# THE CHOICE AND OPTIMIZATION OF A COMPOSITE MATERIAL USED TO RENOVATE THE BEARING-TYPE JOINTS

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## 1. INTRODUCTION

The main purpose of the research carried out in this paper is the choice and optimization of a composite material used to renovate the bearing – type joints with the solutions of high performance. In order to reach this purpose the main objectives have bun set these objectives are: the study of the influence of some factors of the material through identification and qualitative and quantitative quantification of the share of the nature and the composite material adherence on metal substrates, the PCM being compared with the adherence of the matrix material. The composite material chosen for the test has as matrix the polyamide PA12 reinforced with molybdenum disulphide, different mass percentage of glass microspheres and basalt microfibres.

## 2. MATERIAL AND METHOD

The object of the research was chosen to be metalopolymeric tribological action couplings renovated with PCM, the constitution of the material intake used in the compensation of waste wear parts. The matrix was the polyamide PA12 (OCT 6-05-425). The CM adherence was compared with the adherence of the basic material. The reinforcement of the composite material was carried out with the following agents: molybdenum disulphide DM-1 (TU 48-19-133-90), used to improve the reaction of the composite material to load and wear fatigue; empty glass microspheres (glass microballoons) MC-BP gr.5 (TU 6-48-91-92), with the following chemical composition: $SiO_2$:76-78 %; $Na_2O$: 10-12 %; CaO: 6 %; ZnO: 1-1,5 %; $B_2O_3$: 4 %, density 0,37-0,42 g/cm$^3$, resistance to compression -150 kg/cm$^2$ (grinding -10%); humidity-not more than 0,3%; basalt microfibres used to increase the resistance to traction, rigidity, contraction during formation; lubrication improvement.

The composite was prepared by mixing the components in a ball mill ZE-101 during 30 minutes at the speed of the drum of 80...120 m$^{-1}$. the sorting of the basalt microfibres took place in a grinding device Ц-10 with the following sorting through a reciprocating sieve.

The coverage was applied by pressing at heat substrate by substrate of carbon steel of ordinary quality in hidraulic press DV 2428. the dimensions and the form of the samples were established according to the studied characteristics. Technological parameters were maintained in semi – automatic system.

The researches were carried out according to the matrix – the program with 3 factors Box-Benkin shown in chart 1 and the obtained data were processed applyind the following program STATGRAPHICS: Special ► Experimental design ► Create design ► Response surface.

The adherence was estimated through the method of pins with an open device described in [4]. The wear was determine data the friction machine SMT according to the scheme of the segment tree in the conditions of limited lubrication (1 oil drop SAE 10W-40 la 400 m. of path) under the load $P_c$ = 1,5 MPa and the sliding speed $v_r$ = 0,63 ms$^{-1}$.

## 3. RESULTS DISCUSSIONS

Competent choice of the materials used to renovate the bearing-type joints is a very important technological stage. These materials must have a range of features that should assure work capacity at least at the level of new pieces. In this aspect PCM presents a number of advantages in comparison with traditional materials used in cars repairing industry.

The main advantage of PCM in comparison with traditional materials is the possibility to obtain some unique characteristics owing to rational and controlled combination between the basic polymer and many other materials for reinforcement. Though reinforcing agents have specific individual characteristics, they may significantly change their characteristics in combination the way you want, both their own characteristics and the characteristics of the basic material.

The possibility of the modulation of PCM characteristics and thus obtaining a new various

range of physical and mechanic characteristics, that are important to assure the use in a lot of procedures of used pieces renovation in general and the use of PCM on, polyamide basis is motivated, its efficiency of PCM on polyamide basis is [1,2,5,6].

It is known that in order to assure a desired reliability level of the joints renovated by PCM, the compensating wear layer must have a good adherence with the layer in which it is applied to resist the loads that appear during exploitation and to have good resistance to wear.

At the same time, reinforcing agents often influence the resistance to adherence inadequatly, even unexpectedly. That is why, when creating a new PCM it is important to study its adherence in comparison with the basic material simultaneously with the dominant exploitation characteristics.

Next, we are going to present the results of the researches concerning the resistance of PCM adherence and its resistance to wear in the condition of friction with lubrication (these situation occur very often with agricultural machines and processing industry machines).

The adherence has been estimated for PCM applied on carbon steel layers in delivery status the function of the constituents concentration. For this research the polyamide PA12 (OCT 6-05-425), has been used as matrix it is a kind of polyamide with improved resistance to ultra-violet radiation action and to weather conditions it has increased resistance to wear and shocks showing phisico-mechanical characteristics with a large temperature scale, having the smallest density of all known today polyamides. At the same time, it is resistance to the majority of chemicals solvents (aliphatic and aromatic hidrocarbons, ketones, esters, ethers, oils, etc.).

The quantification of the influence of the constituents, concentration on coverings adherence was made through the relative adherence determined as the relation beteveen PCM estimated adherence and the matrix material adherence that is of the polyamide PA12. There has been studied CM adherence at the substrates of carbon steel in delivery state the function of constituents, concentration. After statistical processing of the

**Table 1.** The program of the experiments

| Nr. crt. | Encoded values | | | Natural values, % | | |
|---|---|---|---|---|---|---|
| | x1 | x2 | x3 | X1 (MoS2) | X2 (Hallow glass microspheres MC-BII) | X3 (Basalt fibres) |
| 1. | 1 | 0 | -1 | 5 | 20 | 2 |
| 2. | 0 | 1 | -1 | 3 | 30 | 2 |
| 3. | 0 | 0 | 0 | 3 | 20 | 4 |
| 4. | -1 | 0 | -1 | 1 | 20 | 2 |
| 5. | 1 | 1 | 0 | 5 | 30 | 4 |
| 6. | 0 | -1 | 1 | 3 | 10 | 6 |
| 7. | 0 | 0 | 0 | 3 | 20 | 4 |
| 8. | -1 | -1 | 0 | 1 | 10 | 4 |
| 9. | 1 | 0 | 1 | 5 | 20 | 6 |
| 10. | 0 | -1 | -1 | 3 | 10 | 2 |
| 11. | 1 | -1 | 0 | 5 | 10 | 4 |
| 12. | -1 | 1 | 0 | 1 | 30 | 4 |
| 13. | -1 | 0 | 1 | 1 | 20 | 6 |
| 14. | 0 | 0 | 0 | 3 | 20 | 4 |
| 15. | 0 | 1 | 1 | 3 | 30 | 6 |

experimental data there have been obtained the following equation of regression, that in coded coordinates, adiquatly describes the evolution of the relative adherence the function of constituents, concentration:

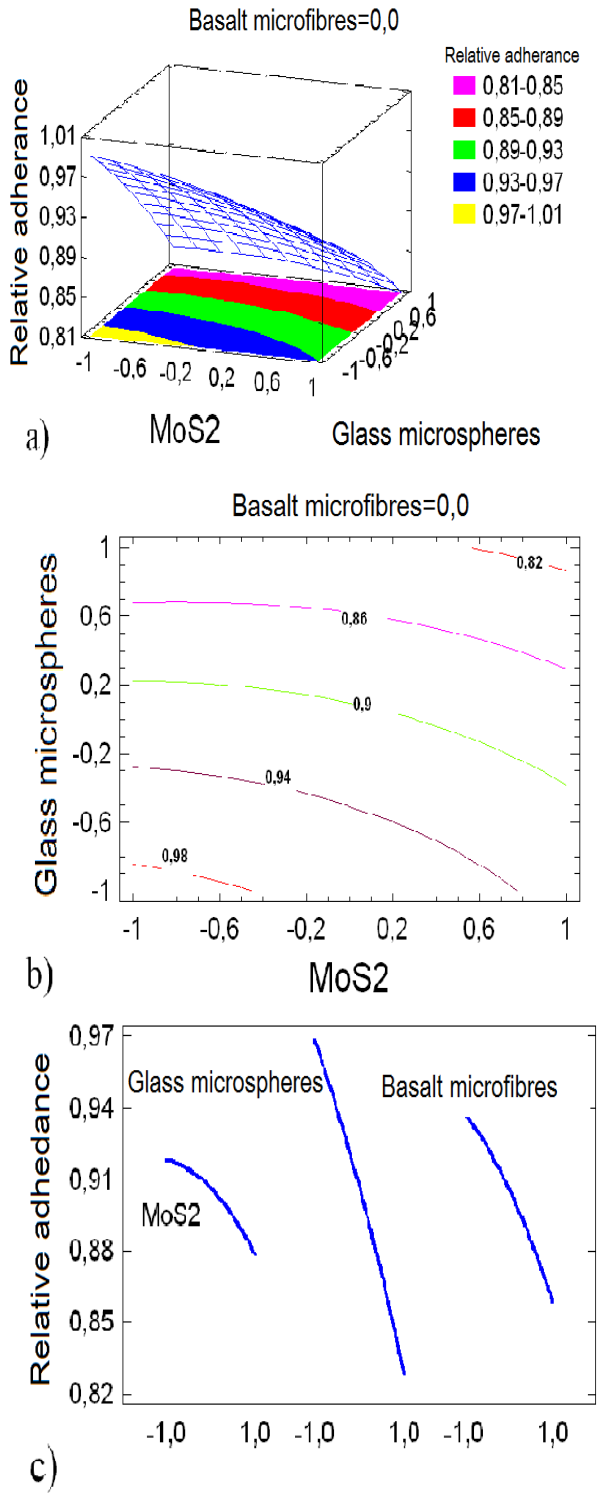


**Figure 1**. The estimation of PCM relative adherence the function of constituents concentration for level 0 (the concentration of basalt microfibres 4%): *a) the response surface, b) the responce levels and c) dominants effects*.

$$A_r=0,907-0,02x_1-0,07x_2-0,04x_3-0,008x_1^2+0,01x_1x_2+0,01x_1x_3-0,083_2^2-0,03x_2x_3-0,008x_3^2, \quad (1)$$

where $A_r$ is the adhesion in MPa; $x_1$, $x_2$ and $x_3$ represent the percentage of the components in coded coordinates and $MoS_2$, - glass microsferes and basalt microfibres**.**

In figures 1 and 2 are presented the graphics of the studied PCM relative adherence the function of constituents concentration for various levels of response factors.

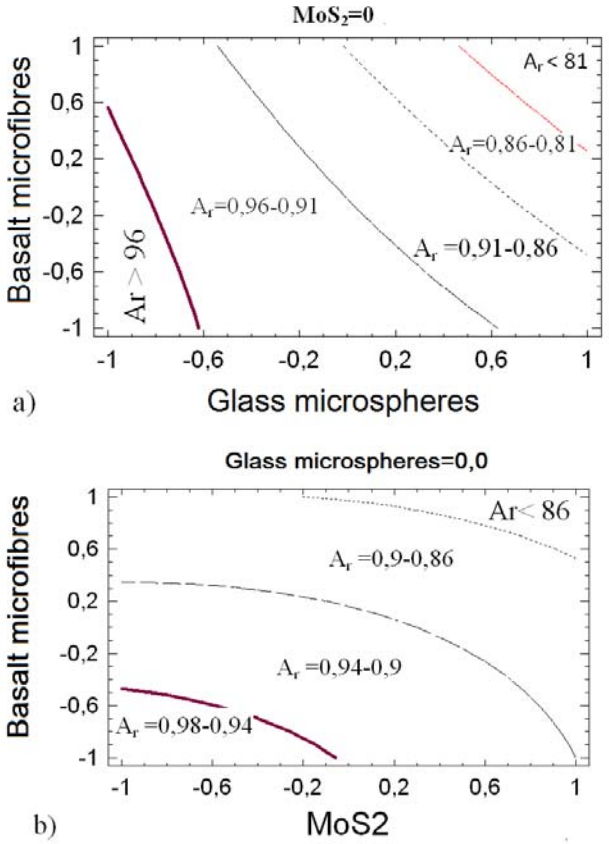


**Figure 2.** The estimation of PCM relative ad herence the function of constituents concentration for various levels of response factors: *a) $MoS_2$=0; b) eglass microspheres=0.*

According to the analysis of equation 1 and the graphics from figures 1 and 2 we, may state that all the reinforcing agents influence negatively PCM adherence at the substrates of carbon steel ($b_1$, $b_2$ *and* $b_3$ differ from 0 having negative values), the dominant influence belongs to glass microspheres ($|b_2| = 0,07>|b_1|$ *and* $|b_3|$), *than follow basalt microfibres* ($|b_3| > |b_1|$). This fact is explained by the higher percentage of glass microspheres in comparison with the percentage of molybdenum disulphide and basalt microfibres. At the same time we may state that the influence of $MoS_2$ contents on the adhesion isn't significant ($b_1 < 0$ and $b_{22} = 0$), having under certain condition the growth of the

contents of glass microspheres and basalt microfibres ($b_{12}$.and $b_{13} > 0$).

## 4. CONCLUSIONS

***1.*** The analysis of the data from specialty literature shows the possibility to use the polyamide PA12 as wear compensator at the renovation of component machine pieces of agricultural machines and of processing industry machines. The polyamide PA12 improves exploitation properties by reinforcing them with molybdenum disulphide, glass microspheres and basalt microfibres.

***2.*** According to the experimental studies of the composite material relative adherence based on polyamide we may state that studied reinforcing agents influence negatively the adherence of the filler at the substrates of carbon steel.

***3.*** It's necessary to continue the researches in order to find some improvement methods for PCM polyamidic adherence at metalic substrates as wellas to study adherence stability during exploitation in various environments.

### *Bibliography*

***1. Marian Gr.*** *Contribuţii teoretico-experimentale la studiul fiabilităţii pieselor şi îmbinărilor utilajului agricol recondiţionate cu compozite pe bază de polimeri: Teza de doctor habilitat în tehnică: 05.20.03. – Chişinău, 2005. – 252 p.*

***2. Sîrghii V.*** *Contribuţii la asigurarea tehnologică a fiabilităţii pieselor utilajului agricol recondiţionate cu aplicarea compoziţiilor din mase plastice: Teza de dr. în tehnică: 05.20.03. – Chişinău, 2007, 252 p.*

***3. Marian Gr., Gorobe V., Ţapu V.*** *Perspektivy ispol´yovaniâ poristyh polimernyh kompozicij pri vosstanovlenii soprâženii s zazorom. În: Doklady Meždunarodnoj naucno-praktičeskoj konferencii, Minsk, 2009, p. 62-63.*

***4. Marian Gr., Gorobe V., Ţapu V., Sîrghii V . ş.a****. Sporirea gradului de aderenţă a compozitelor poliamidoepoxidice prin aplicarea straturilor intermediare de conversiune. In: Ştiinţa Agricolă. Univ. Agrară de Stat din Moldova. 2006, nr. 1, p. 75 - 79.*

***5. Koleasko I.*** *Issledovanie i razrabotka tehnologii vosstanovleniâ s.-h. tehniki poliamidnymi pokrytiâmi: Teza de cand. în şt. tehnice: 05.20.03. – Chişinău, 1980. – 152 p.*

**6. *Dudcak V.*** *Razrabotka tehnologii vosstanovleniâ detalej sel´skohozâistvennoi tehniki kompozicionnymi polimernymi pokrytiâmi: Teza de cand. în şt. tehnice: 05.20.03. – Chişinău, 1985. – 143 p.*

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