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## RESEARCH ARTICLE

### STUDY OF ELECTRICAL CONDUCTING triboelectric properties of fabrics for safety shoes. annotation.

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#### *Abstract*

This paper investigates the triboelectric properties of the two groups of samples of conductive fabrics in contact with different textile materials and natural leather used for uppers and lining of footwear with electrophysical characteristics.

##### *Key words:*

textile materials; static electricity;  
 surface voltage measurement;  
 charge measurement; surface  
 voltage distribution measurement.

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#### **Introduction:**

The main trends of the world production of shoes are the creation of new and expansion of the range of chemical products, footwear, introduction and development of advanced technologies.

Raw material base materials for external and internal parts of the shoe is very high - it is natural and artificial leather, woven and nonwoven webs, polymeric materials [1]. Along with the development and improvement of research on these materials giving special properties held intensive technology of materials for footwear: heat resistance, high strength, electrical conductivity etc.

One of the representatives of such materials are electrically conductive fabric on the basis of fiber ( EEW ) . Such fabrics have unique properties : high electrical conductivity characteristic of metal; ease , flexibility , and other valuable characteristics peculiar to textile materials such as good air permeability , dimensional stability , durability , flexibility , comfort and light weight [ 3 ]

It is known that during the operation of shoe material, products in contact with the surfaces of homogeneous and heterogeneous bodies. Because of a breach of contact and on the contact surfaces are formed static electricity, electrification occurs materials. The ability of the materials under certain conditions to accumulate on the surface of static electricity referred electrified.

During operation, there are two main shoes dynamic phase behavior of electrostatic charges on the surfaces of the individual parts. The increase in the charge density on the material takes place inside the shoe, where the material is carried on the foot contact with the lining material, leading to recharge and runoff or dispersion of charge [ 2 ]

.Widely used methods for measuring electrostatic properties of textile materials are presented in the European standards, which describe the test methods for measuring surface resistivity [4], electrical resistance through a material [5] and electric charge decay [6] and is applied in textile materials research and evaluation laboratories [7]. Measurements of electrostatic properties are alsodescribed in Chinese standards for testing static properties and static voltage semi-decay of textile materials [8] and static electricity testing of textiles [9].

There are many factors that can affect the measured data: the composition of the fibers and yarns, the weaving mode, the compactness of the fabric, the production equipment and the process of treatment of the finally produced textile material, the atmospheric conditions (temperature, pressure and humidity), and the state of stress, the surface defects and many other.[10]. Studies by various authors suggest that this time there are no specific data on indicators electrified textile shoe materials and research results can be advisory in nature.

**Material used Objects and methods of investigation this paper** investigates the triboelectric properties of new fabrics with shielding and conductive properties. To develop conductive tissue samples ( EPT ) used the conductive mixed yarn . To obtain tissue samples of fabric structural parameters have been set in advance (weaving density in warp and weft) two sets of tissue samples were obtained.

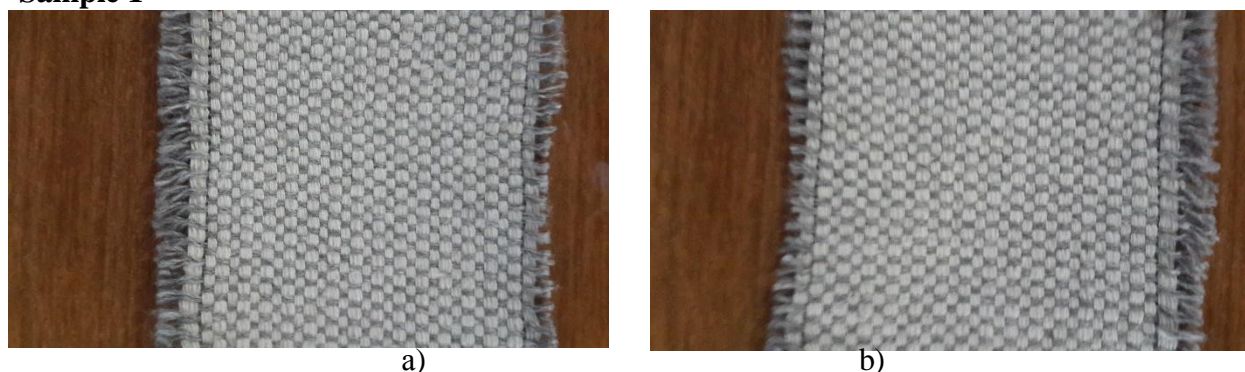
The mixture weft yarn: 60% cotton and 40 % - conductive fiber nitrone(EPVN) obtained by two-step chemical nickel - plated fibers nitronecommercially available. The proportion of the nickel content in the fiber is 17 ... 18 %. Chase the electrical resistance of 35 ohms / the linear density of 50 text. [11]

As the second component to the first group of samples employed c / b yarn linear density of text25'4. For the second group of yarns with a linear density of text 25'2.

The first group of samples at a density elaborated based on 110 and weft 150 yarns per 10 cm, a second group with a density of warp and weft. 220 and 150 ends per 10 cm, respectively. Table 3.1 shows the characteristics of the samples developed fabrics.

Tissue samples: the sample number one - plain weave with the laying of the electrically conductive yarn in weft. ( Figure 1 ) , the sample number 2- 4/4 twill weave with the laying of conductive thread in weft , the sample number 3- interlocking paving combined with an electrically conductive yarn in weft .

### Sample 1



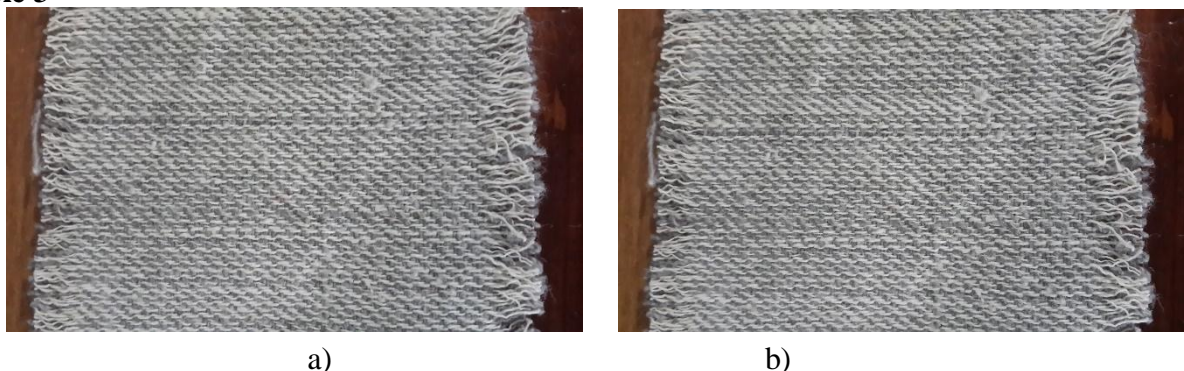
**Figure 1. - Plain weave with the laying of conductive weft yarns,  
a) front side, b) wrong side.**

### Sample 2



**Figure 2 - Twill weave 4/4 with the laying of the electrically conductive yarn in weft. a) front side, b) wrong side.**

**Sample 3**



**Figure3- Interlocking paving combined with an electrically conductive yarn in weft. a) front side, b) wrong side.**

**Table 1:- Structural characteristics of tissue samples**

№	Designation of tissue samples	Structural Features				
		The linear density of tex		tissue density,		Weave pattern
		On the basis of	According duck	On the basis of P <sub>o</sub>	According duck P <sub>y</sub>	
		Fabrics for prolonged insole				
1.	Sample 1.1	25×4	50	110	150	plain weave
2.	Sample 1.2	25×4	50	110	150	1/3 Twill Weave
3.	Sample 1.3	25×4	50	110	150	Sateen 5/3
		Fabrics for the primary backing				
4.	Sample 2.1	25×2	50	220	150	Plain
5.	Sample 2.2	25×2	50	220	150	Twill 1/3
6.	Sample 2.3	25×2	50	220	150	Sateen 5/3

Electrification of textile has a surface effect and results from the interaction (friction) between the two surfaces. When friction electrification increases, because there are new and are destroyed previous contacts friction surfaces. Electric charges can arise not only in friction, but also in tension and compression.

### Proposed method

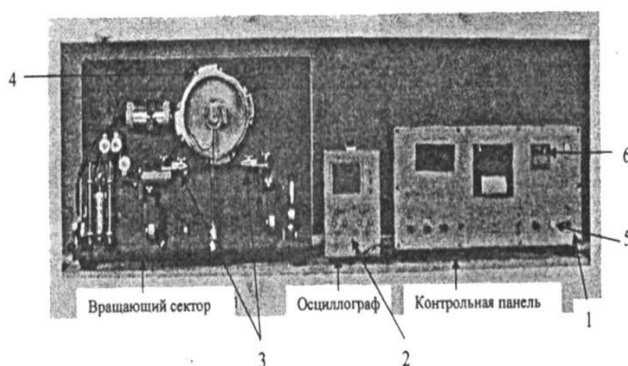
The following indicators determine proposed method Electrified, as a physical quantity: the electric field, the charge value of the surface density of the charge polarity, volume resistivity, and surface resistivity. Thus electrified can be regulated both by the specific surface electrical resistance in ohmmeters, the electrostatic V / m, as well as the electrostatic potential. However, the first feature is not very useful due to the strong dependence of the index on the atmospheric conditions. Characterize electrified textile materials possible through electrostatic potential [12-14].

Caused by friction of various materials electrostatic potential is a measure of triboelectric properties of the surfaces of friction pair materials (triboelectric effect). [2]

The essence of the triboelectric method is that in the process of rubbing one material to other forms electrostatic double layer. This method electrification simple, requires no additional hardware and in practice most commonly used. The disadvantages of this method include the fact that the sign and magnitude of the charge, which occurs on the surface of the test product, the properties depend on the specific triboelectric couples and arrangement of specific materials in the triboelectric series [12-13].

For determination of the resulting friction shoe materials used Static Discharge RS-101D device. The action of the device is based on the determination of the electrostatic potential generated between the friction surfaces of the material.

The device consists of a control panel, which has controls oscilloscope for processing the measurement results and the rotating main parts, where examples set (Fig. 4). To determine the sample electrified on the device, the following operations: pressed on the switch (1) is activated by pressing the oscilloscope (2) buttons. Samples were loaded into pairs of contact terminals (3 and 4). The device is activated by pressing the start (5) on the control panel. After 1 minute of operation, the appliance automatically switches off. The results of the measurements are recorded readings.



**Fig. 4. The device for determining the triboelectric properties of the RS-101D textile materials.**

For measuring the electrostatic voltage on the surface of the contact, pairs used material samples measuring 140 mm×20 mm 60 mm and 60 mm. The experiment was performed at ambient temperature of 23 ° C and relative humidity of 60% Triboelectric properties of the samples were investigated by friction with the EPT shoe materials, which are used for the uppers and lining footwear. Characteristic lining textile materials and leather materials for the top and backing used in research as contact pairs are provided in Tables 1.2.

**Table 2:- Characteristics of textile materials, used for footwear lining**

Number of the sample	Name, composition	Weaving	Thickness, mm	Surface density, $m/u^2$
1	Teak stern twill cotton 100 %	twill	0,4	170
2	Tick dyed cotton twill 100 %	reps were	0,7	360
3	Cloth	unbleached calico	0,3	140
4	wool 40 %, viscose 60 %	twill	0,7	340
5	Silk 100%	satin	0,5	230
6	mixed fabrics x/6 70%, polyester 30%	combined	0,9	370

**Table 3:-Features samples of leather materials for upper and lining**

<b>Number of sample</b>	<b>skin Type</b>	<b>Color of surface</b>	<b>Finishing of the coating</b>	<b>Thickness, MM</b>
1.	half leather	The black, smooth	using polishing cover soil	1,1
2.	half leather	the black	using polishing soil emulsion coating	1,3
3.	Rawhide	Blue, smooth	emulsion coating	1,5
4.	Horsehead	the black	drum dyeing aniline	1,7
5.	half leather	the black	nitro emulsion	1,3
6.	half leather	the black polished	without cover	1,3
7.	Russia leather shoe	black grainy	threaded surface	1,7
8.	Russia leather shoe	Ocher	Chromium coating Tannidnoe	1,2
9.	splits	Gray	Uncoated acrylic primers	1,2
10.	Backing pork skin	Beige	discrete polymeric coating	0,8
11.	Backing leather sheepskin	Blue	emulsion coating	0,9
12.	Backing leather sheepskin	the black	drum dyeing aniline	0,8
13.	Backing skin splits	the black	nitro emulsion	0,9



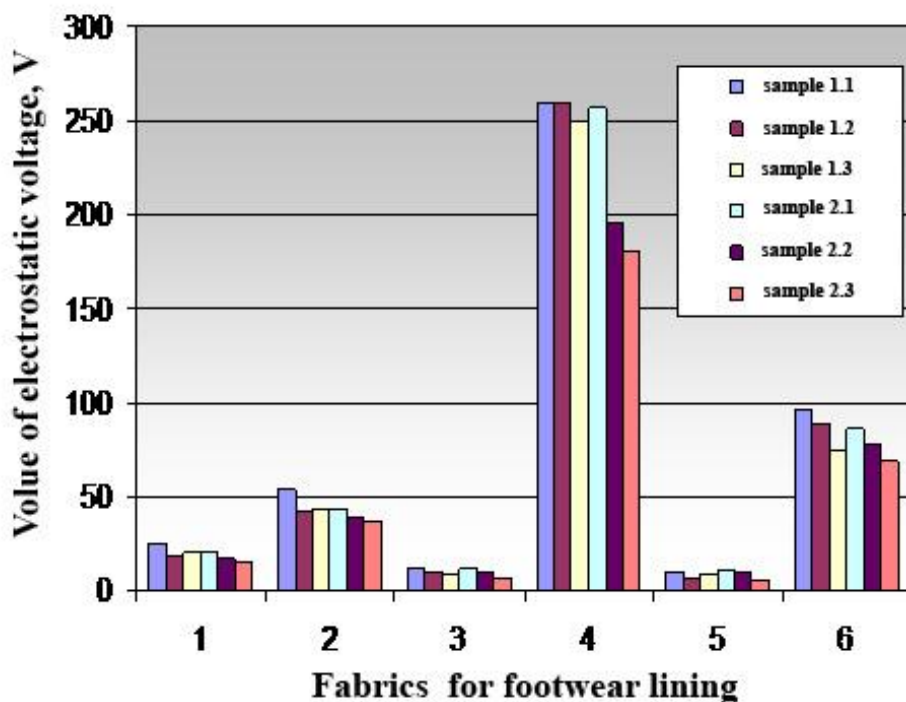


Figure 5. Value of electrostatic voltage of contact pairs –fabrics for footwear lining and samples of conductive fabrics

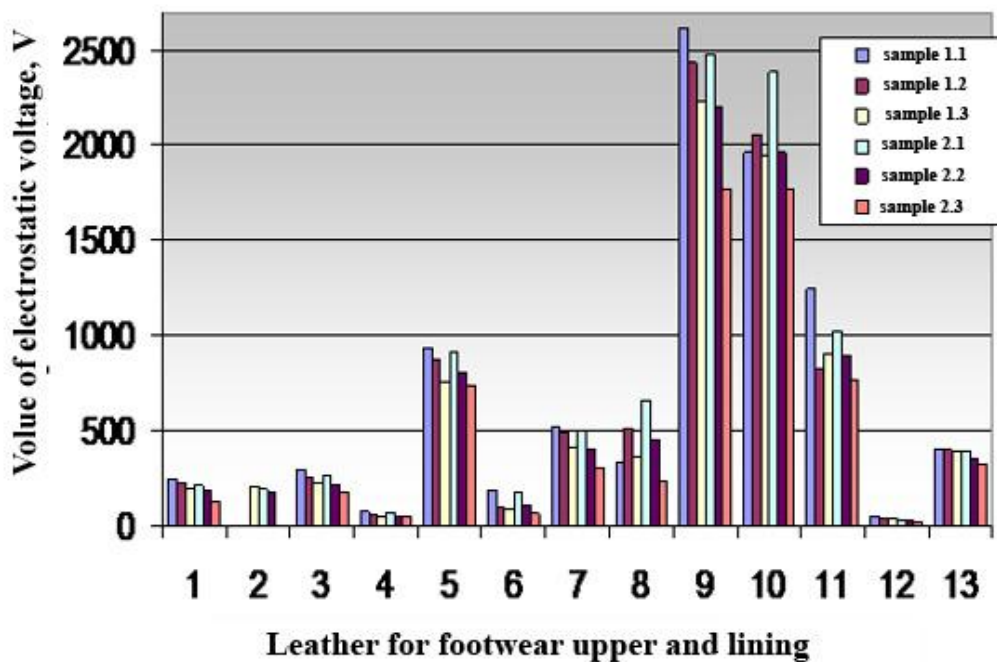


Figure 6. Value of electrostatic voltage of contact pairs - uppers, lining leather and samples of conductive fabrics.

## Results and discussion:-

Analysis of the results of the tests triboelectric properties of materials for shoe uppers and lining in friction with samples of conductive fabric. Revealed the following patterns:

- In the interaction with a natural conductive tissue electrostatic field, voltage value of the skin (ESP) 18-2621V varies and depends on the type of face, skin and finish coating. Lining leather ( split leather , pig skin ) with discrete coated accumulate greater potential ESP - 1245-2621V , with aniline leather drum dyeing by friction with the conductive tissues accumulate less potential static electricity -18-402V.

- The voltage values of the electrostatic field in friction materials of various textile structures depends on the weave fabrics . Lower level of ESP voltage occurs in contact with the tissues of twill, satin weave is more electrically conductive supporting surface;- Friction conductive fabric with textile materials ESP voltage level varies in different range of 50 to 280 V. The smallest electrostatic charging occurs by friction on contact with the conductive fabric natural silk and cotton, and silk mixed fabric + c / b, in the harsh form.

## Conclusion:-

the results obtained triboelectric properties of the conductive tissues led to the following recommendations on the selection of materials for uppers and lining special shoes - use protective skin with a smooth outer surface, or grinded, aniline drum dyeing. Use as a cotton lining rough, silk or cotton materials will allow minimizing the accumulation of static electricity.

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