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DECREASING THE ELECTROSTATIC CHARGE GENERATED ON THE SURFACE OF POLYMERIC TEXTILES

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ABSTRACT
The demand for environmentally friendly textiles is growing. It is well known that quality of clothes depends on their comfort, where the measure of the comfort is the friction coefficient and the intensity of electrostatic charge (ESC) generated during contact/separation and sliding on human skin and underwear. To reduce the triboelectrification of polymeric textiles, it is proposed in the present work to blend polymers textiles of negative charge such as polyester (PET) with polymers of positive charge like polyamide (PA) and wool. Besides, the blend is plain weaved by carbon fibers (CF) as well as copper wires. The proposed composites were tested by sliding under different loads against cotton textiles, where the generated ESC was measured.

The results of the present experiments revealed that blending polymeric strings such as PET that gains negative ESC by that gain positive ESC like PA and wool, after sliding on cotton, reduces ESC, where blending facilitates ESC transfer from one string to the other. Besides, weaving the tested composites by CF and copper wires decreases ESC, where CF displayed the lowest ESC values. The enhancing effect increased with increasing the content of CF and copper wires. It seems that CF and copper wires facilitated the transfer of ESC from surface of negative ESC to the other of positive ESC. In the presence of wool, weaving the composites by copper wires and CF was more effective than PA. It may be from that the wool strings had fine fibers that enhanced the transfer of ESC.

KEYWORDS
Polyester, polyamide, wool, cotton textiles, electrostatic charge, carbon fibers, copper wires.

INTRODUCTION
The measure of the comfort of textiles depends mainly on the intensity of ESC generated on their surfaces. Several attempts were carried out to reduce ESC by blending polymers that gain ESC with polymers of positive ESC as well as carbon fibers to conduct ESC from one surface to the other, [1 - 7]. Conductive polymers and

noble metal nanomaterial were used, [8 – 12], to develop energy-saving textile material to guarantee heating for human body in indoor and outdoor environment.

Because polymeric textiles cause blistering injuries to skin, [13 - 15], several attempts were performed to blend wool and cotton strings by polymeric fibers to decrease ESC generated from their contact with each other, [16, 17]. ESC generated from clothes sliding against car seat covers was tested, [18]. In addition to that, ESC generated from the contact and friction of hair and head scarf were investigated, [19 – 25]. Head scarf of textile fibers like cotton, PA and PET were tested by sliding against hair. Hair gains ESC when rubs human skin, plastic and textiles.

The aim of the present work is to blend polymeric textiles that gain negative charge with polymers of positive charge to reduce ESC. Besides, the composites are blended by carbon fibers as well as copper wires. The proposed composites are tested by sliding against cotton textiles, then the generated ESC is measured.

EXPERIMENTAL

The electrostatic voltage device was used to measure ESC, Fig. 1. The tested composites have been adhered into one surface of a wooden block of 50 × 50 × 50 mm^3, Fig. 2. The tested composites consisted of PET of 1.6 mm diameter blended by strings of PA of 0.5 mm diameter as well as wool of 1.5 mm diameter. The tested composites that contain 50 wt. % PET and 50 wt. % PA as well as that contain 50 wt. % PET and 50 wt. % wool have been plain weaved by carbon fibers and copper wires of 0.1 mm in content of 0, 3, 6, 9and 12 wt. %, Fig. 3.

The tested composites were slid on cotton textile for 200 mm at 20 mm/sec velocity and loaded by normal loads of 2, 4, 6, 8 and 10 N. The experiments carried out to measure ESC were performed for sliding distance of 200 mm.

Fig. 1 Electrostatic field measuring device.

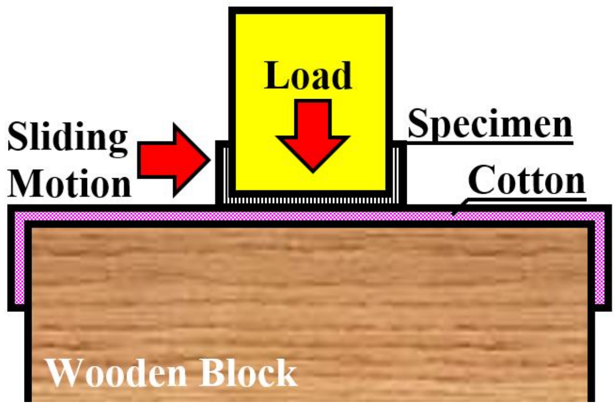

Fig. 2 Arrangement of the teste test procedure.

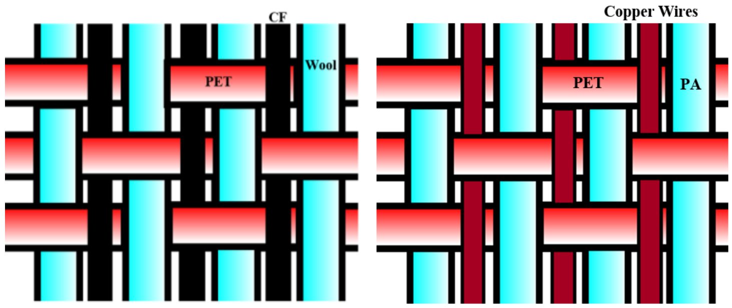

Fig. 3 Tested composites weaved by carbon fibers and copper wires.

RESULTS AND DISCUSSION

ESC generated on the surface of PET strings of 1.6 mm diameter blended by PA strings due to sliding on cotton is illustrated in Fig. 4. ESC decreased with increasing PET content, where the lowest ESC values were observed at 100 wt. % PET content. Those values were 3.8, 3.2, 6.2, 7.5 and 7.7 volts at 2, 4, 6, 8 and 10 N respectively. 100 % PET showed the highest ESC values. Composites containing higher content of PA displayed higher values of ESC. Based on the triboelectric series, the friction between PET and cotton causes PA to be positively charged and PET to be negatively charged. As the intensity of ESC of different polarity increases the attraction between the two contacting surfaces increases. The same trend was observed for wool blending PET, where wool gains positive charge due to friction with cotton, while PET gains negative charge. The blend facilitated the transfer of the charge from one string to the other, Fig. 5.

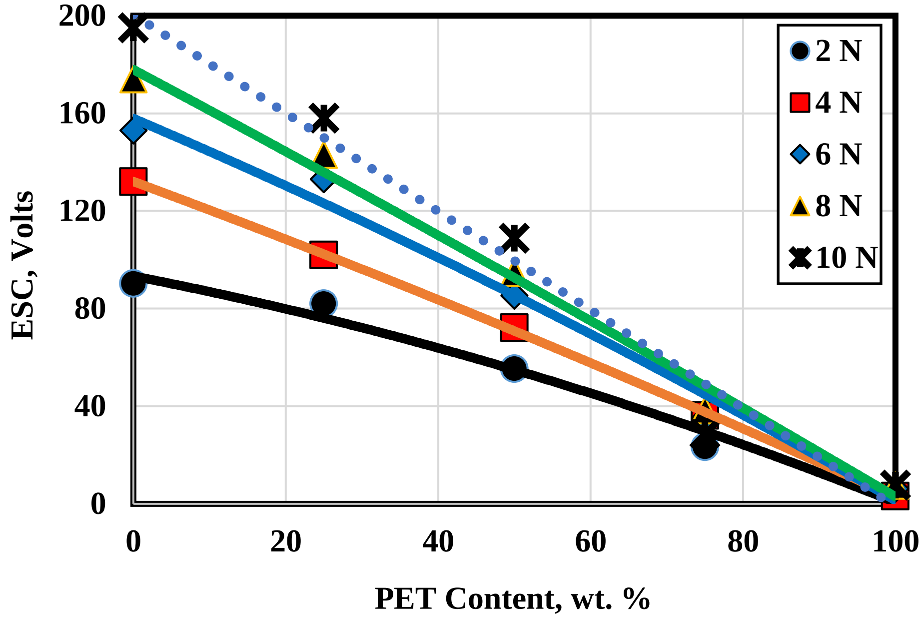

Fig. 4 ESC generated on of polyester strings blended by polyamide from sliding on cotton textile.

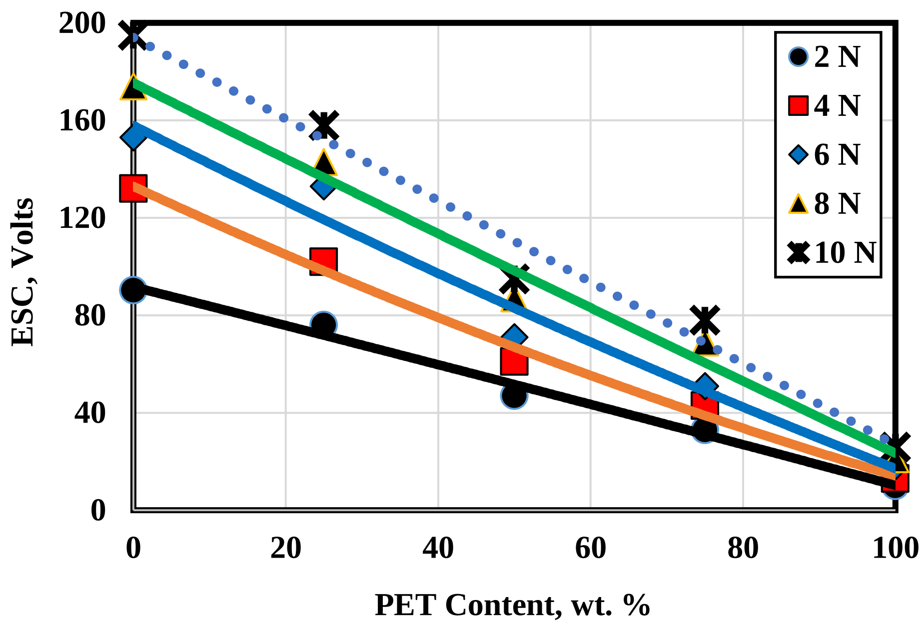

Fig. 5 ESC generated on of polyester strings blended by wool from the sliding on cotton textile.

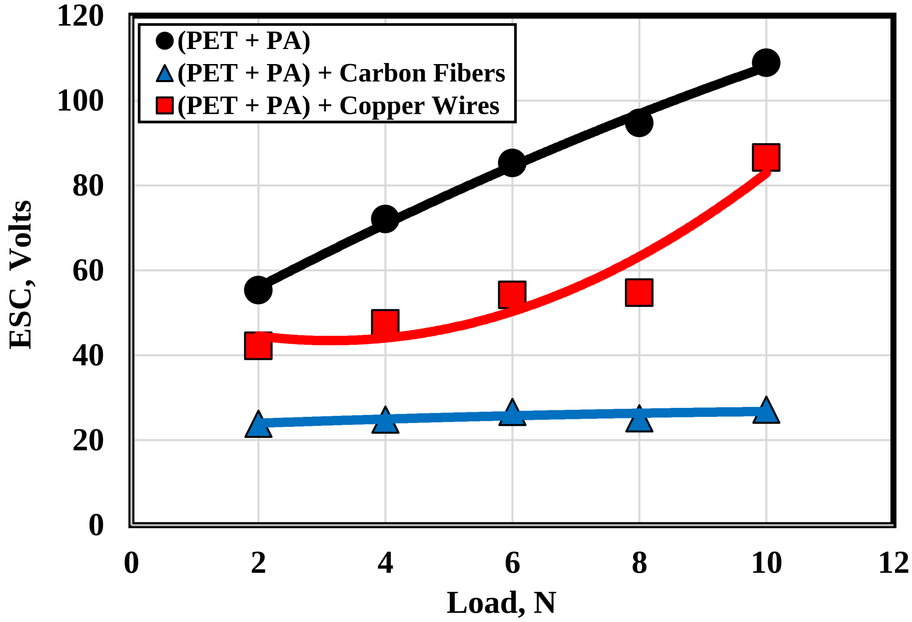

Fig. 6 ESC generated on the tested composites blended by carbon fibers and copper wires.

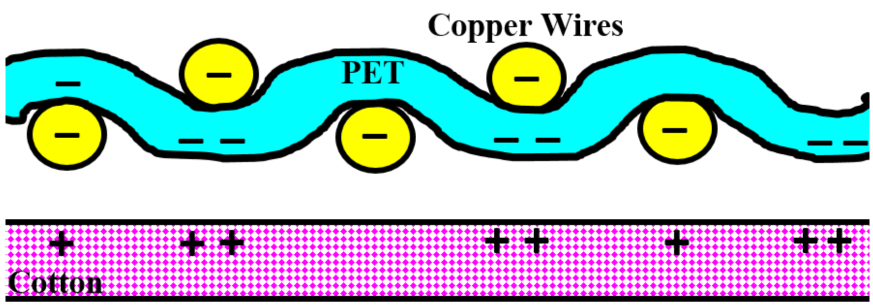

Fig. 7 Representation of ESC generated on the contact surfaces of PET and cotton after sliding.

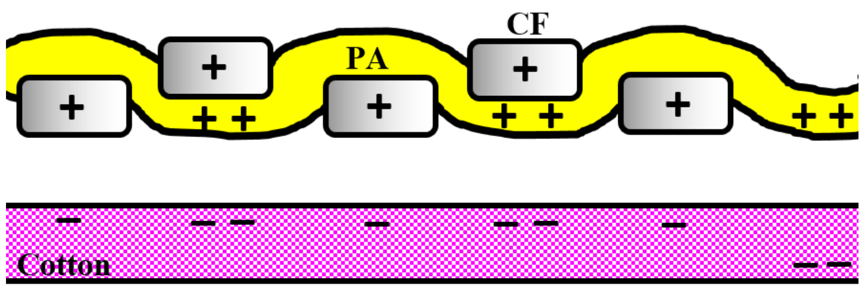

Fig. 8 Distribution of ESC generated on the contact surfaces of PA and cotton after sliding.

The composites containing 50 wt. % PET and 50 wt. % PA as well as that contain 50 wt. % PET and 50 wt. % wool and blended by carbon fibers and copper wires were tested by sliding on cotton, where ESC was measured, Fig. 6. The composites free of carbon fibers and copper wires displayed the highest ESC followed by that blended by copper wires. The lowest ESC values were observed for that blended by carbon fibers. It seems that the addition of CF and copper wires into PET, Fig. 7, and PA, Fig. 8, transferred ESC into the cotton surface of positive and negative charges respectively.

The distribution of ESC on the contact surface after sliding is illustrated in Figs. 7 and 8, where PET gains negative charge after rubbing cottton, while cotton gains positive ESC. The presence of conductng materials such as CF and copper wires facilitated the transfer the charge from one surface to the other. The resultant ESC generated on the two surfaces depends on the relative content of CF and copper wires. It is well know that the intensity of ESC is affected by the rank of the rubbing materials in the triboelectric series.

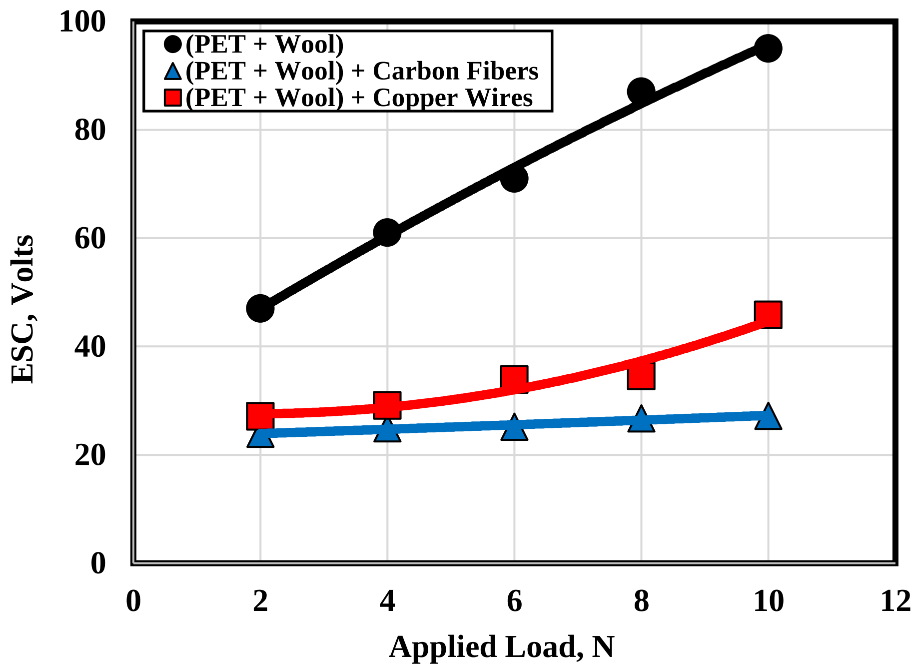

Fig. 9 ESC generated on the tested composites blended by carbon fibers and copper wires.

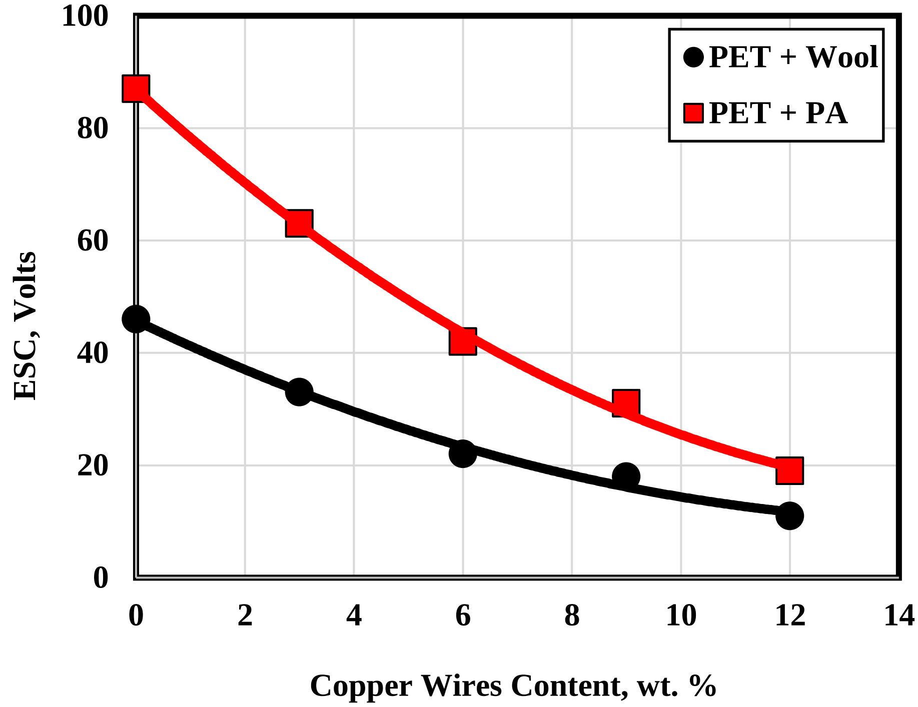

Fig. 10 ESC generated on the tested composites blended by copper wires.

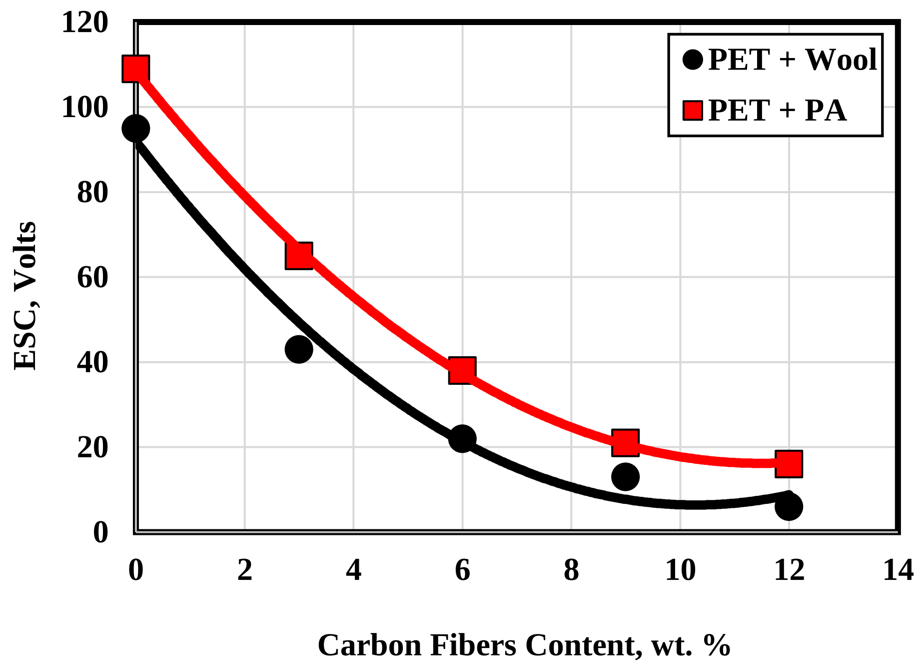

Fig. 11 ESC generated on the tested composites blended by carbon fibers.

The sliding of composites containing 50 wt. % PET and 50 wt. % wool blended by carbon fibers and copper wires of 3.0 wt. % content on cotton are illustrated in Fig. 9. ESC showed that composites free of conducting materials displayed the highest ESC up to 95 volts at 10 N load. Composites blended by CF showed the lowest values of ESC that increased with increasing the applied load. This may be from the easy charge transfer offered by the CF. The reduction effect displayed by CF and copper wires was more significant in the presence of wool than PA. It seems that wool strings had fine fibers that increased the area of the contact that increased ESC. While the surface of PA strings is smooth with no fiber.

The comparative performance of the conductive materials and their influence on reducing ESC is illustrated on Figs. 10 and 11. The ESC values were recorded At 10 N applied load. As the content of both CF and copper wires increased, ESC drastically decreased. In the presence of copper wires, Fig. 10, composites containing 50 wt. % PET and wt. % wool displayed relatively lower ESC values than that observed for composites containing 50 wt. % PET and 50 wt. % PA, Fig. 10.

When the tested composites were blended by CF, ESC showed lower values than that displayed by Copper wires, Fig. 11. The maximum ESC values were displayed by composites free of copper wires.

CONCLUSIONS

1. Blending PET that gains negative ESC by PA or wool that gain positive ESC after sliding on cotton, decreases ESC because the blend facilitates ESC transfer o from one string to the other.
2. Plain weaving the composites by CF and copper wires displayed lower ESC than that observed for composites free of the conducting materials. The lowest ESC values were observed for that blended by CF that increased with increasing the applied load.
3. CF and copper wires facilitated ESC transfer from surface of negative ESC to the other of positive ESC.
4. Weaving the composites by CF and copper wires was more effective in the presence of wool than PA. That may be from the fact that wool strings had fine fibers that enhanced the transfer of ESC.

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