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DEVELOPMENT OF COATINGS BASED ON CORROSION-RESISTANT AND WEAR-RESISTANT HETEROCOMPOSITE POLYMER MATERIALS BASED ON HYBRID COMPOSITE SYSTEMS

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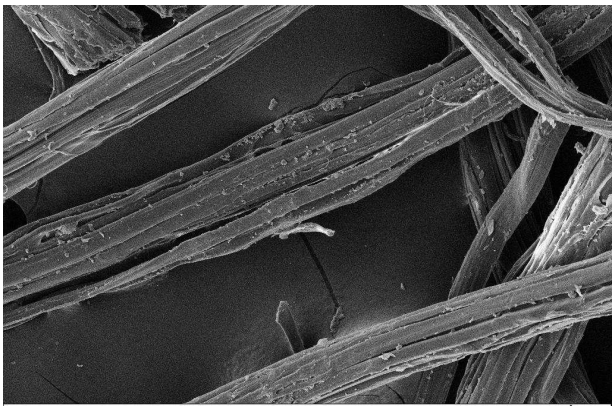
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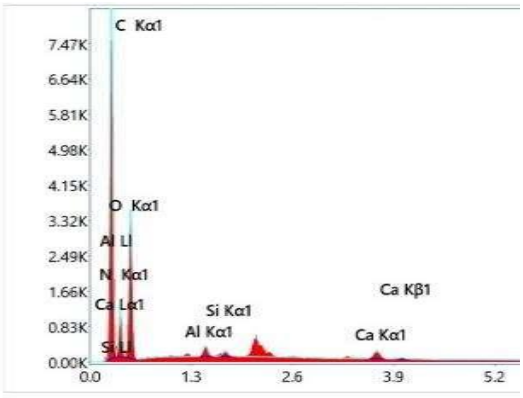
Abstract: This article investigates the tribotechnical properties of heterocomposite polymer materials created using local industrial waste based on epoxy-phenol-formaldehyde hybrid reactoplastic binders. The influence of kaolin, graphite, pyrolysis residues, and short-staple silk waste on the properties of the composite material was evaluated. Based on FE-SEM and X-ray spectral analyses, the microstructure and elemental composition of the materials were studied, and the possibilities of increasing the thermal stability, interphase synergetic effect, and wear resistance of hybrid matrices were scientifically substantiated.

Key words: Heterocomposite polymer, epoxy-phenol-formaldehyde, reactoplastic binder, tribotechnical properties, FE-SEM analysis, industrial waste, wear resistance.

Increasing the reliability of friction-wear structural elements operating under long-term operating conditions is one of the pressing issues in mechanical engineering, the cotton and textile industries, and the pneumatic transport industry. This article investigates the tribotechnical properties of heterocomposite polymer materials created based on epoxy-phenol-formaldehyde hybrid reactoplastic binders, involving local industrial waste—kaolin, graphite, and pyrolysis residues [1].

The thermodynamic and chemical compatibility of epoxy and phenol-formaldehyde resins was investigated, and the vitrification temperature (Tg) and thermal stability of the hybrid matrices were determined. Based on the combination of active polyamine and phenalcamine hardeners, the composition of highly efficient hybrid reactoplast systems was formed, and synergistic phenomena occurring in their interphase boundary layers were studied.





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Figure 1. Gemini 500 (FE-SEM) short-staple silk recycling waste

microstructure (a) and structural analysis (b) obtained using a scanning electron microscope

Figure 1 (a) shows the FE-SEM microstructure of short-staple silk waste: the surface of the fibers is not smooth, and the absorption of the binder increases, ensuring the strength of the composite material. X-ray diffractometer analysis (b) indicates that the predominance of the C Kα1 peak indicates the silk's carbon richness, while Al Kα1 and Si Kα1 are elements that entered the composition of secondary raw materials as a result of processing from the external environment [2].

Since the plate-like structure of AKF-78 kaolin is close to that of graphite, AKF-78 and graphite together form a heterosystem, ensuring the wear resistance of the coating. When kaolin is used as a dispersed filler in organomineral composite materials, the heat resistance, hardness, and wear resistance of the material increase simultaneously.

The results of the "ball-disk" test (at room temperature and a rotation speed of 220 rpm) showed that the friction coefficient decreases inversely with an increase in the load value.

Table 1.

Dependence of the load value and friction time on the friction coefficient

Radius of rotation	**t, min**	**F = 1.96 N;**	**F = 3.92 N;**	**F = 5.886 N;**	**F = 7.848 N;**	**F = 11.77 N;**
r = 3 mm	10	0.397	0.249	0.377	0.620	05625
r = 5 mm	20	02328	0.284	0.378	0.620	0.517
r = 10 mm	30	0.282	0.357	0.495	0.530	0459
r = 15 mm	40	0.423	0.241	0.224	0.345	0.297

Note: Experimental testing processes were carried out by increasing the load without changing the friction radius.

As seen from the table data, the value of the friction coefficient in the metal-polymer pair decreases inversely proportional to the applied load and inversely proportional to the friction time [3]. When the radius of rotation is r = 5 mm, the difference in the average coefficient between 80 and 100 minutes is 13%, and at r = 10 mm, the difference between 120 and 150 minutes is 10%. This confirms that the combination of graphite and kaolin components in the hybrid composition forms a stable antifriction layer on the surface of the composite in a dry friction environment [4].

Conclusion.

It has been experimentally proven that heterocomposite polymer materials created on the basis of hybrid epoxy-phenol-formaldehyde reactoplasts and active polyamine-phenalcamine hardeners, as well as local kaolin-graphite fillers, possess high tribotechnical indicators [5]. These materials can be widely used to increase the operational reliability of mechanical engineering and transport systems.

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