MEDICAL TEXTILE MULTIFUNCTIONALIZATION BY USING PLASMA TREATMENT

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This paper expose aspects regarding design, development and plasma nanotechnology treatments required for obtain a textile product for medical usage. The multifunctional products presented in this paper are based on natural or synthetic fibers treated in plasma. This work presents fundamental research regarding plasma treatment actions to the physic-mechanical, physic-chemical and structural parameters of the textile materials with different fibrous composition made by natural and synthetic fibers. This work exposes the benefit of the plasma treatment for textile materials characteristics improvement.

Keywords: textile, plasma, medical.

INTRODUCTION

The textile industry directions at EU level are to develop and produce raw materials, converting them into finished products for satisfy customer expectations with respect for health and environmental safety (Bhosale *et al.*, 2013). For a sustainable production systems in environment safety, economies of industrial communities, and consumer interests it is required to develop new products, alternative raw materials, and processing technologies more “environmentally friendly” obtained by using new natural processes and increasing environmental concerns (Gorenšek *et al.*, 2013). Synthetic fibers in combination with natural one can conduct to obtaining of new yarn with improved parameters. The nanotechnology plasma treatment can be used for reducing the energy consumption in textile finishing process, chemicals, and time waste in textile processing (Gulrajani et Gupta, 2011). Plasma technology is an alternative that will have a significant impact on the quality of life if will be used in industrial textile processes even if at European level is an increased interest for natural fibers, for their many outstanding properties including aesthetics, comfort, and biodegradability (Buyle, 2009).

EXPERIMENTAL PART

The textile surface designated for medical articles and with composition 65% polyester and 35% cotton was activated by using oxygen plasma. The goal of plasma nanotechnology usage was to obtain surface preparation for colloidal silver and chitosan submission by using foulard method.

The textile surface, treated in plasma for 10, 20, 30 and 90 minutes, was tested in laboratory for evaluating the tear force parameter improvement or depreciation. The results obtained are presented in Table 1.

Table 1. Maximal tear force [N] – in warp direction for samples treated in plasma (Woven fabric 65% polyester 35% cotton, 180 g/m², width 160 cm, density: 43 yarns/cm warp direction and 22 yarns/cm in weft direction

Sample No.	Standard sample	Sample treated in plasma 10 minutes	Sample treated in plasma 20 minutes	Sample treated in plasma 30 minutes	Sample treated in plasma 90 minutes
1	1044	1230	1240	1235	1150
2	1167	1160	1235	1230	1152
3	1195	1240	1231	1229	1151
4	1209	1065	1206	1228	1149
5	1200	1200	1207	1226	1148
6	1120	1203	1208	1224	1146
7	1037	1210	1209	1204	1147
8	1229	1207	1210	1208	1068
9	1204	1208	1204	1201	1059
10	1207	1209	1205	1203	1086
11	1230	1235	1206	1208	1056
12	1200	1200	1207	1203	1089
13	1203	1204	1208	1201	1099
14	1151	1206	1209	1206	1203
15	1210	1209	1208	1119	1117
16	1210	1205	1207	1118	1116
17	1131	1200	1205	1117	1115
18	1012	1203	1208	1113	1112
19	1012	1210	1209	1114	1113
20	1154	1156	1201	1113	1123
Average value	1156.25	1198	1211.15	1185	1119.95
ST DEV	73.34121768	36.97509831	10.72270096	47.79892093	37.0312457
CV	6.3430%	3.0864%	0.8853%	4.0337%	3.3065%

RESULTS AND DISCUSSIONS

The textile woven with 65% polyester and 35% cotton present a high uniformity due to the uniformity of polyester and cotton fibers presence in the yarn structure (figure 1 and figure 2). In this way structural uniformity conducts to different values for tear force in warp direction (figure 1). It knows that in plasma treatment the maximal values for tear force for cotton are after 10 minutes oxygen plasma treatment and for polyester are after 20 minutes oxygen plasma treatment. In discrete cases occur high level values after 10 minutes plasma treatment.

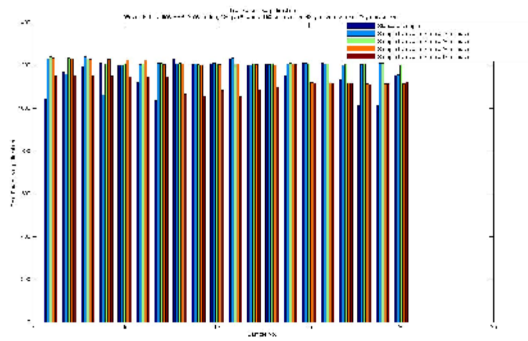

Figure 1. Tear force – warp direction for samples treated in plasma

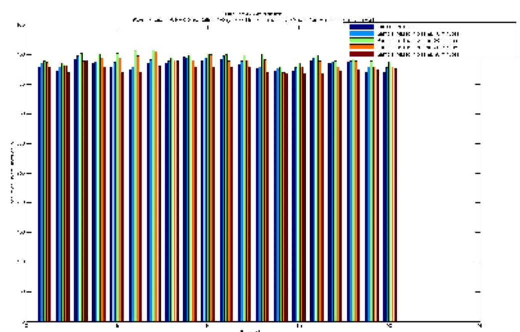

Figure 2. Tear force-weft direction for samples treated in plasma

For the weft direction we can observe that the maximal tear force values are after 20 minutes of oxygen plasma treatment.

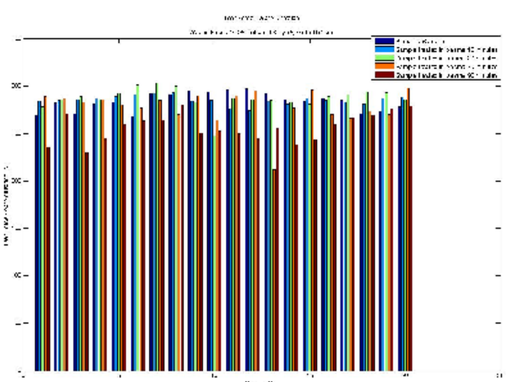

Figure 3. Tear force-warp direction for cotton samples treated in plasma

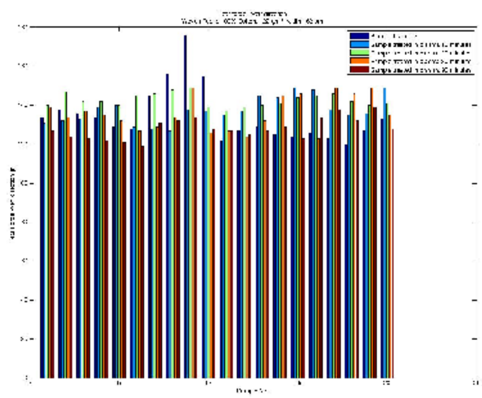

Figure 4. Tear force – weft direction for cotton samples treated in plasma

By using comparative analyze we can conclude that the woven fabric resistance is increased by polyester fibers presence.

The yarn structure is not one ideal and we can have different resistance due to the cotton or polyester predominance.

The polyester can increase the values obtained after 20 minutes plasma treatment and cotton can increase the values after 10 minutes oxygen plasma treatment.

From all cases analyzed it can see that the values obtained for untreated sample are higher than values obtained after 90 minutes plasma treatment. The explanation for this phenomenon can be that after 90 minutes plasma treatment the polyester and cotton yarns are destroyed due to the increased depolymerization (figure 4).

From experimental results it can conclude that higher values for tear force are obtained after 20 minutes plasma treatment and this is due to the polyester yarns presence on woven structure.

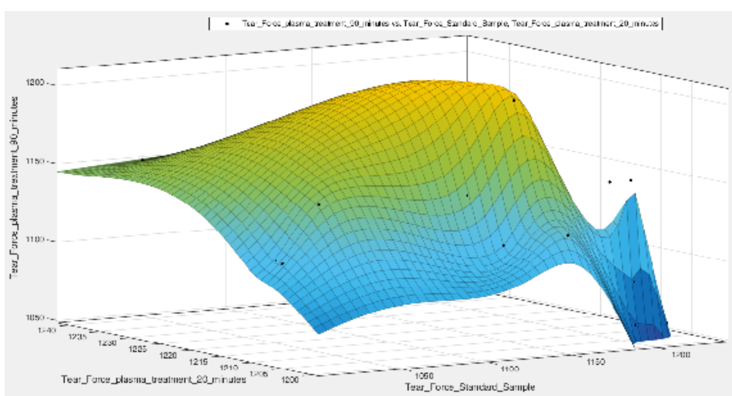

Figure 5. Tear force after 90 minutes plasma treatment in function of value obtained after 20 minute and values for standard sample

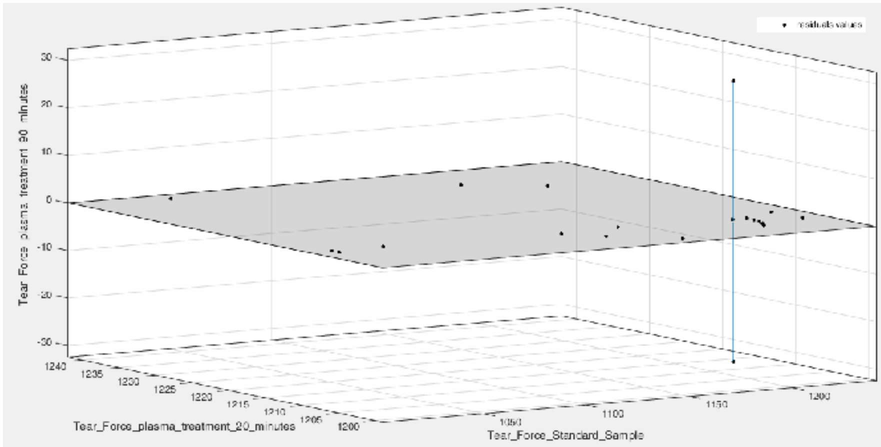

Figure 6. Tear force – residuals values

In the figure 6 it is observed that we have 2 residuals values. Here we have the case of analyzing data by polynomial model was observed that the model doesn't respect a polynomial law and the residuals values are increased (figure 7).

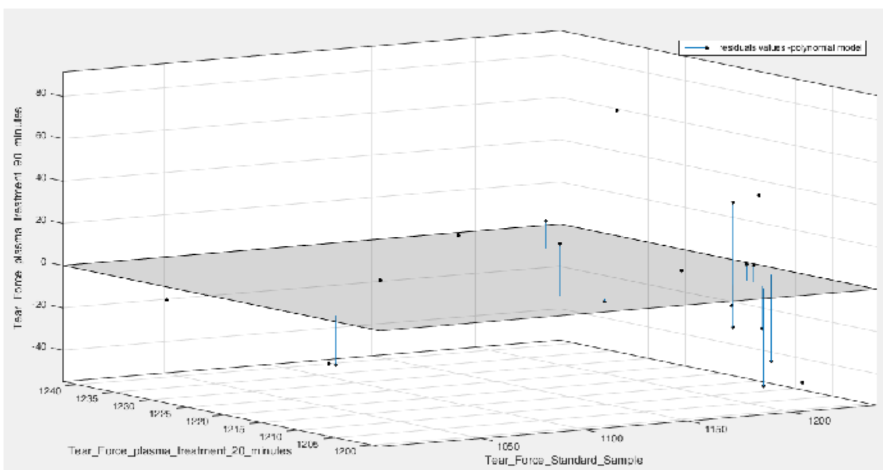

Figure 7. Tear force – residuals values for polynomial model

CONCLUSIONS

The advantages of using plasma treatment for woven fabric with polyester and cotton composition are that in this way is increased tear resistance.

The percent 65% polyester yarns presence on woven fabric conduct to obtaining higher values for tear force than are obtained when we are using woven fabric made from cotton yarns.

The higher values for tear force in case of use cotton woven fabric is after 10 minutes plasma treatment.

The tear force values for standard sample, sample treated in plasma 20 minutes and samples treated in plasma don't fit to polynomial modeling.

The woven fabric treated in plasma has the pilling effect minimized. This will contribute to chemicals substance (chitosan, colloidal silver) economy in the textile materials finishing and treatments for antimicrobial effect.

The high irregularities for values obtained are because the structure of yarns is not ideal one.

Acknowledgements

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