

COATING MATERIAL COMPOSITION, COATING FILM, AND MULTILAYER
COATING FILM

TECHNICAL FIELD

[0001]

The present invention relates to a coating material composition, a coating film, and a multilayer coating film. For more details, the present invention relates to a coating material composition that is capable of being coated twice in one day due to an excellent quick-drying property and wrinkling resistance and, simultaneously, yields a coating film with weather resistance; a coating film produced by curing the coating material composition; and a multilayer coating film in which a coating film produced by curing the coating material composition is laminated on another coating film produced by curing the coating material composition.

BACKGROUND ART

[0002]

Conventionally, oxidative-polymerization type coating materials such as ready-mixed synthetic resin paints have been widely used mainly for iron or wood since the coating materials are inexpensive and have excellent hiding property, workability, and finishing property. Examples of the oxidative-polymerization type coating material include a solvent-based coating material composition

containing an alkyd resin as a main component.

[0003]

The oxidative-polymerization type solvent-based coating material composition containing an alkyd resin as a main component yields a room temperature-drying coating material with excellent coating workability and adhesive property. However, for outdoor use such as building exterior coating, weather resistance may be still unsatisfactory.

[0004]

Furthermore, for the coating workability, if coating can be conducted twice a day, the so-called 2 coats a day method, coating work becomes more efficient.

The so-called 2 coats a day method is, for example, a coating method in which a coating film formed on an object to be coated is recoated 6 hours after coating.

Therefore, in order to conduct the 2 coats a day method, coating material compositions that quickly dry at room temperature are required.

[0005]

However, a drying rate of the solvent-based coating material composition containing an alkyd resin as a main component is still insufficient. For a multilayer coating film recoated at about 6-hour intervals, there is a problem that, when a topcoat (second coating) is applied while an undercoat (first coating) is still insufficiently dried, a coating film surface is wrinkled, in other words, lifting occurs.

[0006]

Therefore, there has been proposed, as a coating material composition that can form a coating film with excellent weather resistance, a coating resin composition obtained by polymerizing compounds having radical-polymerizable double-bond groups in the presence of a resin composition obtained by reacting a resin composition obtained by depolymerizing a polyester resin through an ester exchange reaction with compounds having isocyanate groups (see Patent Document 1).

[0007]

However, a drying property of the coating material composition described in the Patent Document 1 was still not satisfactory since the coating material composition dried only to the extent of being untouchable to the hand 4 hours after coating.

[0008]

Furthermore, for the purpose of suppressing an occurrence of wrinkling when recoating multiple times, a room temperature curable coating material composition including a specific alkyd-modified acrylic resin and a specific amount of an amine compound has been proposed (see Patent Document 2).

[0009]

However, a wrinkling property described in the Patent Document 2 was confirmed under drying conditions of 40°C for 7 days and was not yet satisfactory from the viewpoint of an excellent quick-drying property enough to enable the 2 coats a day method.

[0010]

Patent Document 1: Japanese Unexamined Patent Application,
Publication No. 2012-072245

Patent Document 2: Japanese Unexamined Patent Application,
Publication No. 2014-196402

DISCLOSURE OF THE INVENTION

Problems to be Solved by the Invention

[0011]

The present invention has been made in view of the above-mentioned related art and an object of the present invention is to provide a coating material composition that is capable of being coated twice in one day due to an excellent quick-drying property and wrinkling resistance and, simultaneously, yields a coating film with weather resistance; a coating film produced by curing the coating material composition; and a multilayer coating film in which a coating film produced by curing the coating material composition is laminated on another coating film produced by curing the coating material composition.

Means for Solving the Problems

[0012]

The present inventors conducted extensive studies to solve the above problems.

The present inventors have found that the above-mentioned problems can be solved by including a phenol-modified alkyd

resin (I), a urethane-modified alkyd resin (II), and an alkyd resin (III) at a specific composition in a coating material composition. Thus, the present invention has been completed.

[0013]

That is, the present invention is a coating material composition for forming a coating film on a substrate, the composition including a phenol-modified alkyd resin (I), a urethane-modified alkyd resin (II), and an alkyd resin (III), the composition including the phenol-modified alkyd resin (I) in an amount of 5 to 45 parts by mass relative to 100 parts by mass of a resin solid content in the coating material composition, and the composition including the urethane-modified alkyd resin (II) in an amount of 5 to 45 parts by mass relative to 100 parts by mass of a total resin solid content in the coating material composition.

[0014]

The urethane-modified alkyd resin (II) in the coating material composition may have a urethane modification rate of 10% to 15%.

[0015]

The coating material composition may have a pigment volume concentration (PVC) of 20.0 to 35.0%.

[0016]

The coating material composition may further include a rust-inhibiting pigment.

[0017]

The coating material composition may be an undercoat.

[0018]

The coating material composition may be a topcoat.

[0019]

Another aspect of the present invention is a coating film produced by curing the coating material composition.

[0020]

Another aspect of the present invention is a multilayer coating film in which a coating film produced by curing the coating material composition is laminated on another coating film produced by curing the coating material composition.

Effects of the Invention

[0021]

A coating material composition of the present invention has an excellent quick-drying property and is capable of being coated twice in one day.

Furthermore, a coating film produced by curing the coating material composition of the present invention has a wrinkling resistance.

Note that, the term wrinkling, as used herein, refers to lifting, in other words, means that a coating film surface is wrinkled when a topcoat (second coating) is applied while an undercoat (first coating) is still insufficiently dried.

PREFERRED MODE FOR CARRYING OUT THE INVENTION

[0022]

<Coating material composition>

The present invention is a coating material composition for forming a coating film on a substrate, the composition including a phenol-modified alkyd resin (I), a urethane-modified alkyd resin (II), and an alkyd resin (III), as essential components.

In the present invention, the coating material composition may include components other than these components.

[0023]

The coating material composition of the present invention is capable of being coated twice in one day due to an excellent quick-drying property and wrinkling resistance and, simultaneously, can form a coating film with weather resistance and gloss by including the above-mentioned three essential components at a specific composition.

[0024]

[Alkyd resin (III)]

The alkyd resin (III) included in the coating material composition of the present invention is a resin obtained by condensation polymerization of a polybasic acid component, a polyhydric alcohol component, and an unsaturated fatty acid component.

In the present invention, the alkyd resin is not particularly limited as long as the alkyd resin can be applied to common coating material compositions.

[0025]

In the coating material composition of the present

invention, the alkyd resin (III) contributes to good workability due to high solubility and low viscosity and, additionally, gloss of the resultant coating film due to good flowability.

[0026]

Examples of the polybasic acid component serving as a raw material of the alkyd resin include phthalic acid, isophthalic acid, terephthalic acid, trimellitic acid, tetrahydrophthalic acid, succinic acid, maleic acid, fumaric acid, adipic acid, itaconic acid, azelaic acid, pyromellitic acid, acid anhydrides thereof and the like.

[0027]

Furthermore, examples of the polyhydric alcohol component include ethylene glycol, propylene glycol, butanediol, decanediol, diethylene glycol, pentanediol, neopentyl glycol, glycerin, trimethylolethane, trimethylolpropane, pentaerythritol, and the like.

[0028]

As the unsaturated fatty acid component, for example, fatty acids of drying and semi-drying oils such as a linseed oil, a safflower oil, a soybean oil, a sesame oil, a poppy oil, a perilla oil, a corn oil, a tall oil, a sunflower oil, a cottonseed oil, a tung oil, a dehydrated castor oil, and rice bran oil, as well as synthetic unsaturated fatty acids represented by high diene fatty acids may be exemplified.

[0029]

The alkyd resin (III) which can be applied to the present

invention may include other components in addition to the polybasic acid component, the polyhydric alcohol component, and the unsaturated fatty acid component, as raw materials of the condensation polymerization.

Examples of the other components include monobasic acids such as benzoic acid and p-hydroxybenzoic acid.

[0030]

The alkyd resin may be produced by known methods. For example, the above-mentioned raw material components are subjected to dehydration condensation in an inert gas atmosphere at about 200 to 240°C until an acid value is 10 or less.

[0031]

Note that, the alkyd resin (III) which can be applied to the present invention is not particularly limited, but is preferably, for example, those having a number average molecular weight of 1000 to 5000 and an oil length of 30 to 80.

[0032]

[Phenol-modified alkyd resin (I)]

The phenol-modified alkyd resin (I) included in the coating material composition of the present invention is a resin obtained by modifying the above-mentioned alkyd resin with a phenolic resin.

In the present invention, the phenol-modified alkyd resin is not particularly limited as long as the phenol-modified alkyd resin can be applied to common coating material compositions.

[0033]

In the coating material composition of the present invention, the phenol-modified alkyd resin (I) can increase solvent resistance of the resultant coating film due to the presence of a benzene ring.

Moreover, the phenol-modified alkyd resin (I) imparts the quick-drying property and the wrinkling resistance to the resultant coating film due to low solubility in weak solvents and a high glass transition temperature (T_g).

[0034]

As the phenolic resin for modifying the alkyd resin, conventionally known phenolic resins may be appropriately selected and used.

For example, resins obtained by reacting phenols with formaldehydes may be used.

[0035]

A method for reacting the alkyd resin with the phenolic resin is not particularly limited and known methods may be applied thereto.

For example, the alkyd resin and the phenolic resin may be mixed and heated at a temperature of 120 to 180°C for 1 to 10 hours to react with each other.

[0036]

The phenol-modified alkyd resin (I) included in the coating material composition of the present invention may be commercially available products. Examples thereof include ALUKIDIR 1341 (manufactured by DIC Corporation), ARAKYD 7107 (manufactured by ARAKAWA CHEMICAL INDUSTRIES, LTD.), and

HIRENOL PL-1000S (manufactured by Kolon Industries, Inc).

[0037]

(Content)

In the present invention, a content of the phenol-modified alkyd resin (I) relative to 100 parts by mass of a resin solid content in the coating material composition is 5 to 45 parts by mass under the condition that a content of the urethane-modified alkyd resin (II) is 5 to 45 parts by mass. The content is preferably 8 to 40 parts by mass and particularly preferably 15 to 30 parts by mass.

[0038]

When the content of the phenol-modified alkyd resin (I) relative to 100 parts by mass of a resin solid content in the coating material composition is 5 to 45 parts by mass under the condition that a content of the urethane-modified alkyd resin (II) is 5 to 45 parts by mass, the resultant coating material composition has the wrinkling resistance when recoating, is capable of being coated twice in one day due to the excellent quick-drying property, and, simultaneously, can form a coating film with the weather resistance. In other words, the coating material composition having well-balanced wrinkling resistance, quick-drying property, weather resistance, and gloss can be obtained.

[0039]

[Urethane-modified alkyd resin (II)]

The urethane-modified alkyd resin (II) included in the coating material composition of the present invention is a

modified resin obtained by reacting a hydroxy group in the above-mentioned alkyd resin with a compound having an isocyanate group.

In the present invention, the urethane-modified alkyd resin is not particularly limited as long as the urethane-modified alkyd resin can be applied to common coating material compositions.

[0040]

In the coating material composition of the present invention, the urethane-modified alkyd resin (II) can increase the weather resistance of the resultant coating film due to the presence of a urethane bond.

At the same time, the urethane bond imparts the wrinkling resistance to the coating film due to a high cohesive force and a low solubility in weak solvents.

[0041]

As the compound having an isocyanate group for modifying the alkyd resin, conventionally known compounds may be appropriately selected and used.

Examples thereof include aliphatic diisocyanates such as hexamethylene diisocyanate (including trimer), tetramethylene diisocyanate, and trimethylhexamethylene diisocyanate; alicyclic polyisocyanates such as isophorone diisocyanate and 4,4'-methylenebis(cyclohexyl isocyanate); and aromatic diisocyanates such as 4,4'-diphenylmethane diisocyanate, tolylene diisocyanate, and xylene diisocyanate.

[0042]

A method for reacting the alkyd resin with the compound having an isocyanate group is not particularly limited and known methods may be applied thereto.

For example, the hydroxy group in the alkyd resin may be reacted with the compound having an isocyanate group in the presence of a catalyst.

The catalyst that may be used is not particularly limited as long as the catalyst is used for usual urethanation reactions. Examples thereof include amine-based catalysts such as triethylamine, N-ethylmorpholine, and triethylenediamine; and tin-based catalysts such as dibutyltin dilaurate and dioctyltin dilaurate.

These catalysts may be used singly, or two or more types thereof may be used in mixture.

[0043]

(Content)

In the present invention, a content of the urethane-modified alkyd resin (II) relative to 100 parts by mass of a resin solid content in the coating material composition is 5 to 45 parts by mass under the condition that the content of the phenol-modified alkyd resin (I) is 5 to 45 parts by mass. The content is preferably 7 to 40 parts by mass and particularly preferably 10 to 20 parts by mass.

[0044]

When the content of the content of the urethane-modified alkyd resin (II) relative to 100 parts by mass of a resin solid content in the coating material composition is 5 to 45

parts by mass under the condition that the content of the phenol-modified alkyd resin (I) is 5 to 45 parts by mass, the resultant coating material composition is capable of being coated twice in one day due to the excellent quick-drying property and the wrinkling resistance, and, simultaneously, can form a coating film with the weather resistance.

In other words, the coating material composition having well-balanced wrinkling resistance, quick-drying property, weather resistance, and gloss can be obtained.

[0045]

(Urethane-modification rate)

The urethane-modified alkyd resin (II) preferably has a urethane modification rate of 10% to 15%.

The urethane modification rate of 10 to 15% increases the cohesive force due to the urethane bond and improves the wrinkling resistance.

[0046]

As used herein, the urethane modification rate of the urethane-modified alkyd resin (II) refers to a numerical value obtained by converting the number of moles of isocyanate groups in the compound having an isocyanate group to be reacted into a mass of tolylene diisocyanate when a mass of the alkyd resin serving as the raw material of the urethane-modified alkyd resin (II) is considered as 100.

Since an isocyanate equivalent of the tolylene diisocyanate is 87, the urethane modification rate can be determined according to the following expression:

Urethane modification rate (%) = Charged amount of isocyanate compound relative to 100 of Alkyd resin * 87 / Isocyanate equivalent of isocyanate compound.

[0047]

[Other components]

The coating material composition of the present invention may optionally include components other than the phenol-modified alkyd resin (I), the urethane-modified alkyd resin (II), and the alkyd resin (III) serving as essential components.

Examples of the other components include a pigment, a combination resin, a solvent, an anti-sagging and anti-settling agent, an anti-flooding agent, an anti-foaming and anti-solvent popping agent, a leveling agent, a formaldehyde catch agent, a dryer, and the like.

[0048]

When the coating material composition of the present invention includes the pigment, at least one of an extender pigment, a coloring pigment, and a rust-inhibiting pigment may be applied or two or more thereof may be used in combination.

[0049]

(Rust-inhibiting pigment)

The coating material composition of the present invention preferably includes the rust-inhibiting pigment.

Inclusion of the rust-inhibiting pigment imparts a rust-inhibiting property to the coating material composition. For example, when the coating material composition of the present

invention is used as an undercoat agent, an undercoat film having a rust-inhibiting function may be formed.

[0050]

As the rust-inhibiting pigment, conventionally known compounds that may be applied to coating material compositions may be appropriately selected and used.

Examples thereof include zinc phosphate, iron phosphate, aluminum phosphate, calcium phosphate, zinc phosphite, calcium phosphite, zinc cyanide, zinc oxide, aluminum triphosphate, zinc molybdate, aluminum molybdate, calcium molybdate, aluminum phosphomolybdate, aluminum zinc phosphomolybdate, zinc powder (Zn), aluminum powder (Al), and the like.

[0051]

(Solvent)

A solvent that can be applied to the coating material composition of the present invention is not particularly limited, but is preferably a weak solvent.

The weak solvent can improve recoatability and suppress wrinkling of the coating film due to low dissolving power for the previously formed coating film.

Furthermore, the weak solvent can decrease an odor.

[0052]

Examples of the weak solvent include aliphatic hydrocarbon-based solvents. For example, those having a high flash point, a high boiling point, and low hazardousness represented by mineral spirits and turpentine are preferred. More specific examples thereof include mineral spirits, white

spirits, mineral turpentine, isoparaffin, solvent kerosene, aromatic naphtha, VM & P naphtha, solvent naphtha, and the like.

[0053]

[Pigment volume concentration (PVC)]

The coating material composition of the present invention preferably has a pigment volume concentration (PVC) in a range of 20 to 35%, and particularly preferably 25 to 30%.

[0054]

As used herein, the pigment volume concentration (PVC) means a percentage by volume (%) of a pigment in a total solid content of all resins and all pigments in a coating material composition.

The pigment volume concentration (PVC) of the coating material composition in the range of 20 to 35% achieves a good hiding property while maintaining gloss.

[0055]

<Preparation method of coating material composition>

The coating material composition of the present invention can be prepared by applying methods that one skilled in the art usually uses.

For example, the coating material composition can be prepared by mixing components with a disper mixer, a ball mill, an S.G. mill, a roll mill, a planetary mixer, etc.

[0056]

[Substrate]

A substrate onto which the coating material composition of

the present invention is applied is not particularly limited. Examples thereof include metal substrates such as steel, aluminum, and stainless steel; and wood substrates. Note that, the substrate has various shapes depending on application types thereof and the coating material composition may be applied on the substrate having any shape.

[0057]

<Application of coating material composition>

The coating material composition of the present invention may be applied either as an undercoat or as a topcoat.

[0058]

In particular, the coating material composition of the present invention has an excellent quick-drying property and wrinkling resistance when recoating multiple times, and is capable of being coated twice in one day, so that it is possible that undercoating is firstly conducted and then a topcoat is recoated thereon in a day.

[0059]

<Coating film>

(Monolayer coating film)

A coating film of the present invention can be obtained by curing the coating material composition of the present invention.

When the coating material composition of the present invention is used as an undercoat, the composition yields an undercoating film. On the other hand, when the coating material composition is used as a topcoat, a surface coating

film may be formed.

[0060]

The coating film obtained by curing the coating material composition of the present invention has an improved rust-inhibiting property when the coating material composition includes the rust-inhibiting pigment.

[0061]

Furthermore, when used as the topcoat, a surface coating film having both the gloss due to the alkyd resin (III) and the weather resistance due to the urethane-modified alkyd resin (II) is formed.

[0062]

(Multilayer coating film)

Since the coating material composition of the present invention may be applied either as the undercoat or as the topcoat, a coating film produced by curing the coating material composition of the present invention may be laminated on another coating film produced by curing the coating material composition of the present invention to thereby form a multilayer coating film.

[0063]

When the multilayer coating film is formed using the coating material composition of the present invention, the undercoat may be the same as or different from the coating material composition of the present invention used as the topcoat.

Different compositions may be appropriately used depending on

purposes and within the scope of the invention.

EXAMPLES

[0064]

Hereinafter, the present invention will be described in more detail with reference to Examples, but the present invention is not limited thereto.

[0065]

<Production of alkyd resin (III)>

A flask equipped with a stirrer, a reflux condenser, a water separator, a temperature controller, and a nitrogen inlet was charged with 21.5 parts of a linseed oil, 32.1 parts of a soy oil, 7.1 parts of glycerin, 11.4 parts of pentaerythritol, and 0.04 parts of lithium hydroxide, heated to 240°C for 30 minutes, and then kept at 240°C for 30 minutes. Then, the resultant mixture was cooled to 150°C, charged with 31.9 parts of phthalic anhydride and 5 parts of reflux xylol, heated to 220°C, reacted with each other at 220°C until a resin acid number reached 5. Thereafter, mineral turpentine was added thereto to adjust a non-volatile content to 50%. Thus, a varnish of an alkyd resin was obtained.

[0066]

<Production of urethane-modified alkyd resin (II)>

[Production of urethane-modified alkyd resin (II) A]

(Production of alkyd resin)

A flask equipped with a stirrer, a reflux condenser, a

water separator, a temperature controller, and a nitrogen inlet was charged with 55 parts of a soy oil, 13 parts of glycerin, 13 parts of pentaerythritol, and 0.04 parts of lithium hydroxide, heated to 240°C for 30 minutes, and then kept at 240°C for 30 minutes.

Then, the resultant mixture was cooled to 150°C, charged with 19 parts of phthalic anhydride and 5 parts of reflux xylol, heated to 220°C, reacted with each other at 220°C until a resin acid number reached 7. Thereafter, mineral turpentine was added thereto to adjust a non-volatile content to 50%. Thus, a varnish of an alkyd resin was obtained.

[0067]

(Modification of alkyd resin)

200 parts of the resultant varnish of an alkyd resin was charged with 12.5 parts of tolylene diisocyanate, followed by reacting with each other at 100°C for 6 hours. Then, mineral turpentine was added thereto to adjust a non-volatile content to 50%. Thus, a varnish of a urethane-modified alkyd resin A having a urethane modification rate of 12.5% was obtained.

[0068]

[Production of urethane-modified alkyd resin (II) B]

A varnish of a urethane resin-modified alkyd resin B having a urethane modification rate of 5% was obtained in the same manner as in the varnish of a urethane-modified alkyd resin A, except that the charged amount of tolylene diisocyanate was changed to 5 parts.

[0069]

[Production of urethane-modified alkyd resin (II) C]

A varnish of a urethane resin-modified alkyd resin C having a urethane modification rate of 10% was obtained in the same manner as in the varnish of a urethane-modified alkyd resin A, except that the charged amount of tolylene diisocyanate was changed to 10 parts.

[0070]

[Production of urethane-modified alkyd resin (II) D]

A varnish of a urethane resin-modified alkyd resin D having a urethane modification rate of 15% was obtained in the same manner as in the varnish of a urethane-modified alkyd resin A, except that the charged amount of tolylene diisocyanate was changed to 15 parts.

[0071]

<Example 1>

A coating material composition was prepared by formulating 27.5 parts in terms of solid content of the alkyd resin (III), 2.0 parts in terms of solid content of the phenol-modified alkyd resin (I), 5.0 parts in terms of solid content of the urethane-modified alkyd resin (II) A, and 3.0 parts of a rust-inhibiting pigment and stirring with a high-speed disper for 30 minutes.

Note that, the coating material composition was formulated with mineral spirits as a solvent and, in addition to the above components, titanium oxide, an extender pigment, an anti-sagging agent, an anti-foaming agent, a dryer, etc.

[0072]

<Examples 2 to 28, Comparative Examples 1 to 3>

Coating compositions of Examples 2 to 28 and Comparative Examples 1 to 3 were prepared in the same manner as in the coating material composition of Example 1 according to formulae described in Tables 1 to 7.

Note that, in the tables of Examples 2 to 28 and Comparative Examples 1 to 3, "yes" in the row of the rust-inhibiting pigment means that 3.0 parts of the rust-inhibiting pigment was formulated in the same manner as in Example 1.

[0073]

For resin components in Tables 1 to 7, numerical values in parentheses refer to mass ratios of the components when a total resin solid content in the coating material composition is considered as 100% by mass.

Furthermore, Example 21 is an example in which 5.0 parts of the urethane-modified alkyd resin (II) B was formulated and Examples 22 and 23 are examples in which 5.0 parts of the urethane-modified alkyd resin (II) C and 5.0 parts of the urethane-modified alkyd resin (II) D were formulated, respectively.

In Tables 1 to 7, the urethane modification rate of the urethane-modified alkyd resin (II) and the pigment volume concentration (PVC) of the resultant coating material composition are also described.

[0074]

Formulation components used in Examples and Comparative Examples are described below.

Alkyd resin (III): the above-obtained vanish of an alkyd resin

Urethane-modified alkyd resin (II) A: the above-obtained

vanish of a urethane-modified alkyd resin (II) A

Urethane-modified alkyd resin (II) B: the above-obtained

vanish of a urethane-modified alkyd resin (II) B

Urethane-modified alkyd resin (II) C: the above-obtained

vanish of a urethane-modified alkyd resin (II) C

Urethane-modified alkyd resin (II) D: the above-obtained

vanish of a urethane-modified alkyd resin (II) D

Phenol-modified alkyd resin (I): ALUKIDIR 1341 (manufactured
by DIC Corporation)

Rust-inhibiting pigment: calcium phosphite

[0075]

[Evaluation]

The coating material compositions of Examples 1 to 28 and Comparative Examples 1 to 3 were evaluated for wrinkling resistance, weather resistance, gloss, a hiding property, and a rust-inhibiting property according to the methods below. The results are presented in Tables 1 to 7.

[0076]

(Wrinkling resistance)

The resultant coating material composition was diluted to 10%.

A tin plate was prepared, coated with the 10% diluted coating material composition using a 4-22 MIL sagging tester, horizontally disposed, and cured at 23°C and 50% humidity for 6 hours to thereby form an undercoat film.

The resultant undercoat film was coated with the 10% diluted coating material composition using a brush so as to give a film thickness of 35 μm after drying to thereby form a topcoat film.

The resultant topcoat film was visually observed and evaluated for the wrinkling resistance by confirming the thickness of the undercoat film where wrinkling occurred according to the following evaluation criteria.

Excellent: wrinkling occurred on the undercoat film at 12 MIL or more.

Good: wrinkling occurred on the undercoat film at 9 MIL.

Fair: wrinkling occurred on the undercoat film at 8 MIL.

Poor: wrinkling occurred on the undercoat film at 7 MIL or less.

[0077]

(Gloss)

Specular gloss was evaluated according to JIS K 5516 7.11. Specifically, a glass plate was coated with an undiluted coating material composition using a 4 MIL applicator, horizontally disposed, dried at 23°C for 48 hours, and then measured for 60-degree gloss using a digital variable angle glossmeter (manufactured by Suga Test Instruments Co., Ltd., "UGV-5K").

Evaluation criteria are described below.

Excellent: 85 or more

Good: 80 or more but less than 85

Fair: 75 or more but less than 80

Poor: less than 75

[0078]

(Hiding property)

A contrast ratio was evaluated according to JIS K 5516 7.9. In other words, the contrast ratio was evaluated according to the contrast ratio test in JIS K 5600-4-1 4.1.2 Method B. Specifically, a hiding-chart (manufactured by Nippon Testpanel Co., Ltd) used for general test methods of coating was coated with an undiluted coating material composition using a 4 MIL applicator, dried at 23°C for 48 hours, measured for the tristimulus value Y in a white part (YW) and a black part (YB) using a chroma meter (manufactured by KONICA MINOLTA, INC., CR-400), and then calculated for the contrast ratio YB/YW as a percentage.

Evaluation criteria are described below.

Excellent: 95 or more

Good: 90 or more but less than 95

Fair: 85 or more but less than 90

Poor: 80 or more but less than 85

[0079]

(Production of test panel for evaluating weather resistance and rust-inhibiting property)

For production of a test panel for evaluating the weather resistance and the rust-inhibiting property, a cold-finished steel plate (150 * 70 * 0.8 mm) was prepared as a substrate. Firstly, a rust-inhibiting oil on a surface of the cold-finished steel plate was cleaned with a solvent (xylene) and

the solvent was wiped off with a waste.

Then, a back surface of the cold-finished steel plate from which the solvent had been wiped off was coated with a rust-inhibiting coating material composition (HI-PON Fine Primer II, manufactured by NIPPON PAINT CO., LTD) and back-sealed.

After the rust-inhibiting coating material on the back surface of the cold-finished steel plate had dried, a surface of the cold-finished steel plate was coated with the coating material compositions of Examples 1 to 28 and Example 1 and Comparative Examples 1 to 3 using a brush so as to give a coating amount of 100 to 120 g/m².

After leaving to stand at room temperature for 24 hours, a side surface (end surface) of the test panel was coated with the above-mentioned rust-inhibiting coating material composition, and was side-sealed.

Moreover, the resultant panel was left to dry at room temperature for 6 days. Thus, the test panel for evaluating the weather resistance and the rust-inhibiting property was obtained.

[0080]

(Weather resistance)

The above-produced test panel was evaluated for the weather resistance under outdoor exposure using a chalking tape according to JIS K 5516 7.17.

Note that, an exposure period was 1 year.

Evaluation criteria are described below.

Excellent: There was no blistering, peeling, or cracking and

color or gloss was not greatly changed.

Chalking grade: 3 or less.

Good: There was no blistering, peeling, or cracking and color or gloss was not greatly changed.

Chalking grade: 4.

Fair: There was no blistering, peeling, or cracking and color or gloss was not greatly changed.

Chalking grade: 5.

Poor: There was no blistering, peeling, or cracking and color or gloss was greatly changed.

Chalking grade: 5.

[0081]

(Rust-inhibiting property)

The above-produced test panel was evaluated for a cycle corrosion property by subjecting to 36 cycles of the test under the conditions described in Annex 1 (Cycle D) of JIS K 5600 7.9 according to the test method described in JIS K 5674 7.12.

Evaluation criteria are described below.

Excellent: There was no rust on a general surface and the maximum blister width or rust width on one side of a cut portion was less than 1.7 mm.

Good: There was no rust on a general surface and the maximum blister width or rust width on one side of a cut portion was 1.7 mm or more but less than 2.0 mm.

Fair: There was no rust on a general surface and the maximum blister width or rust width on one side of a cut portion was

2.0 mm or more.

Poor: There was rust on a general surface and the maximum blister width or rust width on one side of a cut portion was

2.0 mm or more.

[0082]

[Table 1]

	Example 1	Example 2	Example 3	Example 4	Example 5	Example 6
Alkyd resin (III)	27.5 (79.7%)	27.5 (66.3%)	27.5 (75.3%)	27.5 (73.3%)	27.5 (68.8%)	27.5 (64.7%)
Phenol-modified alkyd resin (I)	2.0 (5.8%)	4.0 (9.63%)	4.0 (11.0%)	5.0 (13.3%)	7.5 (18.8%)	10.0 (23.5%)
Urethane-modified alkyd resin (II) A	5.0 (14.5%)	10.0 (24.1%)	5.0 (13.7%)	5.0 (13.3%)	5.0 (12.5%)	5.0 (11.8%)
(I) + (II)	7.0 (20.3%)	14.0 (33.7%)	9.0 (24.7%)	10.0 (26.6%)	12.5 (31.3%)	15.0 (35.3%)
Urethane modification rate	12.5%	12.5%	12.5%	12.5%	12.5%	12.5%
Pigment volume concentration (PVC)	31.7%	27.9%	30.5%	29.9%	28.6%	27.4%
Rust-inhibiting pigment	Yes	Yes	Yes	Yes	Yes	Yes
Wrinkling resistance	Fair	Good	Good	Good	Excellent	Excellent
Weather resistance	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent
Gloss	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent
Hiding property	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent
Rust-inhibiting property	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent

[0083]

[Table 2]

	Example 7	Example 8	Example 9	Example 10	Example 11
Alkyd resin (III)	27.5 (61.1%)	27.5 (57.89%)	27.5 (47.82%)	25.0 (47.6%)	22.5 (40.9%)
Phenol-modified alkyd resin (I)	12.5 (27.8%)	15.0 (31.58%)	20.0 (34.8%)	20.0 (38.1%)	25.0 (40.9%)
Urethane-modified alkyd resin (II) A	5.0 (11.1%)	5.0 (10.52%)	10.0 (17.4%)	7.5 (14.2%)	7.5 (9.1%)
(I) + (II)	17.5 (38.9%)	20.0 (42.1%)	30.0 (52.2%)	27.5 (52.3%)	32.5 (50.0%)
Urethane modification rate	12.5%	12.5%	12.5%	12.5%	12.5%
Pigment volume concentration (PVC)	26.3%	25.2%	21.8%	23.4%	22.6%
Rust-inhibiting pigment	Yes	Yes	Yes	Yes	Yes
Wrinkling resistance	Excellent	Excellent	Excellent	Excellent	Excellent
Weather resistance	Excellent	Good	Excellent	Excellent	Good
Gloss	Excellent	Good	Good	Good	Fair
Hiding property	Excellent	Excellent	Good	Good	Good
Rust-inhibiting property	Excellent	Excellent	Excellent	Excellent	Excellent

[0084]

[Table 3]

	Example 12	Example 13	Example 14	Example 6	Example 15
Alkyd resin (III)	30.0 (71.42%)	27.5 (64.7%)	27.5 (66.3%)	27.5 (64.7%)	27.5 (57.9%)
Phenol-modified alkyd resin (I)	10.0 (25.0%)	12.0 (28.2%)	10.0 (24.1%)	10.0 (23.5%)	10.0 (21.1%)
Urethane-modified alkyd resin (II) A	2.0 (4.8%)	3.0 (7.06%)	4.0 (9.6%)	5.0 (11.8%)	10.0 (21.1%)
(I) + (II)	12.0 (29.8%)	15.0 (35.2%)	14.0 (33.7%)	15.0 (35.3%)	20.0 (42.1%)
Urethane modification rate	12.5%	12.5%	12.5%	12.5%	12.5%
Pigment volume concentration (PVC)	27.6%	27.4%	27.9%	27.4%	25.2%
Rust-inhibiting pigment	Yes	Yes	Yes	Yes	Yes
Wrinkling resistance	Good	Excellent	Excellent	Excellent	Excellent
Weather resistance	Fair	Good	Excellent	Excellent	Excellent
Gloss	Excellent	Excellent	Excellent	Excellent	Excellent
Hiding property	Excellent	Excellent	Excellent	Excellent	Excellent
Rust-inhibiting property	Excellent	Excellent	Excellent	Excellent	Excellent

[0085]

[Table 4]

	Example 16	Example 17	Example 18	Example 19	Example 20
Alkyd resin (III)	27.5 (64.7%)	22.5 (52.9%)	27.5 (52.4%)	27.5 (47.8%)	27.5 (64.7%)
Phenol-modified alkyd resin (I)	5.0 (11.8%)	5.0 (11.8%)	5.0 (9.52%)	5.0 (8.7%)	10.0 (23.5%)
Urethane-modified alkyd resin (II) A	10.0 (23.5%)	15.0 (35.3%)	20.0 (38.0%)	25.0 (43.5%)	5.0 (11.8%)
(I) + (II)	15.0 (35.3%)	20.0 (47.1%)	25.0 (47.5%)	30.0 (52.2%)	15.0 (35.3%)
Urethane modification rate	12.5%	12.5%	12.5%	12.5%	12.5%
Pigment volume concentration (PVC)	27.4%	27.4%	23.4%	21.8%	27.4%
Rust-inhibiting pigment	Yes	Yes	Yes	Yes	No
Wrinkling resistance	Good	Good	Good	Fair	Excellent
Weather resistance	Excellent	Excellent	Excellent	Excellent	Excellent
Gloss	Excellent	Good	Good	Good	Excellent
Hiding property	Excellent	Excellent	Good	Good	Excellent
Rust-inhibiting property	Excellent	Excellent	Excellent	Excellent	Fair

[0086]

[Table 5]

	Example 21	Example 22	Example 6	Example 23
Alkyd resin (III)	27.5 (64.7%)	27.5 (64.7%)	27.5 (64.7%)	27.5 (64.7%)
Phenol-modified alkyd resin (I)	10.0 (23.5%)	10.0 (23.5%)	10.0 (23.5%)	10.0 (23.5%)
Urethane-modified alkyd resin (II)	B: 5.0 (11.8%)	C: 5.0 (11.8%)	A: 5.0 (11.8%)	D: 5.0 (11.8%)
(I) + (II)	15.0 (35.3%)	15.0 (35.3%)	15.0 (35.3%)	15.0 (35.3%)
Urethane modification rate	5.0%	10.0%	12.5%	15.0%
Pigment volume concentration (PVC)	27.4%	27.4%	27.4%	27.4%
Rust-inhibiting pigment	Yes	Yes	Yes	Yes
Wrinkling resistance	Fair	Good	Excellent	Excellent
Weather resistance	Good	Good	Excellent	Excellent
Gloss	Excellent	Excellent	Excellent	Good
Hiding property	Excellent	Excellent	Excellent	Excellent
Rust-inhibiting property	Excellent	Excellent	Excellent	Excellent

[0087]

[Table 6]

	Example 24	Example 25	Example 26	Example 27	Example 28
Alkyd resin (III)	27.5 (64.7%)	27.5 (64.7%)	27.5 (64.7%)	27.5 (64.7%)	27.5 (64.7%)
Phenol-modified alkyd resin (I)	10.0 (23.5%)	10.0 (23.5%)	10.0 (23.5%)	10.0 (23.5%)	10.0 (23.5%)
Urethane-modified alkyd resin (II) A	5.0 (11.8%)	5.0 (11.8%)	5.0 (11.8%)	5.0 (11.8%)	5.0 (11.8%)
(I) + (II)	15.0 (35.3%)	15.0 (35.3%)	15.0 (35.3%)	15.0 (35.3%)	15.0 (35.3%)
Urethane modification rate	12.5%	12.5%	12.5%	12.5%	12.5%
Pigment volume concentration (PVC)	16.7%	21.0%	27.4%	33.1%	37.5%
Rust-inhibiting pigment	Yes	Yes	Yes	Yes	Yes
Wrinkling resistance	Excellent	Excellent	Excellent	Excellent	Excellent
Weather resistance	Excellent	Excellent	Excellent	Good	Fair
Gloss	Excellent	Excellent	Excellent	Good	Fair
Hiding property	Fair	Good	Excellent	Excellent	Excellent
Rust-inhibiting property	Good	Excellent	Excellent	Excellent	Good

[0088]

[Table 7]

	Comparative Example 1	Comparative Example 2	Comparative Example 3
Alkyd resin (III)	25.0 (50.0%)	25.0 (50.0%)	0
Phenol-modified alkyd resin (I)	0	25.0 (50.0%)	25.0 (50.0%)
Urethane-modified alkyd resin (II) A	25.0 (50.0%)	0	25.0 (50.0%)
(I) + (II)	25.0 (50.0%)	25.0 (50.0%)	50.0 (100.0%)
Urethane modification rate	12.5%	12.5%	12.5%
Pigment volume concentration (PVC)	24.3%	24.3%	24.3%
Rust-inhibiting pigment	Yes	Yes	Yes
Wrinkling resistance	Poor	Excellent	Excellent
Weather resistance	Excellent	Poor	Excellent
Gloss	Good	Good	Poor
Hiding property	Excellent	Excellent	Excellent
Rust-inhibiting property	Excellent	Excellent	Excellent

CLAIMS

1. A coating material composition for forming a coating film on a substrate, the composition comprising:

a phenol-modified alkyd resin (I); a urethane-modified alkyd resin (II); and an alkyd resin (III);

the composition comprising the phenol-modified alkyd resin (I) in an amount of 5 to 45 parts by mass relative to 100 parts by mass of a resin solid content in the coating material composition, and

the composition comprising the urethane-modified alkyd resin (II) in an amount of 5 to 45 parts by mass relative to 100 parts by mass of a total resin solid content in the coating material composition.

2. The coating material composition according to claim 1, wherein the urethane-modified alkyd resin (II) has a urethane modification rate of 10% to 15%.

3. The coating material composition according to claim 1 or 2, having a pigment volume concentration (PVC) of 20.0 to 35.0%.

4. The coating material composition according to any of claims 1 to 3, further comprising a rust-inhibiting pigment.

5. The coating material composition according to any of claims 1 to 4, being an undercoat.

6. The coating material composition according to any of claims 1 to 4, being a topcoat.

7. A coating film, the film being produced by curing the coating material composition according to any of claims 1 to 4.

8. A multilayer coating film, comprising:

 a coating film produced by curing the coating material composition according to any of claims 1 to 4; and

 another coating film produced by curing the coating material composition according to any of claims 1 to 4 laminated on the coating film.