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TEXTILE SURFACE HYDROPHOBIZATION BY USING PLASMA NANOTECHNOLOGY

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Abstract. *In this paper are presented aspects regarding textile surface modification in plasma by using fluorocarbon nano-coating for obtain a hydrophobic character. The samples analyzed consist in woven structure made from 100% cotton yarns. For determine the fabric surface modification, samples treated in plasma were tested tear force according ISO13937-2 and for capture the contact angle values by using VCA Optima device. For observe the treatment performance samples were analyzed by using SEM or different experimental time. By analyzing data correlations we can conclude that after 20 minute plasma treatment the tear force value is maximized and after this point it starts an accentuated depolymerization process till 90 minutes.*

Keywords: hydrophobic, plasma, woven, cotton, contact angle, nanotechnology

1. Introduction

Hydrophobization is used for obtain textile surface with water, oil and strain repellency. For cotton hydrophobization were applied the silica hydrosols were applied to the cotton fabrics by dipping process, followed by the modification with trimethoxysilane and heat treatment to prepare superhydrophobic cotton fabrics [1].

Hydrophobic character may be by using hydrophobization agents such as paraffin waxes, silicones, silanes and fluorinated polymers. Because textile surface have a negative net change, can be used for hydrophobization some cationic surfactants (fluorine groups) [2].

The goal is to obtain a cotton fabric with low energy surface. From all polymers possible to use for obtain hydrophobic character, fluorocarbon chemicals have the lowest surface energy, and this was the raison in choosing for cotton fabric hydrophoization the fluorocarbon treatment by plasma technology. The conventional padding hydrophobization treatment conduct to large quantities of water, chemicals and energy consumes which means high production costs. Plasma technology can substitute finishing processes which determine low costs and a positive environmental impact.

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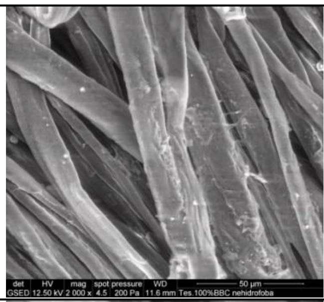
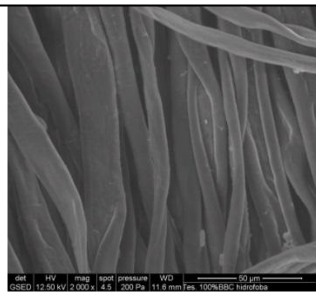
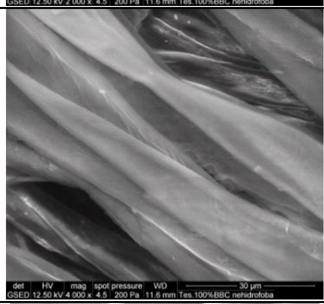
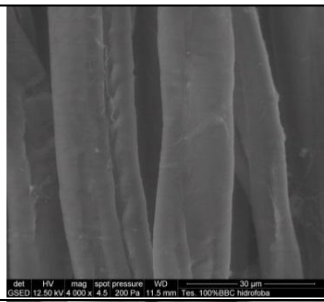
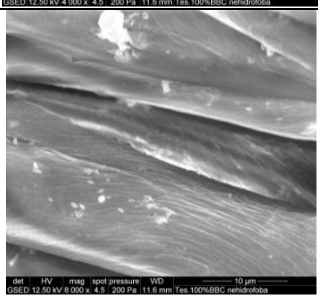
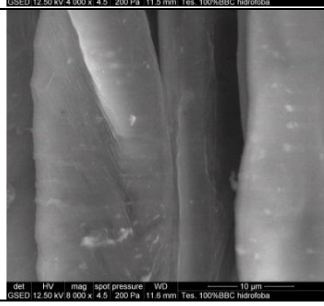
2. Experimental part and discussions

The experimental part presented in this paper consists in hydrophobization of textile cotton materials by using plasma technology. It is know that cotton have an intrinsic hydrophilic character because of is natural polymer-cellulose [3].

Cellulose is a carbohydrate, and the molecule is a long chain of glucose (sugar) molecules. The negatively charged groups (OH) attract water molecules and make cellulose- cotton to absorb water and CH2 is a group which tends to make substances hydrophobic [4].

Cotton can absorb about 25 times its weight in water. Plasma treatment for cotton hydrophobization is based on applying fluorocarbon on textile surface. The surface modification is occurring at nano level conduct to cotton hydrophobization [5].

Table 1. Cotton samples analyze – SEM

Sample no.	Before plasma treatment	After plasma treatment
1		
2		
3		

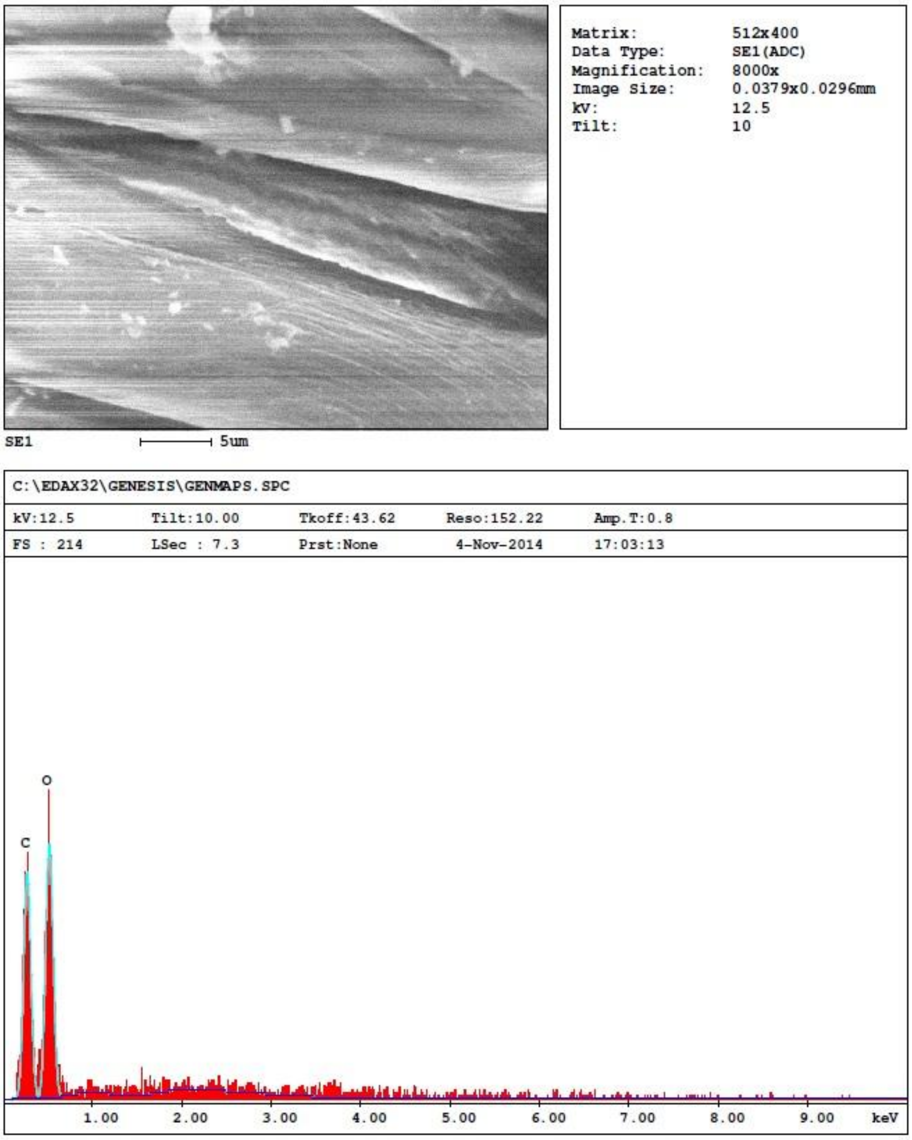


Fig. 1. Hydrophilic cotton – before fluorocarbon plasma treatment.

The samples were analyzed before and after plasma treatment by using scanning electron microscopy (SEM – table 1). Also the chemical modification is highlighted by observed by using energy dispersive spectrometry method (EDAX – figure 1, 2). After treatment with fluorocarbon that degree of hydrophobization is tested by using contact angle VCA optima device. In figure 1 we can see the high value for oxygen peaks, that means that cotton hydrophilic material have hydroxyl groups (OH) which attract water molecules. The hydrophobization is evidently highlight in EDAX - figure 2, where we can see a high value for carbon peaks which means the hydrocarbons groups are increased.

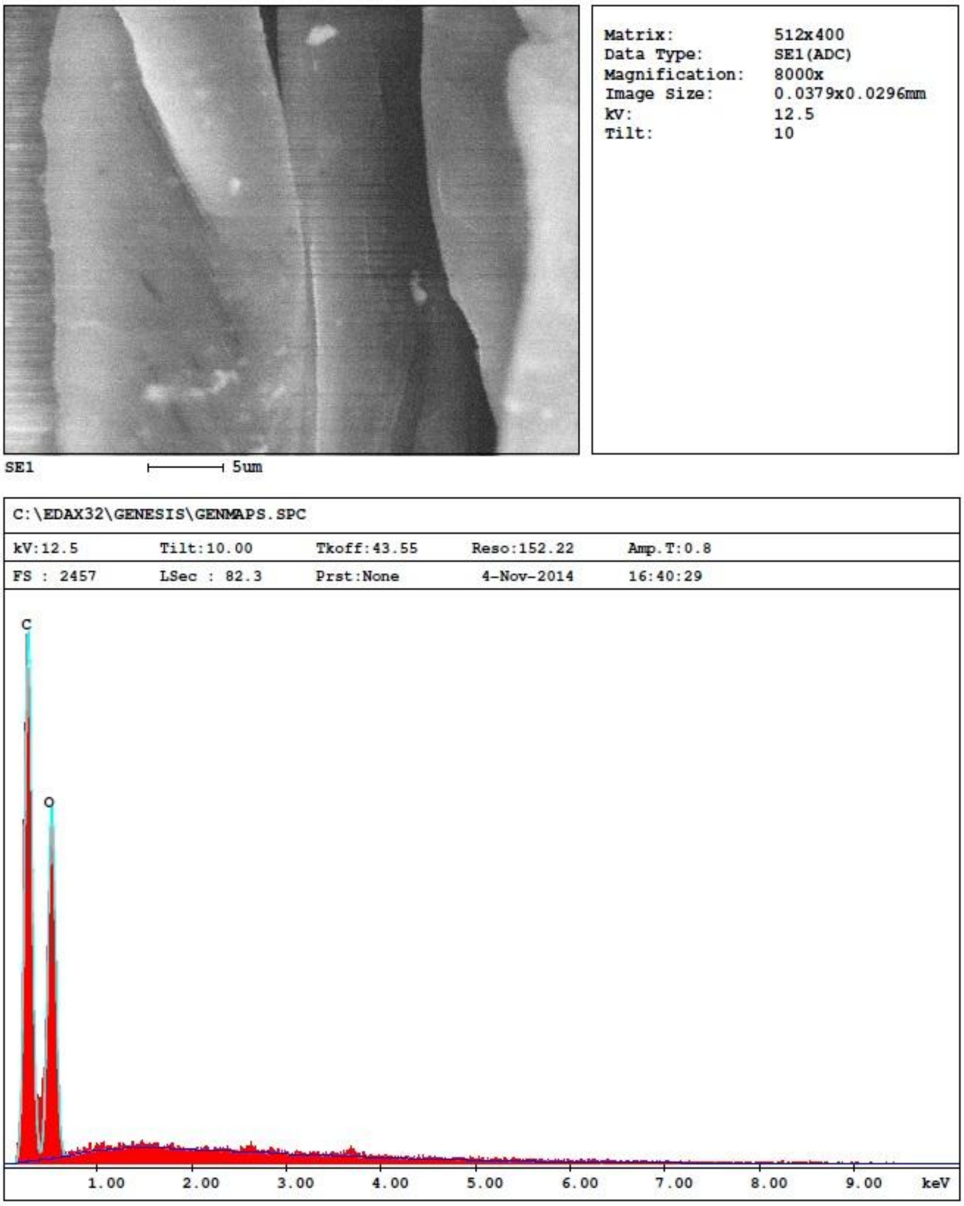


Fig. 2. Hydrophobic cotton - after fluorocarbon plasma treatment.

Contact angle values are invers proportional with hygroscopicity, air permeability and water absorption values (figure 3 and 4). These parameters are influenced also about structure of the woven and yarns from which is made the cotton fabric. The separation water/cotton fabric interface [8] is determined by the Young–Laplace equation, with the contact angle playing the role of a boundary condition via Young's Equation (1).

$$\gamma_{sv} = \gamma_{s1} + \gamma_{1v} cos\theta_y \quad (1)$$

Contact angle values:

➔ Lower than 90° then the cotton fabric is hydrophilic;

➔ Higher than 90° then cotton fabric is hydrophobic.

Because in our experiment the contact angle is higher than 120° this means that the textile surface is highly hydrophobic and has a low surface energy.

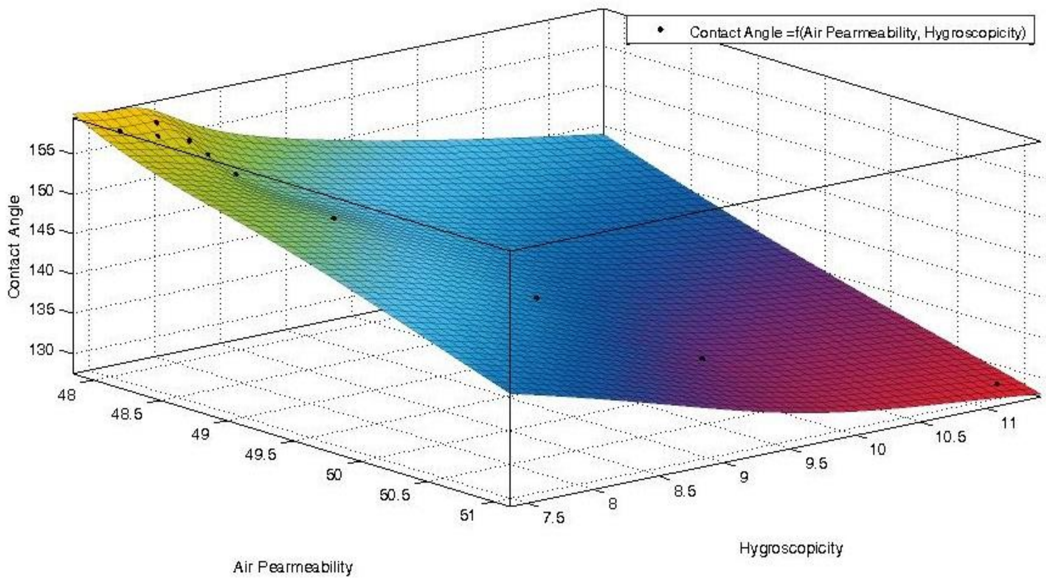


Fig. 4. Contact angle in function of air permeability and hygroscopicity.

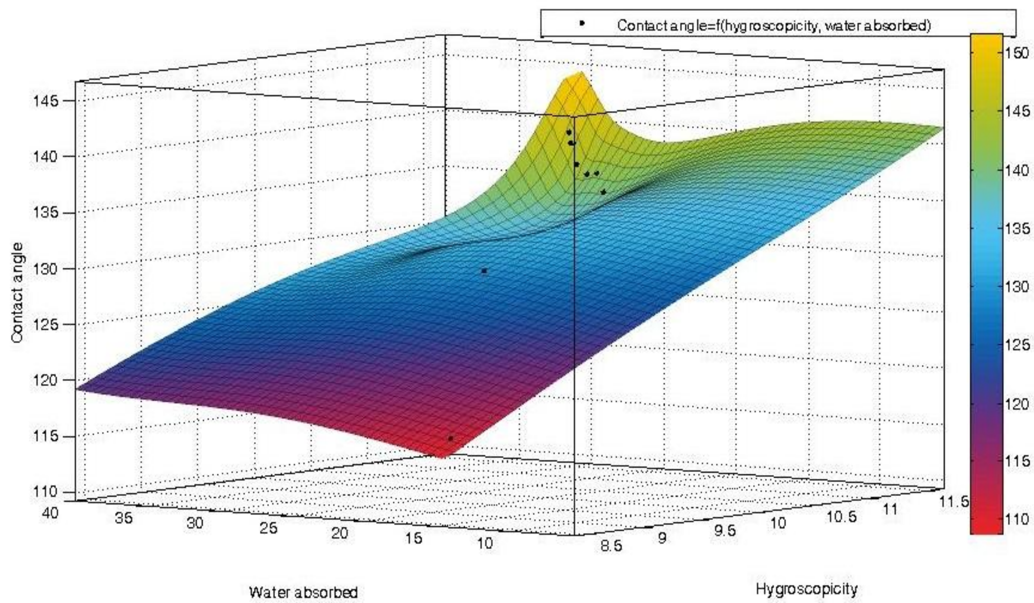


Fig. 5. Contact angle in function of water absorption and hygroscopicity.

3. Conclusions

By analyzing data correlation we can conclude that after 20 minutes plasma treatment, the tear force values are maximized and after this point is starting the depolymerization process which affects all physic-mechanical parameters [6, 7].

High values for contact angle indicate that cotton fabric have a hydrophobic character. Contact angle value is inverse proportional with values for air permeability and hygroscopicity.

By increasing washing cycle's number the fabric loses the hydrophobic character and contact angle present lower values.

For contact angle high value the textile surface has a high hydrophobic character due to the CH_2 groups which are responsible for water repellence.

The cotton fabric having hydrophobic character was designed for medical articles.

R E F E R E N C E S

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