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ASSESSMENT OF THE STABILITY OF POLYMER COMPOSITE MATERIALS WITH BIOCIDAL PROPERTIES TO THE INFLUENCE OF MICROSCOPIC FUNGI-MICROMYCETE, ASPERGILLUS NIGER

Urazmetova N.Sh., Karimova M.A., Usmanov U.U.

Urgench branch of TMA Department of Microbiology

Annotation: The purpose of this work is to evaluate the resistance of polymer composite materials with biocidal properties to the effects of microscopic fungi. However, exposure to external factors during the operation of such coatings can lead to a decrease in their mechanical characteristics, in particular, wear resistance, adhesion to the substrate and hardness. As a result, damage appears on the surface of organic glasses, which leads to a significant decrease in optical characteristics. The destructive effect of microorganisms is one of the main factors leading to a decrease in the mechanical characteristics of polysiloxanes. Polysiloxanes have been shown to be susceptible to bacteria, including Pseudomonas aeruginosa, Bacilius subtilis, Streptococcus vindans, Salmonella enteritidis, and others [1,12]. It should be noted that the most acute problem of biodegradation of polysiloxanes with functional groups (for example, vinyl or epoxy) [2,13] manifests itself in tropical climates.

Keywords: Pseudomonas aeruginosa, Bacilius subtilis, Streptococcus vindans, Salmonella enteritidis, Aspergillus niger, Czapek-Dox, Penicillium chrysogenum and Aspergillus fumigatus, polymer composites, biodamage.

Relevance. The developed methods for protecting polymer materials from biodegradation are not suitable for polysiloxanes, which are used to coat organic glazing. Thus, the introduction of nanoparticles that exhibit toxicity to microorganisms [3,16] leads to a decrease in the optical characteristics of the The purpose of this work is to assess the resistance of polymer composite materials with biocidal properties to the effects of microscopic fungi. The purpose of this work is to evaluate the resistance of polymer composite materials with biocidal properties to the effects of microscopic fungi. The developed methods for protecting polymer materials from biodegradation are not suitable for polysiloxanes, which are used to coat organic glazing. Thus, the introduction of nanoparticles that exhibit toxicity to microorganisms leads to a decrease in the optical characteristics of glazing even in cases where the particle sizes are smaller than the wavelength [5,17,10]. The introduction of functional groups into polysiloxane compositions that exhibit toxicity to microorganisms leads to an inevitable decrease in the wear resistance of the polysiloxane coating [6,18,10]. Enhancing the antimicrobial properties of polysiloxane coatings due to modification of functional groups leads to a decrease in abrasion resistance [7,9,19]. Known methods for reducing the rate of biodegradation are based on the use of dispersed particles, for example, silver nanoparticles, copper dioxide, which increase the toxicity of the material for microorganisms [8,20,11]. To achieve this goal, the following tasks were solved. To determine the resistance of samples of polymer composite materials with different concentrations of Cu_2O to the effects of microscopic fungi when introducing micromycete spores in sterile distilled water and in Czapek-Dox medium.

Materials and methods. The work used a community of pure cultures of mold (microscopic) fungi (micromycetes) Aspergillus niger; Penicillium chrysogenum and Aspergillus fumigatus isolated from multilayer coated polymer composite samples incubated in a tropical climate in Vietnam. Cultivation of micromycetes, preparation of cultivation media and spore suspensions were carried out in accordance with GOST 9.048-89. For cultivation, we used dense (agar)

Czapek-Dox medium of the following composition (g/l): NaNO3 – 2.0; KH2PO4 – 1.0; MgSO4 × 7H2O – 0.5; KCl – 0.5; FeSO4 – 0.01; sucrose – 30.0; added agar – agar – 20.0; dH2O – up to 1000 ml. pH of the medium 6.0±0.5. Determination of the resistance of composite polymer material samples to the effects of microscopic fungi It is known that copper oxide particles have a biocidal effect against various microorganisms [4,11]. Therefore, adding Cu2O to an epoxy polymer should slow down or completely suppress the growth of microscopic fungi on its surface. Visual inspection of samples treated with spores of the micromycete community, which were washed off with distilled water, on the 21st day of incubation did not show the presence of growth of microscopic fungi on the surface of both the control (without introducing spores) and experimental variants (spores in distilled water). In the variant with the samples being sprayed with Czapek-Dox medium without micromycete spores, visual inspection also did not reveal the growth of microscopic fungi. Only when spores were introduced in Czapek-Dox medium on epoxy polymer samples both without Cu2O and in the presence of a biocide, the growth of micromycetes was noted. It should be noted that the mycelium of microscopic fungi was observed not only on the surface of the samples, but also on the walls of the container in which the incubation took place. When microscopying the samples (×160), the mycelium and conidiophores, morphologically similar to the conidiophores of Aspergillus niger, were clearly visible. Despite the fact that upon visual inspection of the samples in both control variants and the experimental variant, in which fungal spores were washed off with distilled water, no growth of microscopic fungi was observed, microscopic examination revealed damage to the surface of the samples in variants without Cu2O and in the presence of a biocide with a mass concentration of 0.18 % by weight in the matrix polymer (Table 1). Thus, when 0.18% Cu2O was added to the samples of control variants, the damage decreased by 1.5 times and 2.2 times compared to the variant without copper oxide for control 1 and 2, respectively; and in the version with additional addition of spores in distilled water 2.0 times. When 0.92% Cu2O was added in these variants, there was no damage to the samples. The addition of Cu2O at a concentration of 0.18% and 0.92% reduced the damage area by 1.5 and 3.8 times, respectively, compared to the variant without Cu2O when micromycete spores were applied in Czapek-Dox medium.

Table 1 – Damage to samples of polymer composite materials by microscopic fungi

Cu2O concentration, % (by mass)	Distilled water option		Option with Czapek-Dox medium	
	Control 1 (no disputes)	Experience	Control 2 (no disputes)	Experience
0	0.74	3.54	2.94	12.7
0.18	0.51	1.73	1.32	8.4
0.92	-	-	-	3.3

Results: The addition of Cu2O at concentrations of 0.18% and 0.92% reduced the affected area by 1.5 and 3.8 times, respectively, compared to the option without Cu2O when micromycete spores were applied in Czapek-Dox medium.

Conclusion. Upon visual inspection of the surface of samples of epoxy material with different concentrations of Cu2O, the growth of microscopic fungi was noted only when micromycete spores were introduced in Czapek-Dox medium. Based on morphological characteristics, the micromycetes grown on the samples were classified as Aspergillus niger. When spores of microscopic fungi were applied in distilled water, the growth of micromycetes on the surface of the samples was not observed.

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