Study of electrification process of knitted textiles

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Abstract: Triboelectric generators are structures whose function is based on the natural phenomenon of triboelectricity. In their basic form, they are made up of two distinct surfaces that come into contact with one another while being connected to two different electrodes, which transfer the generated electric power to either storage or consumption [1]. Due to their high output power, great reliability, low cost, and versality in terms of material and structural design, textile triboelectric generators have recently been employed to harvest energy from human motion [2]. Thanks to the advantages of knitted textiles (flexibility, good fit to the body, etc.) more and more attention is paid to the use of knitted structures to convert mechanical energy into electric power created during friction.

The aim of this study is to analyze the relations between the friction of knitted structures and surface electrification. Two commercially available yarns from polyamide (200 tex, 6 TPCm) and polyester (220 tex, 14 TPCm) are used for a pair of knitted samples. The choice of materials is based on the triboelectric series - list of materials ordered by how they develop a charge relative to other materials. All samples are machine knitted in plain jersey with loop density 24 in cm^2. Experiments were performed by applying different loads, testing samples from both sides (technical front and back) in different directions (both row and course) (Fig. 1). The principle of friction measurements between two fabrics were based on the force measurement during rectilinear motion of a sled over a horizontal platform [3]. Triboelectric properties of knitted fabric were characterized using the standard laboratory equipment - Martindale tester. As a result of such relative movement of the fabrics knitted from polyamide and polyester yarns, an electric charge was induced, which caused the appearance of an electric current in an external electrical circuit consisting of two metallic electrodes M1 and M2 connected to each other by a load resistor R (Fig. 2). This process was controlled by voltage record on resistor R. The charge as the integral of V/R was calculated to evaluate the level of fabric electrification.

Preliminary results show that due to the anisotropy of knitted fabrics in the course and wale directions, the different morphologies of the front and back surfaces, both the friction and the resulting charge vary depending on the side of knit, the direction of movement (along course or wale) and the applied load.

Keywords*: knitted fabric, friction, triboelectricity*

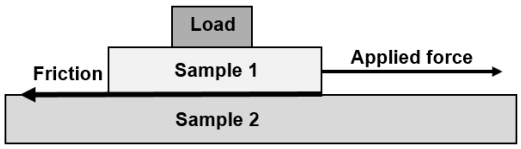

Figure 1 Model of kinetic friction between two fabrics

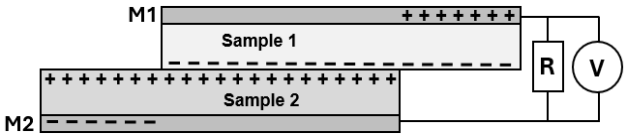

Figure 2 The scheme used to evaluate the electrification of knitted fabrics

Table 1 Relation between friction and generated charge

Materials Sample 1 / Sample 2	***Sample side and direction of movement***	***Kinetic friction coefficient***	***Generated charge nC***
Polyamide / Polyester	face to face	**0.34**	**10.89**
Polyamide / Polyester	back to back	**0.42**	**21.69**

Table 1 shows the most pronounced differences in the generation of charges due to friction depending on the side of the knit and the direction of movement.

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