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APPLICATION OF NANOADDITIVES FOR WEAR RESISTANCE IMPROVEMENT OF PARQUET PROTECTIVE AND DECORATIVE COATINGS

В статье представлен один из перспективных способов повышения износосстойкости модифицированием лакокрасочных покрытий нанодобавками. Были изготовлены образцы с защитно-декоративным покрытием, в состав которого входят нанодобавки. Испытания образцов показали, что применение нанодобавок улучшает эксплуатационные характеристики покрытия, в данном случае износостойкость. В ходе исследования была установлена зависимость износостойкости покрытия от расхода нанодобавки.

This article presents one of the promising ways of wear resistance improvement of nanoadditives modification coatings. The protective and decorative coating, composed of nanoadditives, was used to make samples. Testing samples showed that the use of nanoadditives improves coating operational characteristics, or wear resistance in this case. The dependence of wear resistance coatings on the flow nanoadditives was studied.

Introduction. Nowadays it becomes important to find and develop new technological solutions for floor coverings manufacture, making it possible to reduce the use of expensive materials significantly, including application of high-quality wood in the parquet floors production. The most perspective and effective method of improving the flooring service characteristics is to use the modified protective and decorative coatings.

Improving the coatings wear resistance is associated with an increase in flooring service life, associated with caretaking of wood as a whole.

The main part. In this article we investigate several ways of modifying and testing coatings obtained with the use of modified materials.

Parquet lacquer should be selected on the basis of the actual load coming to the floor for the apartments where it will go to a small number of people.

Such flooring requires parquet lacquer (or floor) with a normal load. For non-residential premises (where there will be a lot of people) parquet lacquer with increased load should be selected. For such areas as museums, theaters, restaurants, and shops (where there is always a huge flow of people) the varnish for parquet doesn't suit unlike rub wax pastes or oil impregnation, as in this case a useful layer of parquet is not pre-polished and serves longer.

The coating quality includes a set of service properties, providing durability and the decorative, protective or special characteristics.

While the basic level of operational coating properties is determined by the chemical nature and structure of the film former (which forms the coating matrix), all other paint material components can be regarded as modifiers.

Modification is any improvement in the characteristics specific to the surface, carried out by adding the functional additives to the current formulation.

Different modifier additives of parquet floors are designed to improve its operational characteristics, such as adhesive strength, durability, and resistance to scratching.

Nowadays, nanotechnology is one of the most perspective areas of science, and research and development at the nanoscale are widely used in various industries.

The metal and metal-oxide powders, as well as carbon nanotubes make up majority of the total production of nonmaterial. Mixed metal oxides, non-oxide materials and silicates come next. Most of these materials are not "new" and have been already widely used in industry, while carbon nanotubes (fullerene) are relatively new [1].

Every day a variety of nanoparticles applications increases. Nanoparticles are widely used as special additives or raw materials for the manufacture of emulsions, composites and coatings. For example, in 2003 the global market of polymer-nanocomposites was 90 million USD. And in 2008 this figure was 210 million USD.

Nanofillers can improve some properties of polymeric materials:

- Mechanical properties (strength, dimensional stability, and modular);
- Resistance to various surroundings (gas, water and carbon);
- Thermal stability and heat resistance;
- Resistance to combustion and reduced smoke discharge;
- Chemical resistance;
- Appearance;
- Electrical conductivity and optical transparency;
- Resistance to sunlight.

It should be noted that nanomaterials have been long used for the paints. These are primarily natural materials used as fillers, such as talc, mica, asbestos, and products based on clay (bentonite).

Liquid glass, ethyl silicate, and microgel film formers are used as film-forming materials.

The price of the product is greatly imports for industrial application. In most cases, nanomaterials are more expensive than conventional materials. However, when the consumer gets a product with unique properties, that allow us to solve some important tasks, the question of price is secondary. Usually economically successful application of nanomaterials requires a small amount of material with enhanced properties.

The main idea of the nanomaterials use is their application for paint systems, not as common fillers, but as additives significantly improving safety and operational characteristics of coatings.

Such inorganic nanoparticles as nanopowders are widely used in paint industry.

Characteristics of some nanoparticles are given in table 1. For the tests, we selected three batches of specimens with different structure of the coating. At an average, complete protective and decorative coating requires application of 13–14 layers of coating materials: pigments, primers, and varnish. The UV-curing coating materials have shown the best strength characteristics.

The coating characteristics were the subject of tests. Each coating layer performs a separate function: soils improve wetting, adhesion, elasticity, wear resistance, and hardness; while lacquer improves elasticity, abrasion resistance, durability, and chemical resistance.

Main focus of the study was given on such coating characteristic as wear resistance. As defined above, nanoadditives (metalnanopowders) are used to improve wear resistance, additives are put in the soil.

We have exposed dependence of wear resistance on the soil rate with the addition of aluminum oxide. To change the flow rate we used a different number of soil layers. Samples were prepared at the "Coswick" factory with the industrial materials application.

The purpose of the work was to determine improvement of operational characteristics of parquet hardwood products, to study the strength characteristics of protective and decorative coatings for the parquet production. These types of coating possess good abrasion resistance, scratch, hardness, and elasticity.

The object of the study is coating used in the parquet production.

Coatings were tested in accordance to the EN438-2: 2005 [2].

Testing required electronic scales, thinner, contrast fluid, 100×100 mm coated samples with the hole in the center (7 mm in diameter), rags, and taber test.

Test execution order is described below.

We prepared strips of sandpaper grit P180, coated with aluminum oxide (for Taber Test S42 or its equivalent).

Samples were kept at a temperature (23 ± 2)°C and relative humidity (50 ± 5)%. Then three samples of one type of coatings were tested and, as a result, the average value was taken. Samples were wiped with the organic solvent, installed and fastened on a rotating disk with abrasive wheels. Checking up the test sample every 25 turns, we just checked the sanding paper for sanding dust clogging. Then paper was replaced as it became clogged after every 500 revolutions.

The test was kept on until we reached the point of deterioration beginning (IP). The IP came when there were clearly identified first worn coatings with an area of 0.6 mm^2 in three-quarters of a circle.

Tests were carried out before the end deterioration point (FP). The FP came when 95% coatings erased. Wear resistance (WR), revolving (rev), are determined by the formula

$$WR = \frac{IP + FP}{2}, \text{ rev.}$$

Table 1

Characteristics of Nanoparticles

Name	Function	Designation
Silicon dioxide SiO_2	Filling pores	Increased resistance to scratching and corrosion action
Titanite dioxide TiO_2	UV-absorbance	UV absorber, achieving the optical effects and improving the resistance to scratching
Aluminum oxide Al_2O_3	Filling pores	Increased resistance to scratching and corrosion protection
Aluminum hydroxide γ-AlO(OH)	Filling pores	Increased resistance to scratching and corrosion protection
Cerium oxide CeO_2	UV-absorbance, catalysis	Increased resistance to scratching, corrosion protection, and thermal catalysis
Zirconium dioxide ZrO_2	Filling pores, catalysis	Increased resistance to scratching corrosion protection, and catalysis

Table 2

The Results of the Tests

Batch number	Type of coating	Flow rate of soil with the addition of aluminum oxide, g/m^2	Sample number	Value, rev.			Wear resistance, rev.
				IP	FP	WR	
1	Standard finish with the top layer of varnish	28	1	700	850	775	782
			2	700	820	760	
			3	700	920	810	
2	Standard coating without layer of varnish	28	1	700	880	790	688
			2	500	630	565	
			3	550	870	710	
3	Enhanced coating without varnish layer	46	1	1360	1510	1435	1467
			2	1390	1520	1455	
			3	1410	1610	1510	

The test samples wiped with a contrast liquid to make it easier to determine the extent of coatings grated. The test results are given in table 2. The obtained study results confirm the efficacy of nanoadditives in the woodworking industry. Also the experiment helped to study coatings, imparting greater strength and durability.

Conclusion. We studied coatings structure in composition of nanoadditives (like aluminum oxide) and analyzed patent study to come to the following conclusion:

- Coatings durability increased at the increase of soil (with aluminum oxide) consumption;
- Coating obtained from the UV-curing materials possesses more hardness and strength;
- Coating applied at the factory is more durable;
- Each separate type of soil improves the individual coatings quality, and all used materials make film flexible;
- Coatings durability increased to increase soil consumption with aluminum oxide;
- Application of a large number of layers increases the adhesion of soil material.

The results confirm the efficiency of nanoadditives for the woodworking industry.

A large number of different materials, used as additives, enables to search modifiers improving the coatings quality without its cost changing. Nanopowders are considered to be most promising material, used in small quantities that significantly affect the product price.

The work is of undeniable economic importance as it helps to improve operational characteristics of flooring. These operational characteristics contribute to the rational use of forest resources of the Republic of Belarus. It is advisable to continue the search modifiers to improve operational characteristics of floor covering (and its durability in particularly).

References

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