Surface Study on Bamboo Fabric Using DC Glow Discharge Plasma

K.A.Vijayalakshmi[1], K.Vignesh[1*], N.Karthikeyan[1]

[1]Plasma Laboratory, Department of Physics, Sri Vasavi College, Erode, Tamilnadu, India

Abstract: ***Low temperature plasma treatment on bamboo fabric has been used to improve the surface properties. The modified bamboo fabric surface was characterized by FTIR, SEM, XRD and color fastness test. The modified functional group of bamboo fabric (e.g. C-O, O-H) is investigated using FTIR studies. The surface roughness was studied using SEM results. The improved crystalline structure after plasma treatment was examined using XRD results. Wash fastness test shows the color fastness of bamboo fabric after plasma treatment.***

Keywords: Bamboo fabric, surface study, plasma treatment, SEM, XRD, color fastness

1. Introduction

In recent years textile industry has concern for the natural fabric materials. Cellulose fiber is a natural material with many advantages such as, low cost, low density, acceptable strength properties, and enhanced energy recovery. Natural Bamboo is a cellulose material, wildly available in nature, the biggest renewable resource and eco-friendly material [1]. Natural Bamboo fabric has many great advantages. Bamboo fabric is an antibacterial and antifungal material [2-5].Bamboo fabric has a good wearing property for its smoothness, non-irrigative for skin and UV protection [6-8] and bio degradable cloth materiel. Bamboo fabric has many textile product applications like medical textile applications, home based products and body innerwear cloths, etc.

Plasma technology has been widely used as an effective method for surface modifications of textiles such as cotton, wool, linen, flax, sisal, keratin and polymer materials [9-19].Textile industry also needs traditional, non-polluting, less energy consumption and low cost process for textile finishing. Low temperature plasma is an eco-friendly, non-polluting, energy consumption and low cost process for textile processing [20].When textile material are exposed to a plasma different effects are often observed including, ablating (or) etching, modification of the material surface [21], without changing the bulk properties of the material and surface oxidation which could all contribute to the improvement of the surface properties.

2. Material and Experimental Setup

2.1 Material

The bamboo fabric was purchased from Sri Karpagavinayaga Textiles and Exports Private Ltd, India.

2.2 Experimental Setup

The bamboo fabric was taken into different sizes for plasma treatment. Low temperature DC glow discharge plasma was generated in the cylindrical stainless steel chamber 50cm of length and 30 cm of internal diameter. Two Aluminium square electrodes were fixed inside the chamber which is perpendicular to the axis, separated by 3cm distance and it is connected to the high tension DC power supply (1.5 Kv). Vacuum of 10^{-3} mbar was maintained inside the chamber using a vacuum pump. Pirani gauge was used for pressure measurement. The bamboo fabric material were placed between the electrodes separated by a distance 3 cm. the discharge potential and base pressure were 400v, and 0.03 mbar respectively.

2.3. Operating parameters

Discharge potential - 400v
Discharge power - 10w
Pressure - 0.03 mbar
Exposure time - 1-10 min
Electrode separation- 6cm
Plasma gas - air
Sample - bamboo fabric

3. Results and Discussion

3.1 FTIR Results

FTIR spectra of both untreated and plasma treated bamboo fabric were analyzed. In the untreated sample the absorption bonds are C-H (s, b) bend, C-H (s) stretch, C-H (w)finger print region ,C-O (s) stretch, O-H (b) stretch are presented. In the plasma treated bamboo fabric absorption bonds are only in the C-H (b, s) stretch, C-H (v) scissoring and bending, C-H (m) stretch is presented. This clearly shows that the C-0, 0-H bonds are converted into C-H bonds after the plasma treatment. When the treatment time increases the FTIR spectra bonds are broken or there is no bonds present in the fabric surface.

3.2 XRD results

Figure 2 illustrates the X-ray diffract gram of the plasma treated and untreated bamboo fabric. It clearly indicates that there is no change in shape and position of the diffraction peak, except that the peak is more intense in the case of plasma treated sample. This result confirms that the plasma treatment improved the degree of crystalline of bamboo fabric surface. Due to the plasma treatment the intensity is increased and there is no change in the structure.

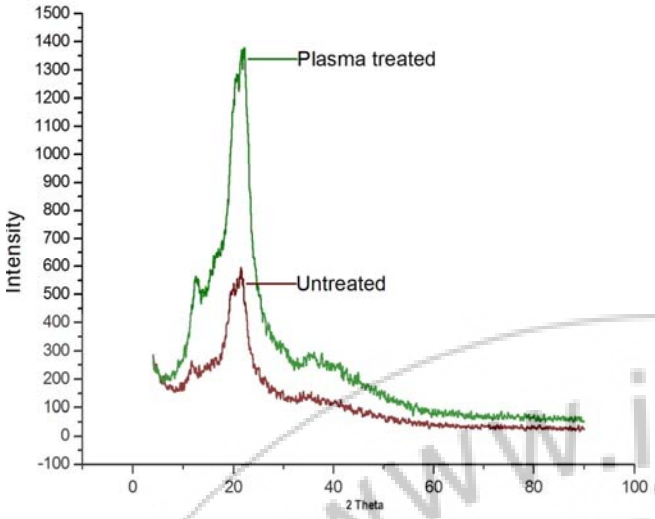
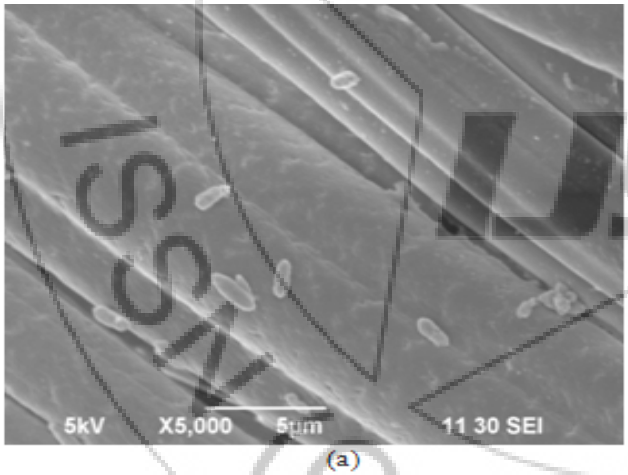


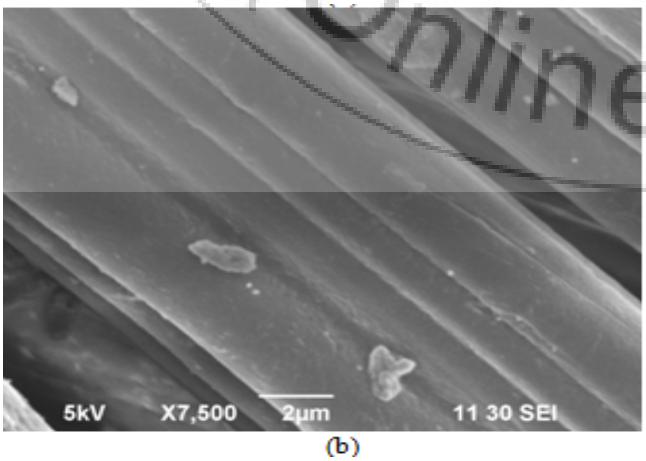
Figure 2: XRD result of plasma treated and untreated bamboo fabric

3.3 SEM Results

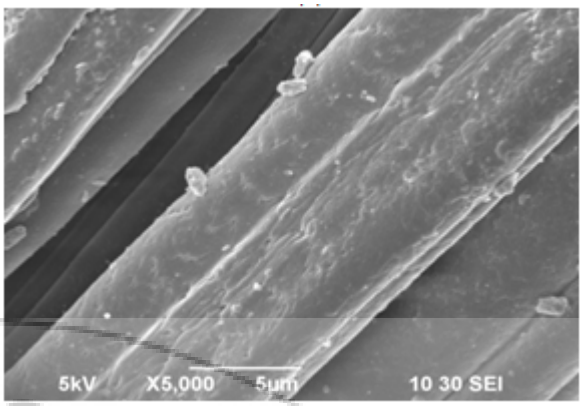
Figure 3.shows the untreated and plasma treated SEM images. In figure.3 (a) And (b) are the untreated bamboo fabric. The untreated fabric surface there is a smooth surface. But in the plasma treated fabric surface figure.3 (c) and (d) some cracks and fragments appear on the bamboo fabric surface. These indicate the effect of plasma bombardment and etching on the surface and this change in the surface morphology after plasma treatment can be explained by the localized ablation of the surface layer. [21]



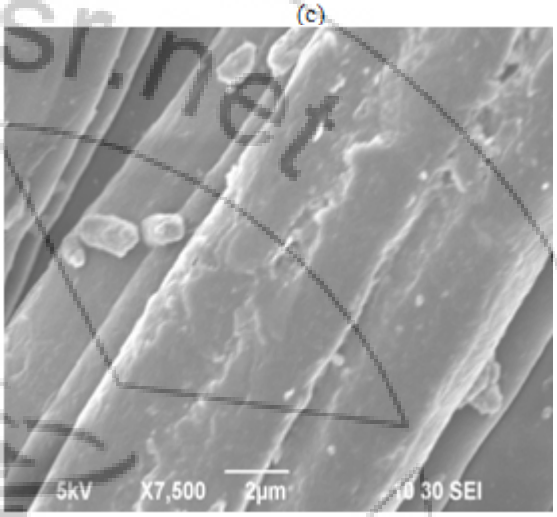
(a)



(b)



(c)



(d)

3.4 Color Fastness Test

The color fadedness of bamboo fabric before and after plasma treatment is investigated. Turquoise Blue H5Q (3%) and Red H8B (3%) dyed bamboo fabric were taken for the color fastness test. In the red dyed fabric color fastness before plasma treatment is high and after plasma treatment (10mins) the color fastness is low. The color fastness increased in blue dyed fabric after plasma treatment (5mins).comparing the red and blue dyed fabrics the blue dyed fabric is less than the red dyed fabric.

4. Conclusion

The effects of plasma treatment on surface properties of bamboo fabric were investigated. The FTIR results of plasma treated bamboo fabric shows the change in chemical bonds.SEM observations shows that cracks, pits and fragments appear on the fabric surface after plasma treatment. This result confirms the plasma treatment should increase the surface roughness on the textile fabric surface. The XRD results confirm the plasma treatment should increase the intensity of fabric without modifying the crystalline surface. The color fastness test result shows that in the untreated fabric the color fastness is less when compare plasma treated fabric.

References

[1] Lee SG, Choi SS, Park WH, Cho D. Macromol.Symp.2003; **197:89**.

[2] Scurlock J. M. O., Dayton D. C., Hams B; Bamboo: an overlooked biomass resource?" Biomass and Bioenergy Vol.19 (2000) pp. 229-244.
[3] Zhang Q., Jiang S., Tang Y.; "Industrial utilization of bamboo", INBAR Technical Report no. 26. 2002.
[4] 4.BambooClothes,http://www.bambooclothes.com/ABOU.html, 2007.
[5] Lackman M.; "Bamboo: Facts behind the Fiber", http://organicclothing blogs.com/My weblog /2007/ 09/bamboo-facts-be.html, 2007.
[6] Nishina A., Hasegawa K. I., UchiboriT.; "2,6-dimethoxy-P-benzoquinone as an antibacterial substance in the bark of Phyllostachys-heterocycla var. pubescent, a species of thick-stemmed bamboo", Journal of Agricultural and Food Chemistry, Vol. 39 (2) 1991, pp. 266-269.
[7] Wang H. X., Ng T. B.; "Dendrocin, a distinctive antifungal protein from bamboo roots", Biochemical and Biophysical Research Communications Vol. 307 (2003), pp. 750–755.
[8] Novel Approaches to Process Bamboo Plants into Fibers and their UV-blocking Property. Afrin et al., 2011.
[9] Kan CW, Chan K, Yuen CWM, Miao MH. J. Mat. Proc. Technol.1998; **82**: 122.
[10] Lee M, Wakida T, Lee MS, Kipak P, Chen JR. J. Appl. Polymer. Sci.2001; **80**: 1058.
[11] Dai XJ, Elms FM, George GA. J. Appl. Polymer. Sci.2001; **80**: 1461.
[12] Wong KK, Tao XM, Yuen CWM, Yeung KW. Textile Res. J. 1999; **69**:846.
[13] Wong KK, Tao XM, Yuen CWM, Yeung KW. Textile Res. J. 2001; **71**:49.
[14] Wong KK, Tao XM, Yuen CWM, Yeung KW. Textile Res. J. 2000; **70**:886.
[15] Lee SG, Choi SS, Park WH, Cho D. Macromol. Symp. 2003; **197**:89.
[16] Couto E, Tan IH, Demarqueite N, Carasch JC, Leao A. Polym.Eng. Sci. 2002; **42**:790.
[17] Martin AR,Manolache S, Denes FS, Mattoso LHC. J. Appl. Polym.Sci.2002; **85**:2145.
[18] Molina R, Jovanˇci´c P, Joci´c D, Bertran E, Erra P. Surf. InterfaceAnal.2003; **35**:128.
[19] Barni R, Riccardi C, Selli E, Massafra MR, Marcandalli B,Orsini F, Poletti G, Meda L. Plasma Process. Polym.2005; **2**:64.
[20] Riccobono P.X. and Rolden L.,Plasma treatment of textiles: A novel approach to the envioronmental problems of desizing, textile chem.color.5, 239-248(1973).
[21] Couto E, Tan IH, Demarqueite N, Carasch JC, Leao A. Polym.Eng. Sci. 2002; **42**: 790.