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ENHANCING THE PERFORMANCE AND COMFORT OF POLYMERIC TEXTILES

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ABSTRACT
The present work aims to develop the performance and the comfort of the polymeric textiles to enhance the quality of the clothes. It is known that one of the measures of the comfort is the generation of electrostatic charge (ESC) on the surface of the textiles when they rub other materials, human hair and skin. As ESC increased, the comfort of the clothes decreased. In the present work ESC generated from contact-separation as well as sliding of polymeric textiles on cotton is discussed. Test specimens of composites containing polyester (PET) and polyamide (PA) textile fibers were blended by 2.0 wt. % carbon fiber (CF) and tested by contacting cotton textiles under 10 N load. Ultra surface DC Voltmeter was used to measure ESC of the tested textile composites.

It was found that ESC generated on PET/PA strings blended by CF from the contact-separation and sliding on cotton drastically decreased with increasing PET content. PA strings displayed positive ESC, while PET showed negative one, then the zero value of ESC was detected at 40 wt. % PET content. Composites blended by 2.0 wt. % CF showed significant reduction in the values of ESC due to their conduction of ESC from one surface to the other. Besides, cotton gained zero ESC at 30 and 40 wt. % PET at contact-separation and sliding respectively. Finally, sliding of the tested polymeric textiles against cotton displayed relatively higher ESC values than that observed in contact-separation. And the zero value of ESC was observed at 22 wt. % PET, while composites blended by 2.0 wt. % CF showed zero value detected at 40 wt. % PET.

KEYWORDS
Polyester, polyamide, carbon fibers, cotton textiles, triboelectric charge.

INTRODUCTION
The friction of polymeric textiles on cotton generates ESC, [1, 2]. Test specimens containing polyester (PET) and polyamide (PA) strings were testedat contact-separation and sliding against cotton textiles, where ESC of the tested materials

were measured.The results revealed that at contact-separation, ESC generated on the surface of PET blended by CF decreased with increasing CF content, while PET free from CF showed the highest negative ESC values. It was attributed that CF transfers the charges from the two contacting surfaces. While at sliding, ESC recorded higher values than that measured at contact-separation and the effect of CF was significant. Besides, PA strings displayed relatively lower values than that observed for PET because PET strings had fine fibers that increased the area subjected to ESC.

It was revealed that blending wool and cotton fibers with polymeric ones drastically decreases ESC generated from their contact with each other. Therefore, the tested blends had become environmentally safe textile materials.The suitability of car seat covers to enhance the stabilityand safetyof the driver was developed by thedetectingthe generatedESC. At contact-separation of the tested upholstery materials of car seat covers against the textiles of clothes, the values of the generated ESCdependedon the type of the materials, [3, 4]. Polyamide textiles generated negative voltage. HighESC increase was observed for synthetic rubber that limits their application. Friction of clothes sliding against car seat covers was studied, [5]. Five different types of synthetic leather and nine different types of synthetic textiles, were tested. Triboelectrification of the textiles had low attention.

Besides, the potential for textiles to cause friction-induced injuries to skin such as blistering, [6 -8], was considered. In sport activities,runners suffered from blisters caused by the friction between textile and foot skin. Based on that, it is essentialto measure and predict friction and determine the mechanical contacts between foot, sock and shoe during running. The solution is to use textiles with conductive threads because they did not give ignitions provided they were correctly earthed.

Friction coefficient and ESC generated from the friction of hair and head scarf of different textiles materials were studied, [9 - 17]. Head scarf of common textile fibres such as cotton, PA and PETwere tested by sliding against African and Asian hair. Sliding of cotton head scarf against hair displayed higher friction than that observed by polyester head scarf. WhilePA sliding against hair showed the lowest friction.

Electrostatic properties of hair had no attention although these properties are very sensitive to the friction between hair and head scarf textiles. Hair developsESC when rubbed with human skin, plastic and textiles. Human hair is a good insulator with an extremely high electrical resistance. Due to that, ESCgenerated on hair is not easily dissipated in dry environments, [18 - 20].

The aim of the present work is to reduce ESC generated from the contact-separation and sliding of PET/PA strings blended by CF on cotton.

EXPERIMENTAL

The measurement of ESC was achieved by the electrostatic fields (voltage) measuring device, Fig. 1. The test specimens were adhered toone surface of wooden block of 50 × 50 × 10 mm^3, Fig. 2. Test specimens consisted of PET of 1.6 mm diameter blended by different content of PA strings of 0.5 mm diameter in volumetric ratio of 0, 10, 20, 30, 40, 50, 60, 70, 80, 90 and 100 vol. %. The blend was shaped in forms of plain weaves textiles, Fig. 3. Then content of CF added to the blend was 2.0 wt. %.

Experiments were carried out by loading the test specimens on the cotton textile.The load values was 10 N. The cotton textiles were adhered to wooden base. After 5 minutes of loading, the load was removed and ESC on the two contacting surfaces was measured. At sliding, the test specimens were loaded and slid at 20 mm/sec velocity for 200 mm distance. Every experiment was repeated five times, where the average value was considered.

Fig. 1 Electrostatic field measuring device.

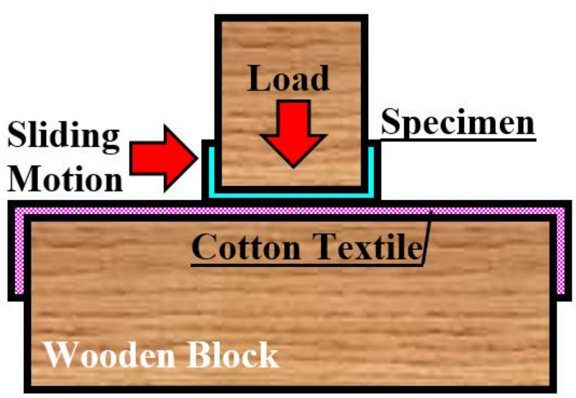

Fig. 2 Arrangement of the teste test procedure.

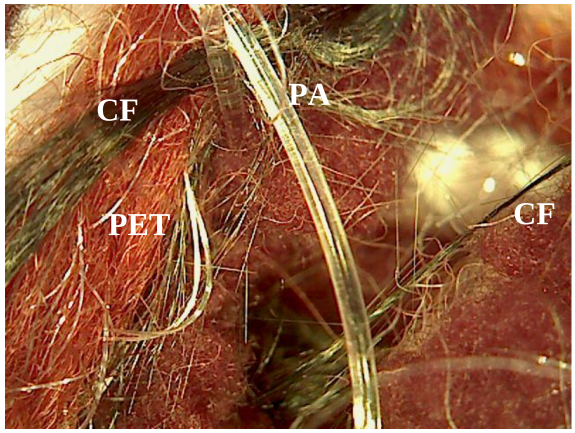

Fig. 3 PET/PA blended by CF test specimen.

RESULTS AND DISCUSSION

The results of experiments carried out in the present work measuring ESC are illustrated in Figs. 4 – 7. ESC generated on PET/PA strings blended by CF from the contact-separation with cotton is shown in Fig. 4. ESC drastically decreased with increasing PET content. 100 wt. % PA strings displayed positive ESC, while 100 wt. % PET showed negative one. The zero value of ESC was detected at 40 wt. % PET content. Composites blended by 2.0 wt. % CF showed significant reduction in the values of ESC due to their ability o conduct ESC from one surface to the other. Values of ESC decreased for 100 wt. % PA free of CF from 518 to 334 volts for composites blended by 2.0 wt. % CF. ESC decreased from -890 to -340 volts for PET. ESC generated on the surface of the cotton from contact-separation is illustrated in Fig. 5, where the zero value of ESC was observed at 30 wt. % PET. At 100 % PET content, the values of ESC were between 1620 and 277 volts for composites free of CF and that blended with 2.0 wt. % CF respectively. While ESC value displayed from rubbing cotton by 100 wt. % PA decreased from -1230 to -77 volts as the influence of CF.

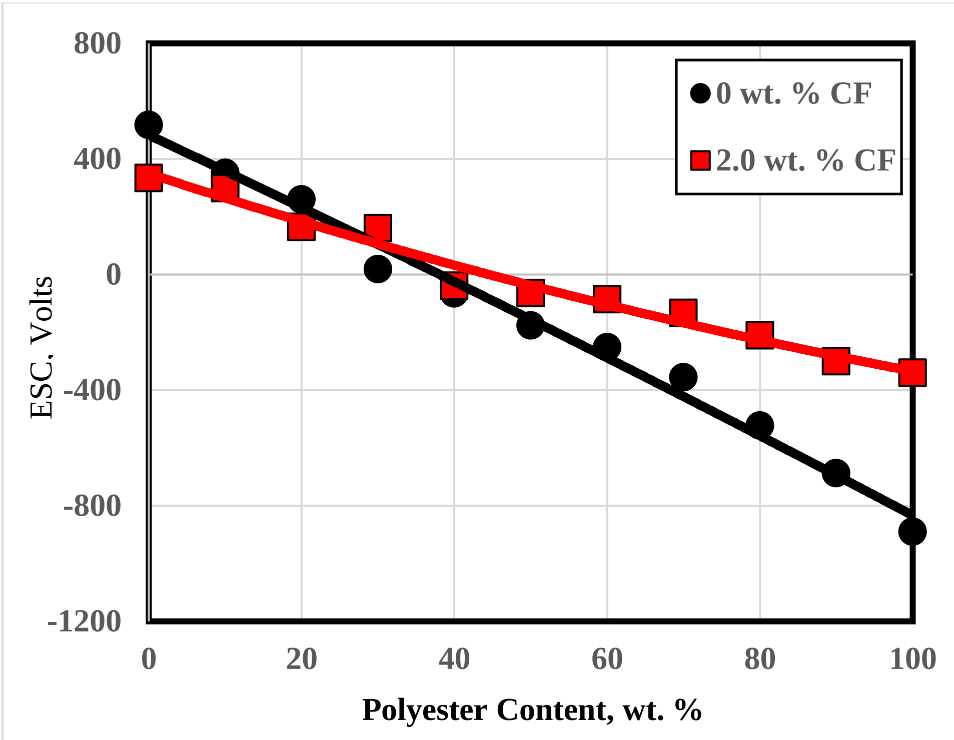

Fig. 4 ESC generated on PET/PA strings from the contact-separation with cotton.

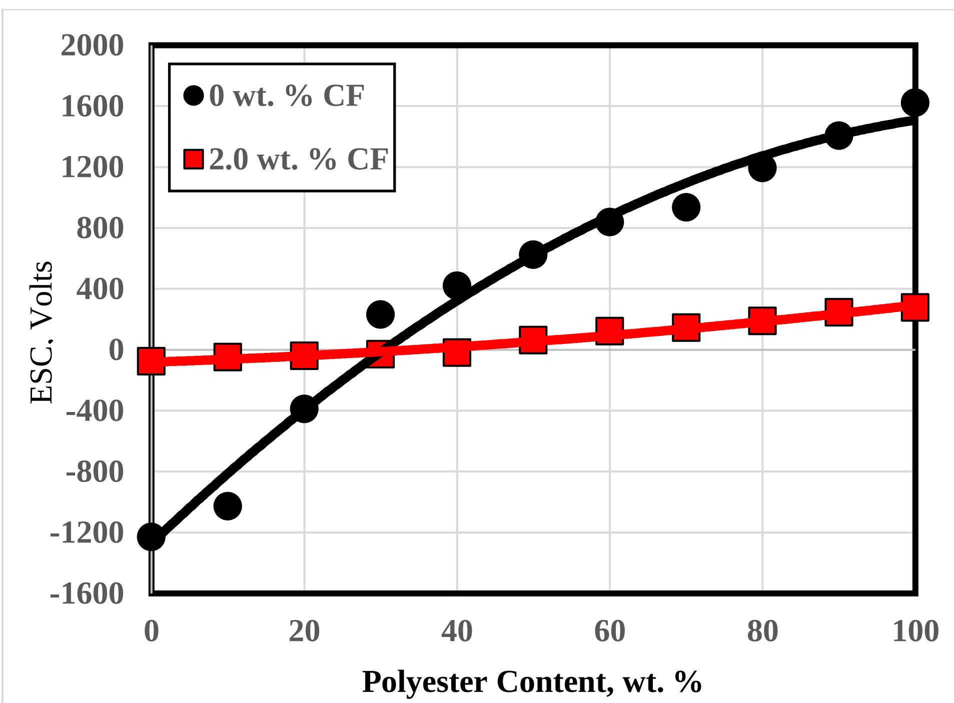

Fig. 5 ESC generated on cotton textile from the contact-separation with PET/PA strings.

The distribution of ESC on the contact surface after contact- separation and sliding is shown in Fig. 6. The double layers of ESC generated on the two contacting surfaces were influenced by the presence of CF. It is known that PET gaines negative ESC and PA gaines positive one when they rub cottton textiles. Threfore, it is expected that the resultant ESC would decrease due the ability of CF to transfer the charge from one surface to the other. Based on the fact, the intensity of ESC depends on the rank of the contact materials in the triboelectric series. It is known that the gap between PET and cotton is bigger than the gap between cotton and nylon. According to the tribo-electric series, the contact between PA and cotton as well as PET and cotton causes the object in the upper position of the series to be positively charged (PA) and that in the lower position to be negatively charged (cotton), while PET gains negative ESC when rub cotton that gains positive ESC. The intensity of ESC of different polarity increases attraction between the two contacting surfaces.

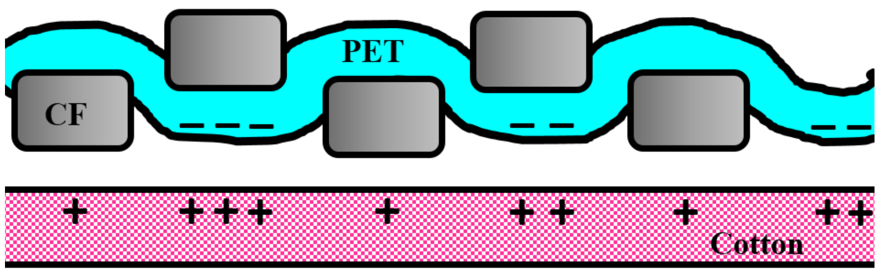

Fig. 6 Representation of ESC generated on the contact surfaces after contact-separation and sliding.

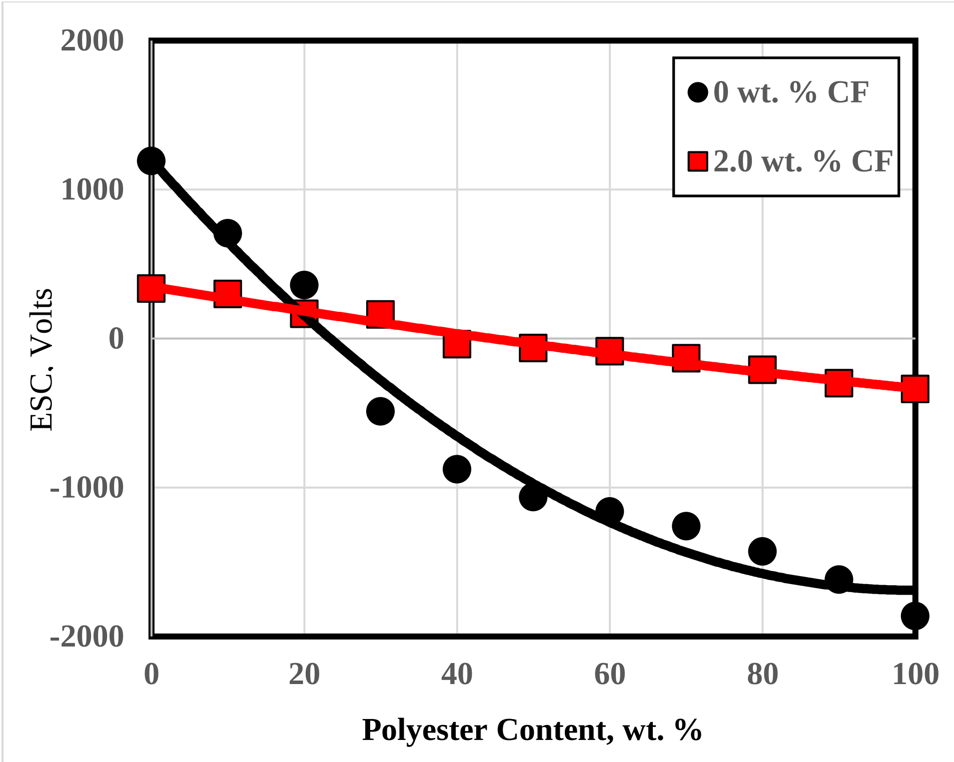

Fig. 6 ESC generated on PET/PA strings from sliding on cotton textile.

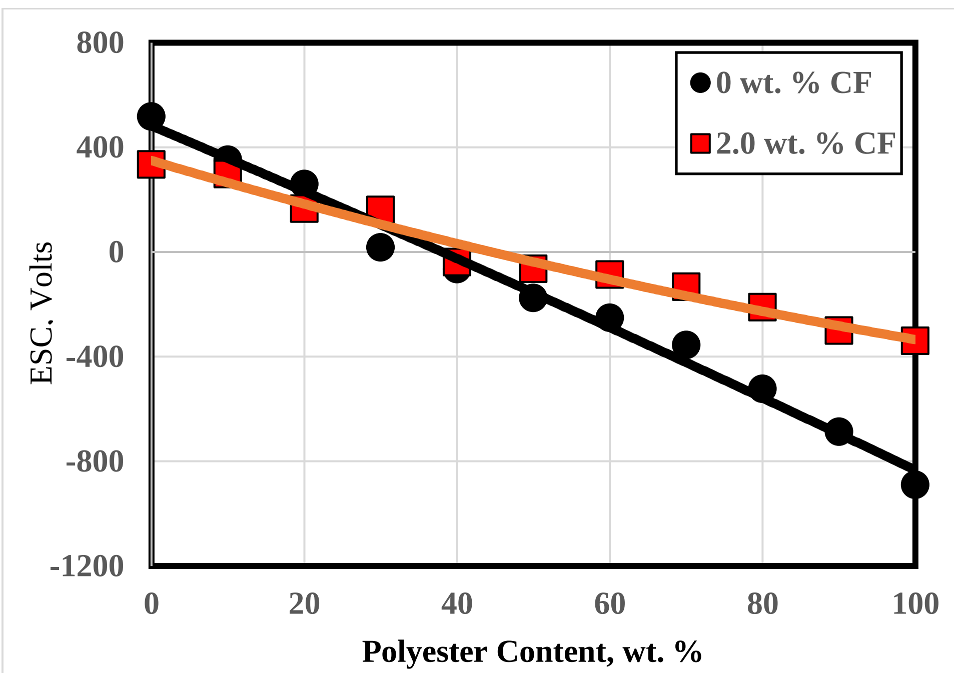

Fig. 7 ESC generated on cotton textile after sliding on PET/PA strings.

It is observed that sliding of the tested polymeric textiles against cotton displayed relatively higher ESC values than that observed in contact-separation, Fig. 7. The values were 1191 and -1864 volts for PA and PET respectively, where the zero value of ESC was observed at 22 wt. % PET. PET/PA strings blended by 2.0 wt. % CF showed drastic ESC decrease. PA displayed 334 volts while PET showed -340 volts. The zero value was detected at 40 wt. % PET. ESC generated on the cotton textiles from sliding on the tested composites recorded 518 volts at 100 % PET then decreased to 334 volts in presence of CF. 100 wt. % PET content displayed -890 volts decreased to -340 volts when the composites were blended by CF.

CONCLUSIONS

1. ESC generated on PET/PA strings blended by CF from the contact-separation and sliding with cotton drastically decreased with increasing PET content.
2. 100 wt. % PA strings displayed positive ESC, while 100 wt. % PET showed negative ESC, where the zero value of ESC was detected at 40 wt. % PET content.
3. Composites blended by 2.0 wt. % CF showed significant reduction in the values of ESC due to their ability to conduct ESC from one surface to the other.
4. Cotton gained zero ESC at 30 and 40 wt. % PET at contact-separation and sliding respectively.
5. Sliding of the tested polymeric textiles against cotton displayed relatively higher ESC values than that observed in contact-separation.
6. The zero value of ESC was observed at 22 wt. % PET, while composites blended by 2.0 wt. % CF showed zero value detected at 40 wt. % PET.

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