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THERMAL BEHAVIOUR OF COTTON FABRIC COATED WITH ELECTROSPINNING

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Abstract: *Electrospinning was patented by Formhals in 1934. Prior to the year 2000 electrospinning was the domain of only a few specialists; This situation has changed dramatically in recent years. Many research groups in research and industry work currently on electrospinning topic, the number of conferences or sessions at conferences devoted to electrospinning is continuously increasing. Electrospinning is a fabrication technique, which can be used to create nanofibrous nonwovens from a variety of starting materials. The structure, chemical and mechanical stability, functionality, and other properties of the mats can be modified to match end applications. On the other hand cellulosic polymers have gathered great interest in recent years in the field of nanoproducts useful for high-value applications. The electrospun cellulosic composite fibers with reliable thermal properties are suitable and promising in serving as thermo-regulating materials in many fields. Based on this information, in this study we applied cellulose acetate by electrospinning into a raw cotton fabric in order to examine electrospinning effect in thermal properties. In order to analize thermal behaviour samples were tested with a thermochromic camera. It was found that coating woven cotton fabric by electrospinning with cellulose acetate, reduced the rates of cooling and heating.*

Key words: *Electrospinning, Thermocamera, Cotton fabric, Woven fabric, Cellulose acetate.*

1. INTRODUCTION

Filter applications, functionalization of textiles, fiber reinforcement, catalysis, drug delivery, wound healing or tissue engineering are just a few examples of potential applications of nanotechnology on textile field. The route towards such nano-objects is based primarily on electrospinning [1]. Electrospinning is a process that creates nanofibers through an electrically charged jet of polymer solution or polymer melt [2]. Electrospinning was patented by Formhals in 1934, wherein an experimental setup was outlined for the production of polymeric filaments using electrostatic force [2]. Prior to the year 2000 electrospinning was the domain of a few specialists, the average number of papers published per year on this topic was well below 20. This situation has changed dramatically in recent years. In 2009 for instance, significantly more than 1500 papers were published on electrospinning, it is estimated that more than 200 research groups in academia and industry work currently on this topic, and the number of conferences or sessions at conferences devoted to electrospinning is continuously increasing [1, 3]. Electrospinning is applied predominantly to polymer-based materials including natural and synthetic polymers, but it has been extended towards the production also of metal, ceramic and glass nanofibers exploiting precursor routes [1]. In this study we appliers cellulose based electrofibers into a cotton woven fabric.

Cellulosic polymers have gathered great interest in recent years in the field of nanoproducts useful for high-value applications. The biodegradability, biocompatibility, and versatility of these natural polymers are the reasons for those approaches regarding the possibilities to transform them in nanostructured materials with large applications especially in biomedicine, for tissue engineering scaffolds, wound dressing, controlled release, and technology purposes such as filtration, catalysis, sensors, affinity membranes [4]. Cellulose derivatives like cellulose acetate, ethyl cellulose, carboxymethyl cellulose sodium salt, hydroxypropyl methylcellulose, and methylcellulose and also underivatized cellulose have been electrospun from their solutions in adequate solvents and their possible applications especially in biomedicine and technology are reported [5]. Cellulose acetate phthalate is a mixed ester of cellulose commonly used as a pharmaceutical excipient for enteric coating of tablets and capsules [6]. Ultrafine cellulosic (glycol/cellulose) composite fibers show high latent heat of fusion and crystallization; this shows a maximum in the efficiency of enthalpy and indicates that the fibers have good thermal stability and reliability.

Based on this information, we applied cellulose acetate into cotton fabric by electrospinning and investigated the effect on the thermal properties

2. EXPERIMENTAL

In order to coating with electrospinning we prepared a solution with %15 cellulose acetate into 85% acetone. We put cellulose acetate solution into a syringe which needles diameter is 1,5 micrometers. Through a micropump which feeds with 20 Kw power unit from 10 cm distance we coated electrofibers onto a raw twill cotton fabric with 210 g/m^2 at 1,5 mL/hr.

An experimental setup established to measure temperature changes in electrospinning coated fabric and uncoated one. To study the influence of the characteristics of each sample on the thermal conductivity, samples were tested with a thermochromic camera. The tests were performed taking meassuarements each 15 seconds for 120 seconds of heating cycle and 120 seconds of cooling cycle. The distance between the heater (by radiation) and the fabric is 30 cm. The test starts with the fabric at room temperature 21^o C. After 120 seconds, the heater is taken away.

3. RESULTS

Table 1 shows temperatures which have been measured by thermocamera comparing the results of the coated by electrospinning and non coated cotton fabric. It is shown different temperatures analyzed each 15 seconds during 2 minutes of heating and cooling process.

Table. 1: *Temperatures of coated and non-coated fabric*

	Heating (ºC)							
	15 s	30 s	45 s	60 s	75 s	90 s	105 s	120 s
Without electrospinning	36,5	36,8	37,7	37,9	37,9	37,0	37,6	38,1
Coated with electrosppining	30,1	32,1	33,1	35,0	35,4	36,0	36,7	37,4
	Cooling (ºC)							
	15 s	30 s	45 s	60 s	75 s	90 s	105 s	120 s

Without electrospinning	29,4	27,2	26,8	26,1	26,1	25,7	25,4	25,7
Coated with electrosppining	28,7	27,1	26,7	26,4	26,3	26,2	25,8	25,6

In order to see more clearly the different thermal behaviour of treated and untreated sample, results are shown in a different graphics, where it is appreciate the behaviour of the fabric during heating and cooling processes, Fig. 1 and 2 respectively.

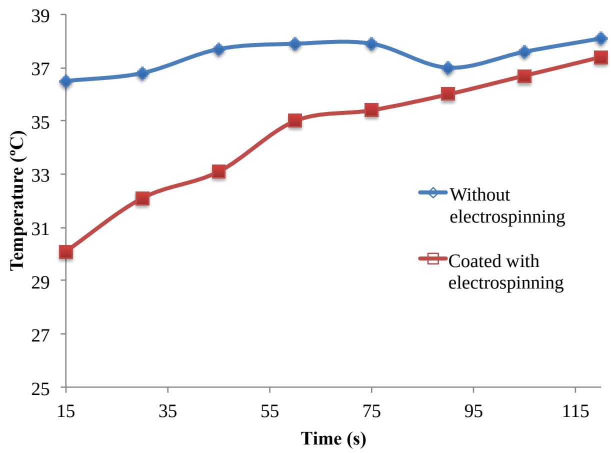

Fig. 1*: Thermal behavior of each sample during heating*

At the beginning of heating the temperature in fabric without electrospinning starts heating at 36,5º·C and increase with a high acceleration till 38.1ºC after 2 minutes being heated. On the other hand the temperature in the fabric coated with electrospinning starts heating at 30,1ºC and increase till 37.4 ºC, comparing with the other fabric temperature increased with less acceleration.

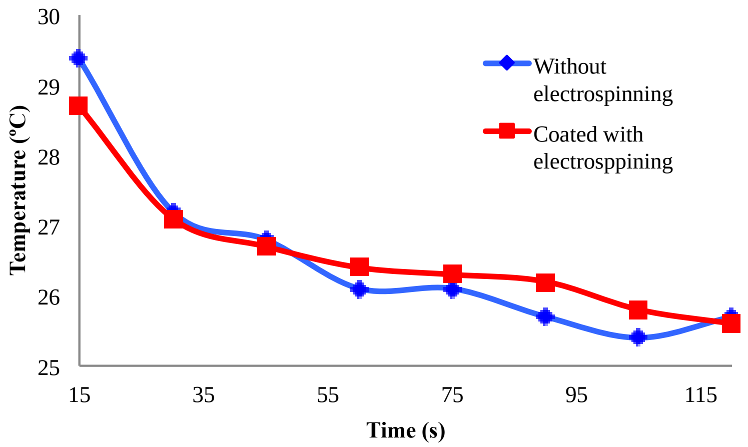

Fig. 2*: Thermal behavior of each sample during cooling*

After we remove the heater, we saw that both fabrics started cooling at same temperature. The differences between temperatures measured in both fabrics are not very significative in cooling process.

4. CONCLUSIONS

Our experimental results shown that when we apply cellulosed acetate by electrospinning coating into 100% woven cotton fabric, during heating it the temperature on fabric increase in a slover acceleration. Moreover, in cooling process, the temperature on fabric decreases a bit slowly..

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