STUDY OF TENSIONAL PROPERTIES OF GORETEX WATERPROOF MEMBRANES

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REZUMAT: In lucrare s-au analizat proprietăţile tensionale ale membranelor impermeabile din GoreTex si a firelor de constantan, utilizate la realizarea unei mănuşi inteligente. Calitatea şi durabilitatea ţesăturilor se apreciază prin determinarea proprietăţilor tensionale, exprimate prin indici/indicatori a căror limite de variaţie se diferenţiază în funcţie de caracteristicile structurale de bază si cele derivate, precum si de parametrii procesului de prelucrare si de finisare.

Cuvinte cheie: membrane impermeabile din goretex, forța de rupere, fire constantan, proprietăți tensionale.

ABSTRACT: In the paper, there were analyzed the tension properties of the GoreTex waterproof membranes and the constantan yarns, used to make a smart gloves. The quality and durability of fabrics are appreciated by determining the tensile properties expressed by indices / indicators whose variation limits differ according to the basic and derived structural characteristics as well as the parameters of the processing and finishing process.

Keywords: Gore-Tex waterproof membranes, breaking force, constantan yarns, tension properties.

1. INTRODUCTION

In recent years, intelligent clothing products not only protect the human body or parts of it, but also provide a thermal balance between the heat generated by the human body during the physical effort and the heat released to the environment.

Conventional clothing does not always take into account this requirement.

On the one hand, the heat generated by the body during a physical effort is not entirely dissipated externally, producing heat stress, and on the other hand, during periods of relaxation between physical activities, the body releases less heat, causing sometimes the appearance of hypothermia. Intelligent textiles come to meet these demands by their ability to adapt to environmental conditions or to communicate vital information about the body they are wearing [1-3]. Together with the research and development of intelligent textiles used in various fields like: medical, sports, industrial, military, the complexity of applications has increased, therefore this segment of the textile industry is constantly growing and developing [4-7]. Textile industry specialists collaborate with specialists from other areas of research, both to make new types of raw materials or finished products, and to extend the field of use of those already available on the market [8]. On the other hand, for the textile industry, the potential offered by the combination of textiles and information technologies is very high, giving new valences to both normal and professional clothing products [9]. Integrating the information technology into clothing can mean the beginning of a new era, not only in the textile industry, but also in medical, industrial, sports or fashion [10-12]. The material offers optimized comfort for moderate and extreme weather conditions and it is used for a wide range of outdoor footwear [13]. This fabric is designed to provide superior comfort and durable waterproof protection in a wide range of outdoor activities. The GORE-TEX® revolutionary patented membrane technology is specifically engineered to form an impenetrable barrier against wind and water while maintaining breathability [12]. GORE-TEX® Performance Shell fabric is used in a two-layer construction for a lighter and softer feel and in three-layer construction for a heavier-duty alternative [13].

2. EXPERIMENTAL PART

2.1. Materials and methods

Verification of the tension properties of a fabric is performed by dynamometric tests, on standardized specimens, specifying the orientation of the stress on the direction of a specific yarn, warp or weft system. The tensile stress on one of the technological axes of the fabric is also a complex demand for the opposite system threads, arranged transversally (contraction/bending, compression, friction and shearing). The transverse contraction is not uniform and it has the effect of uneven distribution of the tensions, which causes the asymmetry of the axial stresses breaking.

The tests were performed on Honsfield electronic dynamometer; the test pieces have had standard dimensions (200x50mm) and were stressed in the warp and the weft directions.

2.2. Results and discussions

The intelligent glove is intended for a variety of areas: mountaineering, medicine, people with physical, medical, locomotor problems, etc., and it will be made of the following layers of fabric (Fig. 1) [14]:

- The first layer is for comfort it is a fine cotton fabric made of polyester with cotton or cotton with nylon;
- The second layer, made of cotton, is the support layer for the heating system (from constantan wires) and for the electronic equipment (devices);
- The third layer, an outer protective layer, made of GORETEX, is resistant to abrasion and mechanical stress.

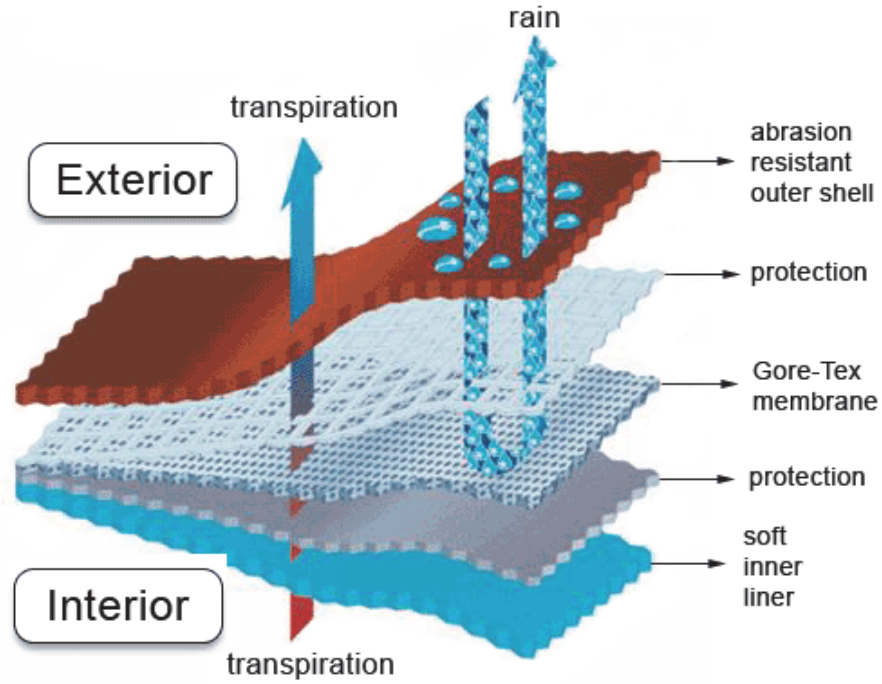

Fig. 1. Layers distribution in the structure of a smart gloves.

In the cuff and pockets of the support layer are placed both the elements for transmission, collection, display and data transfer, as well as the accumulators for their supplying. The variation in the breaking strength and elongation at break in case of constantan wire is shown in Fig. 2, where there are found very low values for both indicators. The average breaking strength is Pr = 0.817 N, and the relative elongation at break is e = 1.16%. Constantan has a strong negative Seebeck coefficient of over 0 degrees Celsius, which leads to a good temperature sensitivity. The Seebeck coefficient (also known as the thermal power or thermoelectric sensitivity) of a material is a measure of the magnitude of a thermoelectric voltage induced in response to a temperature difference in that material induced by the Seebeck effect (the direct thermoelectric effect consists of the appearance of a thermoelectric voltages in a circuit composed of two or more different conductors or semiconductors whose contacts are maintained at different temperatures) [15].

Gore impermeable material is a porous Teflon laminate (polytetrafluoroethylene-PTFE), which does not break. Verification of the tension properties of Gore-TEX fabrics was performed by dynamometric tests, on standardized specimens, in the direction of the two yarn systems. Finally, the force-strain diagrams (Fig.2 and Fig.3) were

obtained. From the analysis of the tension properties of the Gore-TEX fabrics studied by the investigation of the force-deformation diagrams, it can be observed that the values of the breaking force and the elongation relative to the rupture (Pr_{warp} = 584 N, e_{warp} = 20,42%) are higher than in the direction of weft, (Pr_{weft} = 508 N, e_{weft} = 14.84%); the factors of influence being the properties of the component fibers (average fiber strength, length, fineness, fiber friction coefficient).

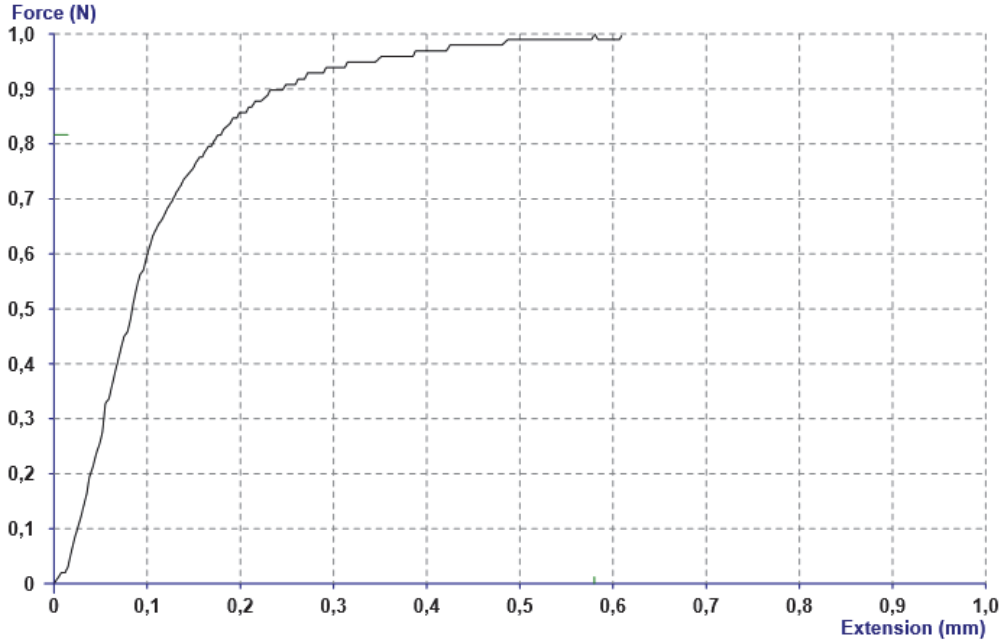

Fig. 2. Force-strain diagram of constantan yarns.

Gore-TEX is an impermeable material made of PTFE (polytetrafluoroethylene -laminated Teflon), which does not break but is also porous [16].

The Gore-tex material consists of five successive layers, in the middle being the porous Teflon membrane, protected from the inside by a special fabric and outwardly by an impermeable layer.

The membrane structure contains more than one billion nano-pores per centimeter square each with a diameter of 0.2 micrometers, that is 20,000 times smaller than a drop of water but 700 times larger than a gaseous molecule resulting from water, so the vapors from sweat crosses easily the fabric, but the drops of rain cannot penetrate [17-19] (Fig.4).

The intelligent glove made of these materials has the following features:

- Allows transfer of moisture/vapors;
- Maintains a constant temperature of the hand;
- Provides waterproofing by using Gore-Tex material;
- Heats your hands in case of hypothermia;
- Blood pulse detection (by using a pulse oximeter);
- Deceleration of vibrations in the area between thumb and forefinger, using a micro motor (2-3 mm) with eccentric (flywheel), with haptic interface, powered by a battery;
- Displays the amount of oxygen in the blood [20].

Measurement of body temperature and humidity variation is done by means of pressure, humidity, acceleration transducers.

For measuring acceleration, an accelerometer will be used based on the inertia of the body. *Constantan* is a copper-nickel alloy, discovered in 1887 by Edward Weston, also known as Eureka, Advance and Ferry. It usually contains 55% copper and 45% nickel. Its main feature is resistivity, which is constant for a wide range of temperatures, which leads to its use in multiple applications [20-22]. Gore standards require that, during the heavy efforts, the fabrics breathe well enough to allow sweat to escape easily. To avoid the build-up of awkward sweat, the GORE-TEX membrane allows moisture to evaporate through the fabric. This breathability allows the skin to feel more comfortable and dry, even during great efforts. GORE-TEX® Pro Shell is engineered with the most rugged, highly breathable fabrics, making it ideal for extended exposure to extreme conditions [21-22]. These fabrics are designed to perform at an elite level in order to meet the demands of outdoor professionals and serious enthusiasts alike. The advanced waterproof membrane used by GORE-TEX® Pro Shell fabric incorporates increased breathability characteristics, allowing the user to enjoy longer exposure to harsh conditions without losing vital body heat.

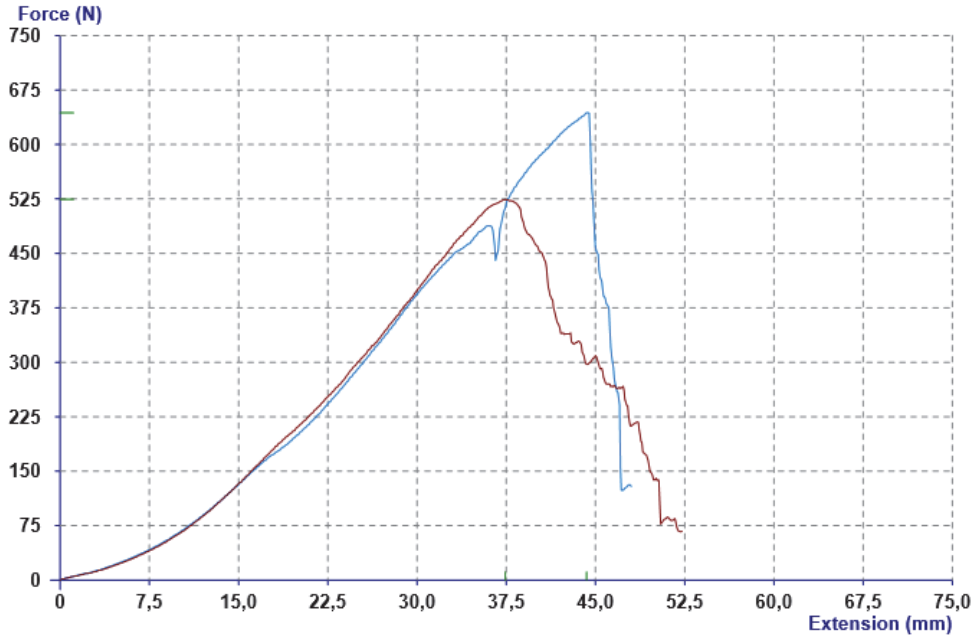

Fig. 3. Strength / deformation diagram of Gore-Tex fabrics requested in the warp direction.

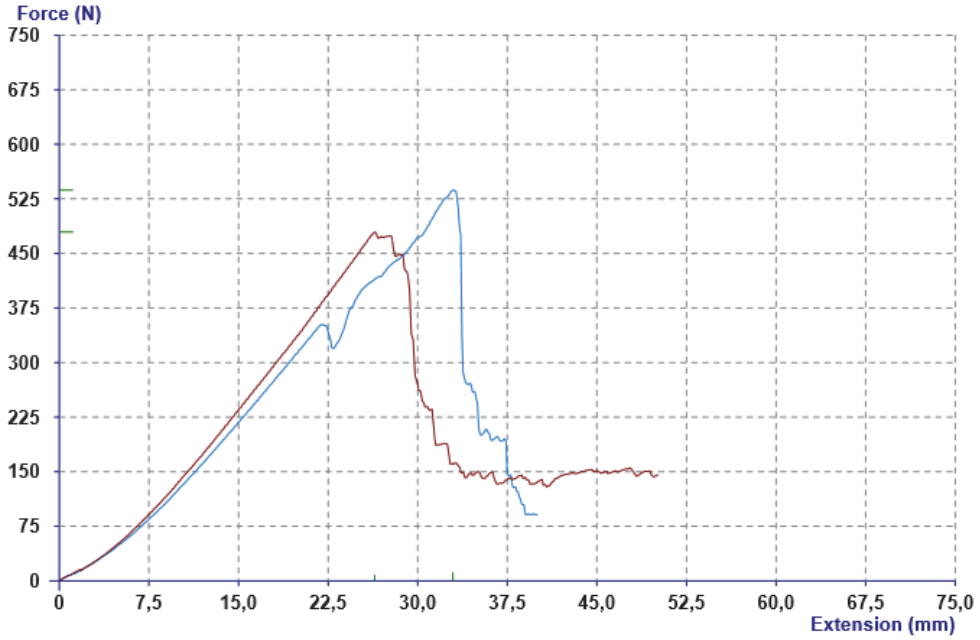

Fig. 4 The force-strain diagram of Gore-Tex fabrics required in the direction of the weft.

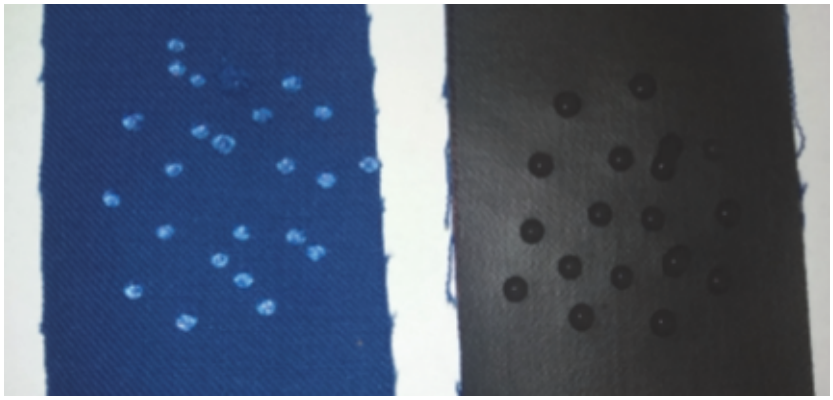

Fig. 5. Images of water drops on both sides of GoreTex material.

3. CONCLUSIONS

The new generation of intelligent clothing products requires innovation in the clothing industry, while providing a huge potential for new areas of research and business.

In terms of intelligent clothing, most achievements are at the prototype stage, with implementation barriers related to costs, the human factor, the speed with which information technology is developing, etc.

However, it is believed that this area has a growing interest and potential, because smart textiles are the implementation of tomorrow's technology in today's clothing.

Current achievements show that intelligent clothing and computerized portable systems are a certainty, being part of the present, but especially of our future.

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