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**FIRE RESISTANCE OF KNITTED MATERIALS  
FOR THE PRODUCTION OF PROTECTIVE GLOVES**

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In the conditions of a full-scale war in Ukraine, it is important to ensure reliable protection of the hands of military personnel of combat vehicle crews [1]. Since the threats of damage to the hands from various harmful factors are often simultaneous, it is important to provide protection against each of the possible injuries. In most cases, products are given protective properties by applying a protective coating to the palm part. It is possible to simplify the process of creating this personal protective equipment if the protective properties are provided by choosing the appropriate raw materials for their manufacture and the weaving structure. It is possible to form functional layers from several types of raw materials that have protective properties against various types of hazards.

For the experiment, samples of knitted materials produced by interweaving of plains on a two-thread flat knitting machine PA-8 from three types of raw materials (sample 2 – meta-aramid (MA) yarn, sample 3 – para-aramid (PA) threads, sample 4 – high-molecular polyethylene (PE)) with different thread lengths in the loop were developed. To ensure dual functionality (simultaneous protection against mechanical damage and fire), single-layer and double-layer samples are formed. For the outer layer of two-layer samples, which will be in direct contact with an open source of flame and provides protection against various types of dangers (puncture, cut), a knitted material made of high-strength polyethylene (samples 5 and 6) or para-aramid threads is used (samples 7 and 8). The inner part, which will provide protection against fire and increased thermal effects in the personal protective equipment, is a knitted material made of fire-resistant yarn made of meta-aramid fibers. Also, on the 7th gauge glove machine [2], knitted samples were prepared in the form of a product of a given shape, which is the area of the beginning of the glove in the area of the fingers, produced by plated weaving (sample 1). A para-aramid thread was used as a plating (covering) thread, and a yarn made of meta-aramid fibers was used as a soil thread. The fire resistance test of a knitted sample of a given shape was carried out with a vertical position of the burner, which ensured the direction of the flame to the edge of the sample. The flame exposure time was 10 seconds [3] for all types of samples.

In accordance with DSTU EN ISO 15025:2016 [4], endurance to a single action of fire is established. Knitted material with PE threads (sample 4) has a residual burning time of 40 s, a hole measuring 75x45 mm is formed at the point of contact of the sample with the flame. Two-layer packages of knitted materials, the outer layer of which is formed from PE threads, and the inner layer from MA yarn (samples 5 and 6, which differ in the density of the knitting of the layer from fire-resistant raw materials) turned out to be less effective in providing protection against the action of flames due to the destruction of the outer layer. As a result of

the flame, the layer of knitted material with PE threads burns, reaches the upper edge of the sample in 1 min 35 s and as a result is completely destroyed.

Drops formed from the burning of high molecular weight polyethylene fall on the inner layer of the MA yarn sample, which leads to charring of the inner layer. The flame penetrates the inner layer of a two-layer package of knitted materials in 40 seconds of residual burning. It was found that the fire resistance of packages of materials with a front layer of high molecular weight PE threads is affected by the knitting density (change in the length of the thread in the loop) of the inner layer of fire-resistant yarn based on MA fibers (5-6 samples). Smaller flame spread and destruction of the inner layer of MA yarn under the influence of droplet formation due to the burning of PE threads can be achieved if the density of its knitting is reduced. This should be taken into account when forming a functional package of knitted materials for a means of personal protection, the outer layer of which will provide high resistance to mechanical damage (puncture, cut, etc.) and at the same time will prevent damage to the human body due to elevated temperature effects.

The best result in terms of flame protection can be achieved in the case of using a two-layer package of materials, in which a knitted material with PA threads is used as an outer layer, and a knitted material with MA yarn is used as an inner layer. There are also positive results in the case of using platinized weaving, where PA thread is used as the plating thread, and MA yarn is used as the ground thread.

### References

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