FUNCTIONAL ANTISTATIC AND DRAPING PROPERTIES OF THE LITURGICAL CLOTHING ENSEMBLE

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REZUMAT. Încărcarea electrostatică a obiectelor textile prezente în ansamblul de îmbrăcăminte liturgică conduce la deteriorarea pieselor de îmbrăcăminte și, în același timp, nu există nici o drapare bună. Scopul acestei cercetări este de a determina din perspectiva proprietăților funcționale antistatice și de drapaj, pe baza valorilor experimentale, variantele optime ale materialelor textile și structurilor de îmbrăcăminte destinate veșmintelor preoților care slujesc în biserica creștin ortodoxă.

Cuvinte cheie: permeabilitatea electrică, constanta dielectrică, rezistivitate electrică.

ABSTRACT. The electrostatic charging of the textile objects present in the liturgical clothing ensemble leads to damage related to the behavior of wearing parts present in the garment and at the same time there is no good draping. The purpose of this research is to determine from the perspective of the antistatic and draping functional properties, on the basis of experimental values, the optimal variants of textile materials and clothing structures intended for the vestments of priests serving in the Christian Orthodox Church.

Keywords: electrical permittivity, dialectical constant, electrical resistivity.

1. INTRODUCTION

Materials are made of atoms that are normally electrically neutral because they contain equal numbers of positive charges (protons in their nuclei) and negative charges (electrons in "shells" surrounding the nucleus). The phenomenon of static electricity requires a separation of positive and negative charges. When two materials are in contact, electrons may move from one material to the other, which leaves an excess of positive charge on one material, and an equal negative charge on the other. When the materials are separated they retain this charge imbalance [1]. During textile manufacturing process, there is a potential of static charge generation when fibers are extruded, and yarns are woven or knitted, and finished. Fibers, yarns, or fabrics are rubbed with guides, rollers or tension devices on the machinery and this operation of contact and separation continuously occur throughout the process [2].

There are many factors that affect charge generation such as environment (temperature, humidity), structural (polymer type, structure of fabric) and working factors (fabric speed, tension, and contact area between fabric and machine parts, material type that is in contact with fabric [3].

2. METHOD AND MATERIALS

Testing of the experiment was carried out with a Concept 40 - Novocontrol dielectric spectrometer in ICCMMPP Iasi to determine the dielectricity of the constant and the resistance of some samples from different materials with varying characteristics in the temperature of the environment and the frequency of the alternating current given by the structure and composition of a sampled fabric. Samples from 3cm diameter disc were taken from the following materials: underwear knitted fabric in glat structure, shirt with canvas bundle, mantle made of canvas bundle on the front and with hemstich on the back, surplice weaved with canvas bundle, surplice weaved with canvas bundle on the front and with hemstich on the back, surplice from jacard fabric with Damascus effect, surplice weaved with atlas bundle, surplice weaved with canvas bundle, surplice weaved with canvas bundle, surplice weaved with atlas bundle, phelonion from jacard fabric with Damascus effect, phelonion from jacard fabric, phelonion from jacard fabric with Damascus effect, phelonion weaved with canvas bundle, and inserted into the electronic spectrometer where the results were recorded.

Table 1. **Table value of physical quantities derived from the dielectric spectrometer measurements Concept 40 - Novocontrol made on the sample of mantle made of canvas bundle on the front and on the back with hemstich**

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Fixed value(s) : AC Volt [Vrms]=1.000

Freq. [Hz]	Eps'	Eps''	Sig' [S/cm]	Rspec.[Ohms cm]	Tan(Delta)
1.0000e+06	2.7458e+00	8.8485e-02	4.9203e-08	2.0324e+07	3.2226e-02
7.1429e+05	2.7634e+00	8.5121e-02	3.3809e-08	2.9578e+07	3.0803e-02
5.1020e+05	2.7801e+00	8.2402e-02	2.3378e-08	4.2776e+07	2.9639e-02
3.6443e+05	2.7964e+00	8.0499e-02	1.6313e-08	6.1301e+07	2.8787e-02
2.6031e+05	2.8118e+00	7.9384e-02	1.1491e-08	8.7027e+07	2.8232e-02
1.8593e+05	2.8269e+00	7.9266e-02	8.1954e-09	1.2202e+08	2.8040e-02
1.3281e+05	2.8417e+00	8.0317e-02	5.9315e-09	1.6859e+08	2.8264e-02
1.0000e+05	2.8543e+00	8.2202e-02	4.5709e-09	2.1877e+08	2.8800e-02
7.1429e+04	2.8695e+00	8.5883e-02	3.4112e-09	2.9315e+08	2.9930e-02
5.1020e+04	2.8853e+00	9.1257e-02	2.5890e-09	3.8625e+08	3.1628e-02
3.6443e+04	2.9021e+00	9.8582e-02	1.9977e-09	5.0057e+08	3.3969e-02
2.6031e+04	2.9202e+00	1.0806e-01	1.5642e-09	6.3931e+08	3.7005e-02
1.8593e+04	2.9401e+00	1.1996e-01	1.2403e-09	8.0624e+08	4.0804e-02
1.3281e+04	2.9621e+00	1.3458e-01	9.9389e-10	1.0062e+09	4.5434e-02
1.0000e+04	2.9826e+00	1.4930e-01	8.3018e-10	1.2046e+09	5.0055e-02
7.1429e+03	3.0098e+00	1.7018e-01	6.7594e-10	1.4794e+09	5.6542e-02
5.1020e+03	3.0404e+00	1.9525e-01	5.5392e-10	1.8053e+09	6.4217e-02
3.6443e+03	3.0753e+00	2.2559e-01	4.5715e-10	2.1875e+09	7.3356e-02
2.6031e+03	3.1152e+00	2.6215e-01	3.7945e-10	2.6354e+09	8.4151e-02
1.8593e+03	3.1611e+00	3.0632e-01	3.1671e-10	3.1575e+09	9.6904e-02
1.3281e+03	3.2140e+00	3.5980e-01	2.6571e-10	3.7635e+09	1.1195e-01

3. ELECTRICAL PERMITIVITY (DIELECTRIC CONSTANT)

Electrical permittivity (dielectric constant) is a magnitude, denoted by ε, which indicates the opposite resistance to electrical polarization of a dielectric. It characterizes the electrical properties of an environment and is given by the relationship, where:

- E - the intensity of the electric field;
- D - electrical induction.

The unit of measure in IS is farad per meter.

In an isotropic environment:

- χ_e = the electrical susceptibility of the environment;
- ε_0 = dielectric constant of the vacuum.

In practice, a dimensional dimension is expressed by the relationship between the permittivity of an environment and that of the void, called relative permissiveness.

Electrical resistivity is the magnitude that characterizes the distinct behavior of materials under the action of an electric current. Resistivity is the property specific to a particular material to resist the passage of an electrical current through it. Consider homogeneous material, given size and time of application and to a fixed electrical current. Resistivity is characteristic of each type of material and is the basis for calculating the electrical resistance of different bodies made of the material.

The electrical resistivity of a material, denoted ρ (rho), is represented by the formula:

$$P = \frac{R \cdot A}{l} \tag{3.1}$$

where: ρ is the static resistivity, measured in ohm meters, Ω·m; R is the electrical resistance of a uniform sample of material, measured in ohms, Ω; l is the length of the sample, measured in meters; A is the area of the cross section of the sample, measured in square meters, m².

From this formula derives another, with a practical character, a formula that helps us to calculate the surface area of a conductor for the transport of electricity:

$$P = \frac{\rho \cdot m \cdot l}{v \cdot U_2} \tag{3.2}$$

Where: S is the cross-sectional area of the electric conductor in mm²; ρ is the specific electrical resistivity (copper = 0.0172 mΩ·mm); m is the double length of the transport cable (return path), measured in meters; v is a loss ratio (0.01 for losses of max. 1%, 0.03 for loss of 3%); U is the electrical voltage to which the transport network operates (in Volts V); L is the power absorbed by the consumer (in Watts W).

4. RESULTS AND DISCUSSION

A. For the success of the garment in terms of its thermo-physiological and ergonomic comfort characteristics, a main observation implies that the surplice (s1) of the entire structure of the garment is made of natural silk, the atlas and the linen cloth.

Both materials ensure good air circulation, constant temperature exchange and at the same time enable good body breathing. Cellular breathing of the skin is not jeopardized, even if the whole clothing ensemble comprises the three layers: underwear, priestly uniforms and outer sacerdotal cape (phelonion).

In terms of the weight of the clothing ensemble, the weight of the silk and linen fabrics is quite small, and thus ensures increased ergonomic comfort to the wearer and specific activity.

It is ensured by the use of the two materials a good electrostatic neutrality of the clothing layers and thus does not suffer even the aesthetic aspect, related to the draping.

The surplice does not stick to the underwear, the shirt and the trousers, and the felon does not polarize with the stihar, ensuring a good draping.

B. As a form of presentation, the liturgical odor, called antimis, presents itself as a double planar surface: the face is printed with drawings from the life of Jesus Christ, culminating in the grave scene, and the one on the back is a lining without drawing.

In order to be neutralized from the point of view of the electric loads the contact surfaces of the antimis, it has been determined from the experiments that it is necessary for both textile surfaces, which form a unitary one, to be made of natural silk or linen.

Under very exceptional conditions, a polyester fabric with an atlas connection which has undergone chemical finishing (antistatic) treatments that do not electrostatically charge during use may be used as a substituent.

It is to be remembered that when the sponge gathers bread crumbs on the textile surface of the antimis, the exchange of electrical charges does not take place. It is possible to use a silicone synthetic sponge. As the textile surface of the antimis is close to 0, when it is made of natural silk, bread crumbs are not attracted to the electrical charges present in the fibers and yarns (they do not magnetize) and can be gathered on the surface of the disc, to be poured into the Holly Chalice.

The various type of woven fabrics have a tendency of either giving up electrons and become positive (+) in charge (or) attracting electron and become negative (-) in charge when brought in contact with other materials.

The silk woven fabric materials have tend to give up electrons and gain a positive electrical charge when brought in contact with other materials but the polyester woven fabrics have tend to attract electrons and gain a negative electrical charges when brought in contact with other materials.

In case of cotton woven fabrics do not tend to get to attract or giving up electrons when brought in contact or rube with other materials.

The tribo electric effect (tribo electric charging) is a type of contact electrification in which sudden materials become electrically charged after the come in to contact with other materials through friction. Any two materials are come into contact and then separate, the electron to be exchange.[4]

After coming in contact, the chemical bond is formed between parts of the two surfaces, called adhesion, and electrical charges move from one material to other material in order to equalize the electrochemical potential.

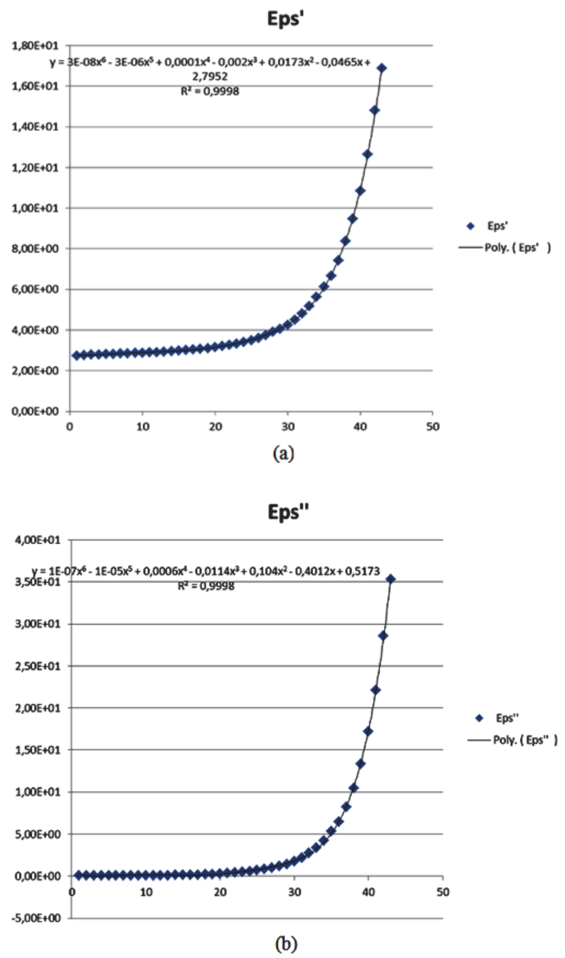
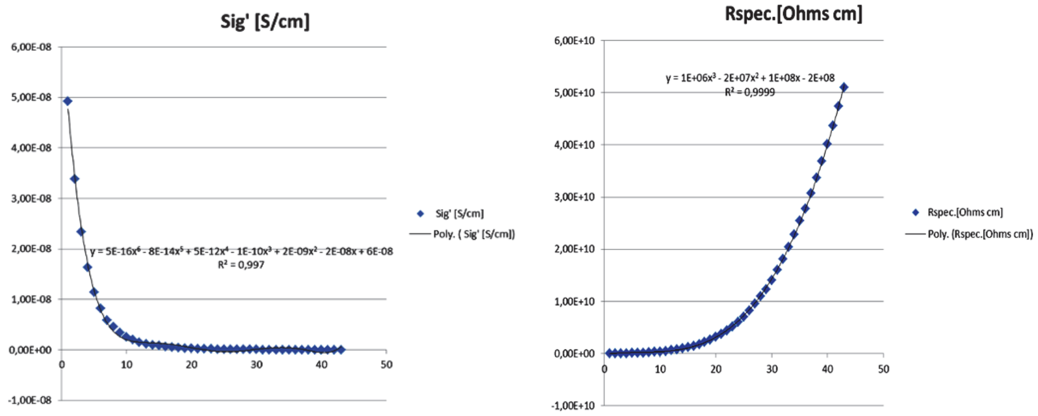


Fig. 4.1. Mathematical diagrams of the relationship between the dielectric constant and the intensity of electric field of alternating current obtained by the polynomial function, starting from the values in Table 1.



(c) (d)

Fig. 4.2. Mathematical diagrams of the relationship between the dielectric constant and the frequency of the electrostatic alternating current obtained by the polynomial function, starting from the values in Table 1.

5. CONCLUSIONS

For the liturgical garment it is necessary that all the layers of the garment structure that make up the cultic clothing ensemble be arranged in such a way that the electrical charges of each coating to neutralize each other, leading to a good draping and a pleasant appearance.

REFERENCES

[1] Slade, PE, *Antistats. Handbook of Fiber Finish Technology*, New York, USA, 1998.
[2] Taylor, DM, Secker, PE, *Industrial Electrostatics: Fundamentals and Measurements*, John Wiley and Sons New York, USA, 1994.
[3] Morton, WE, Hearle, JWS, *Physical Properties of Textile Fibers*, Manchester UK, 1993.
[4] Perumalraj, R, *Characterization of Electrostatic Discharge Properties of Woven Fabrics*, Journal of Textile Science & Engineering, Erode, India, 2016.

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