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Evaluation of Negative Ion Generation on Polyester Fabrics to Improve Well-Being

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Abstract. PES-type synthetic fibers, despite some disadvantages (hydrophobicity, discomfort, etc.), have great interest in the production of textile garments (good mechanical resistance, easy drying and care, …). In order to improve the polyester properties some research is focused on improving the comfort those fibers can confer to the garments which include such composition, mainly when they are 100% polyester. Some studies have demonstrated the importance of the atmosphere we are surrounded by on the mud of people. Many new properties are attributed to negative ions. They are responsible, according to some studies, of the wellness or even create some illnesses. In this paper we use a polyester fabric to demonstrate it is possible to characterize some particles and apply them onto textiles. Those particles were padded onto polyester fabrics and the behavior was determined according to the number of anions/ cc (a/cc). Results evidence the influence of the friction system but also the influence of the binder on the total amount of ions generated from the polyester fabric.

INTRODUCTION

Ions are molecules in the air that contain small electrical charges (positive and negative). An ion is an atom with a certain electrical charge (positive or negative), the atom has the same number of protons (+) as electrons (-). When for some reason it loses an electron, the atom that was previously neutral now becomes a positive ion because the positive charge predominates, on the contrary if more than one electron enters the atom becomes a negative ion.

Ions have a significant influence on our biological and psychic processes. An ionic imbalance in the air, with excess positive ions, is harmful to plants, animals and humans. Various authors have studied the relationship of negative ions present in the environment with people's sense of well-being. In 1931 the first work related with the influence of ions on human beings was published [1]. Positive ions were found to cause increased pulse, blood pressure, and metabolic rate, resulting in unpleasant sensations such as headache, vertigo, and fatigue. On the other hand, negative ions cause a decrease in practically all the clinical manifestations caused by positive ions, reversing the damage and producing a feeling of well-being. Over the years, various studies have been published which verify these results [2-14].

Negatively charged ions can and do have an important role to play in the effect they have on sleep. Ions are positive or negative atoms charged on molecules that are formed when there is enough energy to form said molecule. A molecule that loses an electron remains charged with a positive charge and a molecule that attracts an electron remains negatively charged.

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There are a number of beneficial effects that negatively charged ions have in sleep, since negative ions increase the flow of oxygen to the brain, resulting in greater alertness, producing a decrease in drowsiness and therefore greater mental energy.

The ability to increase the flow of blood and oxygen to the brain can have a profound effect on sleep patterns and the results of better sleep are transformed into a higher state of alertness and more energy.

Dr. M Terman and Dr. JS Terman at Columbia University [15], studied the effect of negative ions on seasonal affective disorder (SAD), concluding that negative ions promote alpha waves in the brain and increase the amplitude of brain waves, which translates to a higher level of consciousness. Negative ion-induced alpha brain waves were found to be uniformly distributed throughout the left and right brain hemispheres. All this creates a calming effect in general and will help us to enter sleep quickly and reach REM sleep (rapid eye movement) of the state more quickly.

Negative ions can affect the levels of serotonin, a hormone that is manufactured in our brain. It is a neurotransmitter involved in the transmission of nerve impulses. Serotonin helps maintain a "happy feeling" and helps keep our moods in check, helping with sleep. Low serotonin levels in our brain are believed to be the reason for mild to moderate depression that can lead to symptoms of anxiety, apathy, fear, insomnia, and fatigue. When the brain produces serotonin, the stress is relieved.

Today's society is characterized by being made up of people who are mostly characterized by lack of time, and this results in them moving in stressful environments. Any contribution to greater relaxation is welcome and considering that textiles are used by anyone, they can be a stress release mechanism. Tissues can be functionalized by adding compounds that give them new properties. However, cotton composite fabrics are characterized by their good touch and the ability to absorb moisture, which is directly related to the feeling of comfort. However, fabrics composed of synthetic fibers are not characterized by low levels of moisture absorption and are less comfortable than cotton.

In this paper we are not focused on the effects of ions in health but on how increase the number of negative ions. The first aim of this study is to develop polyester fabrics with the capability of generate negative ions. This function would be conferred by means of functionalization of the textile surface with some particles. The quantity of ions generated will be measured and the influence of parameters such as friction and temperature will be discussed.

MATERIALS AND METHODS

Materials

A conventional openwork polyester fabric with a plain weave and a weight of 160 g / m^2 was used. It is made up of continuous multifilament of Nm = 25 and the weft and warp density varies, being 18 picks / cm and 22 ends / cm, respectively.

On the other hand, different particles and materials have been used to improve the characteristics of the fabric, such as the use of silicates, concisely Montmorillonite K10, and an acrylic binder Color Center ESFF supplied by color-Center (Spian)

Methods

Particles Characterization

Samples were characterized by Scanning Electron Microscopy, and it was used the Ultra 55 model from Zeiss at the central services at Universitat Politècnica de València. In order to measure by EDX the particle composition, samples were coated with carbon.

Application

Samples were treated by padding. The liquor bath was comprised of 50 g/L of Montmorillonite K-10 and part of the samples were treated without acrylic binder whereas the rest was treated with a binder concentration of 10 g/L. The pick up of the samples was calculated by weighting the sample before and after the treatment. Samples were flat dried at 80º C with an infrared system. Samples treated with binder were cured at 150º C for 3 minutes once they had been dried.

Ions Measurement

The release of ions has been studied using the COM-3200Pro Air Ion Counter from COM System, facilitating the release of ions from the tissue by friction, using a magnetic stirrer at 200 or 1000 rpm, and with the help of a 3 cm magnetic fly on the fabric. This test lasts 15 minutes and the number of ions or anions per centimeter cubic is offered (a/cc) according to the procedure suggested by Yunsen sun et al. [16-18].

RESULTS AND DISCUSSIONS

In order to know how is the particles to add to the fabric, microscopy analysis was conducted. Figure 1 shows the montmorillonite powder. It can be clearly appreciated the dispersity in the particles size. Particles can present irregular shapes and with sizes from few microns till around 40 microns.

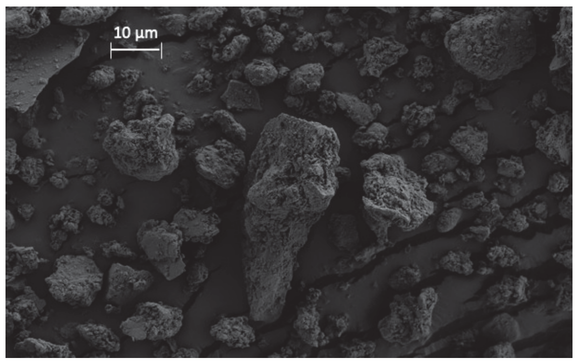

FIGURE 1. Montmorillonite K-10.

The analysis by EDX, as shown in table 1, evidences the presence of oxygen as the main component but also some metals such as Aluminum, Silica, Iron or Zinc, in its structure.

TABLE 1. Montmorillonite analysis from SEM_EDX.

Reference	Element	%
Montmorillonite K10	O	59,74
	Mg	0,87
	Al	4,97
	Si	27,73
	Fe	5,57
	K	0,38
	Ca	0,26
	Zn	0,48

Acrylic resin has been used as a binder in some of the treated fabrics. Figure 2a shows the polyester fabric treated with50 g/L of Montmorillonite that once the particles are placed on the fabric, the polydispersity in size of Montmorillonite is still appreciated. Figure 2b shows the aspect of polyester fibers treated with the same amount of Montmorillonite but with 10 g/L of binder in the recipe. Apparently both images seem to be similar.

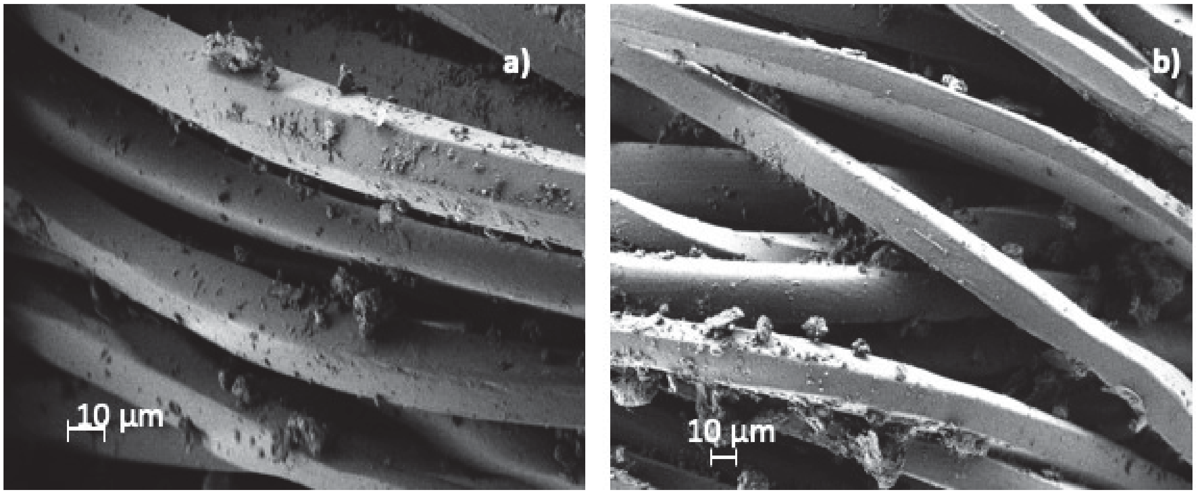

FIGURE 2. Polyester fibers with Montmorillonite K10 in its surface. a) Without binder; b) with 10 g/L binder.

In order to determine the capacity of generating negative ions from polyester, fabrics have been tested. Apparently there is a considerable difference between the samples evaluated in this paper, and the number of ions should be quantified. Table 2 shows the results from the tests conducted. As it has been demonstrated from results, the number of ions is fluctuating from one sample to other depending on the speed of the friction, but also on the treatment applied onto the fibers.

TABLE 2. Anions/cc (a/cc) for polyester fabrics.

Reference	**200 rpm**		**1000 rpm**	
	Total amount **(a/cc)**	Average **(a/cc)**	Total amount **(a/cc)**	Average **(a/cc)**
NT	90	0	38.458	43
6NT K-10	84.706	97	283.356	320
6NT K-10 ESFF	0	0	48.472	56

Apparently both images from Figure 2 seem to be similar however, ions results reveal that there is a difference in its behavior. The fact that they seem to be practically identical, this means that acrylic binder concentration of 10 g/L is not high enough to create the igloo effect covering the whole particle. However, the fact that the ions behavior is completely different as observed in table 2, evidences that particles are covered by the binder avoiding ore reducing the capacity of the particles to crate negative ions.

In order to observe the behavior of ions with time, some graphics with data have been represented. The number of ions obtained for the polyester fabric is shown in figure 3. It can be appreciated that polyester sample without any treatment (NT) shows different behavior depending on the speed of rubbing. Figure 3a shows a sample rubbed at 200 rpm, and it is observed how some picks of ions are appreciated. Figure 3b shows the negative ions from the same sample (no treated, NT) but rubbed at 1000 rpm. In this case, we can observe how the area of the graphic has increased, and many picks appear. The release of negative ions can be appreciated by the presence of many picks which indicate the generation of negative ions is increasing and decreasing constantly. Furthermore, it can be appreciated that the intensity of the picks increases by time. Apparently it seams that samples with reduced friction are accumulating electrostatic energy and it is released from time to time. When the friction is increased, there are more cycles for charge and discharge, but what is more interesting the number of negative ions is increasing with time.

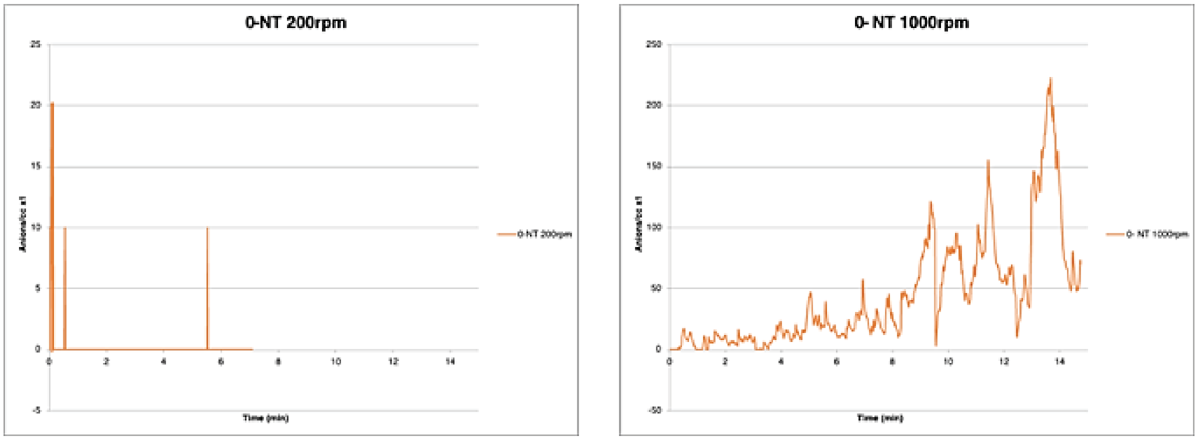

FIGURE 3. Negative ions on polyester fabric. a) 200 rpm; b) 1000 rpm.

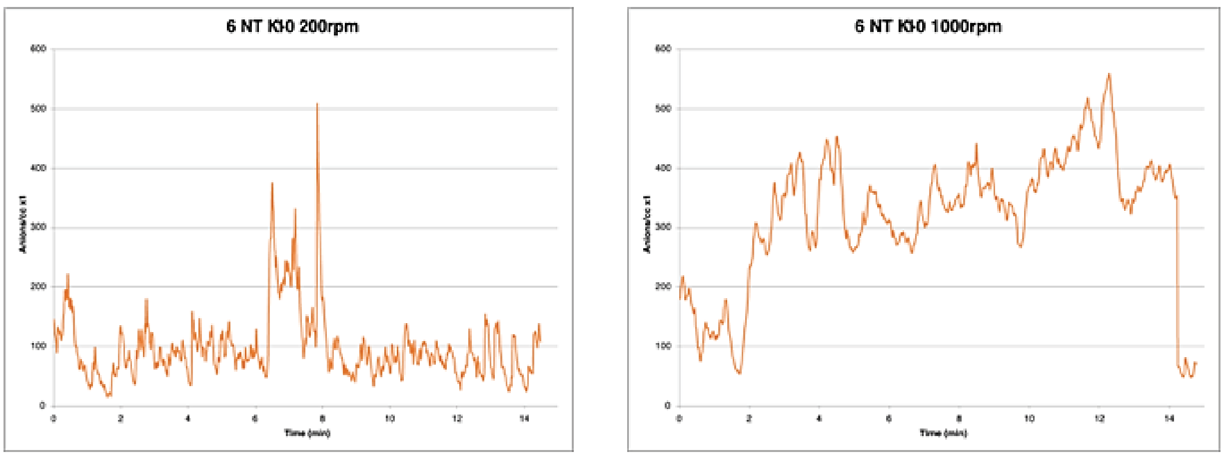

FIGURE 4. Negative ions on polyester fabric treated with Montmorillonite K10. a) 200 rpm; b) 1000 rpm.

Figure 4 is similar to figure 3, the difference is based on the treatment applied onto the fabric, as the Montmorillonite K10 has been padded. The presence of this compound on the fabric increases the number of ions generated in two ways. The first one we need to analyze is the number of picks, which has been considerably increased due to the presence of Montmorillonite (figure 4a) in comparison with the fabric non treated (figure 3a). Apart from the increase in the number of picks, it is worth to note that the scale in the graphic has been changed. This is due to an increase in the intensity of the picks. Thus, we can observe there is an increase in the generation of negative ions when the polyester fabric is rubbed due to the presence of Montmorillonite K10. Something similar can be appreciated when the test is conducted at 1000 rpm. There is a change not only in the number of picks but in the intensity as well. This increase in the number of ions, can be attributed to the electrostatic electricity accumulated on the fabric due to the friction however, it is noteworthy the increase in the total amount of negative ions generated, even when the friction is not too high.

This increase in the number of ions from the treated fabric can be attributed to the presence of Montmorillonite K10. The main reason for that behavior can be attributed to the metals present in the particle, which can be assigned to a piezoelectric material. Thus, when the rubbing is increased the friction is increased as well and this explains why the sample rubbed at higher speed (rpm) releases higher amounts of ions.

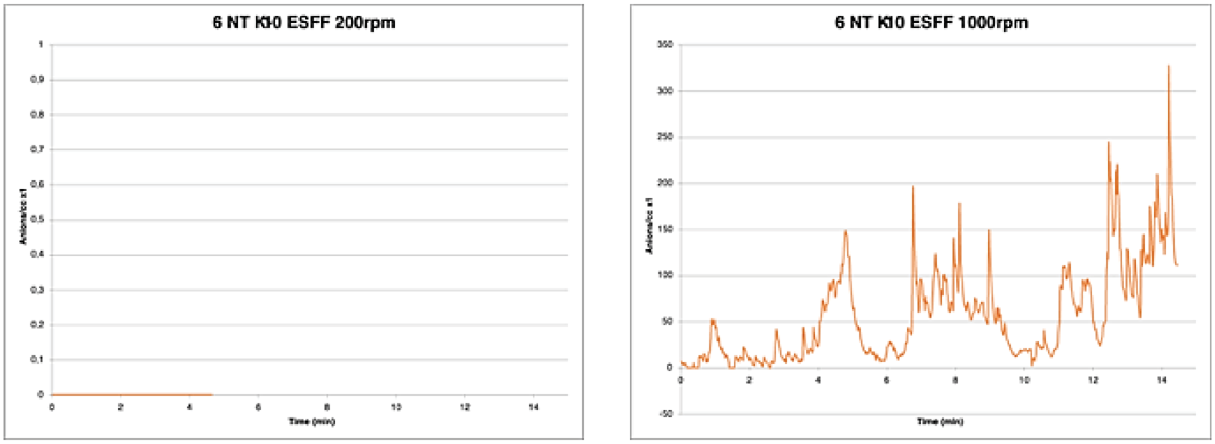

FIGURE 5. Negative ions on polyester fabric treated with Montmorillonite K10 and 10 g/L of binder. a) 200 rpm; b) 1000 rpm.

As we described in methods, the test was conducted applying Montmorillonite onto the fabric with and without binder. Results from the sample treated with Montmorillonite and binder are shown in Figure 5. Despite the fact that figure 2 shows no apparent differences between the fabric treated with Montmorillonite with or without binder, the number of ions/cc when the particles are applied with binder decreases in comparison to the samples treated without binder. This means there is a negative effect of the binder presence in the generation of negative ions. The analysis of samples does not show any evidence of igloo effect, what means the particles are not recovered by the resin. This effect on the reduction of anions/cc can be attributed to the fact that the binder is reducing the friction coefficient and then the force is reduced. It means that the friction with the magnet onto the fabric is reduced due to the presence of the resin, what implies the binder action is similar to that from a softener.

Those results allow to corroborate that Montmorillonite shows similar behavior to what others intended to develop with tourmaline. Akira Nishito's invention [19] patents an ionizing effect mattress that has tourmaline in the mattress. The mattress is made of foam but with tourmaline discs attached to the mattress. Another similar invention corresponds to the inventor Yukio FujinoMorihiro Kabaya [20], who protects a bedding fabric with aluminum, zirconium, silicon or other specified far infrared radiant ceramic that radiates electromagnetic waves with a maximum wavelength of 8 to 14 µm when heated at a temperature approximately equal to the temperature of the human body. Similar compounds to the ones we could find in the Montmorillonite K10 applied onto polyester fibers during the experiments described in this paper.

The Adrasa company is one of the developers of a finishing product whose purpose is the release of ions. Its product, Biocare Texfinish FCS, tries to imitate tourmaline by generating free radicals, such as the hydroxyl ion (-OH) or its associated forms, acting as a revitalizer of the body after its release. Regulates the nervous system, improves blood circulation and acts as a muscle relaxant. [21]

CONCLUSIONS

The well-being is a high concern nowadays. Some studies demonstrated that the negative ions can enhance this feeling because of the activation of different mechanisms. In this paper we tried to demonstrate the capacity of polyester fabrics to generate negative ions, and how this capacity can be improved. We did not intended to demonstrate the relationship between negative ions generated and good mud, as this is not our field of expertise, but studied how we can enhance the number of anions from a fabric. The number of negative ions generated from polyester fabrics, is directly related with the intensity of friction and the time the fabric is exposed to rubbing what can be attributed to the electrostatic discharge typical in synthetic fibers.

The presence of Montmorillonite on the samples increases the number of anions/cc, what is due to the presence of some metals such as aluminum, zinc, silica and iron. Those metals can contribute to a piezoelectric behavior. The fabrics must be treated without binder though, as we demonstrated there is a strong decrease in the number of ions created when there is the presence of an acrylic binder. This means the number of anions/cc can be modified. Due to the fact that there are evidences about how the negative ions contribute to a higher relax consequently, polyester fabrics treated with Montmorillonite K-10 can help to relax oneself.

The fact that ions are generated while the fabric is rubbed means that they will be generated while a person is wearing the cloth, and the more active the higher number of ions would be generated. This circumstances can deal into different applications such as working cloths, garments for sports or any other activity which can be stressful so that they could be considered as stress release garments.

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