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The Effect of Plasma Treatment on the Comfort Properties of Bamboo Woven Fabric

Varshalini S [1], Dr. Bhaarathi Dhurai [2]

[1]M. Tech Scholar, Department of Fashion Technology, Kumaraguru College of Technology, Coimbatore.
[2]Associate Professor, Department of Fashion Technology, Kumaraguru College of Technology, Coimbatore.

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ABSTRACT-

In this study, atmospheric air pressure plasma is treated on plain bamboo fabric. The importance of doing this surface modification is to study the comfort properties of the effect made by plasma treated bamboo fabric. This study is concentrated on the evaluation of the comfort properties like air permeability, water vapour permeability, and wickability of the surface modified fabric. The results show that the plasma treated fabric outperforms the untreated bamboo fabrics in terms of air permeability and wickability in the warp and weft directions with a 5 minute interval time. But water vapour characteristics reveal the similar characteristics in both plasma treated and untreated fabric. Thus, this research work helps in understanding the comfort properties of surface modified bamboo fabric.

Key words: Bamboo fabric, plasma treatment, air permeability, water vapour permeability, wickability.

1. INTRODUCTION

One of the most current concerns of textile and garment manufacturers is that the comfort of clothing. The human sensory response to clothing materials is the inspiration for comfort, which is influenced by variety of thermal, physiological, and mechanical factors. Textiles have many comfort features that make clothing comfortable, including heat transfer, thermal protection, air permeability, moisture permeability, UV protection, water absorption, water repellency, size and fit. So as to satisfy unique requirements for a range of applications, the surface of textiles provides a very important platform for functional modifications. The surface of textiles are often altered employing a kind of methods, from conventional solution treatment to biological methods. Here, bamboo fabric has been treated with plasma in atmospheric air to satisfy the range of applications together with comfort properties like air permeability, vapor permeability, and wickability. Bamboo is that the fastest-growing plant on earth. Bamboo fiber is obtained from bamboo pulp, which extracted from the bamboo stem through the strategy of hydrolysis-alkalization and multiphase bleaching. Bamboo fiber has various micro-gaps, which is more softer than cotton and increase its moisture absorption. they're elastic, environment-friendly, and biodegradable. The fiber is bacteriostatic, antifungal, antibacterial, hypoallergenic, hydroscopic, natural deodorizer, and resistant against UV. Furthermore, it's highly durable, stable and hard and has substantial strength. The atmospheric air plasma was done on the material with system frequency of 60KHZ in aluminium electrode with the electrode gap of 7.5 cm at temperature was treated within the bamboo fabric which is cellulosic in nature. In this paper we are going to discuss whether the comfort properties of bamboo fabric are impacted by surface modifications.

2. LITERATURE REVIEW

Bamboo fiber has a complex natural structure but gives extremely good mechanical properties, which might be utilized inside the textile, papermaking, construction, and composites industry. But, bamboo fibers can effortlessly absorb moisture and are prone to corrosion limiting their use in engineering applications.(1)

Plasma treatment has higher moisture absorption, higher dye uptake and eco-friendly surroundings. By means of plasma treatment, the practical finishes might be imparted which encompass antimicrobial, soil repellency, stain resistance, smooth manage and advanced dyeing. several surface capabilities which includes adsorption ,desorption and cross linking arise as a result of plasma treatment on textile materials.(2)

Plasma technology carried out to biopolymers industries is a dry and eco-friendly manner for attaining surface alteration with out changing its bulk residences. sorts of plasma are frequently used; thermal (hot) and non-thermal (cold). Thermal plasma has a temperature of the order of 1000k on the other hand cold plasma is maintained round room temperature. Non-thermal atmospheric plasmas are best for biopolymers substances due to the fact they're warmness touchy and are applicable to non-stop tactics.(3)

Argon plasma at air pressure was used to improve the wettability and dyeability of natural bamboo fibers. Optical emission spectroscopy (OES) was employed to characterize the discharge. SEM and scanning probe microscopy (SPM) analyses show that the fiber surface becomes rougher after plasma treatment thanks to the results of plasma bombardment and etching. The wettability and dyeability are significantly enhanced after plasma treatment. Longer treatment time, resulting in rougher surface, leads to better surface wettability and dyeability.(4)

Natural fibres are amenable to modifications as they encompass several hydroxyl groups within the cellulose and lignin. Chemical modifications may activate these groups or introduce new functional groups which might effectively interact with the matrix. Usually the effect of this fibre surface modification is characterised by its influence on the mechanical and thermal properties.(5)

The plasma is the one of technique which enables to modify the surface structure of textile materials. The effect of plasma treatment applied on rechargeable antibacterial finishing for bamboo/cotton woven fabrics was carried out in the literature. The fabric was exposed to plasma treatment at optimized air conditions to increase the hydrophilicity. characterization of the functional changes due to the plasma treatment has been carried out by FTIR and air permeability test. Plasma treatment provides increased bond strength, wettability, permeability and biocompatibility. (6) In this research paper, surface modification using plasma treatment in pure 100% bamboo fabric is carried out to find the difference between treated and untreated fabric.

The results of water vapour permeability and air permeability of plasma treated bamboo/cotton blended fabric and untreated fabric is used to compare the study of this paper using ASTM standards.(7)

According to the literature research, bamboo fabric's comfort qualities will undoubtedly have an impact on the treatment of plasma.

3. METHODOLOGY

3.1 Air permeability

An air tronic tester with model number 3240A and ASTM D737 is used to test air permeability. It has a volumetric counter with a minimum capacity of 50 litres per hour and a maximum capacity of 5800 litres per hour. Different testing areas are available which is of 2, 5, 10, 20 cm2. We tested bamboo fabric that had been treated with plasma versus untreated using a test area of 10 cm2 with a pressure drop of 100 Pa and a measuring volume of 10 litres per minute, and readings were recorded.

3.2 Water vapour permeability

Water Vapour Permeability Tester with Model M261 with the specifications of ASTME 96 is used with 45ml of water at 20 °C±2 °C in each open dish predetermined from the dimensions of the dish to allow an air layer which is 10±1mm deep between the surface of the water and the underside of the supported specimens. The specimens were placed over the turn table and the water vapour permeability readings of plasma treated and untreated fabrics were calculated.

3.3 Wickability

The wickability test was conducted manually. In this test, a strip of fabric is suspended vertically in a distilled water with its lower edge exposed. The rate in rise of the water's leading edge is then measured at various intervals. The test fabric's capacity to wick moisture is directly measured by the height of the rise that is observed over time. One way to account for this is to weigh the fabric after the test to find out how much water it has absorbed. After that, the readings were evaluated and the mass, which is equivalent to the measured height of water rise, could be expressed as a percentage of the mass of the length of dry fabric.

4. RESULTS AND DISCUSSION

4.1 AIR PERMEABILITY

The air permeability of the fabric samples was tested and the results are given in table no 1. The result shows that plasma treated bamboo fabric has slightly higher air permeability characteristics when compared to the untreated bamboo fabric samples.

TABLE 1: Air permeability of the Bamboo fabric samples

Fabric type (plain woven bamboo fabric)	Air permeability (lit/min)
Plasma treated fabric	20.34
Unt	

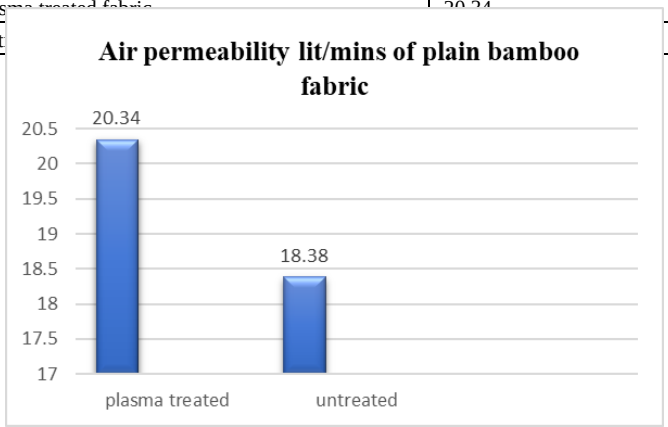

Chart 1: Air permeability of the Bamboo fabric sample

4.2 WATER VAPOUR PERMEABILITY

The water vapour permeability of the fabric samples were tested and results are given in table no 2. The result shows that plasma treated bamboo fabric and untreated fabric has similar water vapour permeability.

TABLE 2: Water vapour permeability of the fabric samples

Fabric type (plain woven bamboo fabric)	Water vapour permeability ($g/m^2/24$ hr)
Plasma treated fabric	134.97
Untreated fabric	135

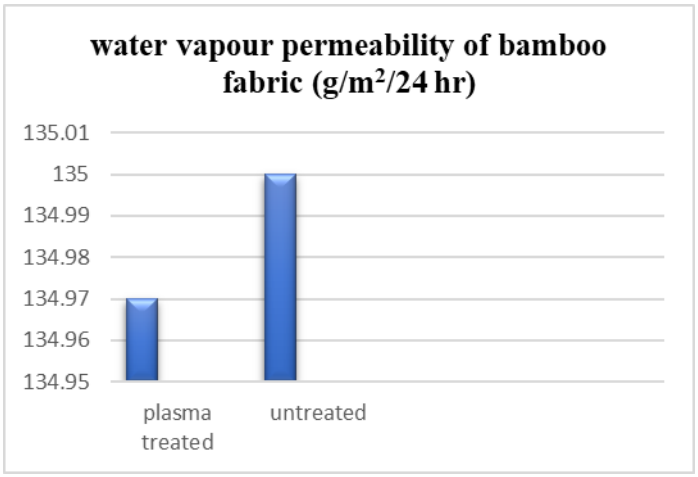

Chart 2: Water vapour permeability of the Bamboo fabric sample

4.3 WICKABILITY

The wickability of the fabric samples was tested, and the results are given in table no 3 and 4. The result shows that plasma treated bamboo fabric has a higher wickability property when compared to untreated bamboo fabric.

Table 3: Wickability of bamboo fabric sample in warp direction

Time in minutes	Wickability of untreated bamboo fabric (cms)	Wickability in plasma treated bamboo fabric (cms)
1 min	1.88	2.04
3 min	3.08	3.2
5 min	3.74	4.00

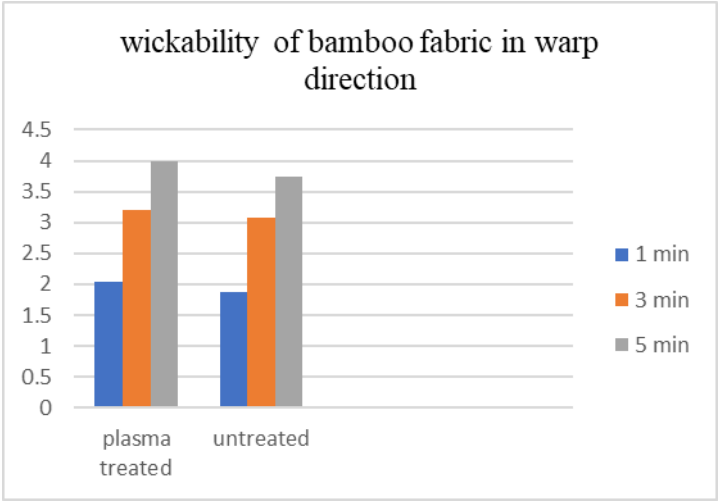

Chart 3: Wickability of Bamboo fabric sample in warp direction

Table 4 :Wickability of bamboo fabric sample in weft direction

Time in minutes	Wickabilityof untreated bamboo fabric (cms)	Wickability in plasma treated bamboo fabric (cms)
1 min	1.78	1.96
3 min	2.90	3.00
5 min	3.58	3.82

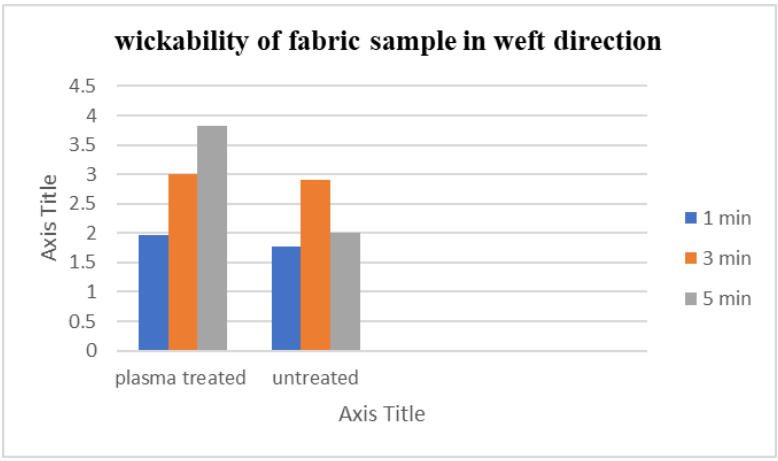

Chart 4: Wickability of Bamboo fabric sample in weft direction

5. CONCLUSION

From the analysis of the results, it is found that the plasma treated bamboo fabric has a higher air permeability property when compared to untreated fabric. In the water vapour permeability test, both plasma treated and untreated fabric has similar property. In the wickability test, the warp direction and weft direction of the plasma treated fabric had the higher wicking property. Thus, this study demonstrates that there ia s significant change that occur in the comfort properties of surface modified fabrics, and each surface modified fabric performs differently in each comfort property such as air permeability, water vapour permeability and wickability.

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