"Development and research of fiber-composite materials based on Rusar-S fibers for personal armor protection"

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Abstract. The personal armor protection equipment supplied by the armed forces and special forces is made from fabrics based on aramid fibers of the Ruslan type, which have higher physical and mechanical characteristics compared to foreign aramid threads of the Kevlar and Twaron brands. To date, Russian aramid yarns "Ruslan", manufactured using wet spinning technology, have reached their technological limit in terms of improving physical and mechanical properties. Therefore, to achieve a similar or superior level, the use of new heavy-duty threads and efficient technologies in armor elements is required. Thus, the relevance of this work is due to the need to develop alternative technological solutions for creating fiber-composite structures with increased strength and protective characteristics.

The purpose of this work is to develop an integrated approach to the technology of obtaining reinforced organoplastics based on high-strength aramid fibers of the third generation Rusar-S and reactive binders with enhanced physical, mechanical and armor-protective properties.

To achieve this goal, it is necessary to solve the following **main tasks**:

- conduct research on the effect of high temperatures on the physical and mechanical stability of Rusar-S aramid fiber;

- study the mechanism of interaction in the aramid fiber-epoxyurethane binder system, investigate the influence of the fiber structure on the sorption characteristics;

- to study the influence of surface modification of Rusar-S aramid fibers on the adhesive strength and impact resistance of organoplastic;

- develop a technology for producing plane-oriented fiber composite materials with improved weight, size and armor protection characteristics;

- to study the influence of climatic factors on the stability of the parameters of fiber-composite products based on Rusar-S fibers.

Scientific novelty. It has been shown that the structural features of Rusar-S aramid fibers, determined by the technology of their production - dry-wet molding, lead to improved wettability of the fiber surface with reactive binders and an increase in the strength characteristics of microplastics. The dependences of the influence of sorption of the epoxyurethane binder in different temperature-time intervals on the complex of physical and mechanical characteristics of the Rusar-S aramid fiber have been established. It has been revealed that the use of physicochemical methods for modifying the surface of Rusar-S aramid

yarns leads to an improvement in the wettability of their surface without reducing the strength characteristics, which, in turn, makes it possible to increase the adhesive properties at the matrix-fiber interface and obtain composite materials of increased strength. The influence of ultraviolet treatment of Rusar-S aramid fibers on increasing the impact strength and anti-fragmentation resistance of organoplastics based on a polyurethane matrix by increasing the adhesive strength at the fiber-matrix interface of composite materials has been established. It has been proven that when exposed to climatic factors, the strength and armor-protective properties of fiber-composite materials based on Rusar-S aramid fibers are maintained for 8 years.

Theoretical and practical significance. Composite materials have been developed based on third-generation aramid yarns Rusar-S and a reactive binder, which have improved heat resistance, strength and deformation characteristics. It has been shown that the use of untwisted Rusar-S threads contributes to the creation of homogeneous polymer compositions with improved mechanical and armor-protective properties, ensuring their widespread use in personal armor protection. A technology has been developed for producing plane-oriented fiber composite materials with improved weight-dimensional and armor-protective characteristics.

The developed optimal structures of composite materials based on ultraviolet-treated Rusar-S fibers were introduced into serial products produced by JSC Center for High-Strength Materials "Reinforced Composites" (JSC HSMC "Armocom").

Provisions for defense:

1. Development of composite materials with increased elastic-strength and armor-protective properties based on third-generation aramid fibers Rusar-S and reactive binders.

2. Study of the influence of surface modification using ultraviolet treatment of aramid yarns on the process of wettability, adhesion and impact strength of layered composites.

3. Development of an integrated technological approach to obtaining modified fiber-composite materials with improved weight-dimensional and armor-protective characteristics.