Findings. It was demonstrated the tool granulosity, elbor disc's material of bond and fine elbor grinding parameters essentially influence for surface's parameter R_a. Grinding discs from elbor ЛО with granulosity 14–28 μм on bacelit-gum bond and fine parameters of cutting ensure the best value of parameters R_a which satisfy the high requirements for technological complexes and machine systems' friction parts surface quality. It was shown the advantages of surfaces' treatment by elbor discs.

Originality. For the first time it was shown the main regularities of fine precision elbor grinding of new composite materials based on aluminium alloys wastes agree with plain, round external and internal grinding.

Practical value. It was developed the recommendations for choice of cutting parameters for elbor grinding of parts for different purposes that are manufactured from composite alloys based on aluminium alloys wastes and which ensure the requirements for necessary parameters of surface roughness.

Keywords: *new composite materials, aluminium alloys wastes, tool, friction parts, surface' roughness, fine elbor grinding.*

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PLANNING THE EXPERIMENT AND OPTIMIZATION OF THE CONTENT OF NANOADITION IN POLYPROPYLENE MONOTHREADS

Purpose. *Planning the experiment and optimization of the content of the composition Polypropylene\ binary nanoaddition in order to obtain Polypropylene monothreads with high mechanical and antibacterial properties.*

Methodology. *For planning the experiment the simplex-grid method has been used in pseudo coordinates . The optimization of the content of the nanoaddition has been carried out using the Harrington criterion.*

Findings. *The influence of the nanoaddition silver\silica (Ag/SiO_2) on the properties of the Polypropylene (PP) monothreads has been explored using the method of mathematical modeling and the content of composition for their forming has been optimized.*

Originality. *The mathematical model, that defines the interconnection between the content of the mixture components and the properties of the nanofilled PP threads, has been created.*

Practical Value. *Modified monothreads formed of the optimal content of the PP\nanoaddition composition combine high level of strength and elasticity and develop antibacterial effect.*

Keywords: *nanoaddition, planning, mathematical model, optimization.*

Topicality of working out methods of obtaining fibers and threads with antibacterial effect is caused by necessity in creating some medical products to cure and protect medical workers and biologists. Attaching bactericidal properties to threads by inserting metal nanoparticles is one of the most perspective. Using binary nanocompos, where nanoparticles of biometals are brought in the surface of inert sorbents, enables creating fundamentally new

materials, that combine antibacterial and sorption effect. Thus, nanocompo Ag/SiO_2 is almost ten times more effective compared to original components, shows high prolonged antibacterial effect and is safer for peoples' health and the environment [1].

Formulation of the problem. In modern medicine biologically active materials made from Polypropylene (PP) have become really meaningful, because they are chemically inert, resistant to microorganisms and have high level of strength and elasticity. It is known that metallic ions are of high antibacterial properties and at the same time they have a toxic effect on living beings. Within the transition to the nanostate, toxicity of metals decreases [2]. Nanoadditions also have a great influence on mechanical indicators of threads. To define the interconnection between the composition content and the characteristics of threads it is necessary to carry out a great number of multivariate experiments. They are connected with time and materials' expenditure, because the impact of each factor is explored apart from others, with fixed meanings of other parameters. One of the ways, which allows to carry out scientific researches fast enough and find the decisions most approximate to optimal ones with minimal expenditures, is the usage of mathematical methods of planning the experiment.

Purpose of this work – planning the experiment and optimization of composition content Polypropylene/ binary nanoaddition in order to obtain Polypropylene monothreads with high mechanical and antibacterial properties.

Main material. Strength and elasticity are the main parameters that define the safety of the surgical stitch. When planning the experiment such parameters were chosen as original ones:

y_1 - strength of monothreads when ruining, y_2 - the original module of threads, y_3 - diameter of the retardment of the microorganisms' growth, y_3 - diameter of the retardment of the St. aureus microorganisms' growth, and original ones were: x1, x2, x3 – approximate concentrations of PP, Ag and SiO_2 respectively.

The simplex-grid method in pseudo coordinates is the most appropriate method for mixture systems optimization [3]. Simplex is the simplest geometrical figure, formed by the set *k+1* independent points in k-dimensional space. Independent variables are called 'factors', space with coordinates x1, x2, x3 is called «factorial space», and the geometrical delineation of the function of response in factorial space is called «response surface». Correlation of the ingredients in systems being explored must satisfy the following condition: $\sum_{i=1}^{q} x_i = 1$, where x_i is approximate concentration of ingredients ($x_i \geq 0$); q – quantity of the ingredients ($q \geq 2$).

As certain limits are put on the concentration of some ingredients of three-component mixture, the researches were carried out in the limited part of the factorial space. As the result the 'cut-out ' part was received , which was unsimilar to simplex, and experimental points were located in it. Having written the coordinates of experimental points of the simplex grid, we received matrix of planning. In order to use the standard plan the part being explored was transformed into the new coordinate system

(z_1, z_2 z_3… z_q) [3]. Simplex vertices were being accepted as independent ingredients of the mixture, so called pseudocomponents. To transit from the previous

coordinate system ($x_1, x_2,...x_q$) to the new one ($z_1, z_2 \dots z_q$) the following matrix equation was used: $X = AZ$.

It can be written in the detailed way:

$$\begin{vmatrix} x_1^{(u)} \\ x_2^{(u)} \\ \vdots \\ x_q^{(u)} \end{vmatrix} = \begin{vmatrix} x_1^{(1)} & x_1^{(2)} & \cdots & x_1^{(q)} \\ x_2^{(1)} & x_2^{(2)} & \cdots & x_2^{(q)} \\ \vdots & \vdots & \cdots & \vdots \\ x_q^{(1)} & x_q^{(2)} & \cdots & x_q^{(q)} \end{vmatrix} \times \begin{vmatrix} z_1^{(u)} \\ z_2^{(u)} \\ \vdots \\ z_q^{(u)} \end{vmatrix} \quad (1)$$

In equation (1) elements of matrix A are the coordinates of vertices of transformed simplex, and $x_i^{(u)}$ та $z_i^{(u)}$ (i = 1, 2,..., q) – original and new coordinates of u- transformed point. Herewith such conditions are being done in z-coordinates:

$$0 \le z_i \le 1, \quad (i = 1, 2, \dots, q), \quad z_1^{(u)} + z_2^{(u)} + \dots + z_q^{(u)} = 1,$$

where u is any point of the factorial space.

To work out a model, which defines the interconnection between the content of the components and the properties of the modified monothreads, the incomplete cubical polynoma was used:

$$\hat{y} = \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_{12} x_1 x_2 + \beta_{13} x_1 x_3 + \beta_{23} x_2 x_3 + \beta_{123} x_1 x_2 x_3 \quad (2)$$

where $\beta_i, \beta_{ij}, \beta_{ijk}$ - are polynomial coefficients, moreover $i \ne j \ne k$ = 1, 2, 3.

To estimate numeric values of the coefficients of the equation, the plan of carrying out the experiments in the area of the factorial space being explored was prepared (table 1), herewith z-coordinates were chosen from the standard plan for the model given [3], x-coordinates were counted according to the formula (1).

Table 1. **Simplex-grid plan**

№ of the experiment	Plan of experiment						Obtained variable
	Plan in pseudocoordinates			Working plan			
	z_1	z_2	z_3	x_1	x_2	x_3	
1	1	0	0	0.9851	0.0050	0.0099	$\bar{y}_1$
2	0	1	0	0.9880	0.0021	0.0099	$\bar{y}_2$
3	0	0	1	0.9920	0.0040	0.0040	$\bar{y}_3$
4	0,5	0,5	0	0.9866	0.0036	0.0099	$\bar{y}_{12}$
5	0,5	0	0,5	0.9900	0.0030	0.0070	$\bar{y}_{13}$
6	0	0,5	0,5	0.9886	0.0045	0.0070	$\bar{y}_{23}$
7	0,333	0,333	0,333	0.9785	0.0037	0.0079	$\bar{y}_{123}$

To define the influence of correlation PP/ Ag/SiO_2 the mixture on the mechanical and antibacterial properties of monothreads according to the plan a series of experiments was carried out and original and obtained parameters were defined (table 2).

Table 2. **Influence of the concentration Ag/SiO_2 on the properties of PP monothreads**

Original variable	Number of the experiment						
	1	2	3	4	5	6	7
y_1	480	540	590	510	530	570	540
y_2	6200	7800	7900	6500	6900	8000	7700
y_3	14.1	8,5	13.8	13.5	9,5	13.3	11.4

On the basis of the data mentioned in table 2 polynomial coefficients (2) have been counted using the method of the least squares in the matrix form. The countings have been done using the specially created programme in the Delphi programming environment on the Object Pascal language. As the result, the system of the equations has been received (3). It is a mathematical model, that describes the process being explored in z-coordinates.

$$\begin{cases} y_1 = 479{,}99z_1 + 539{,}99z_2 + 590z_3 + 0z_1z_2 - 19{,}99z_1z_3 + 20{,}00z_2z_3 + 104{,}80z_1z_2z_3 \\ y_2 = 6200z_1 + 7800z_2 + 7899{,}99z_3 - 2000z_1z_2 - 599{,}99z_1z_3 + 600z_2z_3 + 17036{,}16z_1z_2z_3 \\ y_3 = 14{,}1z_1 + 8{,}5z_2 + 13{,}8z_3 + 8{,}8z_1z_2 - 17{,}8z_1z_3 + 8{,}6z_2z_3 - 18{,}33z_1z_2z_3 \end{cases} \quad (3)$$

Having defined the coefficients, the mathematical model was being checked in adequacy, which means ability to predict the results of the research in some area with necessary exactness. For this, additional experiments were being put in so called control points, the value of the Student criterion was being counted and compared with the table data. Received values of the criterion mentioned are the evidence of the adequacy of this model.

To solve the problem of optimization the so called generalized function of advisability (D) was used. Harrington offered to use it as the generalized criterion of optimization [4]. To count value D state values of responses were transformed into the non-dimensional scale of advisability for each original parameter using exponential dependency. The generalized criterion of D optimization was being counted as the geometric mean of partial functions of advisability. The value of the Harrington criterion is limited within the interval [0...1] (0 stands for absolutely unacceptable value of the response given, 1 stands for the most optimal value of the response).

Optimal content of the mixture being explored was being defined using the method of scanning by step 0,01 in z-coordinates. According to the matrix equation (1) the content of original components was transformed into the x- system. While the criterion of advisability D=0.8256 the determined optimal correlation of mixture components for monothreads formation is mas%: PP – 99,16; Ag – 0,38; SiO_2 – 0,46, and indicators that characterize the quality of modified threads, are as following: comparative strength of monothreads when ruining – 587 MPa, original module – 7944 MPa, diameter of area of St.aureus bacteria growth retardment – 14,0 mm.

Laboratorial patterns of monothreads have been worked out from the composition of optimal content and their properties have been explored. It has been found out, that stitch threads have an antibacterial effect; they also have good operating characteristics and fix the surgical knot in a proper way due to high strength and elasticity.

Conclusions. Planning the experiment concerning the influence of the binary nanoaddition silver\silica on the properties of the Polypropylene monothreads has been carried out using the method of mathematical modeling**.** The content of Ag/SiO_2 in the PP fusion has been optimized and biologically active monothreads with maximal mechanical characteristics have been formed.

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ПЛАНУВАННЯ ЕКСПЕРИМЕНТУ ТА ОПТИМІЗАЦІЯ ВМІСТУ НАНОДОБАВКИ В ПОЛІПРОПІЛЕНОВИХ МОНОНИТКАХ

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Мета. *Планування експерименту та оптимізація складу композиції поліпропілен/бінарна нанодобавка щодо одержання поліпропіленових монониток з високими механічними та антимікробними властивостями.*

Методика. *Для планування експерименту застосовано симплексно-гратковий метод у псевдокоординатах. Оптимізацію вмісту нанодобавки проведено з використанням критерію Харрингтона.*

Результати. *Методом математичного моделювання досліджено вплив нанодобавки срібло/кремнезем (Ag/SiO_2) на властивості поліпропіленових (ПП) монониток та оптимізовано склад композиції для їх формування.*

Наукова новизна. *Створена математична модель, що встановлює взаємозв'язок між вмістом компонентів суміші та властивостями нанонаповнених ПП ниток.*

Практична значимість. *Модифіковані мононитки, сформовані з оптимального складу композиції ПП/нанодобавка, поєднують високі міцність, еластичність та проявляють антимікробну дію.*

Ключові слова : *нанодобавка, планування, математична модель, оптимізація*

ПЛАНИРОВАНИЕ ЭКСПЕРИМЕНТА И ОПТИМИЗАЦИЯ СОДЕРЖАНИЯ НАНОДОБАВКИ В ПОЛИПРОПИЛЕНОВЫХ МОНОНИТКАХ

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Цель. *Планирование эксперимента и оптимизация состава композиции полипропилен / бинарная нанодобавка для получения полипропиленовых мононитей с высокими механическими и антимикробными свойствами.*

Методика. *Для планирования эксперимента применен симплексно-решетчатый метод в псевдокоординатах. Оптимизация содержания нанодобавки проведена с использованием критерия Харрингтона.*

Результаты. *Методом математического моделирования исследовано влияние нанодобавки серебро / кремнезем (Ag/SiO_2) на свойства полипропиленовых (ПП) мононитей и оптимизирован состав композиции для их формования.*

Научная новизна. *Создана математическая модель, устанавливающая взаимосвязь между содержанием компонентов смеси и свойствами нанонаполненых ПП ниток.*

Практическая значимость. *Модифицированные мононитки, сформованные из оптимального состава композиции ПП/нанодобавка, имеют высокие прочность и эластичность, а также проявляют антимикробное действие.*

Ключевые слова: *нанодобавка, планирование, математическая модель, оптимизация.*

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ЛЮДВІЧЕНКО Т.Г.
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ПРОБЛЕМИ ОРГАНІЗАЦІЇ ПРОЦЕСУ ПРОЕКТУВАННЯ КОЛЕКЦІЇ ТРИКОТАЖНОГО ОДЯГУ ТА ШЛЯХИ ЇХ ВИРІШЕННЯ В УМОВАХ ПАТ «СОФІЯ»

Мета: *висвітлення досвіду впровадження у виробництво новітніх технологій моделювання верхніх трикотажних виробів.*

Методика: *у роботі в ході досліджень використано методи аналізу та синтезу науково-технічної інформації. Об'єктом дослідження є етапи проектування категорій одягу з трикотажу в умовах Публічного акціонерного товариства «Софія» – української компанії з виробництва трикотажу, зокрема асортименту ексклюзивних трикотажних виробів для торгової марки «Bravadi».*

Результати: *розглянуто один з головних напрямів успішної роботи щодо проектування асортименту ексклюзивних трикотажних виробів для ТМ «Bravadi». На технологічній базі підприємства з використанням сучасного плосков'язального обладнання з комп'ютерним управлінням процесом в'язання та створення візерунків створено вишукані колекції трикотажних виробів.*