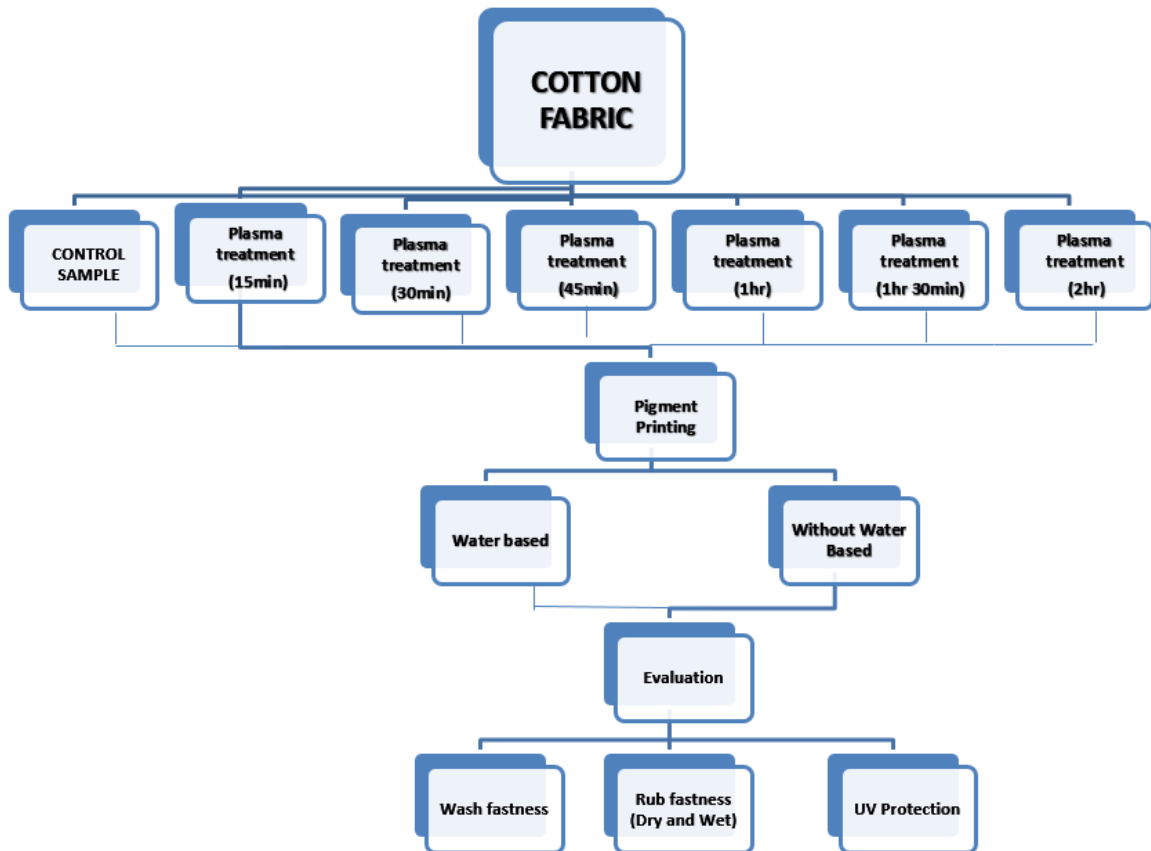


Plate 1

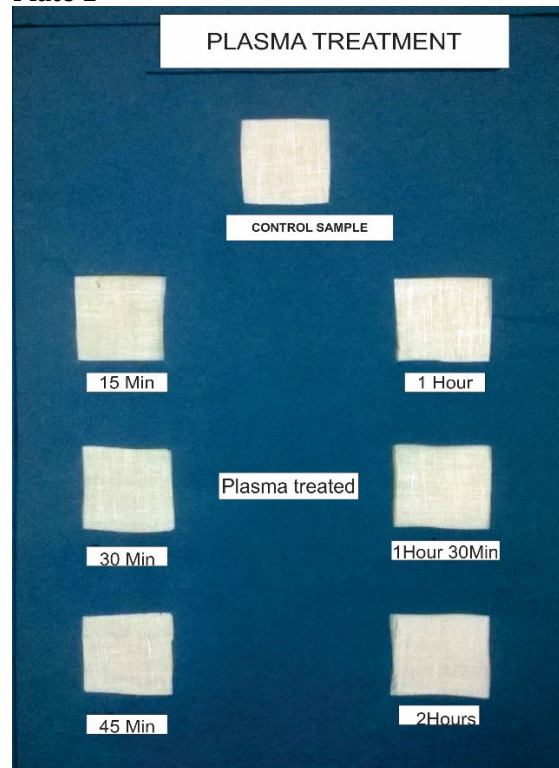


Plate 1 Plasma Treatment

Plate 2

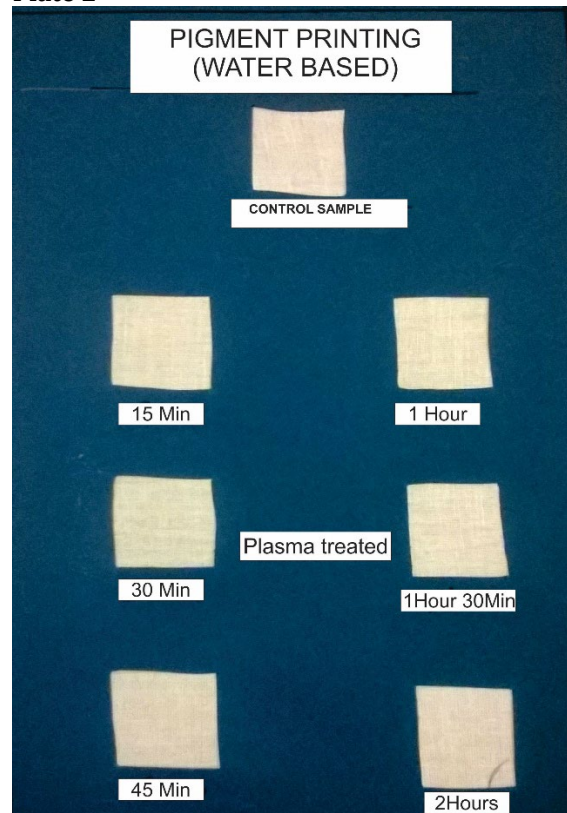


Plate 2 Pigment Printing (Water Based)

6. RESULTS AND DISCUSSION

Quantitative and Qualitative test

Microscopic, burning, and chemical test was conducted on the given sample and from all the tests it was confirmed that the given sample is cotton as it showed convolutions and lumen in microscopic test. When the fibers were burnt in the flame it was and gave burning paper smell with grey feathery ash. In chemical test it was dissolved in concentrated H₂SO₄.

Physical test

The cotton sample which was used in the research has average of 65 EPI and 48 PP, GSM of 91.39g/m². The sample has the yarn count of 33.53Ne and 22.86Ne, warp and weft wise. The fabric was of average 0,29mm. Cover factor of the given sample was 17.24 threads per inch.

Colour fastness to Dry & wet Rubbing

Standard Test No. /Method: for cotton 105 C10 (Programme B).

Figure 1

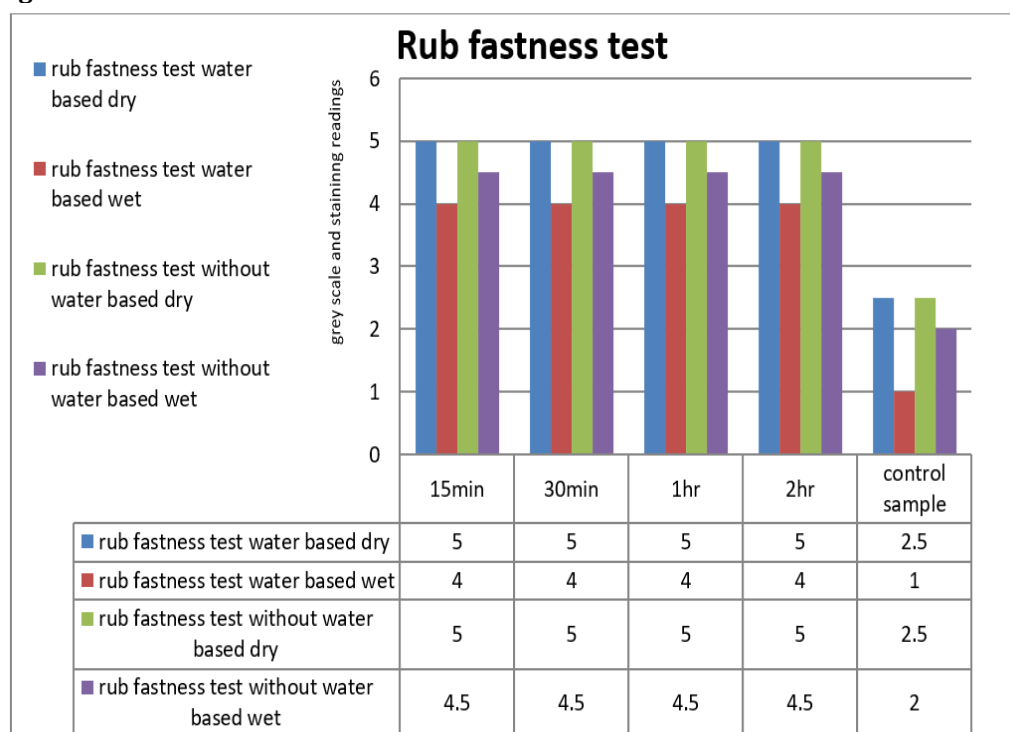


Figure 1 Rub Fastness Test on Treated and Untreated Printed Cotton Fabric

From Figure 1 it is seen that unmodified water-based pigment printed samples have the rating of 2.5 for dry rubbing and 1 for wet rubbing whereas for modified samples it increased to 5 for dry and 4 for wet rubbing. In case of without water based pigment printed unmodified samples rating for dry and wet rubbing it was 2.5 and 2. In modified samples it was 5 and 4.5 which is excellent. Hence it was observed that plasma treatment improves the rub fastness property of printed cotton fabrics, with this it was also observed that without water based pigment printing gives better results as compared to water based pigment printing.

Test Name: Colour fastness to Washing

Standard Test No. /Method: For wool ISO 105 C10 (Programme A), for cotton & polyester 105 C10 (Programme B)

Figure 2

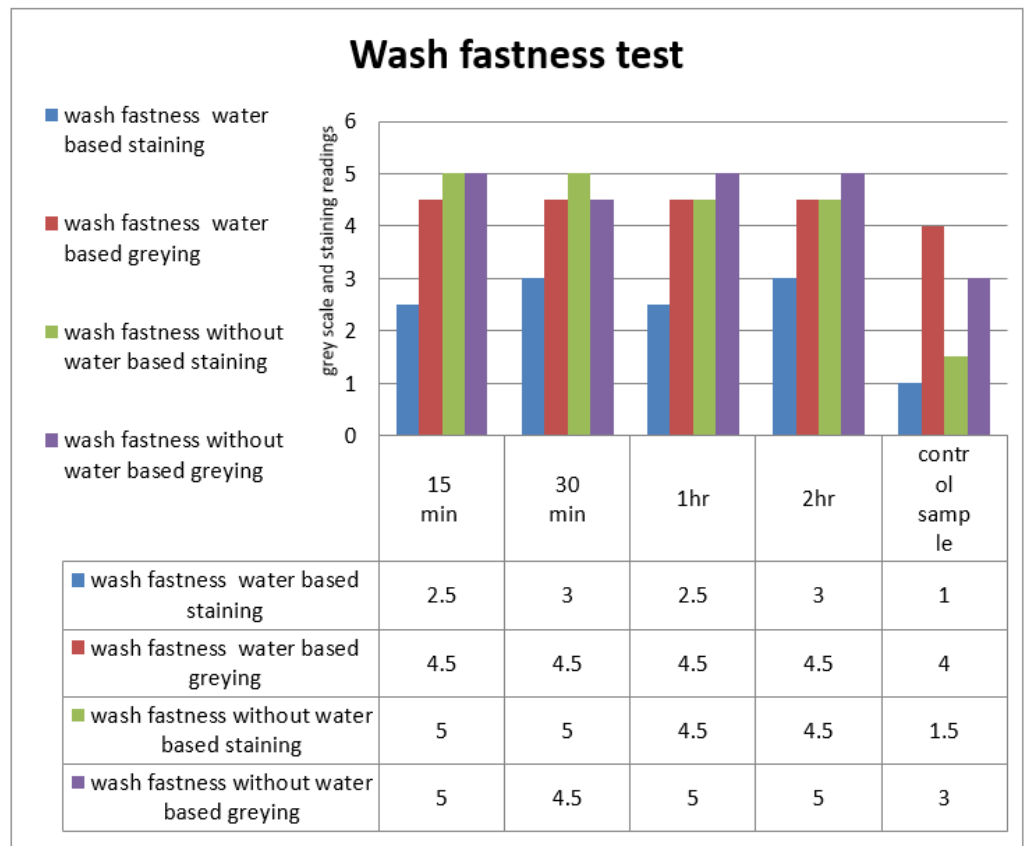


Figure 2 Wash Fastness Test on Treated and Untreated Cotton Fabric

From Figure 2 it is seen that modified and unmodified cotton samples were printed with water based and without water based pigment printing and its wash fastness was checked. Water based unmodified sample showed the reading of 1 for staining which is very poor but improvement was seen in modified cotton samples wherein it gave the reading of 4.5 which is very good. On the other hand without water based unmodified printed samples had the staining rating of 1.5 has increased to 5 in modified printed samples. Hence according to wash fastness test it was also seen that without water based pigment printing with plasma treatment showed better results than the water based pigment printing.

UV Protection

Standard Test No. / Method: [AATCC 183:2010]

Figure 3

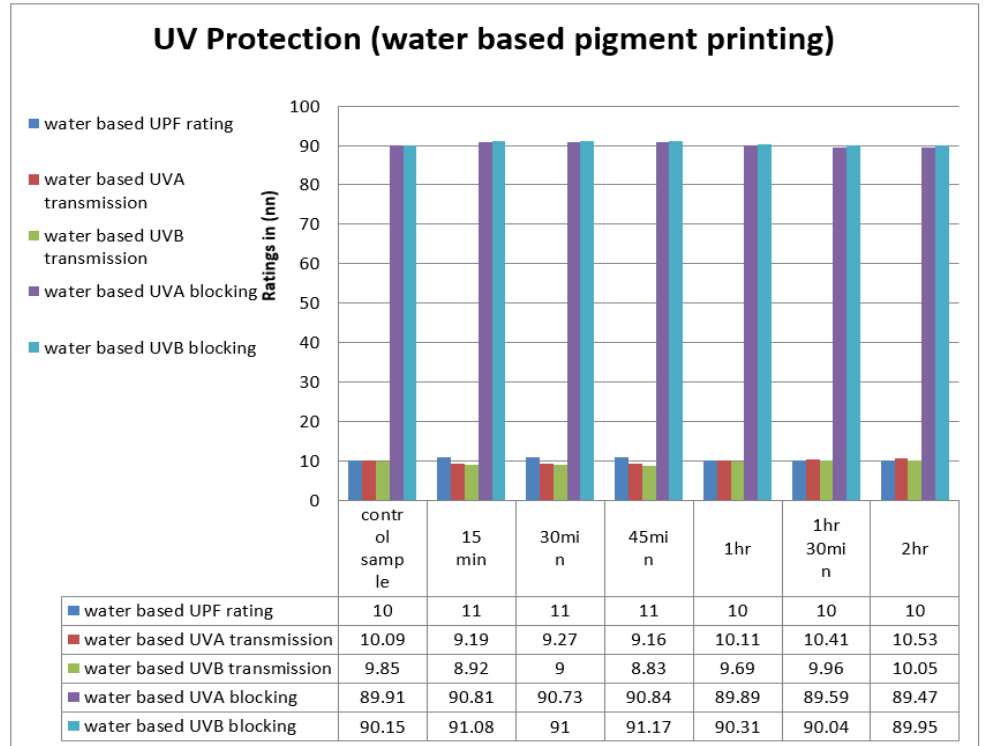


Figure 3 UV Protection Test on Water Based Printed Treated and Untreated Cotton Fabric

Figure 4

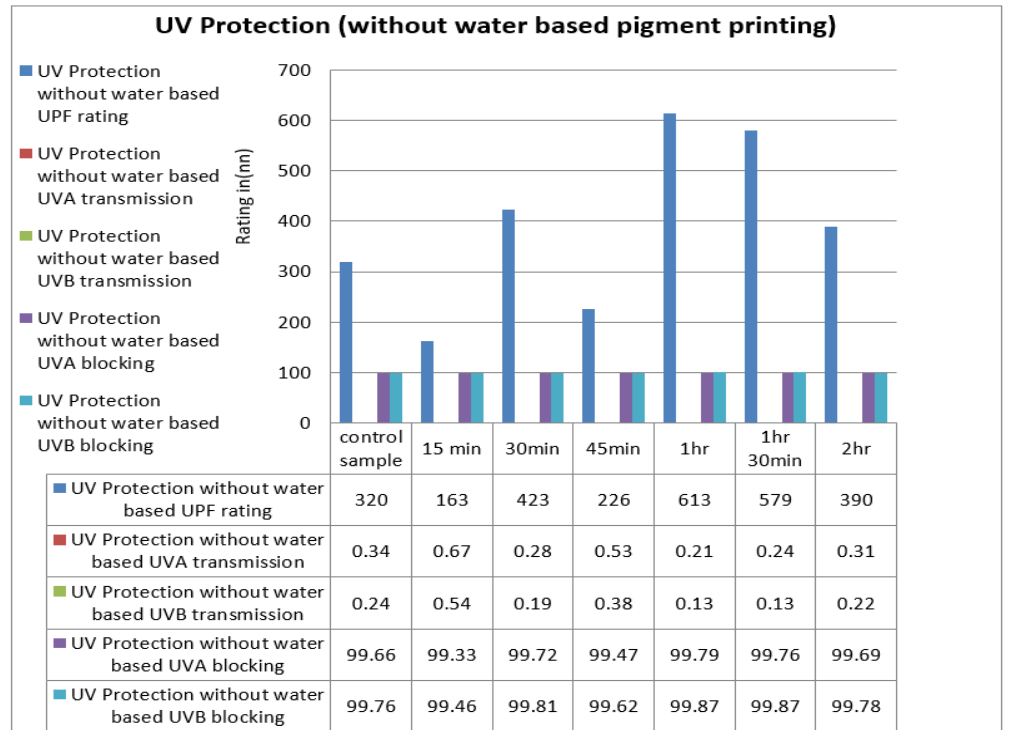


Figure 4 UV Protection Test for Without Water Based Printed Treated and Untreated Cotton Fabric

According to [Figure 3](#) and [Figure 4](#), it was seen that unmodified cotton inherently has very poor UV protection but with plasma treatment and printing it increases a little wherein if we see the readings for unmodified it was 5 which with treatment and water based pigment printing the UPF value increases to 10 and 11. UV-A UV- B transmission decreases with few points and Blocking of the same is increased. In the case of without water based pigment printing, unmodified sample also has good UPF value i.e. 320 which is considered as UV protected but with one hour of plasma treatment increases to 613 which is the highest reading amongst all the tested samples. Hence it is proved that without water based pigment printing along with 1hr of plasma treatment helps to get UV protected cotton fabric.

7. CONCLUSION

On the basis of Quantitative and Qualitative tests it has been proved that the given sample is cotton. Plasma treatment was done on raw cotton fabric with time differences of 15mins, 30mins, 45mins, 1 hour, 1½ hour and 2 hour, it was observed that the treated sample has different texture; it gave different odor and soft feel as compare to the original sample. It also showed better results in every tests compare to control sample.

In this experiment it is seen that the wash fastness of raw cotton show poor results whereas plasma treated cotton showed improved wash fastness.

The results were same for both water based and without water based pigment printing:

Rub fastness test was conducted to check the fastness property and the results were such that the raw cotton fabric showed poor staining and greying results whereas plasma treated cotton fabric showed improve fastness property with grey scale rating of 4.5. The difference in time did not make any difference as in even 15 min sample showed the same results as 2hr sample.

This test was conducted to check the UV protection of the cotton fabric and on the basis of this test it has been concluded that the cotton fabric itself have very poor UV protection, with plasma treatment it increases a little, but we still cannot call it a UV protected fabric. In this study printing with water base and without water base pigments were used to print the samples and the difference was checked. It has been concluded that without water base pigment printing with 1hr of plasma treatment makes the cotton fabric UV protected.

CONFLICT OF INTERESTS

None.

ACKNOWLEDGMENTS

None.

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