

【DESCRIPTION】

【Invention Title】

CLEAR PAINT COMPOSITION

【Technical Field】

The present invention relates to a clear paint composition capable of producing a coating film having excellent appearance characteristics, chipping resistance and scratch resistance.

【Background Art】

A car body is generally subjected to multiple painting processes such as electro-deposition coating, intermediate coat painting, topcoat painting, and clear painting, for appearance and protection of its surface from the external environment. Specifically, a common automobile painting process is that after electro-deposition coating on the car body, an intermediate coat paint is applied and cured, and a topcoat paint and a clear paint are continuously painted on the intermediate coat coating layer, followed by drying and curing them. This automobile painting process is generally performed by the 3 coat 2 bake (3C2B) painting method in which the primary curing is performed after intermediate coat painting and the secondary curing is performed after clear paint painting.

As a clear paint for automobiles, a thermosetting coating composition containing an acrylic resin having a hydroxyl group or an amino resin is widely used. For example, it was common that the conventional composition for the clear paint contains an acrylic resin and a melamine resin, and the melamine resin reacts with the hydroxyl group contained in the acrylic resin to form a chemical bond and form a coating film. However, the conventional composition

for the clear paint as described above has a limitation that scratch resistance of the coating film prepared therefrom is remarkably insufficient due to lack of mechanical physical properties, particularly, surface tension and flexibility of the coating prepared.

As an alternative to overcome the limitations of such conventional clear paint, Korean Patent Registration No. 1,115,869 (Patent Document 1) discloses a 1K clearcoat composition for automobiles for improving scratch resistance, comprising an acrylic resin, a melamine resin, a silane-modified blocked isocyanate resin, and a resin for adjusting flow properties. However, in the case of the clear coat composition of Patent Document 1, the appearance characteristics of the coating film prepared therefrom are deteriorated, and thus there was a limit to applying it as a paint for a car body.

Therefore, there is a need for research and development on the clear paint composition capable of producing a coating film having excellent appearance characteristics and mechanical physical properties, especially, excellent scratch resistance, flexibility, and hardness.

【Disclosure】

【Technical Problem】

The present invention provides a clear paint composition capable of producing a coating film having excellent scratch resistance and chipping resistance by enhancing the surface tension and flexibility of the coating prepared.

【Technical Solution】

The present invention provides a clear paint composition comprising a silane-modified acrylic resin, a first polyester polyol resin, a second polyester polyol

resin, a melamine resin, and an urethane resin, wherein the number average molecular weight of the first polyester polyol resin is greater than the number average molecular weight of the second polyester polyol resin.

【Advantageous Effects】

The clear paint composition according to the present invention uses an organic resin and an inorganic resin in combination to strengthen the surface tension and flexibility of the coating film prepared therefrom, and thus the coating film prepared therefrom has excellent scratch resistance. In addition, the clear paint composition contains a low molecular weight polyester resin, and thus the coating film prepared therefrom has excellent flexibility and resilience, and also the clear paint composition contains two kinds of polyester resin, and thus the coating film prepared therefrom has excellent appearance characteristics, flexibility, chipping resistance, and scratch resistance.

【Best Mode】

Hereinafter, the present invention will be described in detail.

As used herein, "weight-average molecular weight" and "number average molecular weight" are measured by a conventional method known in the art, and may be measured by, for example, a gel permeation chromatograph (GPC) method. Furthermore, the "glass transition temperature" is measured by a conventional method known in the art, and may be measured, for example, by differential scanning calorimetry (DSC). In addition, functional group values such as "acid value" and "hydroxyl value" may be measured by a method well known in the art, and may represent a value measured by, for example, a titration method.

In addition, the term "(meth)acrylate" in this specification means acrylate and/or methacrylate.

The clear paint composition according to the present invention includes a silane-modified acrylic resin, a first polyester polyol resin, a second polyester polyol resin, a melamine resin, and an urethane resin.

Silane-modified acrylic resin

The silane-modified acrylic resin serves to improve the physical properties of the coating film, such as hardness, acid resistance, and scratch resistance.

The silane-modified acrylic resin may be directly synthesized according to a known method, or may be a commercially available product. At this time, the silane-modified acrylic resin may be, for example, one prepared by modifying an acrylic resin prepared by polymerizing at least one selected from the group consisting of a vinyl monomer and a (meth)acrylate monomer, by using a silane monomer.

The type of the vinyl monomer is not particularly limited, but may be, for example, at least one selected from styrene, methylstyrene, dimethylstyrene, fluorostyrene, ethoxystyrene, methoxystyrene, phenylene vinyl ketone, vinyl t-butylbenzoate, vinyl cyclohexanoate, vinyl acetate, vinyl pyrrolidone, vinyl chloride, vinyl alcohol, acetoxystyrene, t-butylstyrene, vinyltoluene, chlorostyrene, and cyclohexylvinyl ether.

In addition, the (meth)acrylate monomer may be, for example, at least one selected from 2-hydroxypropyl methacrylate, propyl methacrylate, t-butylaminoethyl methacrylate, dicyclopentenyl oxyethyl methacrylate, acrylic acid dimer, hexanediol diacrylate, butyl acrylate, triisopropylsilyl acrylate, benzyl methacrylate, 2-hydroxyethyl methacrylate, trimethylol propane triacrylate, tripropyleneglycol diacrylate, ethyl methacrylate, isobutyl

methacrylate, hydroxyisopropyl methacrylate, isopropyl methacrylate, cyclohexyl methacrylate, triisopropyl silyl methacrylate, isobornyl acrylate, t-butylcyclohexyl methacrylate, trimethylcyclohexyl methacrylate, methyl methacrylate, acrylic acid, t-butyl methacrylate, isobornyl methacrylate, methacrylonitrile, methacrylic acid, acrylamide, and methacrylamide.

The silane monomer may be an alkoxy group-containing silane monomer. For example, the silane monomer may comprise gamma-glycidoxypropyl triethoxy silane, gamma-glycidoxypropyl trimethoxy silane, gamma-glycidoxypropyl methyldiethoxy silane, 3-mercaptopropyl trimethoxy silane, vinyltrimethoxysilane, vinyltriethoxy silane, gamma-methacryloxypropyl trimethoxy silane, gamma-methacryloxypropyl triethoxy silane, gamma-aminopropyl trimethoxy silane, gamma-aminopropyl triethoxy silane, 3-isocyanato propyl triethoxy silane, gamma-acetoacetatepropyl trimethoxysilane, gamma-acetoacetatepropyl triethoxy silane, beta-cyanoacetyl trimethoxy silane, beta-cyanoacetyl triethoxy silane, acetoxyceto trimethoxy silane, and the like.

The silane-modified acrylic resin may have a glass transition temperature of 30 to 50 °C, 35 to 48 °C, or 40 to 45 °C, a weight-average molecular weight (Mw) of 5,500 to 8,500 g/mol, 6,000 to 8,000 g/mol, or 6,500 to 7,500 g/mol, and a viscosity at 25 °C of 500 to 2,500 cps, 700 to 2,000 cps, or 900 to 1,800 cps. If the glass transition temperature of the silane-modified acrylic resin is within the above range, it is possible to secure proper physical properties of the coating while having good storage stability. If the weight-average molecular weight is within the above range, the long-term physical properties of the prepared coating film, such as durability and weatherability,

are improved. If the viscosity at 25 °C is within the above range, there is an effect that the workability of the composition is easy.

In addition, the silane-modified acrylic resin may have a hydroxyl value (OHv) of 80 to 90 mgKOH/g, or 82 to 88 mgKOH/g, and an acid value (Av) of 5 mgKOH/g or less, 4 mgKOH/g or less, or 1 to 3 mgKOH/g. If the hydroxyl value of the silane-modified acrylic resin is within the above range, the hardenability of the composition is improved to ensure impact resistance, water resistance, adhesive property, and cold chipping resistance. If the acid value is within the above range, the reactivity of the composition is adjusted, thereby improving the appearance characteristics of the coating film.

The silane-modified acrylic resin may be contained in a content of 1 to 20 parts by weight, 5 to 15 parts by weight, or 7 to 13 parts by weight based on the first polyester polyol resin of 1 to 20 parts by weight. If the content of the silane-modified acrylic resin is within the above range, it is possible to prevent the problem of deterioration of the gloss of the coating film prepared from the paint composition containing the same, and the problem of deterioration of appearance characteristics and hardening density of the coating film.

First polyester polyol resin

The first polyester polyol resin serves to improve the appearance characteristics and flexibility of the prepared coating film.

The first polyester polyol resin may be a product directly synthesized according to a known method or a commercially available product. For example, the first polyester polyol resin may be prepared by reacting a carboxylic acid with a polyol.

In this case, the carboxylic acid may be at least one selected from the group consisting of isononanoic acid, adipic acid (AA), isophthalic acid (IPA), trimellitic acid anhydride (TMA), cycloaliphatic acid, phthalic anhydride, isophthalic acid, terephthalic acid, succinic acid, adipic acid, fumaric acid, maleic anhydride, tetrahydrophthalic anhydride, hexahydrophthalic anhydride (HHPA), and derivatives thereof. In addition, the polyol may be at least one selected from the group consisting of methoxypolyethylene glycol, 1,6-hexanediol (1,6-HD), neopentyl glycol (NPG), trimethylol propane (TMP), ethylene glycol, propylene glycol, diethyleneglycol, butanediol 1,4-hexanediol, and 3-methylpentanediol.

The first polyester polyol resin may have a hydroxyl value (OHv) of 100 to 180 mgKOH/g, 120 to 150 mgKOH/g, or 130 to 145 mgKOH/g, and an acid value (Av) of 10 to 50 mgKOH/g, 15 to 35 mgKOH/g, or 20 to 25 mgKOH/g. If the hydroxyl value of the first polyester polyol resin is within the above range, the composition has good water dispersibility and the coating from it has good physical properties. If the acid value is within the above range, there is an effect that the storage stability and crosslinking density are improved, so the cold chipping resistance is good.

In addition, the number average molecular weight (M_n) of the first polyester polyol resin is greater than the number average molecular weight of the second polyester polyol resin. For example, the first polyester polyol resin may have a number average molecular weight (M_n) of 1,300 to 2,500 g/mol, 1,400 to 2,300 g/mol, or 1,500 to 2,000 g/mol.

The first polyester polyol resin may have a lower hydroxyl value (OHv) than the second polyester polyol resin. That is, the first polyester polyol resin may have a greater number average molecular weight and a lower hydroxyl value

than the second polyester polyol resin.

In addition, the first polyester polyol resin may have a viscosity at 25°C of 1,000 to 3,500 cps, 1,500 to 3,000 cps, or 1,800 to 2,700 cps. If the viscosity at 25°C of the first polyester polyol resin is within the above range, there is an effect that workability is easy.

The first polyester polyol resin may be contained in a content of 1 to 20 parts by weight, 5 to 15 parts by weight, or 7 to 13 parts by weight based on a silane-modified acrylic resin of 1 to 20 parts by weight. If the content of the first polyester polyol resin is within the above range, there is an effect that the appearance, impact resistance and cold chipping resistance of the prepared coating film are good.

Second polyester polyol resin

The second polyester polyol resin plays a role in improving the chipping resistance and scratch resistance by increasing the solid content and reactivity of the composition, and improving the flexibility and resilience of the prepared coating film.

In this case, the second polyester polyol resin may be a product directly synthesized according to a known method or a commercially available product. For example, the second polyester polyol resin may be prepared by reacting caprolactone and polyol. In this case, the polyol may be cyclohexanedimethanol (CHDM) and the like, but is not limited thereto.

In addition, the second polyester polyol resin may have a hydroxyl value (OHv) of 200 to 400 mgKOH/g, 230 to 350 mgKOH/g, or 250 to 300 mgKOH/g. If the hydroxyl value of the second polyester polyol resin is within the above range, there is an effect that the crosslinking density with the

curing agent is improved, thereby improving the durability of the prepared coating film.

The number average molecular weight (M_n) of the second polyester polyol resin is smaller than the number average molecular weight (M_n) of the first polyester polyol resin. For example, the second polyester polyol resin may have a number average molecular weight of 500 to 1,000 g/mol, 550 to 900 g/mol, or 600 to 800 g/mol.

In addition, the second polyester polyol resin may have a viscosity at 25°C of 700 to 2,500 cps, 800 to 2,400 cps, or 850 to 2,300 cps. If the viscosity at 25°C of the second polyester polyol resin is within the above range, there is an effect that workability is easy and the appearance is excellent.

The second polyester polyol resin may be contained in a content of 1 to 20 parts by weight, 5 to 15 parts by weight, or 7 to 13 parts by weight based on a silane-modified acrylic resin of 1 to 20 parts by weight. If the content of the second polyester polyol resin is within the above range, there is an effect that the prepared coating film has good impact resistance and cold chipping resistance.

The clear paint composition may contain the first polyester polyol resin and the second polyester polyol resin in a weight ratio of 1:0.1 to 1:5, a weight ratio of 1:0.2 to 1:3, or a weight ratio of 1:0.5 to 1:2. If the mixing weight ratio of the first polyester polyol resin and the second polyester polyol resin is within the above range, it can improve the durability, cold chipping resistance, and appearance of the prepared coating film.

Melamine resin

The melamine resin, as a curing agent, plays a role in curing the composition by crosslinking with each component

of the clear paint composition.

The melamine resin may be a product directly synthesized according to a known method, or a commercially available product. For example, the melamine resin may be at least one selected from the group consisting of methoxy methyl melamine, methyl melamine, butyl melamine, isobutoxy melamine, butoxy melamine, hexamethylol melamine, hexamethoxy methyl melamine, hexabutoxy methyl melamine, hexamethoxybutoxy methyl melamine, and iminomethoxy methyl melamine.

In addition, the melamine resin may have a weight-average molecular weight (M_w) of 100 to 5,000 g/mol, 500 to 4,500 g/mol, or 1,000 to 4,000 g/mol, and a viscosity at 25°C of 400 to 1,200 cps, 500 to 1,100 cps, or 600 to 1,000 cps. If the weight-average molecular weight of the melamine resin is within the above range, there is an effect that the adhesive property and hardness of the prepared coating film are improved by improving the crosslinking density. If the viscosity at 25°C is within the above range, there is an effect that the gloss and appearance are excellent.

The melamine resin may be contained in an amount of 15 to 35 parts by weight, 16 to 30 parts by weight, or 17 to 27 parts by weight, based on silane-modified acrylic resin of 1 to 20 parts by weight. If the content of melamine resin is within the above range, there is an effect that the adhesive property and hardness of the prepared coating film are improved by improving the crosslinking density.

Urethane resin

The urethane resin plays a role in improving the workability of the clear coat composition and improving the appearance characteristics of the coating film prepared from the composition.

The urethane resin may be a product directly synthesized according to a known method, or may be a commercially available product. For example, the urethane resin can be prepared by reacting alcohol with diisocyanate.

In this case, the alcohol may be at least one selected from the group consisting of cyclohexanol, ethylhexanol, butanol, 1,6-hexanediol, ethylene glycol, propylene glycol, diethylene glycol, butylene glycol, neopentyl glycol, trimethylol propane, butanediol, 1,4-hexanediol, and 3-methylpentanediol.

In addition, the diisocyanate may be, for example, at least one selected from the group consisting of isophorone diisocyanate, trimethylene diisocyanate, tetramethylene diisocyanate, pentamethylene diisocyanate, hexamethylene diisocyanate, propylene diisocyanate, ethylene diisocyanate, 2,3-dimethylethylene diisocyanate, 1-methyl trimethylene diisocyanate, 1,3-cyclopentene diisocyanate, 1,4-cyclopentene diisocyanate, 1,2-cyclopentene diisocyanate, 1,3-phenylene diisocyanate, 1,4-phenylene diisocyanate, 2,4-toluene diisocyanate, 2,6-toluene diisocyanate, 4,4-diphenylpropane diisocyanate, xylene diisocyanate, and 1,1,6,6-tetramethylhexamethylene diisocyanate.

The urethane resin may not contain unreacted NCO groups. If urethane resin that does not contain unreacted NCO groups is used, there is an effect that the appearance of the prepared coating film is excellent.

In addition, the urethane resin may have a weight-average molecular weight (Mw) of 8,000 to 13,000 g/mol, 9,000 to 12,500 g/mol, or 10,000 to 12,000 g/mol, and a solid content of 60 to 80 wt.%, 65 to 75 wt.%, or 67 to 73 wt.%. If the weight-average molecular weight of the urethane resin is within the above range, there is an effect that the gloss and appearance characteristics of the coating film are excellent. If the solid content is within the above range,

there is an effect that the workability of the composition is excellent.

The urethane resin may be contained in an amount of 1 to 10 parts by weight, 2 to 9 parts by weight, or 3 to 8 parts by weight, based on the silane-modified acrylic resin of 1 to 20 parts by weight. If the content of urethane resin is within the above range, there is an effect that the prepared coating film has excellent flexibility and appearance characteristics.

Solvent

The clear paint composition may further contain a solvent. In this case, the solvent controls the viscosity of the clear paint composition and plays a role in controlling the quick-drying properties of the composition, and may be a conventional solvent used for a clear paint composition.

The solvent may contain, for example, at least one selected from the group consisting of acetate-based, alkylbenzene-based, ketone-based and carbonate-based solvents. As another example, the solvent may be non-polar solvents such as n-heptane, toluene, xylene, petroleum compounds and n-hexane; polar solvents such as ethyl acetate, n-butyl acetate, isobutyl acetate, ethyleneglycol monoethyl ether acetate, dibasic esters, 3-methoxy butyl acetate, amyl acetate, butylglycol acetate, methyl ethyl ketone, methyl isobutyl ketone, acetone, diisobutyl ketone, isophorone and cyclohexanone; and a mixture of the non-polar solvent and the polar solvent, etc., and may be appropriately selected and used according to the characteristics or volatilization rate of the resin contained in the composition.

In addition, the solvent may be contained in an amount of 5 to 30 parts by weight, 10 to 25 parts by weight, or 12 to 23 parts by weight, based on the silane-modified acrylic resin of 1 to 20 parts by weight. If the content of the

solvent is within the above range, it is possible to prevent problems such as defects in the coating film, such as the occurrence of pinholes in the coating film, and occurrence of stains.

Additive

The clear paint composition may further comprise at least one additive selected from the group consisting of a dispersant, a moisture absorbent, a leveling agent, an anti-sagging agent and an UV absorber.

The additive may be contained in an amount of 20 to 40 parts by weight, 23 to 37 parts by weight, or 25 to 35 parts by weight, based on the silane-modified acrylic resin of 1 to 20 parts by weight. If the content of the additive is out of the above range, the appearance characteristics of the prepared coating film may be deteriorated.

The dispersant plays a role in improving the storability of the composition. In addition, the dispersant may be used without any particular limitation as long as it can be used in a paint composition, and may be, for example, benzene propanoic acid. In addition, the dispersant may be contained in an amount of 0.1 to 3 parts by weight, 0.2 to 2 parts by weight, or 0.3 to 1 part by weight, based on the silane-modified acrylic resin of 1 to 20 parts by weight.

The moisture absorbent plays a role in improving the fouling resistant of the prepared coating film. The moisture absorbent can be used without any particular limitation as long as it can be used in a paint composition, and may be, for example, an ortho-ester-based compound. The ortho-ester-based moisture absorbent may be, for example, formamidine acetate, 2-methoxy-1,3-dioxolane, 1,1,3,3-tetramethoxypropane, triethyl-O-acetate, triethyl-O-formate, triethyl-O-propionate, triisopropyl-O-formate, trimethyl-O-acetate, trimethyl-O-formate and the like. In addition, the

moisture absorbent may be contained in a content of 1 to 10 parts by weight, 2 to 9 parts by weight, or 3 to 8 parts by weight, based on the silane-modified acrylic resin of 1 to 20 parts by weight.

The leveling agent plays a role in imparting leveling property and wettability to the prepared coating film. In addition, the leveling agent may be used without any particular limitation as long as it can be used in a paint composition, and may be, for example, a polyether-modified polysiloxane-based. In addition, the leveling agent may be contained in an amount of 0.1 to 2 parts by weight, 0.2 to 1.5 parts by weight, or 0.5 to 1 part by weight, based on the silane-modified acrylic resin of 1 to 20 parts by weight.

The anti-sagging agent plays a role in improving the workability of the composition by controlling the sagging of the composition. In addition, the anti-sagging agent may be used without any particular limitation as long as it can be used for a paint composition, and may be, for example, polyester resin having a diurea group. In addition, the anti-sagging agent may be contained in an amount of 10 to 30 parts by weight, 15 to 25 parts by weight, or 17 to 23 parts by weight, based on the silane-modified acrylic resin of 1 to 20 parts by weight.

The UV absorber plays a role in blocking UV rays reaching the prepared coating film and improving the weatherability of the final coating film. The UV absorber may be a benzotriazole-based UV absorber. In addition, the UV absorber may be contained in an amount of 1 to 5 parts by weight, 1 to 4 parts by weight, or 1 to 3 parts by weight, based on the silane-modified acrylic resin of 1 to 20 parts by weight.

As described above, the clear paint composition according to the present invention uses an organic resin and an inorganic resin in combination to strengthen the surface

tension and flexibility of the coating film prepared therefrom, and thus the coating film prepared therefrom has excellent scratch resistance. In addition, the clear paint composition contains a low molecular weight polyester, and thus the prepared coating film has excellent flexibility and resilience, and also the clear paint composition contains two kinds of polyester resin, and thus the prepared coating film has excellent appearance characteristics, flexibility, chipping resistance, and scratch resistance.

Hereinafter, the present invention will be described in more detail through examples.

However, these examples are only for helping the understanding of the present invention, and the scope of the present invention is not limited to these examples in any sense.

Examples 1 to 9, and Comparative Examples 1 to 4.

Preparation of clear paint composition

A silane-modified acrylic resin, a first polyester polyol resin, a second polyester polyol resin, a melamine resin, an urethane resin, a solvent and an additive were mixed according to the contents of Tables 1 and 2 to prepare a clear paint composition.

Table 1:

Component (parts by weight)	Example 1	Example 2	Example 3	Example 4	Example 5	Example 6
Silane-modified acrylic resin	11	13	7	15	11	11
First polyester polyol resin	10.5	10.5	13	10.5	14	10.5
Second polyester polyol resin	10	7	10	9	9	15
Melamine resin	24	24	24	22	22	20
Urethane resin	5	5	5	5	5	5

Additive	Dispersant	0.3	0.3	0.3	0.3	0.3	0.3
	Moisture absorbent	3	3	3	3	3	3
	Leveling agent	0.7	0.7	0.7	0.7	0.7	0.7
	Anti-sagging agent	20	20	20	20	20	20
	UV absorber	2	2	2	2	2	2
Solvent		13.5	14.5	15	12.5	13	12.5
Total		100	100	100	100	100	100

Table 2:

Component (parts by weight)		Example 7	Example 8	Example 9	Comparative Example 1	Comparative Example 2	Comparative Example 3	Comparative Example 4
Silane-modified acrylic resin		22	9	8	–	13	13	13
First polyester polyol resin		9.5	21	9	13	–	12	12
Second polyester polyol resin		9	8	22	12	12	–	11
Melamine resin		17	18	18	27	27	27	20
Urethane resin		4	4	4	4	4	4	–
Additive	Dispersant	0.3	0.3	0.3	0.3	0.3	0.3	0.3
	Moisture absorbent	3	3	3	3	3	3	3
	Leveling agent	0.7	0.7	0.7	0.7	0.7	0.7	0.7
	Anti-sagging agent	20	20	20	20	20	20	20
	UV absorber	2	2	2	2	2	2	2
Solvent		12.5	14	13	18	18	18	18
Total		100	100	100	100	100	100	100

The components and brand names of each component used in the Examples and Comparative Examples below are shown in Table 3.

Table 3:

Component	Note
silane-modified acrylic resin	Solid content: 70 wt.%, Tg: 42°C, Viscosity at 25°C: 1,500cps, Mw: 7,000g/mol, Av: 2mgKOH/g, OHv: 85mgKOH/g, Content of hydroxyl group: 2.5 wt.%
first polyester polyol resin	Solid content: 70 wt.%, Viscosity at 25°C: 2,300cps, Mn: 1,700g/mol, OHv: 135mgKOH/g, Av: 23mgKOH/g
second polyester Polyol resin	Solid content: 86 wt.%, Viscosity at 25°C: 1,200cps, Mn: 700g/mol, OHv: 282mgKOH/g
Melamine resin	Solid content: 58 wt.%, Viscosity at 25°C: 800cps, Mw: 2,500g/mol
Urethane resin	Solid content: 70 wt.%, Mw: 11,000g/mol
Dispersant	Benzene propanoic acid
Moisture absorbent	Trimethyl orthoacetate
Leveling agent	Polyether modified polydimethylsiloxane
Anti-sagging agent	polyester resin having hydroxyl group and diurea group (Manufacturer: Nuplex, Brand name: SETAL91715SS-55)
UV absorber	Manufacturer: BASF, Brand name: TINUVIN5151
Solvent	Butyl acetate

Experimental example: Evaluation of the properties of the prepared coating film

On the electro-deposition-coated specimen, the primer coat composition (manufacturer: KCC, brand name: FU2270, oil-based) was bell-painted to a dry thickness of 35 μ m, and

first cured at 140°C for 25 minutes. Thereafter, the base coat composition (manufacturer: KCC, brand name: TT663, water-based) was bell-painted to a dry thickness of 15 μm , and the remaining water in the paint was evaporated (drying) in a drying furnace at 80°C for 3 minutes. Thereafter, after cooling to room temperature for 2 minutes, the clear coat compositions (oil-based) from Examples and Comparative Examples were bell-painted to a dry thickness of 40 μm , followed by secondary curing at 140°C for 25 minutes to form the final coating film. The appearance characteristics and physical properties of the final coating film were measured in the following way, and the results are shown in Table 4.

(1) Coating film appearance

For the final coating, the CF value was measured using a Wave Scan DOI (BYK Gardner), which is an automobile appearance measuring instrument, and it was determined that the higher the CF value is, the better the appearance characteristics of the coating film is. Specifically, if the CF value was 70 or more, it was evaluated as excellent (◎), if it was 65 or more and less than 70, it was evaluated as good (○), if it was 60 or more and less than 65, it was evaluated as normal (Δ), and if it was less than 60, it was evaluated as bad (×).

(2) Hardness

The hardness of the clear coating film was measured by the pencil hardness method. Specifically, the maximum hardness that does not damage the clear coating film was measured using each of 3B, 2B, B, HB, F, H, 2H and 3H pencils (3B, 2B, B, HB, F, H, 2H, 3H: inferior↔superior).

(3) Adhesive property

After the specimen was heat-treated and left at room

temperature for 24 hours, the adhesive property was evaluated by a cross-cut adhesion test method.

Specifically, in the cross-cut adhesion test method, 100 squares of 2 mm in width and 2 mm in length were made on the surface of the clear coating film with a knife, and then the square was removed using a tape to measure the adhesive property. At this time, if 100 squares remained 100% intact, the measured adhesive property was expressed as M-1 (excellent), and if the remaining squares were 70% or more and less than 100%, it was expressed as M-2 (excellent), and if the remaining squares were 50% or more and less than 70%, it was expressed as M-3 (normal), and if the remaining squares were 30% or more and less than 50%, it was expressed as M-4 (bad), and the remaining squares were less than 30%, it was expressed as M-5 (very bad).

In addition, the heat-treatment was repeated at 150°C for 20 minutes and then left at room temperature for 20 minutes as one cycle, and a total of 3 cycles were repeated.

(4) Water resistance

After the specimen was immersed in a constant temperature water bath at 40°C for 240 hours and left at room temperature for 1 hour, the peel test was performed in the same way as the cross-cut adhesion test method of item (3), and the same evaluation criteria were also applied.

(5) Acid resistance

After 0.2 ml of 0.1N sulfuric acid was added dropwise to the surface of the coating film of the specimen, it was treated in an oven preheated to 30°C or higher for 150 minutes. At this time, the occurrence of etching, staining, or swelling of the part where sulfuric acid was dropped on the specimen was visually observed, and the highest temperature at which damage did not occur in the specimen

was determined as the acid resistance temperature.

(6) Scratch resistance

The 20° gloss of the specimen was measured (measurement of initial gloss), and after reciprocating the surface of the specimen 10 times using a car wash resistance tester (product from Amtec Kistler company), the 20° gloss was measured. Thereafter, the gloss retention rate was calculated from the initial gloss and the gloss after surface treatment using Equation 1 below.

[Equation 1]

Gloss retention rate = gloss after surface treatment / initial gloss × 100

(7) Solvent resistance

After putting a cotton cloth moistened with xylene on the coating film of the specimen, it was scratched 4 times with a force of 2kg every 1 minute to record the time when the surface of the lower coating film appeared.

Table 4:

	Coating film appearance	Hardness	Adhesive property	Water resistance	Acid resistance	Initial gloss	Scratch resistance	Solvent resistance
Example 1	◎	F	M-1	M-1	45°C	91%	87%	10 minutes
Example 2	◎	F	M-1	M-1	44°C	92%	87%	10 minutes
Example 3	◎	F	M-1	M-1	45°C	90%	85%	10 minutes
Example 4	○	HB	M-1	M-2	41°C	86%	81%	9 minutes
Example 5	○	HB	M-1	M-1	40°C	87%	80%	9 minutes
Example 6	○	HB	M-1	M-2	42°C	85%	81%	9 minutes
Example 7	△	B	M-1	M-2	39°C	84%	78%	8 minutes

Example 8	○	B	M-2	M-2	38°C	86%	79%	8 minutes
Example 9	△	B	M-1	M-2	39°C	87%	77%	8 minutes
Comparative Example 1	X	2B	M-2	M-4	36°C	78%	64%	5 minutes
Comparative Example 2	△	2B	M-3	M-3	35°C	77%	62%	4 minutes
Comparative Example 3	X	B	M-3	M-4	34°C	79%	62%	5 minutes
Comparative Example 4	△	2B	M-3	M-3	35°C	75%	63%	5 minutes

As shown in Table 4, the coating films prepared from the clear paint compositions of Examples 1 to 9 were excellent in appearance characteristics, hardness, adhesive property, acid resistance, solvent resistance, and scratch resistance.

On the other hand, the coating films prepared from the compositions of Comparative Examples 1 to 4 had insufficient physical properties such as appearance characteristics and adhesive properties, water resistance, acid resistance, scratch resistance and solvent resistance.

In particular, Comparative Example 1 without the silane-modified acrylic resin and Comparative Example 3 without the second polyester polyol resin were remarkably deficient in coating film appearance, water resistance and solvent resistance. In addition, Comparative Example 2 without the first polyester polyol resin and Comparative Example 4 without urethane resin were significantly insufficient in hardness and adhesive properties.

【CLAIMS】

【Claim 1】

A clear paint composition comprising a silane-modified acrylic resin, a first polyester polyol resin, a second polyester polyol resin, a melamine resin, and an urethane resin, wherein the number average molecular weight of the first polyester polyol resin is greater than the number average molecular weight of the second polyester polyol resin.

【Claim 2】

The clear paint composition according to claim 1, wherein the silane-modified acrylic resin has a glass transition temperature of 30 to 50 °C, a hydroxyl value of 80 to 90 mgKOH/g, and an acid value of 5 mgKOH/g or less.

【Claim 3】

The clear paint composition according to claim 1, wherein the first polyester polyol resin has a hydroxyl value of 100 to 180 mgKOH/g, an acid value of 10 to 50 mgKOH/g, and a number average molecular weight of 1,300 to 2,500 g/mol.

【Claim 4】

The clear paint composition according to claim 1, wherein the second polyester polyol resin has a hydroxyl value of 200 to 400 mgKOH/g, and a number average molecular weight of 500 to 1,000 g/mol.

【Claim 5】

The clear paint composition according to claim 1, wherein the mixing ratio of the first polyester polyol resin

and the second polyester polyol resin is a weight ratio of 1:0.1 to 1:5.

【Claim 6】

The clear paint composition according to claim 1, wherein the composition contains 1 to 20 parts by weight of the silane-modified acrylic resin, 1 to 20 parts by weight of the first polyester polyol resin, 1 to 20 parts by weight of the second polyester polyol resin, 15 to 35 parts by weight of the melamine resin and 1 to 10 parts by weight of the urethane resin.