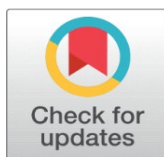


ENHANCEMENT OF WOOL FABRIC BY PLASMA TECHNOLOGY AND PIGMENT PRINTING

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ABSTRACT

The textile industry is looking for innovative production systems to enhance the product quality and society requires new strategy working in natural aspect. India accounts for 1.8% of total global wool production. India has the world's seventh-largest wool and woollen textile sector. Worsted yarn, woollen yarn, wool tops, fabric (woollen/worsted), shoddy yarn, shoddy fabrics, blankets, knitwear, hand-made carpets, and machine-made carpets comprise India's wool and woollen industry. Plasma treatment modifies the surface properties of internal materials; it has an economic advantage over conventional wet processing due to its low chemical and water consumption; and closed plasma treatment systems is an environment friendly process because plasma byproducts can be trapped rather than released into the environment. (<https://www.ibef.org/exports/wool-and-woollen>) This present research aims to study the effect of pigment printing on 100% wool fabric by using plasma i.e., Di-electric barrier discharge plasma treatment. Wool fabric was treated with plasma for different time variation of 15 minutes, 30 minutes, 1 hour and 2 hours. The water based and non-water-based pigment printing was done using the screen printing on untreated sample and plasma treated sample. The change induced in the fastness properties, UPF of plasma treated and untreated sample were studied. The experimental result indicate that the wash fastness and rub fastness of pigment printing both water based and non-water based pigment printing was better on the plasma treated rather than untreated sample the pigment doesn't peel off so we can use with water based pigment printing as it is eco-friendly over non-water based pigment printing. UPF rating for water-based pigment printing revealed that untreated samples have a higher UPF rating than plasma treated samples. When non-water-based pigment printing was performed, plasma treatment for 1 hour and 2 hours has a higher UPF rating than untreated samples, and the same is true for 15 minutes and 30 minutes plasma treated samples. It uses less water energy but more electrical energy because this energy is used for a longer period of time in this study.

Keywords: Wool Fabric, Plasma Treatment, Water Based Pigment Printing, Non-Water Based Pigment Printing, UV Transmittance

1. INTRODUCTION

Wool is oldest and important animal fiber. Chemical structure of wool is composed of protein known as keratin. The natural protein fiber consists of amino acids. These proteins are made up of five elements: carbon, hydrogen, oxygen, nitrogen, and sulphur. These five elements are combined to produce 15-20 amino acid chains that are connected together to construct ladder-like polypeptide chains. When the fibre of wool is untwisted, it has a kinky appearance. The length ranges from 3.6 to 35cm, with longer fibres being coarser than shorter fibres. Wool fibres have a conventional core-shell structure, with an inner section protein core, the

cortex, covered by overlying cuticle cells with scale edges pointing in the direction of the fibres. [Udakhe & Tyagi \(2011\)](#)

The fourth state of matter is plasma. Plasma as a Greek word refers to fabricated. Plasma was first invented by Irving Langmuir in 1928. Before that it was suggested by Sir William Crooks as the fourth state of matter. Plasma is partially ionized gas composed of electron, ions, photons, atom, and molecules, with negative global electric charge. Plasma modifies the surface of the fabric by the bombardment with high energy electrons and ions. Plasma treatment have been used for both surface modification and enhancing the bulk property of textile material, resulting in improved textile products ranging than the conventional composition. [Chinnammal & Arunkumar \(2014\)](#).

Plasma enhances the dyeing rate of the polymer, improves color fastness, and change the surface energy of fiber and fabric. Plasma treatment can be done on various fabrics such as PP, PE, PET, Cotton, rayon, wool, nylon etc. Plasma is used in bio-medical, automobile, electronics, semi-conductors, and textiles. [Malik and Parmar \(2007\)](#)

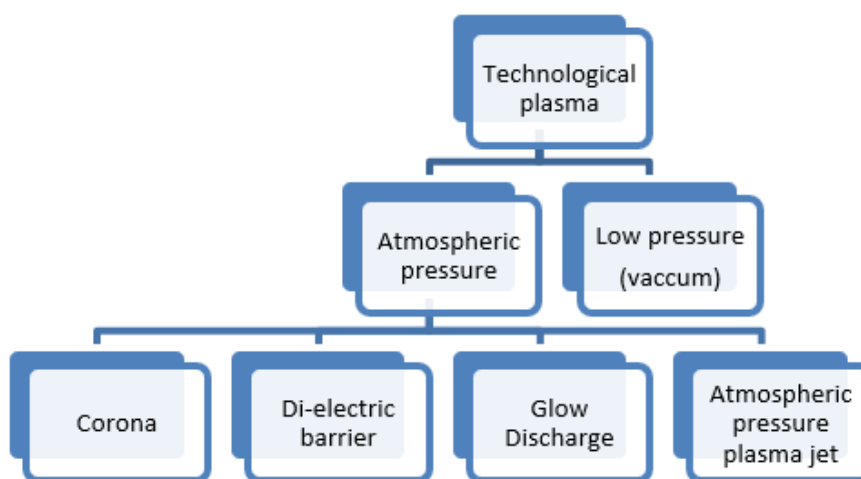
2. CLASSIFICATION OF PLASMA IS BASED ON

- 1) Pressure in plasma chamber - atmosphere as well as low pressure.
- 2) Ionization, temperature of electron and ions: hot and cold plasma
- 3) Frequency of power supply –dc and ac plasma (rf, microwave, ghz plasma)
- 4) The electron affinity of process gases uses electropositive and electronegative gas plasma.

[Xiros \(2018\)](#)

3. TECHNOLOGICAL PLASMA

2 main types: Atmospheric and Low Pressure (Vacuum)



[Atav \(2013\)](#)

4. PIGMENT PRINTING

Pigments are the most common synthesized organic compounds. Pigment printing is used to create eye-catching designs by applying pigment paste to the fabric's surface. Pigments are present in particle form, with particle sizes ranging

between 0.1-3 microns. Pigment printing is accomplished with the use of a binder. It is easy to apply, allow maximum output; fastness properties are good to average, economical. Pigment printing is not comfortable to wear, rub fastness is medium and are sensible to crushing during roller printing. [Atav \(2013\)](#)

AIM:

To study the effect of plasma on wool and to improves it printability.

OBJECTIVE:

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

5. MATERIALS AND METHODS

100% Merino wool with EPI and PPI i.e., 52 and 41per inch, thickness of 0.53mm, yarn count of warp is 43.5Tex and weft is 47.3Tex, Gram square per meter of 139.9gm/m² Cover Factor 20.67 Thread Per inch was used.

Method

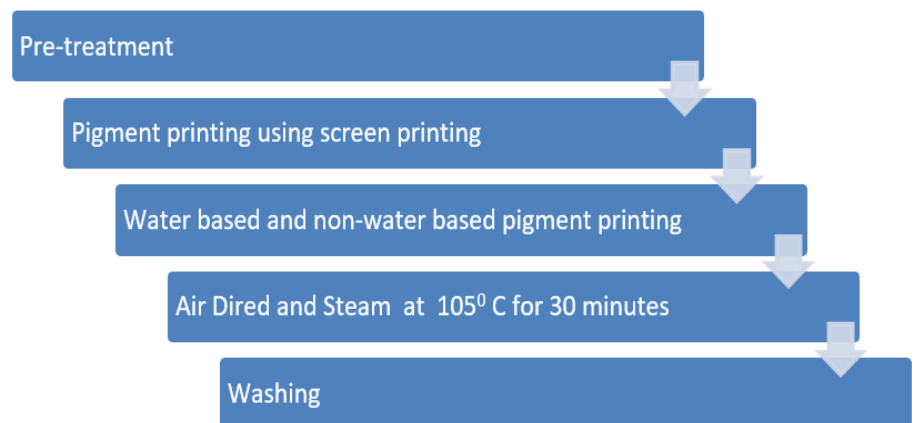
Plasma Treatment

Plasma chamber with dielectric barrier discharge (DBD) is used to treat wool fabric with different time and Voltage keeping the Electrode space constant of 3mm. Similar to a study conducted by Udakhe and Tyagi in this study also air was employed as the non-polymerizing gas. [Udakhe & Tyagi \(2011\)](#)

Table 1

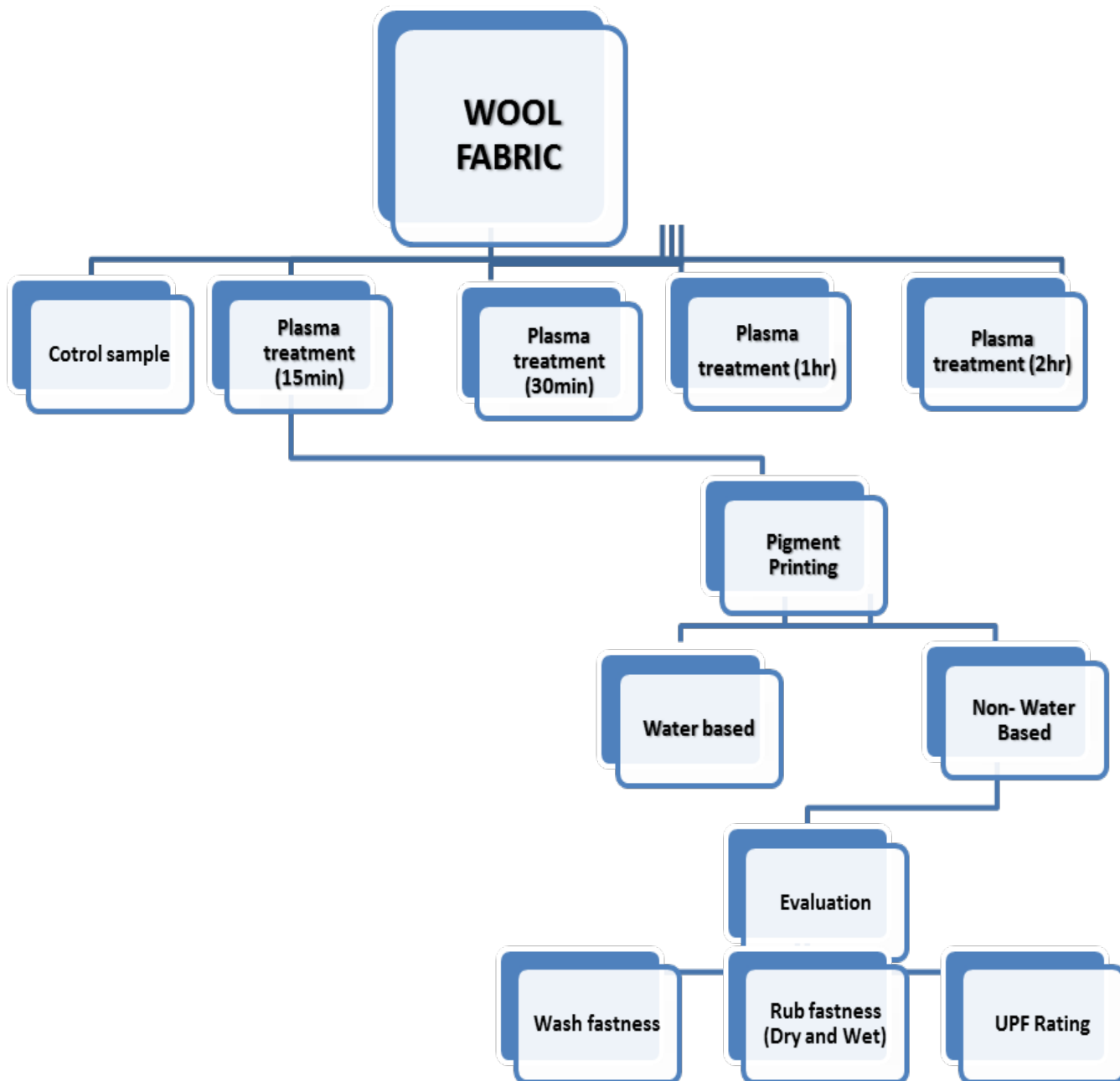
Table 1		
ELECTRODE SPACE (mm)	TIME	VOLTAGE (Kv)
3mm	15 mins	3.5-4.5
3mm	30 mins	3.5-4.5
3mm	1 hr.	3.5-4.5
3mm	2 hrs.	3.5-4.5

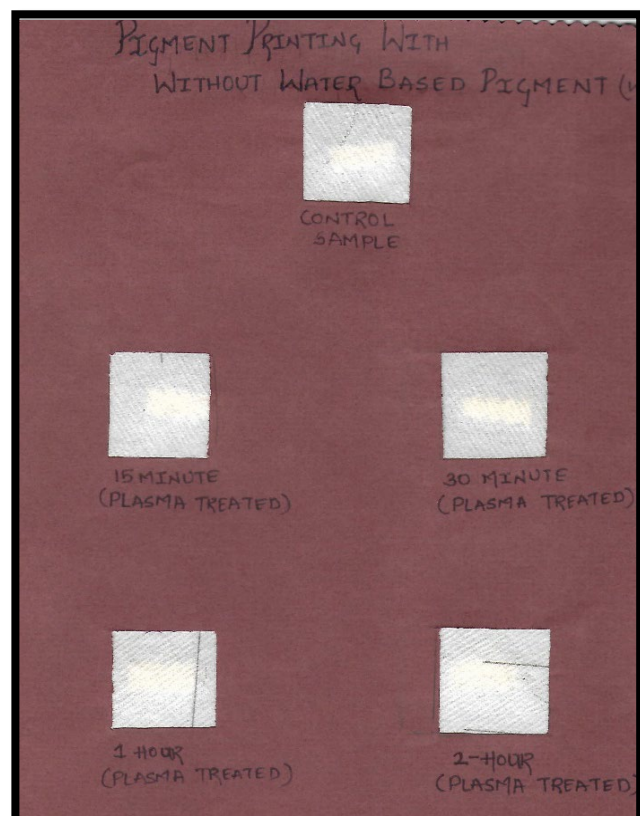
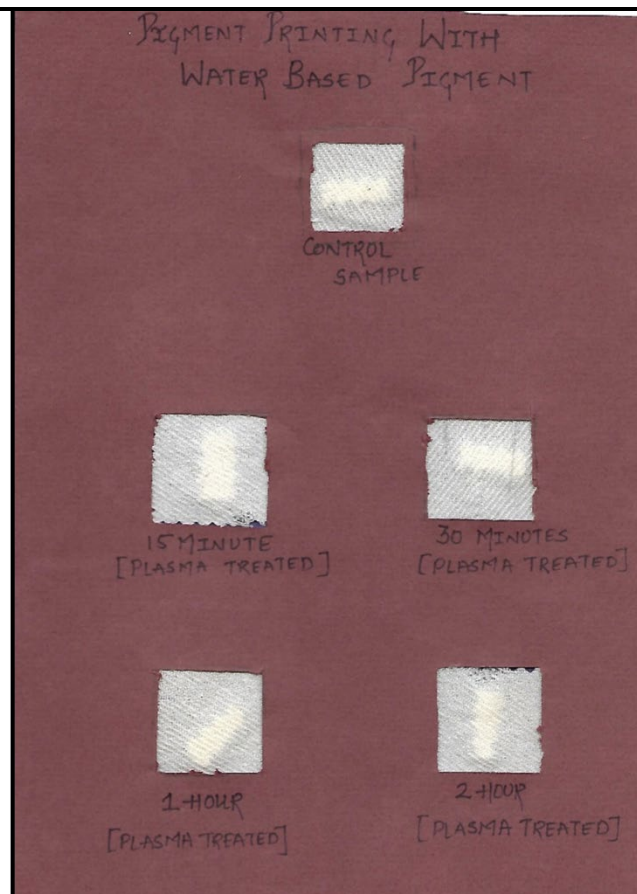
6. PIGMENT PRINTING PROCESS



7. TESTING FASTNESS PROPERTIES AND UPF

The Color fastness to Washing, Dry & wet Rubbing, UV Protection were determined according to Standard Test No. /Method: For wool ISO 105 C10 (Program A), Standard Test No. Method: ISO 105 X12 and Standard Test No./ Method: AATCC 183:2010. Wash fastness.



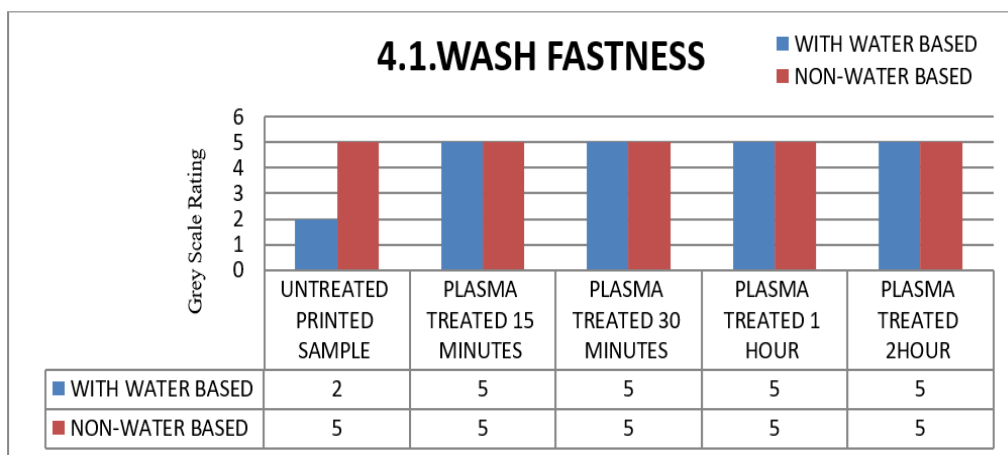


8. RESULT AND DISCUSSION

In this research the study is done on pigment printing properties of wool by using plasma technology. In the burning test, the fibers produced the prominent burning hair smell and residue was in the form of lumpy, brittle, crushable. In the microscopic test, some fibers show scales on the surface indicating the presence of wool fibers. In the chemical solubility test, some fibers open, swells also dissolve and disintegrate when treated with alkali.

8.1. COLOR FASTNESS TO WASHING

Standard Test No. /Method: For wool ISO 105 C10 (Programme A)



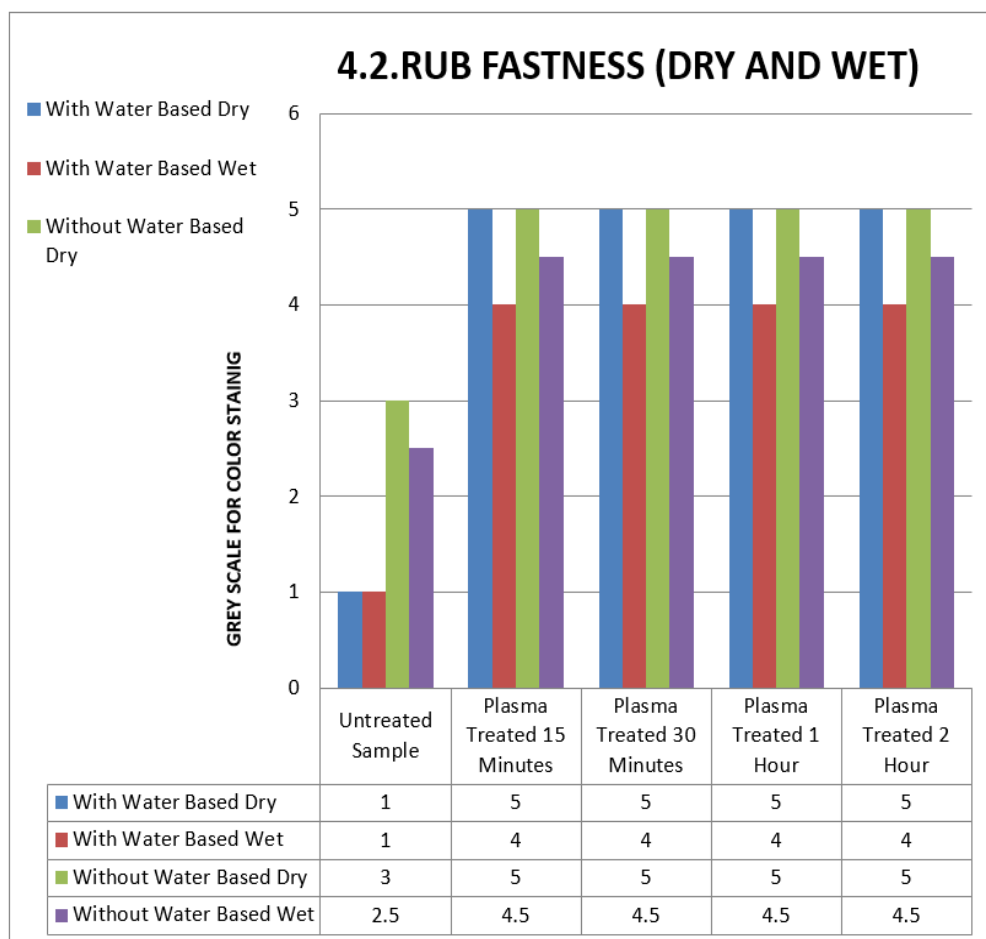
From the above table it was observed that color fastness to washing test as per the grey scale change in color rating it was seen that plasma treated printed wool fabric+ with water-based printing paste showed no color change when adjacent fabric wool and cotton was used. There was severe color stain on the untreated wool printed fabric with water-based printing paste. When plasma treated printed wool fabric was printed+ with non-water-based printing paste it was see there is no change in color between plasma treated printed and untreated wool printed with non-water based printing paste.

8.2. COLOR FASTNESS TO DRY & WET RUBBING

Standard Test No. Method: ISO 105 X12

From the table it was observed that color fastness to dry and wet rubbing as per grey scale for color staining it was seen that plasma treated + with water-based printing paste showed no staining i.e. 5 for the dry rub fastness and for wet rub fastness showed slight staining i.e. 4 compare to untreated printed wool fabric showed severe staining in both dry as well as wet staining i.e. rating 1.

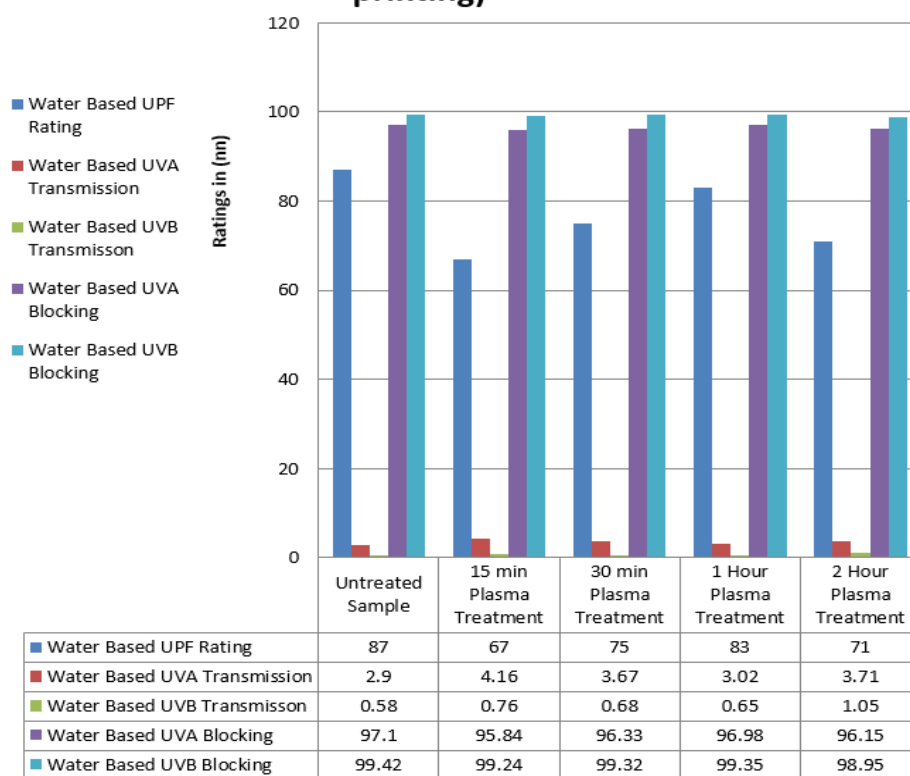
Also, when plasma treated +non- water based printing paste showed no staining for dry rub fastness i.e. 5 and for wet rub fastness showed slight to no staining i.e.4/5 as compared to control non-water based printing paste showed severe and considerable staining in both dry as well as wet rub fastness i.e. 3



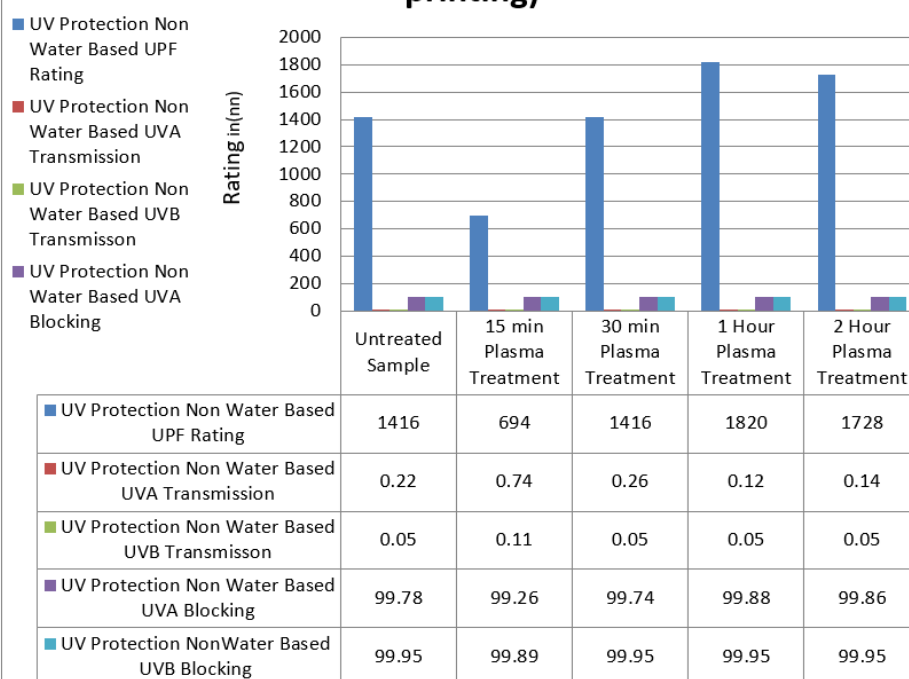
8.3. UV PROTECTION STANDARD TEST NO. / METHOD: [AATCC 183:2010]

From the graph 4.3.a and 4.3.b it was seen that when untreated sample was printed with water based pigment printing the UPF rating is higher i.e.87 than plasma treated for 15 minute is 67, 30 minute is 75, 1hour is 83and 2 hour is 71.when untreated sample was treated with non-water based pigment printing rating is 1416 which is same when plasma treatment was done for 30 minutes but UPF rating is getting reduce when treated for 15 minutes i.e. 694 and UPF rating for plasma treated for 1hour and 2 hour is higher than the untreated pigment printed sample and plasma treated with 15 minutes and 30 minutes. For with water based pigment printing UV-A Blocking for untreated pigment printed sample is greater i.e. 97.10% than plasma treated for 15minutes i.e.95.52%, 30 minutes i.e. 96.33%, 1hour i.e. 96.29% and 2 hour i.e. 96.98% and it is same for the UV-B blocking also that untreated plasma is greater UV-B blocking i.e. 99.42% than plasma treated for 15 minutes i.e. 99.24%, 30 minutes i.e 99.32%, 1hour i.e., 99.35%and 2 hours i.e., 99.29%. Form non-water based pigment printing UV-A blocking untreated pigment printed sample is 99.78% it same for the 30 minutes plasma treated. UV-A blocking increase with 1hour plasma treated and 2-hour plasma treated i.e. 99.88 % for both 1hour and 2 hour plasma treated. For UV-B Blocking untreated without pigment printing is less i.e., 99.05% than the plasma treated for the 15 minutes i.e., 99.89%, 30 minutes i.e., 99.85%, 1hour i.e., 99.95% and 2 hours i.e., 99.95%

4.3.a.UV Protection (water based pigment printing)



4.3.b.UV Protection (non water based pigment printing)



9. SUMMARY AND CONCLUSION

On the basis of Quantitative and Qualitative tests it has been proved that the procured sample is wool.

Plasma treatment was done at the different time variation i.e., for 15 minutes, 30 minutes, and 1 hour and 2 hour it was observed that fabric become rougher with the increase in the plasma treatment on it.

Wash fastness was carried out on wool fabric with both water based and non-water based pigment printing and it was seen that wool fabric give the best result when it was treated with plasma treatment rather than untreated sample. Non-water-based pigment printing is giving best result than with water based but non-water based. so we can use both but we should prefer with water based as it is environmental friendly.

Rub fastness i.e., dry and wet was carried out on both water based and non-water based pigment printing and it was seen that wool fabric give the best result when it was treated with plasma treated rather than untreated wool fabric sample.

UPF rating for pigment printing with water-based printing paste showed that untreated sample shows higher UPF rating than plasma treated sample for all that is 15 minutes, 30 minutes, 1 hour and 2 hour also it was seen that UV-A and UV-B same blocking for pigment printing with water based printing paste is same. For non-water-based pigment printing it was seen that plasma treated for 1 hour and 2 hour is having greater UPF Rating than the 15 minutes, 30 minutes and untreated sample and it was same for the UV-A and UV-B blocking of Pigment printing for non-water-based pigment printing.

CONFLICT OF INTERESTS

None.

ACKNOWLEDGMENTS

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