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PHOTO-REACTIVE ACRYLIC-ALKYD COMPOSITION WITH BIOCIDE ADDITIVE FOR WOOD PROTECTION COATING DEVELOPMENT

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Abstract

Introduction. The study of photo-reactive varnishes can serve as a basis for choosing alternatives in the restoration and preservation of historical and cultural heritage sites. **Purpose of the study**: The study aimed to explore the possibility of using photoreactive acrylic-alkyd composition with biocide additive as a paint and varnish material in construction as well as restoration and preservation. **Methods.** The possibility of obtaining protective thick-layer coatings from the proposed compositions with a thickness up to 80 µm without compromising polymerization efficiency in the layer was demonstrated by express Raman spectroscopy. **Results.** The coatings obtained by UV-curing from the composition with vinylated alkyd oligomers were tested to analyze vapor permeability, hardness, and hydrophobicity. The resistance of the specimens coated with the developed compounds against a mixture of mold fungi was studied. Aspergillus, Chaetomium, Trichoderma and Penicillium fungi were used as strains of micromycetes as those most infesting the open surfaces of timber. The effectiveness of biocide additive in the amount of 0.24 wt % is shown. The developed photo-reactive varnishes make it possible to form a finished wood coating within 1–2 minutes.

Keywords: photo-reactive varnishes, wood coatings, restoration, preservation and construction, alkyd oligomers.

Introduction

Photo-reactive compositions and materials on their basis are used in many fields, which is due to the invariance of their properties set at the stage of formulation and composition development (Babkin et al., 2022; Feng et al., 2023; Ge et al., 2021; Petrov et al. 2023; Ruskol et al., 2008).

The principle of formulation of such compositions is based on the polymerization theory provisions: the presence of compounds with unsaturated double bonds in the system determines the possibility of their reaction with the formation of a new high molecular weight compound, the properties of which will be determined by its molecular weight, structure and its regular pattern. The specifics of the material and its performance will be determined by the presence of functional additives in the formulation, the amount of which is not strictly regulated and is determined only by the composition development process conditions. Thanks to additives, it is possible to regulate the properties of the future material. For example, it is possible to develop protective or decorative coatings for any surface, considering its life cycle, operating conditions, and nature (Babkin et al., 2019; Kondrashov and Kozlova, 2022a).

In any case, the composition formulation will represent a complex system containing additives that a priori should not be antagonistic, nor should they discretely or integrally inhibit the polymerization process (Babkin et al., 2019; Kondrashov and Kozlova, 2022b; Susorov and Babkin, 2015).

Formulation always starts with the selection of film formers. Acrylic oligomers and monomers have traditionally been the most widely used. Oligomers are mainly represented by urethane acrylates, epoxy acrylates, and polyether acrylates. The range of monomers is wider, and their selection is based on the number of bonds capable of polymerization (functionality): isobornyl acrylate (IBOA), hexanediol diacrylate (HDDA), trimethylolpropane triacrylate (TMPTA), etc. (Babkin et al., 2019; Chisholm et al., 2006; Kondrashov and Kozlova, 2022a; Susorov and Babkin, 2015).

An important advantage of photo-reactive systems, compared to organic solvent systems, is the absence of aggressive solvents, which is especially important when handling wood, especially historical wood that has already undergone biocorrosion (Babkin et al., 2021; Il'ina and Strokova, 2023).

In the development of photo-reactive varnish compositions for wood surface coating, the issue of wood biological resistance is the most significant, especially if the life cycle of the object implies operation under extreme conditions (external climatic impact, impact of biological and soil factors, etc.) (Skorokhodov and Shestakova, 2004). This issue can be solved in two ways: by introducing a corresponding additive (antiseptic additive, biocide) into the formulation or by using a copolymerizing film former, which inherently has a bioprotective function. The first option represents a simpler solution, since the range of such additives is quite

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large, and the main patterns of the growth of the coating biological resistance due to the introduction of such additives are easy to predict. However, there is a disadvantage: additives not chemically bonded to the polymer easily migrate within the layer to the surface, and further from the surface, and over time the protection weakens. It is obvious that the kinetics of this process will accelerate if the external conditions of the object operation promote the washing-out of additives from the thin coating layer. There is a solution, which is employed in production wood coatings using photo-reactive varnishes, when the surface is pre-prepared (grinding, surface priming or impregnation) and only after that covered with a thin layer of liquid photo-reactive varnish, almost instantly forming a preserving varnish film. This method is mainly suitable for construction and is not always adequate for restoration and preservation, especially when it comes to an object for which it was decided to perform scientific restoration using authentic materials and recreating the historical appearance of the object.

The second option is more complicated in terms of technology, and, although it is not difficult to select a copolymerizing film former due to the limited choice (among the available options, alkyds are suitable for this purpose), later the process becomes only relatively predictable, since alkyds (and their derivatives — vinylated alkyd oligomers (VAO)) are made from natural raw materials (Drinberg, 2014). Reproducibility of VAO properties in different batches does not always meet expectations — the main difficulty lies in the fact that VAO are characterized by wide and variable molecular-mass distribution with an average molecular mass of 2000–3000. Such variability of properties is determined in synthesis by the use of vegetable oil — a natural raw material, the quality of which depends on a set of unpredictable conditions, including climatic ones, and the amount of vinyl toluene used in resin modification. Therefore, when handling raw materials from different batches, every time it is required to adjust formulations, check curing kinetics, determine the properties of the coatings formed, and take other actions to match the properties set during the initial use of resin (Drinberg, 2014; Poth, 2009; Yakhontova, 1988).

In addition, the effectiveness of biological protection in this case is much lower than when using synthetic biocides. Thus, given the pros and cons of both methods, it is logical to use the third option, when in the formulations of photo-reactive varnishes, synthetic biocides, introduced prior to the application to the surface, are used simultaneously with the film former, which inherently has a bioprotective function.

Alkyd resins, which are traditionally used in the domestic paint and varnish industry, but mainly in siccative systems, can serve as such a film former (Drinberg, 2014; Yakhontova, 1988). Babkin et al. (2014) proved the possibility of using modified alkyd resins — vinyl toluene alkylated alkyds — as film formers of photo-reactive compositions developed to produce coatings using UV-curing. UV-curable compositions can be used for operational object preservation and for restoration using the synthetic method, which involves a balanced combination of archaeological restoration and compilation stylization. They also can be used during restoration and preservation using anastylosis and during renovation as a reasonable choice of preservation of severely destroyed objects not included in the World Heritage List.

Subject, tasks, and methods

The subject of the study was photo-reactive compositions based on two film formers: ethoxylated TMPTA (CAS 28961-43-5) and VAO with different vinyl-toluene content. A photo-initiating mixture of 1-hydroxycyclohexyl phenyl ketone (CAS 947-19-3) with benzophenone (TS 6-09-08-2006-89) in a ratio of 3.6:2 was used as a reaction activator, with a total initiator content in the formulation of 5.6 wt %.

The task of the study was to develop a highly reactive composition that would allow for the rapid formation of a ready-to-use coating comparable in hardness to an organic solvent-based varnish coating. The technical requirements for the coating also included hydrophobicity, optical transparency (to preserve the visual effect of the natural wood surface), and biological resistance.

The compositions were prepared in a laboratory vertical bead mill with glass beads in accordance with GOST R 50563.4-93, observing the following order of component introduction: first, ethoxylated TMPTA was loaded into the working vessel, then 1-hydroxycyclohexyl phenyl ketone and benzophenone photoinitiators were added to it; then grinding was carried out, with the process control regarding the degree of initiator dissolution. The degree of dissolution was determined visually by pouring the mixture onto glass. The homogeneity of the composition and the absence of inclusions on the glass were checked. Then process additives were introduced to ensure further process (dispersant Tego Dispers 670, defoamer Tego Airex 991), and mixing was carried out. The prepared homogeneous mass was filtered, introduced into a VAO solution (80 % solution in vinyl toluene), and mixed.

The Brookfield viscosity of the prepared compositions was determined using a Brookfield DV-E viscometer (530 mPa·s).

The prepared compositions were stored in containers protected against active UV radiation with tightly closed lids.

The criteria for the selection of biocide additive were as follows: minimum possible toxicity and aggressiveness to the surface to be protected + high biocidal protection + minimum particle size in case of powder-type additive (limitations on the particle size of the solid phase were imposed due to the utilized coating formation technology). Polyphase biocide (trade name Polyphase R2085) was chosen as the optimal additive. It is recommended for protecting interior materials and exterior surfaces against fungal infestations. It is known for ensuring protection against mold fungi in coatings for interior and exterior applications: paint, plaster, pigment dispersions, pigmented wood stains. It is believed to be active against a wide variety of fungal microorganisms (mold, wood-staining fungi). The active biocide components are carbendazim (ISO) and 3-iodo-2-propynyl-butyl carbamate.

The choice of Polyphase biocide, among the existing range of active additives for wood protection, is due to the previously proven effectiveness of its use for alkyd systems, as the primary task of the study was to test the hypothesis of the possibility of use and effectiveness of the biocide in photo-reactive systems with the addition of VAO.

Additional advantages of this additive were its liquid form (free-flowing dispersion), low content of volatile organic substances, and previously demonstrated high efficiency in alkyd systems (Anikina, 2014), since in this study it is planned to use it in compositions containing VAO. The intrinsic viscosity of the additive (400 mPa·s at 25 °C) was comparable to that of the prepared composition (530 mPa·s at 25 °C); the biocide was introduced into the composition directly prior to its application on wood.

Coatings for fungus resistance studies were obtained by applying the composition with VAO to wooden planks (spruce) of 30×40×15 mm. Different wood moisture conditions were simulated. The wet wood batch was held in desalinated water for 7 days. The dry wood batch was maintained in a thermostat at a constant temperature of +60 °C for 7 days. The specimens of the wood treated and maintained at different moisture conditions were kept under standard storage conditions, at room temperature, without direct exposure to sunlight, heating, or forced air conditioning. The moisture content in the wood was assessed by changes in the weight of the specimens.

The compositions were applied using a four-range rectangular applicator with a gap thickness of 30 μm. The coatings were cured using an ORK-21 M1 unit with a DRT-400 mercury lamp. Radiation intensity was recorded using a UV Power Puck II UV photometer. UV radiation intensity amounted to: HA = 135 mW/cm^2; HB = 150 mW/cm^2; HC = 24 mW/cm^2; HV = 90 mW/cm^2. The coating thickness was not determined; the concept of "material consumption per surface area" was used for evaluation.

To study the fungus resistance of the compositions considered in this work, three wood specimens (30×40×15 mm) were prepared for each composition of photo-reactive varnish (without biocide as well as with the addition of biocide in different concentrations); wood without coating served as a control. After that, the specimens were infested with aqueous suspension of spores of the mold fungi mixture, containing the test cultures under consideration, using a sprayer and placed in Petri dishes.

Fungi of the following genera were used as strains of micromycetes for modeling of real operation conditions: *Aspergillus* (as the most active biodegradants of acrylic paint materials (Anikina and Smirnov, 2013)), *Chaetomium*, *Trichoderma*, and *Penicillium* (as those most infesting the open surfaces of timber (Mazanik and Snopkov, 2009)). For instance, the following strains of micromycetes were considered in the course of the study: *Aspergillus niger van Tieghem*; *Aspergillus terreus Thom*; *Chaetomium globosum Kunze*; *Trichoderma viride Pers. ex. Fr.*; *Penicillium ochrochloron Thom*. To prepare spore suspension, dry spores of the selected species of mycelial fungi were transferred into a flask containing 50 cm^3 sterile tap water, thoroughly mixed by shaking and rubbing with a glass rod with a rubber tip until all lumps were dispersed. The prepared suspension was filtered through four layers of sterile gauze. The spore concentration of each fungal species in the suspension was 1–2 million/cm^3. To prepare spore suspension, a working batch of 14-day-old (counting from the day of Inoculation) test-cultures of micromycetes was used. The Petri dishes were stored under conditions for optimal fungal growth: at 29 °C and 90 % relative humidity.

The study was aimed to reveal the nature of growth and development of fungi on the surface of the investigated specimens with and without coating. As a characteristic for the determination of microbiological resistance of materials, their fouling by microscopic fungi was considered, which was established after 28 days from the beginning of the experiment; the degree of fungi development was evaluated on a 5-score scale (Table 1), according to GOST 9.048–89 "Unified system of protection against corrosion and aging. Technical items. Methods of laboratory tests for resistance to mold fungi".

Vapor permeability and microhardness were evaluated on free films. The films were obtained using the method of obtaining free films according to GOST 14243-78 "Paint and varnish materials" on plates (fluoroplastic-4), previously degreased with acetone.

The hydrophobicity of the applied coating was evaluated by the value of surface energy, evaluation was carried out by the value of the wetting angle on a laboratory unit using the sessile drop method (Fig. 1).

Comparison liquids — water and glycerin — were used, which were applied to the coating with a dispenser, to exclude stochastic error —

Table 1. **Intensity of fungi development**

Score	Score characteristics
0	No germination of spores and conidia was found under the microscope
1	Under the microscope, germinated spores and slightly developed mycelium can be seen
2	Under the microscope, developed mycelium can be seen, possible sporulation
3	Mycelium and/or sporulation are barely visible to the naked eye, but clearly visible under the microscope
4	Development of fungi covering less than 25 % of the test surface is clearly visible to the naked eye
5	Development of fungi covering more than 25 % of the test surface is clearly visible to the naked eye

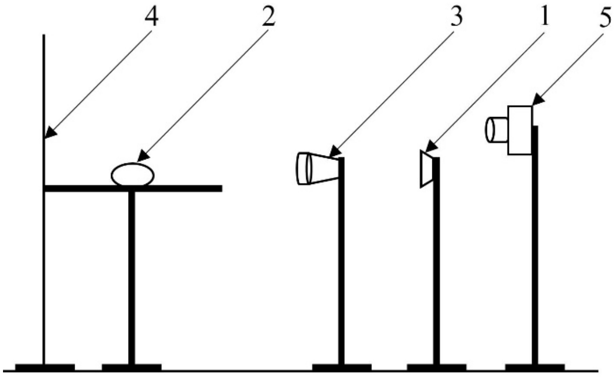

Fig. 1. Unit to determine the wetting angle, where: 1 — light source; 2 — test surface (specimen) on the work table; 3 — set of lenses, 4 — screen, 5 — photo camera

3–5 drops at a time, 2–3 mm in diameter. Imaging was performed under darkened conditions, with a time delay of no more than 30 s after drops were applied to the surface. The photos of the drops were processed in a graphic editor. The values of the wetting angles were calculated in MatLab with a special application by arithmetic mean of five measurements for each point. Based on the data obtained, surface energy values were calculated using the Owens–Wendt–Kaelble equation:

$$\frac{1}{2}\sigma_{\mathrm{lg}}\left(\cos\theta+1\right)=\left(\sigma_{\mathrm{lg}}^{d}\right)^{\frac{1}{2}}\left(\sigma_{sg}^{d}\right)^{\frac{1}{2}}+\left(\sigma_{\mathrm{lg}}^{\rho}\right)^{\frac{1}{2}}\left(\sigma_{sg}^{\rho}\right)^{\frac{1}{2}}, \quad (1)$$

where q — the wetting angle of water or glycerin; σ^d and σ^p — dispersion and polar components of surface energy at the interfaces, SG — solid/gas, LG — liquid/gas.

The vapor permeability of the free films was determined according to GOST 25898-2020 “Building materials and products. Methods for determination of vapor permeability and vapor permeability resistance” (dry cup method), using a laboratory analog as a test vessel.

Mendeleev cement was used as a sealant. Phosphoric anhydride according to GOST 212317 was used as an absorbing material. The device was placed in a desiccator where a constant humidity of ~95 % was maintained due to a saturated solution of copper sulfate (GOST 19347-99). The testing devices with the specimens were weighed on analytical scales every 24 hours for 8 days.

Hardness measurements were performed using a PMT-3 microhardness tester (GOST 7865-77). Hardness values were calculated based on the length of the diamond pyramid impression diagonal (mm). Microhardness was calculated according to Eq. 2:

$$H = 1.854 \times P / C, \quad (2)$$

where P — load, g; C — impression diagonal length, mm.

Raman spectroscopy was used to determine the degree of conversion of unsaturated bonds. The study was carried out using a SENTERRA express Raman spectrometer with a Raman spectrum range of 80–4500 cm^{-1} at spectral resolution of 3 cm^{-1}, laser wavelengths of 488 nm, 532 nm, 785 nm.

The optical properties of the finished coating were determined by the optical density of the free films measured using a SR-25M densitometer in transmitted light. The measurement error was determined with an accuracy up to 0.1.

Results and discussion

I. Analysis of hydrophobicity, vapor permeability, and microhardness of the coatings obtained by UV-curing from the base formulation composition

At the initial stage of studies, the hypothesis of the influence of the nature of the vegetable oil used in VAO production on the nature of its behavior in the photo-reactive system was tested. It is known (Drinberg, 2014) that the most demanded natural raw materials for VAO production are linseed, rapeseed and sunflower oils, which belong to different groups in terms of the film formation nature. Corresponding findings on the peculiarities of their behavior in siccative systems are available. However, in synergistic systems, including compositions of VAO with acrylic oligomers, the influence of the nature of the oil used is not so obvious. Only identifying the relationship of the nature of the VAO origin with the physical-mechanical and physical-chemical properties of coatings formed on wooden surfaces can serve as the basis for formulations and development of recommendations on the use of this type of materials for further application.

Based on the results of the hydrophobicity study, in accordance with the obtained values of the surface energy of the formed coatings (Table 2), it is shown that all coatings are hydrophobic. Comparison of the

Table 2. **Values of the surface energy of the coatings made of compositions with VAO, prepared based on different types of vegetable oils**

Type of vegetable oil	VAO designation	Indicators		
		Surface energy, mJ/m^2	**Vapor permeability, mg×cm^2/day**	**Microhardness, c.u. relative to glass**
Sunflower	VAO$_{SO}$	33	2.7	0.48
Rapeseed	VAO$_{RO}$	32	3.7	0.34
Linseed	VAO$_{LO}$	27	9.5	0.76

coatings from the compositions with formulations including VAO obtained based on three types of vegetable oils (sunflower, rapeseed, and linseed oil) shows a minimal preference for linseed oil due to lower surface energy and, as a consequence, higher hydrophobicity. However, in practical terms, the type of oil is not determinant for this characteristic — all values of surface energy lie within the range of 27–33 mJ/m^2.

In terms of vapor permeability, the best results were demonstrated by the coatings with VAO obtained using linseed oil, which is higher than the values of vapor permeability of the coatings synthesized based on sunflower oil — 3.5 times, rapeseed oil — 2.5 times (Table 2).

The use of oligomer, synthesized with rapeseed or sunflower oil, in the formulations of photo-reactive compositions leads to the formation of low-permeable coatings. This is a positive result for surfaces requiring effective protection in very humid environments, or coatings on metal or other non-porous material. It can also be suitable for coating particleboard or fiberboard, or other composite materials with wood filler and resin binders, but it is hardly suitable for coating porous surfaces, including natural wood.

In terms of microhardness, the best results (almost twofold increase) were demonstrated by the coatings with VAO synthesized using linseed oil. The values of microhardness in the coatings with VAOLO synthesized using linseed oil compared to VAOSO and VAORO were 1.5–2 times higher.

The observed presence of VAOLO in the compositions is due to the chemical composition of linseed oil, which contains a greater number of acids with two and three double bonds in the molecule (glycerides of linoleic and linolenic acids predominate in the composition), compared to sunflower and rapeseed oils. In comparison, sunflower oil, for example, contains mainly fatty acids with only two double bonds (glycerides of linoleic and oleic acids predominate in the composition). As for rapeseed oil, unsaturated acids with only one double bond (glycerides of oleic acid) predominate in the composition. A large number of double bonds in the raw material molecule determines the greater ability of VAOLO to form a dense spatial polymer mesh, which ultimately leads to the formation of a harder coating.

Thus, on the basis of the foregoing, VAOLO synthesized based on linseed oil was selected for further modification with biocide additive of the benzimidazole class. The coating formed after the complete drying of VAOLO is characterized by the following physical-mechanical and physical-chemical properties: surface energy — 27 mJ/m^2, vapor permeability — 9.5 mg×cm^2/day, microhardness — 0.76 c.u. relative to glass (Fig. 2).

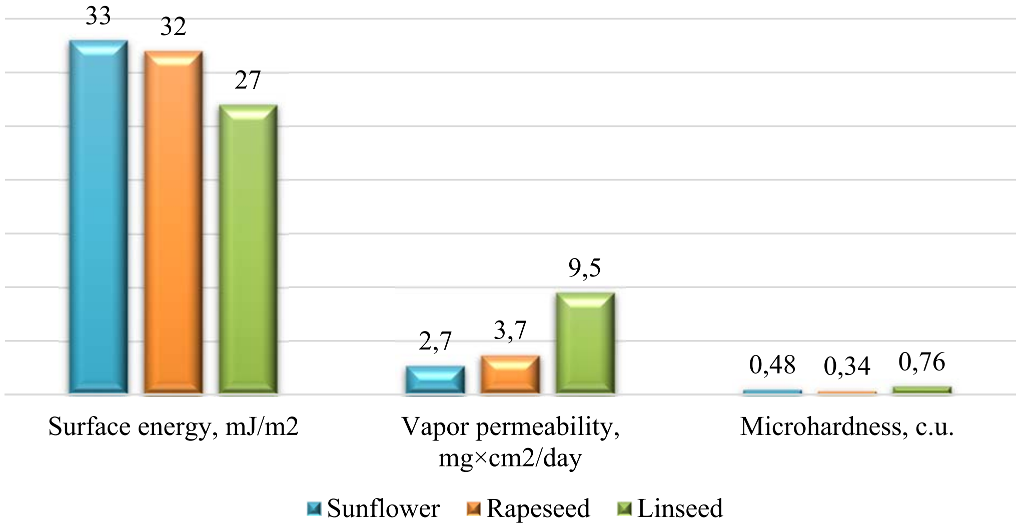

Fig. 2. Changes in the properties of VAO coatings prepared based on different types of vegetable oils

The choice of the amount of biocide additive introduced into acrylic systems modified with alkyd oligomers was justified by the recommendations of paint and varnish manufacturers (Novikova and Chizhova, 2019). It was found that the addition of Polyphase biocide in the amount of 0.24 and 0.66 wt % into the composition does not affect the change of all three parameters (Fig. 3). This fact indicates the indifference of the additive, which does not deteriorate the performance of the compositions and coatings obtained from them. Hence, an important conclusion follows that the biocide additive introduced as free dispersion does not reduce the efficiency of photo-initiated polymerization, which can be judged by the unchanged hardness of the formed coating (0.76 c.u.), which is the main requirement for additives of photo-reactive compositions.

II. Analysis of the fungus resistance of the coatings obtained by UV-curing

To study the fungus resistance of the coated wood specimens, compositions with VAOLO (synthesized based on linseed oil) were selected since this composition ensure the best coating performance, including the highest microhardness values.

During visual inspection (Fig. 4) of the wooden plates, the active growth of the test cultures was noted on the specimens without protective coating. The Aspergillus niger van Tieghem mold fungus turned out to be the most aggressive towards the developed materials, which was expected since this mold fungus is an active degradant for both wood and the acrylic coating (Anikina and Smirnov, 2013). In the case of control specimens, 90 % of the surface were infested and the development intensity did not decrease below 5 in all options (Table 3).

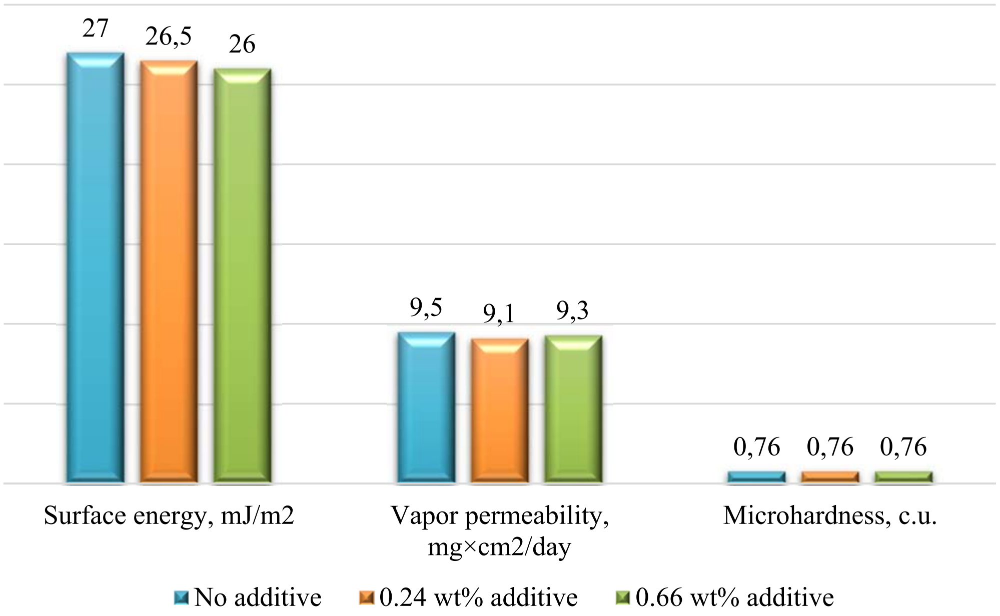

Fig. 3. Changes in the properties of the coatings with compositions with VAO_{LO} and Polyphase additive

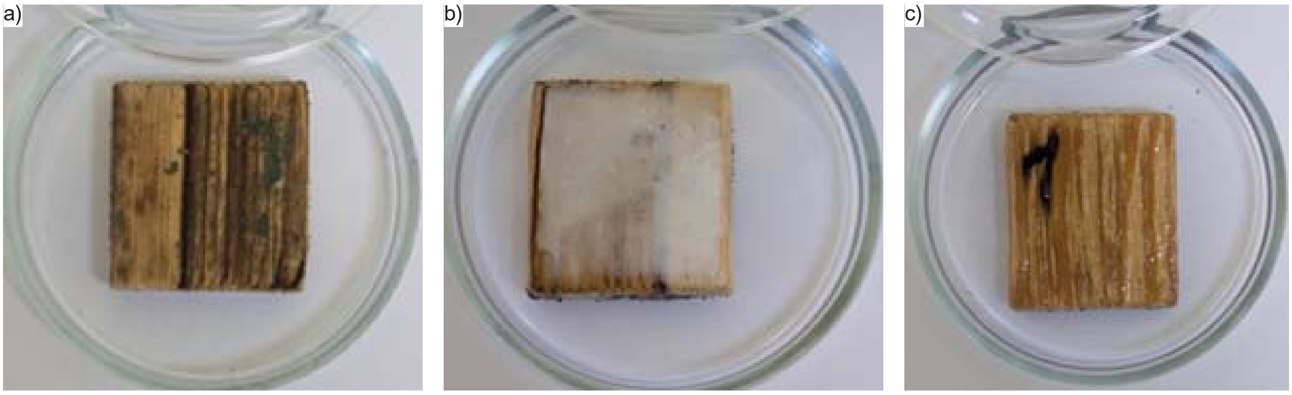

Fig. 4. Resistance of wooden surfaces to mold fungi: a — specimen without coating; b — specimen with coating without biocide; c — with biocide additive 0.24 wt %

Table 3. **Fungus resistance of coatings**

Specimen characteristics	Species composition of test cultures of fungi (mixture)	Score in points
specimen without coating	*Aspergillus niger* van Tieghem, *Aspergillus terreus* Thom, *Chaetomium globosum* Kunze *Trichoderma viride* Pers. ex. Fr. *Penicillium ochrochloron* Thom	5
specimen with coating without biocide		3
specimen with coating with biocide additive 0.24 wt %		1
specimen with coating with biocide additive 0.66 wt %		1

The response of microscopic fungi to the new material is ambiguous. Coating the wood with photo-reactive varnish without biocide forms a slight resistive barrier, reducing the intensity of development to 3, but this composition does not allow to achieve 100 % fungus resistance.

The introduction of biocide additive contributes to the reduction of fungi fouling on the surface of the model specimens (Table 2, Fig. 4). There is also a direct correlation between the amount of biocide in the coatings and the absence of growth and development of the considered micromycetes on the surface, which indicates the effectiveness of the resulting coating with account for the minimum biocide dosage.

III. Studying into the possibility of obtaining thick-layer coatings from the proposed acrylic-alkyd photo-reactive composition

Since the coatings obtained by UV-curing from the compositions with VAOLO demonstrate relatively high vapor permeability, the possibility of obtaining thick-layer coatings that simultaneously provide both air exchange of the protected wood surface and maximum protection against mechanical and biological damage is considered.

It was taken into account that the transparency of the cured coating may decrease with increasing thickness; however, in the measured thickness range of 30–80 μm, the diffuse optical density of the free varnish films was 0–0.2; with no opalescence effect during visual inspection.

Assessment of the double bond conversion by layer depth showed that there was a slight decrease in the double bond conversion by depth (20, 40, 60, and 80 μm) (Fig. 5). This indicates that, despite an increase in the coating thickness, polymerization reactions in the depth of the coating layer take place in full, like on the surface. Therefore, it is possible to obtain thick-layer coatings in a single applied layer without changing the curing conditions.

Thus, based on the mentioned stages of the study, it is worth noting that for photo-reactive materials (UV-curing), it is important to have film formers with unsaturated bonds, capable of opening and participating in chain polymerization, in the formulation.

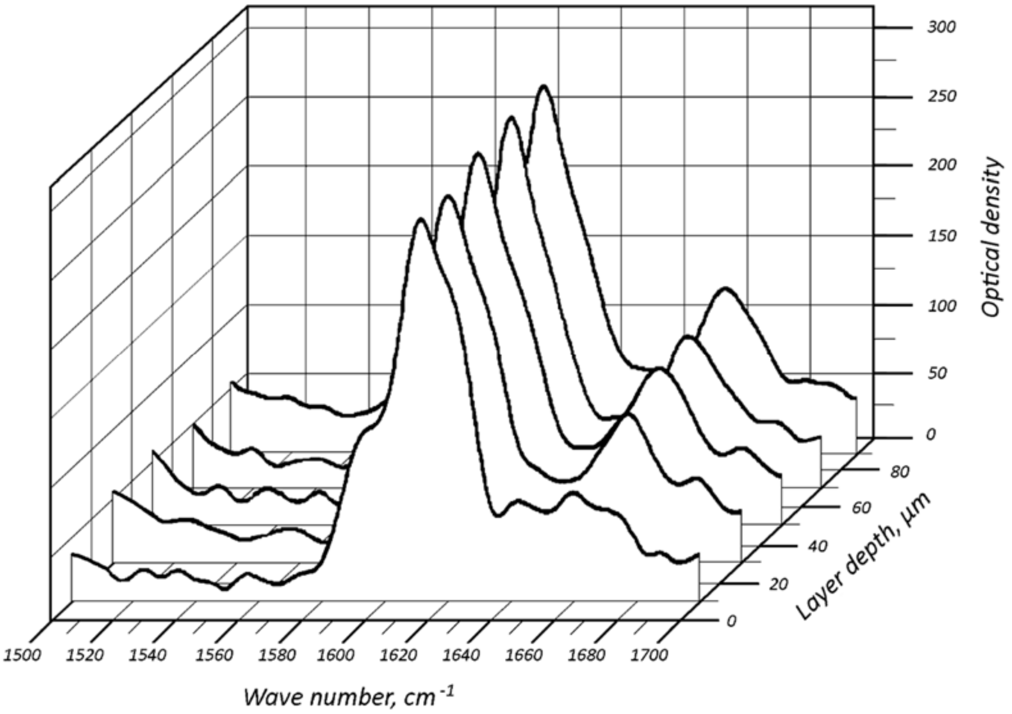

Fig. 5. Changes in the double bond conversion by depth to 80 μm in the coating obtained from the photo-reactive acrylic-alkyd composition

It is explained theoretically and proved in practice that oligomer having a large number of unsaturated bonds in the molecule (VAO) can polymerize with multifunctional (trifunctional) monomer (TMPTA) on each of the unsaturated bonds, forming a three-dimensional cross-linked matrix. The consequence of this is the relatively high microhardness of the formed coating film with the addition of VAO, which has a large number of unsaturated bonds determined by the nature of the raw material (linseed oil).

The combined use of alkyd and acrylic film formers resulted in a coating with high vapor permeability — the resulting coating allows the surface to "breathe".

In case of such coatings, biological protection important for the surfaces of wooden materials is ensured, in our case, by the presence of alkyd (mild natural antiseptic) in the formulation and is additionally provided by the introduction of process additive in the photo-reactive composition. The main condition for all process additives — indifference to the main ingredients (film formers) — in the case of the recommended additive is indirectly confirmed by the absence of significant quantitative changes in the studied parameters of coatings when the additive is introduced in the recommended amounts.

Conclusions

Technological multitasking of developing coatings for wood — a natural material with particular qualitative characteristics, including its application environment — implies obtaining a coating that is simultaneously protective (i. e., with maximum moisture, chemical and biological resistance), decorative, and preserving. The solution should ensure the formation of a surface coating preserving all natural qualities of the material and providing it with new characteristics. As a result, it was proposed to use photo-reactive paint and varnish material based on a mixture of artificial (alkyd) and synthetic (acrylic) film formers with the addition of biocide, allowing to form a finished wood coating within 1–2 minutes. The possibility of obtaining single-layer coatings up to 80 µm thick with a high degree of conversion of double bonds from the proposed formulation was shown.

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ФОТОРЕАКТИВНАЯ АКРИЛ-АЛКИДНАЯ КОМПОЗИЦИЯ С ДОБАВКОЙ БИОЦИДА ДЛЯ СОЗДАНИЯ ЗАЩИТНЫХ ПОКРЫТИЙ ПО ДРЕВЕСИНЕ

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Аннотация
Введение. Изучение фотореактивных лаков может служить основой для выбора альтернативных путей в реставрационно-консервационных работах на объектах историко-культурной ценности. **Цель исследования**: изучение возможности использования фотореактивной акрил-алкидной композиции с добавкой биоцида в качестве лакокрасочного материала для строительных и реставрационно-консервационных работ. **Методы.** Методом экспресс-рамановской спектроскопии показана возможность получения защитных толстослойных покрытий из предложных композиций толщиной до 80 мкм без ущерба эффективности процесса полимеризации в слое. **Результаты.** Проведены испытания покрытий, полученных технологией УФ-отверждения из композиции с винилированными алкидными олигомерами, по параметрам паропроницаемости, твердости и гидрофобности. Изучена резистентность образцов с покрытиями из разработанных составов по отношению к смеси плесневых грибов. В качестве штаммов микромицетов были использованы грибы родов: Aspergillus, Chaethomium, Trichoderma и Penicillium, как наиболее заселяющие открытые поверхности деревянных материалов. Показана эффективность введения добавки биоцида в количестве 0,24 масс.%. Разработанные фотореактивные лаки позволяют формировать готовое покрытие по древесине в течение 1–2 минут.

Ключевые слова: фотореактивные лаки, покрытия по древесине, реставрационно-консервационные и строительные работы, алкидные олигомеры.