

[DESCRIPTION]

[TITLE OF INVENTION]: CLEAR COAT COMPOSITION

[TECHNICAL FIELD]

[1] The present disclosure relates to a clear coat composition having excellent appearance
5 characteristics and scratch resistance.

[BACKGROUND ART]

[2] Background technology relating to the present disclosure is provided herein, and is not necessarily meant to be a known technology.

[3] In order to improve the exterior characteristics of a vehicle body and protect the surface
10 from the external environment, a plurality of coating processes such as electrodeposition painting, intermediate painting, base painting, and clear painting are performed in the vehicle painting system.

[4] Meanwhile, with a wide distribution of automatic car wash machines, car washing can be performed more conveniently and quickly. However, there was a problem in that scratches
15 occur on the clear coating film caused by car wash brushes and soil dust during the car wash using an automatic car wash machine, thereby resulting in a decrease in gloss of the vehicle surface and a poor appearance. In addition, as the coating film is exposed to UV rays of sunlight and weather during a drive or outdoor exposure, there was a problem in that the weather resistance of the clear coating film deteriorates and the appearance characteristics such
20 as scratches occur on the surface. Accordingly, there has recently been an increasing demand for clear coat compositions with high-appearance and high-durability in the vehicle clear coat composition industry.

[5] In this regard, the conventional technology has secured initial scratch resistance by adding a blocked isocyanate resin to the main reaction structure of an acrylic resin and a
25 melamine resin to impart flexibility to the coating film. Specifically, Korean Patent

Registration No. 10-1115869 discloses a one-component clear coat composition for a vehicle containing an acrylic resin, a melamine resin, a silane-modified blocked isocyanate resin, and a flowability adjusting resin. However, such conventional technology has a problem in that the crosslinking density of the final coating film is lowered thereby deteriorating long-term weather resistance and scratch resistance.

[6] Meanwhile, conventionally, excellent physical properties (*e.g.*, appearance, scratch resistance, impact resistance, weather resistance, *etc.*) of a coating film prepared from a clear coat composition could have been obtained through a surface sanding method; therefore, there was a problem in that the work efficiency of the painting operation is reduced.

[7] Therefore, there is a need for the development of a clear coat which can improve problems such as deterioration in appearance, gloss, weather resistance, and scratch resistance after a drive or outdoor exposure of existing clear coats for vehicles. In addition, there is a need for research and development on a clear coat composition, which can obtain excellent physical properties such as the appearance, scratch resistance, impact resistance, and weather resistance of a coating film by a non-sanding method without going through a surface sanding method.

[8] [Prior Art Document]

[9] (Patent Document 1) Korea Patent Registration No. 10-1115869 (February 7, 2012)

[DETAILED DESCRIPTION OF INVENTION]

[TECHNICAL PROBLEMS]

[10] In one aspect of the present disclosure, it is an object to provide a clear coat composition, which is imparted with flexibility and elasticity simultaneously while improving the crosslinking density of the final coating film, thereby being able to maintain appearance and gloss, and performances of scratch resistance, weather resistance, and chipping resistance even after a long-term drive or outdoor exposure as well as appearance and scratch resistance

of the vehicle at the beginning of production.

[11] In another aspect, the present disclosure provides a clear coat composition which can obtain excellent scratch resistance, impact resistance, weather resistance, and appearance characteristics of a prepared coating film by a non-sanding method.

5 [TECHNICAL SOLUTION]

[12] In an aspect, the present disclosure can provide a clear coat composition a first acrylic resin, a second acrylic resin, a polyester resin, a urethane resin, and a melamine resin, in which the first acrylic resin has a glass transition temperature of 0.5°C to 10°C and a hydroxyl value
10 temperature of -10°C to -1°C and a hydroxyl value of 50 mgKOH/g to 110 mgKOH/g.

[EFFECT OF INVENTION]

[13] The clear coat composition according to one aspect of the present disclosure improves the crosslinking density of the final coating film and at the same time imparts flexibility and elasticity, so that not only the appearance and scratch resistance of the vehicle at the beginning
15 of production, but also the appearance and gloss after long-term driving or outdoor exposure , it is possible to form a coating film capable of maintaining scratch resistance, weather resistance, and chipping resistance performance.

[14] The clear coat composition according to another aspect of the present disclosure can form a coating film having excellent scratch resistance, impact resistance, weather resistance
20 and appearance characteristics by a non-sanding method.

[BEST MODE FOR CARRYING OUT THE INVENTION]

[15] Hereinafter, the present disclosure will be described in detail.

[16] As used herein, “a weight average molecular weight (Mw)” and “a number average molecular weight (Mn)” are measured by a method commonly known in the art to which the
25 present disclosure pertains, for example, may be measured by a method such as gel permeation

chromatograph (GPC).

[17] As used herein, “a glass transition temperature (T_g)” is measured by a method commonly known in the art to which the present disclosure pertains, and may be measured by, for example, differential scanning calorimetry (DSC), *etc.*

5 [18] As used herein, functional groups such as “an acid value (Av)” and “a hydroxyl value (OHv)” are measured by a method commonly known in the art to which the present disclosure belongs, for example, may be measured by a method such as titration.

[19] As used herein, “(meth)acryl” means “acryl” and/or “methacryl”, and “(meth)acrylate” means “acrylate” and/or “methacrylate”.

10 [20] As used herein, “parts by weight” means the ratio of the weight between each component.

[21] The clear coat composition according to one aspect of the present disclosure includes a first acrylic resin, a second acrylic resin, a polyester resin, a urethane resin, and a melamine resin, in which the first acrylic resin has a glass transition temperature of 0.5°C to 10°C and a hydroxyl value of 120 mgKOH/g to 200 mgKOH/g; and the second acrylic resin has a glass transition temperature of -10°C to -1°C and a hydroxyl value of 50 mgKOH/g to 110 mgKOH/g. As described above, when two types of acrylic resins having different glass transition temperatures and hydroxyl values are used, the drying speed and crosslinking density of the coating film can be controlled, and thus there is an effect that the appearance characteristic and mechanical properties of the coating film are improved.

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[22] For example, the different glass transition temperatures of the two acrylic resins can form an additional clear coat by a non-sanding method by improving the appearance characteristics by way of controlling the drying speed and surface tension of the coating film of the clear coat composition of the present disclosure; additionally, when the hydroxyl values of the two types of acrylic resins are different, there is an effect that the adhesion and

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mechanical properties are improved by controlling the crosslinking density of the coating film.

[23] <first acrylic resin>

[24] The first acrylic resin, as the main resin of the composition, serves to improve appearance characteristics such as durability and gloss of the prepared coating film.

5 [25] As the first acrylic resin, one synthesized directly according to a known method may be used or a commercially available product may be used. The first acrylic resin may be one which is prepared, for example, by polymerizing one or more of the first vinyl-based monomer and the first (meth)acrylate-based monomer.

[26] As another example, the first acrylic resin may be prepared by reacting a first vinyl-
10 based monomer, a first (meth)acrylate monomer, and benzyl amine, and may have a chemical structure in which a needle-shaped diurea group exists.

[27] As the first vinyl monomer, for example, one or more selected from the group consisting of styrene, methylstyrene, dimethylstyrene, fluorostyrene, ethoxystyrene, methoxystyrene, phenylene vinyl ketone, vinyl *t*-butyl benzoate, vinyl cyclohexanoate, vinyl
15 acetate, vinyl pyrrolidone, vinyl chloride, vinyl alcohol, acetoxystyrene, *t*-butyl styrene, and vinyl toluene may be used.

[28] The first (meth)acrylate-based monomer may include one or more selected from the group consisting of (meth)acrylate monomers not containing a hydroxyl group and (meth)acrylate monomers containing a hydroxyl group.

20 [29] The (meth)acrylate monomers containing no hydroxyl group may include one or more selected from the group consisting of, for example, (meth)acrylic acid, methyl (meth)acrylic acid, (meth)acrylate, methyl (meth)acrylate, ethyl (meth)acrylate, propyl (meth)acrylate, isopropyl (meth)acrylate, butyl (meth)acrylate, isobutyl (meth)acrylate, *t*-butyl (meth)acrylate, pentyl (meth)acrylate, hexyl (meth)acrylate, heptyl (meth)acrylate, isooctyl (meth)acrylate,
25 octyl (meth)acrylate, 2-ethylhexyl (meth)acrylate, isodecyl (meth)acrylate, decyl

(meth)acrylate, dodecyl (meth)acrylate, isobornyl (meth)acrylate, and lauryl (meth)acrylate.

[30] The hydroxyl group-containing (meth)acrylate monomer may include one or more selected from the group consisting of, for example, a hydroxyalkyl-containing (meth)acrylate, specifically 2-hydroxy methyl (meth)acrylate, 2-hydroxy ethyl (meth)acrylate rate, 2-hydroxy propyl (meth)acrylate, and 2-hydroxy butyl (meth)acrylate.

[31] The first acrylic resin may be one which is prepared, for example, using a radical polymerization method, and physical properties (*e.g.*, weight average molecular weight (Mw), hydroxyl value (OHv), acid value (Av), *etc.*) may be controlled depending on the initiator and polymerization time.

[32] The first acrylic resin may have a weight average molecular weight (Mw) of 7,700 g/mol to 8,200 g/mol or 7,800 g/mol to 8,100 g/mol. When the weight average molecular weight of the first acrylic resin is within the above range, long-term physical properties such as durability and weather resistance of the prepared coating film may be excellent. When the weight average molecular weight of the first acrylic resin is below the above range, there may be a problem in that the molecular weight is small, and thus the weather resistance and scratch resistance of the prepared coating film may be insufficient, whereas when the weight average molecular weight of the first acrylic resin exceeds the above range, there may be a problem in that the flowability may deteriorate according to the increase of the molecular weight, and the workability of the clear coat composition containing the first acrylic resin may become poor and surface smoothness may not be good, thereby making it difficult to prepare a coating film having an excellent appearance.

[33] The first acrylic resin may have a hydroxyl value (OHv) of 120 mgKOH/g to 200 mgKOH/g, 140 mgKOH/g to 180 mgKOH/g, or 150 mgKOH/g to 170 mgKOH/g. When the hydroxyl value of the first acrylic resin is within the above range, there is an effect that durability and weather resistance of the coating film are improved. When the hydroxyl value

of the first acrylic resin is below the above range, there may be a problem in that the formation of a coating film by a crosslinking reaction with a curing agent may be insufficient, and mechanical properties such as hardness of the coating film may deteriorate, whereas when the hydroxyl value of the first acrylic resin exceeds the above range, there may be a problem in that the coating film may become brittle and the elasticity may be deteriorated, thereby making the appearance characteristics of the prepared coating film become insufficient.

[34] The first acrylic resin may have an acid value (Av) of 5 mgKOH/g or less, or 0.1 mgKOH/g to 5 mgKOH/g. When the acid value of the first acrylic resin is within the above range, the reactivity of the composition containing the first acrylic resin may be controlled to improve the appearance characteristics of the coating film prepared therefrom. When the acid value of the first acrylic resin is below the above range, the curing reaction rate is decreased, which may result in a problem in that the appearance of the prepared coating film is deteriorated, whereas when the acid value of the first acrylic resin exceeds the above range, the viscosity of the composition is increased due to the increase of resin cohesion, which may result in a problem in that workability and room temperature storage may be reduced.

[35] The first acrylic resin may have a glass transition temperature (T_g) of 0.5°C to 10°C or 1°C to 5°C. When the glass transition temperature of the first acrylic resin is within the above range, there is an effect that the hardness and solvent resistance of the coating film are improved. When the glass transition temperature of the first acrylic resin is below the above range, there may be a problem in that the drying speed and crosslinking density of the coating film may decrease, thereby resulting in insufficient hardness and solvent resistance of the prepared coating film, whereas when the glass transition temperature of the first acrylic resin exceeds the above range, there may be a problem in that the appearance characteristics and chipping resistance of the prepared coating film may be insufficient.

[36] The first acrylic resin may have a solid content (NV) of 60 wt% to 80 wt%, or 65 wt%

to 75 wt% based on the total weight of the resin. When the solid content of the first acrylic resin is within the above range, storage stability of the resin and storage stability of the clear coat composition may be improved and workability may be excellent. When the solid content of the first acrylic resin is below the above range, there may be a problem in that the viscosity may be too low, thereby resulting in poor workability of the clear coat composition containing the first acrylic resin, whereas when the solid content of the first acrylic resin exceeds the above range, there may be a problem in that the viscosity of the first acrylic resin may become too high, thereby resulting in a decrease of stability during the reaction. As a result, dispersion stability may deteriorate and aggregation may occur over time.

[37] The first acrylic resin may have a viscosity of 2,700 cps to 6,300 cps, 3,000 cps to 6,000 cps, or 3,300 cps to 5,700 cps at 25°C. When the viscosity of the first acrylic resin at 25°C is within the above range, the viscosity of the clear coat composition is appropriate, and thus there is an effect that workability is improved. When the viscosity at 25°C of the first acrylic resin is below the above range, there may be a problem in that the viscosity of the composition may be too low and thus the coating flowability, adhesion, and scratch resistance may be lowered due to non-formation of the prepared coating film, whereas when the viscosity of the first acrylic resin at 25°C exceeds the above range, there may be a problem in that the appearance characteristics of the prepared coating film may deteriorate due to the lack of workability of the composition.

[38] The first acrylic resin may be included in an amount of 30 wt% to 50 wt%, or 35 wt% to 43 wt% based on the total weight of the clear coat composition. When the first acrylic resin is contained within the above content range, there is an effect of that adhesion and durability of the coating film are improved. When the content of the first acrylic resin is below the above range, there may be a problem in that the drying property may be deteriorated, thereby resulting in a decrease in adhesion, gloss, and durability of the coating film, whereas when the

content of the first acrylic resin exceeds the above range, there may be a problem in that the drying proceeds quickly and the coating workability and coating flowability of the composition may be insufficient and thus the appearance and scratch resistance of the coating film may be deteriorated.

5 [39] <second acrylic resin>

[40] The second acrylic resin may be contained to control the flowability of a clear coat composition.

[41] As the second acrylic resin, one synthesized directly according to a known method may be used or a commercially available product may be used. The second acrylic resin may
10 be prepared, for example, by polymerizing one or more of the second vinyl-based monomer and the second (meth)acrylate-based monomer.

[42] As another example, the second acrylic resin may be prepared by reacting a second vinyl-based monomer, a second (meth)acrylate monomer, and benzyl amine, and may have a chemical structure in which a needle-shaped diurea group exists.

15 [43] Examples of the second vinyl monomer one or more selected from the group consisting of styrene, methylstyrene, dimethylstyrene, fluorostyrene, ethoxystyrene, methoxystyrene, phenylene vinyl ketone, vinyl *t*-butyl benzoate, vinyl cyclohexanoate, vinyl acetate, vinyl pyrrolidone, vinyl chloride, vinyl alcohol, acetoxy styrene, *t*-butyl styrene, and vinyl toluene may be used.

20 [44] The second (meth)acrylate-based monomer may include one or more selected from the group consisting of (meth)acrylate monomers not containing a hydroxyl group and (meth)acrylate monomers containing a hydroxyl group.

[45] The (meth)acrylate monomers containing no hydroxyl group may include one or more selected from the group consisting of, for example, (meth)acrylic acid, methyl (meth)acrylic
25 acid, (meth)acrylate, methyl (meth)acrylate, ethyl (meth)acrylate, propyl (meth)acrylate,

isopropyl (meth)acrylate, butyl (meth)acrylate, isobutyl (meth)acrylate, *t*-butyl (meth)acrylate, pentyl (meth)acrylate, hexyl (meth)acrylate, heptyl (meth)acrylate, isooctyl (meth)acrylate, octyl (meth)acrylate, 2-ethylhexyl (meth)acrylate, isodecyl (meth)acrylate, decyl (meth)acrylate, dodecyl (meth)acrylate, isobornyl (meth)acrylate, and lauryl (meth)acrylate.

5 [46] The hydroxyl group-containing (meth)acrylate monomer may include one or more selected from the group consisting of, for example, a hydroxyalkyl-containing (meth)acrylate, specifically 2-hydroxy methyl (meth)acrylate, 2-hydroxy ethyl (meth)acrylate rate, 2-hydroxy propyl (meth)acrylate, and 2-hydroxy butyl (meth)acrylate.

[47] The second acrylic resin may be one which is prepared, for example, using a radical
10 polymerization method, and physical properties (*e.g.*, weight average molecular weight (Mw), hydroxyl value (OHv), acid value (Av), *etc.*) may be controlled depending on the initiator and polymerization time.

[48] The second acrylic resin may have a weight average molecular weight (Mw) of 8,500 g/mol to 9,000 g/mol, or 8,600 g/mol to 8,900 g/mol. When the weight average molecular
15 weight of the second acrylic resin is within the above range, the flowability of the composition is appropriate and thus workability may be excellent. When the weight average molecular weight of the second acrylic resin is below the above range, there may be a problem in that the molecular weight is small and thus the flowability of the clear coat composition is insufficient, thereby resulting in poor workability and lowering the acid resistance and chemical resistance
20 of the prepared coating film, whereas when the weight average molecular weight of the second acrylic resin exceeds the above range, there may be a problem in that the workability of the clear coat composition becomes poor due to an increase in molecular weight, and the surface smoothness becomes poor, thereby making it difficult to prepare a coating film having excellent appearance and gloss.

25 [49] The second acrylic resin may have a hydroxyl value (OHv) of 50 mgKOH/g to 110

mgKOH/g, or 60 mgKOH/g to 100 mgKOH/g. When the hydroxyl value of the second acrylic resin is within the above range, there is an effect that weather resistance of the coating film is improved. When the hydroxyl value of the second acrylic resin is below the above range, there may be a problem in that the formation of a coating film by a crosslinking reaction with a curing agent may be insufficient, and mechanical properties such as hardness of the coating film may deteriorate, whereas when the hydroxyl value of the second acrylic resin exceeds the above range, there may be a problem in that the coating film may be overcured and may thus become brittle and the elasticity may deteriorate, thereby making the appearance characteristics, water resistance, and scratch resistance of the prepared coating film become insufficient.

[50] The second acrylic resin may have a glass transition temperature (T_g) of -10°C to -1°C, or -8°C to -2°C. When the glass transition temperature of the second acrylic resin is within the above range, there is an effect that the gloss characteristic and hardness of the coating film are improved. When the glass transition temperature of the second acrylic resin is below the above range, there may be a problem in that the drying speed of the clear coat film is delayed, thereby making solvent resistance and solvent resistance of the prepared coating film insufficient, whereas when the glass transition temperature of the second acrylic resin exceeds the above range, there may be a problem in that the coating film may become brittle, thereby making appearance characteristics and hardness of the prepared coating film insufficient.

[51] The second acrylic resin may have a solid content (NV) of 50 wt% to 70 wt%, or 55 wt% to 65 wt% based on the total weight of the resin. When the solid content of the second acrylic resin is within the above range, storage stability of the resin and storage stability of the clear coat composition may be improved and workability may be excellent. When the solid content of the second acrylic resin is below the above range, there may be a problem in that the viscosity may be too low, thereby resulting in poor workability of the clear coat composition

containing the second acrylic resin, whereas when the solid content of the second acrylic resin exceeds the above range, there may be a problem in that the viscosity of the second acrylic resin may become too high, thereby resulting in a decrease of stability during the reaction, and as a result, dispersion stability may deteriorate and aggregation may occur over time.

5 **[52]** The second acrylic resin may have a viscosity of 20 cps to 120 cps, 40 cps to 100 cps, or 50 cps to 90 cps at 25°C. When the viscosity of the second acrylic resin at 25°C is within the above range, the viscosity of the clear coat composition is appropriate, and thus there is an effect that workability is improved. When the viscosity at 25°C of the second acrylic resin is below the above range, there may be a problem in that the viscosity of the composition may be
10 too low and thus the coating flowability, adhesion, and scratch resistance may be lowered due to non-formation of the prepared coating film, whereas when the viscosity of the second acrylic resin at 25°C exceeds the above range, there may be a problem in that the appearance characteristics of the prepared coating film may deteriorate due to the lack of workability of the composition.

15 **[53]** The second acrylic resin may be included in an amount of 6 wt% to 13 wt%, or 8 wt% to 11 wt% based on the total weight of the clear coat composition. When the second acrylic resin is contained within the above content range, there is an effect that the flowability of the clear coat composition is improved. When the content of the second acrylic resin is below the above range, there may be a problem in that the drying property may be deteriorated, and
20 the flowability of the clear coat composition containing the second acrylic resin may be poor, thereby resulting in poor workability, whereas when the content of the second acrylic resin exceeds the above range, there may be a problem in that the drying proceeds quickly, and thus the coating workability and coating flowability of the composition may deteriorate and the viscosity of the clear coat composition may increase, thereby deteriorating storage stability and
25 appearance.

[54] <polyester resin>

[55] The polyester resin serves to impart flexibility to the clear coat composition, improve crosslinking density, and improve mechanical properties (*e.g.*, cold chipping resistance, impact resistance, scratch resistance, *etc.*) of the prepared coating film.

5 [56] A polyester resin, which is a high-functional and low-molecular-weight resin containing three or more hydroxyl groups in a repeating unit, has the effect of improving durability and mechanical properties of a coating film prepared therefrom due to its high functionality; additionally, by including a polyester resin with high functionality and low molecular weight, it can impart flexibility to the clear coat composition to improve smoothness
10 and crosslinking density, thereby improving the appearance characteristics and scratch resistance of the coating film.

[57] As the polyester resin, one synthesized directly according to a known method may be used, or a commercially available product may be used. The polyester resin may be prepared, for example, from a condensation reaction of a polyol monomer having two or more hydroxyl
15 groups in one molecule and a carboxyl group-containing monomer. Specifically, the polyester resin may be one which is prepared from a first polyol monomer having two hydroxyl groups in one molecule, a second polyol monomer having three or more hydroxyl groups in one molecule, and a carboxyl group-containing monomer.

[58] Carboxyl group-containing monomers may be one or more selected from the group
20 consisting of, for example, adipic acid (AA), isophthalic acid (IPA), trimellitic anhydride (TMA), hexahydrophthalic anhydride (HHPA), alicyclic acid, phthalic anhydride, isophthalic acid, terephthalic acid, succinic acid, adipic acid, fumaric acid, maleic anhydride, tetrahydrophthalic anhydride, caprolactone, and derivatives thereof.

[59] The first polyol monomer has two hydroxyl groups in one molecule, and it may be one
25 or more selected from the group consisting of, for example, cyclohexane dimethanol (CHDM),

polyethylene glycol, 1,6-hexanediol (1,6-HD), neopentyl glycol (NPG), ethylene glycol, propylene glycol, diethylene glycol, butanediol, 1,4-hexanediol, and 3-methylpentanediol.

[60] The second polyol monomer has three or more hydroxyl groups in one molecule, and it may be one or more selected from the group consisting of, for example, trimethylol propane (TMP), trimethylol ethane, pentaerythritol, and glycerin.

[61] The polyester resin may be prepared using a condensation reaction between an acid and an alcohol, and physical properties (*e.g.*, weight average molecular weight (Mw), hydroxyl value (OHv), acid value (Av), *etc.*) may be controlled according to the input ratio between the acid and the alcohol.

[62] The polyester resin may have a weight average molecular weight (Mw) of 2,500 g/mol to 3,500 g/mol, 2,700 g/mol to 3,300 g/mol, or 2,900 g/mol to 3,100 g/mol. When the weight average molecular weight of the polyester resin is within the above range, there are effects of improving the smoothness of the clear coat composition and improving scratch resistance and hardness by forming a soft coating film. When the weight average molecular weight of the polyester resin is below the above range, there may be a problem in that the molecular weight may be small and the mechanical properties of the prepared coating film may deteriorate, whereas when the weight average molecular weight of the polyester resin exceeds the above range, the flowability may decrease according to the increase of molecular weight and the coating film may become brittle, thereby reducing smoothness and deteriorating scratch resistance.

[63] The polyester resin may have a hydroxyl value (OHv) of 200 mgKOH/g to 400 mgKOH/g, 240 mgKOH/g to 320 mgKOH/g, or 250 mgKOH/g to 290 mgKOH/g. When the hydroxyl value of the polyester resin is within the above range, there is an effect that the reactivity with the melamine resin is improved and thus the crosslinking density of the coating film is increased, thereby improving mechanical properties, appearance, and chemical

resistance. When the hydroxyl value of the polyester resin is below the above range, there may be a problem in that the durability and chemical resistance of the prepared coating film may be lowered due to insufficient reactivity with the melamine resin and insufficient crosslinking density, whereas when the hydroxyl value of the polyester resin exceeds the above range, the coating film may be overcured and become brittle, thereby deteriorating appearance and scratch resistance.

[64] The polyester resin may have an acid value (Av) of 15 mgKOH/g to 25 mgKOH/g, or 18 mgKOH/g to 22 mgKOH/g. When the acid value of the polyester resin is within the above range, there is an effect that the weather resistance of the coating film is improved. When the acid value of the polyester resin is below the above range, there may be a problem in that the formation of a coating film by a crosslinking reaction with the curing agent may be insufficient, and thus mechanical properties such as hardness of the coating film may be lowered, whereas when the acid value of the polyester resin exceeds the above range there may be a problem in that appearance characteristics, water resistance, and scratch resistance of the prepared coating film may be insufficient.

[65] The polyester resin may have a glass transition temperature (T_g) of 8°C to 15°C, or 10°C to 14°C. When the glass transition temperature of the polyester resin is within the above range, there is an effect that gloss characteristic and hardness of the coating film are improved. When the glass transition temperature of the polyester resin is below the above range, there may be a problem in that the drying speed of the clear coat composition may be delayed, thereby resulting in poor solvent resistance and chipping resistance of the prepared coating film, whereas when the glass transition temperature of the polyester resin exceeds the above range, there may be a problem in that the coating film may become brittle, thereby making the appearance properties and hardness of the coating film insufficient.

[66] The polyester resin may have a solids content (NV) of 55 wt% to 75 wt%, or 60 wt%

to 70 wt% based on the total weight of the resin. When the solid content of the polyester resin is within the above range, storage stability of the resin and storage stability of the clear coat composition may be improved and workability may be excellent. When the solid content of the polyester resin is below the above range, there may be a problem in that the viscosity may be too low, thereby resulting in insufficient workability of the clear coat composition containing the polyester resin, whereas when the solid content of the polyester resin exceeds the above range, the viscosity of the polyester resin may become too high, thereby resulting in a decrease of stability during the reaction, and as a result, dispersion stability may deteriorate and aggregation may occur over time.

[67] The polyester resin may have a viscosity at 25°C of 800 cps to 1,800 cps, 850 cps to 1,750 cps, or 900 cps to 1,700 cps. When the viscosity of the polyester resin at 25°C is within the above range, the viscosity of the clear coat composition is appropriate and thus there is an effect that workability is improved. When the viscosity at 25°C of the polyester resin is below the above range, there may be a problem in that the viscosity of the composition may be too low, thereby deteriorating coating flowability, adhesion, and scratch resistance due to non-formation of the prepared coating film, whereas when the viscosity of the polyester resin at 25°C exceeds the above range, there may be a problem in that the workability may be insufficient, thereby deteriorating appearance characteristics of the prepared coating film.

[68] The polyester resin may be included in an amount of 2 wt% to 9 wt%, 3 wt% to 8 wt%, or 4 wt% to 6 wt% based on the total weight of the clear coat composition. When the polyester resin is included within the above content range, there is an effect that appearance, scratch resistance, and smoothness of the coating film are improved. When the content of the polyester resin in the composition is below the above range, there may be a problem in that the crosslinking density may be decreased, thereby resulting in deterioration in appearance and scratch resistance, whereas when the content of the polyester resin in the composition exceeds

the above range, there may be a problem in that the viscosity of the composition may be increased excessively and thus workability and drying property may deteriorate, thereby resulting in deterioration of appearance and mechanical properties.

[69] <urethane resin>

5 [70] A urethane resin serves to impart elasticity to the prepared coating film and improve gloss, smoothness, and scratch resistance.

[71] As a urethane resin, one which is synthesized directly according to a known method may be used or a commercially available product may be used. The urethane resin may be prepared from, for example, one or more of an alcohol-based monomer and an isocyanate-
10 based compound.

[72] Alcoholic monomers may be one or more selected from the group consisting of, for example, cyclohexanol, cyclohexanedimethanol (CHDM) ethylhexanol, butanol, 1,6-hexanediol, ethylene glycol, propylene glycol, diethylene glycol, butylene glycol, neopentyl glycol (NPG), trimethylol propane (TMP), butanediol, 1,4-hexanediol, 3-methylpentanediol,
15 and pentaerythritol.

[73] Isocyanate-based compounds may be one or more selected from the group consisting of, for example, isocyanate-based monomers, which may be hexamethylene diisocyanate (HMDI), isophorone diisocyanate (IPDI), trimethylene diisocyanate, tetramethylene diisocyanate, pentamethylene diisocyanate, propylene diisocyanate, ethylene diisocyanate, 2,3-
20 dimethylethylene diisocyanate, 1-methyltrimethylene 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, methylene diphenyl diisocyanate (MDI), 4,4-diphenylpropane diisocyanate, xylene diisocyanate, tetramethyl xylene diisocyanate (TMXDI), 1,1,6,6-tetramethylhexamethylene
25 diisocyanate, hexamethylene diisocyanate trimer, and isophorone diisocyanate trimer; and

isocyanate derivatives which may be isocyanurates derived from diisocyanates, biurates, and allophanates.

[74] The urethane resin may be prepared using an addition reaction between an isocyanate-based compound and an alcohol-based monomer, and physical properties (*e.g.*, number average molecular weight (M_n), glass transition temperature (T_g), *etc.*) may be controlled according to the reaction ratio.

[75] The urethane resin may have a weight average molecular weight (M_w) of 1,400 g/mol to 2,000 g/mol, or 1,600 g/mol to 1,800 g/mol. When the weight average molecular weight of the urethane resin is within the above range, there are effects of improving the smoothness of the clear coat composition and forming a soft coating film thereby having excellent gloss and appearance characteristics of the coating film. When the weight average molecular weight of the urethane resin is below the above range, there may be a problem in that the molecular weight may be small and thus mechanical properties and weather resistance are deteriorated, whereas when the weight average molecular weight of the urethane resin exceeds the above range, there may be a problem in that smoothness and flowability may deteriorate according to the increase of the molecular weight, and thus the appearance characteristics may deteriorate and the coating film may become brittle thereby causing deterioration of scratch resistance.

[76] The urethane resin may have a glass transition temperature (T_g) of 10°C to 20°C, or 12°C to 18°C. When the glass transition temperature of the urethane resin is within the above range, the flexibility of the coating film is increased, thereby having the effect of improving gloss characteristics and scratch resistance of the coating film. When the glass transition temperature of the urethane resin is below the above range, there may be a problem in that the elasticity of the coating film may increase and thus the hardness may decrease, and the drying property of the clear coat composition may become poor, thereby resulting in deterioration in

the appearance characteristic of the coating film, whereas when the glass transition temperature of the urethane resin exceeds the above range, there may be a problem in that the flowability of the clear coat composition may decrease, and thus, the appearance characteristic may deteriorate and the elasticity of the coating film may decrease, thereby deteriorating adhesion and scratch resistance.

[77] The urethane resin may have a solids content (NV) of 65 wt% to 90 wt%, or 70 wt% to 80wt% based on the total weight of the resin. When the solid content of the urethane resin is within the above range, there is an effect that the workability of the clear coat composition is improved. When the solid content of the urethane resin is below the above range, there may be a problem in that the viscosity may be excessively lowered, thereby deteriorating flowability and making workability of the clear coat composition containing the same insufficient, whereas when the solid content of the urethane resin exceeds the above range, the viscosity may become too high, thereby resulting in a decrease of stability during the reaction, and as a result, dispersion stability may deteriorate and an aggregate may occur within the clear coat composition over time.

[78] The urethane resin may have a viscosity at 25°C of 2,200 cps to 4,700 cps, 2,400 cps to 4,500 cps, or 2,600 cps to 4,300 cps. When the viscosity of the urethane resin at 25°C is within the above range, the viscosity of the clear coat composition is appropriate, thereby having an effect of improving workability. When the viscosity at 25°C of the urethane resin is below the above range, there may be a problem in that the viscosity of the composition may be too low, thereby deteriorating coating flowability, adhesion, and scratch resistance due to non-formation of the prepared coating film, whereas when the viscosity at 25°C of the urethane resin exceeds the above range, there may be a problem in that the workability of the composition may be insufficient thereby deteriorating the appearance characteristic of the prepared coating film.

[79] The urethane resin may be included in an amount of 6 wt% to 12 wt%, 7 wt% to 11 wt%, or 8 wt% to 10 wt% based on the total weight of the clear coat composition. When the content of the urethane resin is within the above range, there is an effect that flexibility and appearance characteristics of the prepared coating film are excellent. When the content of the urethane resin in the clear coat composition is below the above range, there may be a problem in that the crosslinking density of the coating film may be lowered, thereby deteriorating scratch resistance and appearance, whereas when the content of the urethane resin in the clear coat composition exceeds the above range, there may be a problem in that the drying property may deteriorate and thus the hardness of the coating film may be lowered.

[80] <melamine resin>

[81] A melamine resin, which is a curing agent, serves to cure the composition by cross-linking with each component of a clear coat composition and improve the hardness of the prepared coating film.

[82] The melamine resin may be an alkylated melamine resin, and it may be directly synthesized according to a known method or a commercially available product may be used.

[83] Melamine resins may include one or more selected from the group consisting of, for example, methoxy methyl melamine, methyl melamine, butyl melamine, isobutoxy melamine, butoxy melamine, hexamethylol melamine, hexamethoxy methyl melamine, hexabutoxy methyl melamine, hexamethoxybutoxy methyl melamine, and aminomethyl melamine.

[84] Examples of commercially available melamine resins include CYMEL-325, CYMEL-303, CYMEL-1161, and CYMEL-1168 (CYTEC Industries Inc.), and LUWIPAL 012 and LUWIPAL 072 (BASF), *etc.*

[85] The melamine resin may have a weight average molecular weight (M_w) of 2,000 g/mol to 3,000 g/mol, 2,200 g/mol to 2,800 g/mol, or 2,400 g/mol to 2,600 g/mol. When the weight average molecular weight of the melamine resin is within the above range, there is an effect

that the crosslinking density is improved thereby improving the adhesion and hardness of the prepared coating film. When the weight average molecular weight of the melamine resin is below the above range, there may be a problem in that the crosslinking density of the coating film may be lowered, thereby deteriorating chemical resistance and scratch resistance, whereas
5 when the weight average molecular weight of the melamine resin exceeds the above range, there may be a problem in that the appearance characteristic of the coating film may deteriorate according to an increase of the molecular weight.

[86] The melamine resin may have a viscosity at 25°C of 600 cps to 1,000 cps, 700 cps to 900 cps, or 750 cps to 850 cps. When the viscosity of the melamine resin at 25°C is within
10 the above range, there is an effect that gloss and appearance are excellent. When the viscosity at 25°C of the melamine resin is below the above range, there may be a problem in that the viscosity may be low and thus the adhesion and scratch resistance of the coating film may deteriorate due to the non-formation of a coating film, whereas when the viscosity of the melamine resin at 25°C exceeds the above range, there may be a problem in that the workability
15 of the composition may be poor and thus appearance characteristic may be insufficient.

[87] The melamine resin may have a solids content (NV) of 50 wt% to 70 wt%, or 55 wt% to 65 wt% based on the total weight of the resin. When the solid content of the melamine resin is within the above range, there is an effect that the workability of the clear coat composition is improved. When the solid content of the melamine resin is below the above
20 range, there may be a problem in that the viscosity may become too low, thereby deteriorating flowability and making the workability of the clear coat composition containing the same insufficient, whereas when the solid content of the melamine resin exceeds the above range, there may be a problem in that the viscosity may become too high, thereby deteriorating the stability during the reaction, and dispersion stability may deteriorate, and thus an aggregate
25 may occur in the clear coat composition over time.

[88] The melamine resin may be included in an amount of 15 wt% to 30 wt%, 18 wt% to 26 wt%, or 19 wt% to 25 wt% based on the total weight of the clear coat composition. When the content of the melamine resin is within the above range, there is an effect that the crosslinking density is improved thereby improving the adhesion and hardness of the prepared coating film. When the content of the melamine resin is below the above range, there may be a problem in that the hardness and appearance characteristic may deteriorate due to a decrease in curability, whereas when the content of the melamine resin exceeds the above range, there may be a problem in that the coating film may become brittle due to excessive curability, thereby deteriorating adhesion, impact resistance, and scratch resistance.

[89] <additives>

[90] The clear coat composition according to one aspect of the present disclosure may further contain additives such as a light stabilizer, an acid catalyst, a moisture absorbent, a curing catalyst, a UV absorber, and a surface leveling agent. Additives are not particularly limited as long as they can be normally added to a clear coat composition.

[91] Light stabilizers play a role in absorbing UV rays and inhibit radical chain reactions caused by ultraviolet rays; acid catalysts play a role in accelerating a reaction and controlling a curing speed; surface leveling agents play a role in improving an appearance characteristic such as smoothness; and absorbent play a role in absorbing moisture to thereby improve storage properties.

[92] The contents of additives are not particularly limited as long as they can be normally contained in the clear coat composition. For example, the additives may be contained in the composition in an amount of 1 wt% to 15 wt%, or 1.5 wt% to 12 wt%, or 1.7 wt% to 11wt% based on the total weight of the clear coat composition.

[93] <solvent>

[94] A clear coat composition according to one aspect of the present disclosure may contain

a solvent. The solvent serves to control the viscosity of the composition, improve a drying property, and improve the appearance characteristic and spreadability of the prepared coating film.

[95] The solvent is not particularly limited as long as it is one commonly used in clear coat compositions, and may include, for example, one or more selected from the group consisting of aromatic hydrocarbon-based solvents, acetate-based solvents, alcohol-based solvents, and propionate-based solvents. Specifically, the solvent may include an aromatic hydrocarbon-based solvent (*e.g.*, toluene, xylene, and xylene); acetate-based solvents (*e.g.*, 1-methoxy-2-propylacetate, methylacetate, ethylacetate, *n*-propylacetate, *n*-butylacetate, methyl glutarate, methyl succinate, methyl adipate, dimethyl glutarate, dimethyl succinate, dimethyl adipate, propylene glycol methyl ether acetate (PMA), butyl carbitol acetate, butyl cellosolve acetate, *etc.*); alcohol solvents (*e.g.*, *n*-butanol, propanol, 1-methoxy-2-propanol, 2-butoxyethanol, *etc.*); ketone-based solvents (*e.g.*, acetone, methyl ethyl ketone, methyl butyl ketone, methyl isobutyl ketone, *etc.*); propionate-based solvents (*e.g.*, ethyl ethoxy propionate, *etc.*), *etc.* may be included. In addition, commercially available aromatic hydrocarbon-based solvents include Kocosol #100, Kocosol #150, *etc.*

[96] The solvent may be included in the composition in an amount of 3 wt% to 50 wt%, or 10 wt% to 35 wt% based on the total weight of the clear coat composition. When the solvent is included within the above range, there is an effect that workability and a drying property may be improved by appropriately adjusting the viscosity of the composition. When the content of the solvent in the clear coat composition is below the above range, there may be a problem in that the solid content in the composition may be high, thereby making the workability of the composition insufficient, whereas when the content of the solvent in the clear coat composition exceeds the above range, there may be a problem in that the solid content in the composition may be low, thereby making poor appearance and adhesion of the

coated film insufficient.

[97] The clear coat composition according to one aspect of the present disclosure may be a one-component type containing a main part and a curing agent part.

[98] The clear coat composition of the present disclosure may have a solid content of 50 wt% to 60 wt%, or 52 wt% to 58wt%. When the solid content of the clear coat composition of the present disclosure is within the above range, there is an advantage in that the coating workability of the composition becomes appropriate. When the solid content of the clear coat composition of the present disclosure is below the above range, there may be a problem in that curing reactivity may be lowered due to a decrease in solid content, whereas when the solid content of the clear coat composition of the present disclosure exceeds the above range, there may be a problem in that the workability of the clear coat composition may be lowered due to a high solid content.

[99] The clear coat composition of the present disclosure may have a viscosity of 45 to 65 seconds, 50 to 60 seconds, or 53 to 57 seconds based on Ford Cup No. 4. When the viscosity of the clear coat composition of the present disclosure is below the above range, there may be a problem in that the vertical surface may drip down, whereas when the viscosity of the clear coat composition of the present disclosure exceeds the above range, there may be a problem in that the viscosity of the composition may be high, thereby deteriorating the appearance characteristic of the coating film prepared therefrom or increasing the load on the coating machine thereby causing the coating machine to be out of order.

[100] Hereinafter, the present disclosure will be described in more detail through examples. However, these examples are only for helping the understanding of the present disclosure, and the scope of the present disclosure is not limited to these examples in any sense.

[101] [Preparation of clear coat composition]

[102] Preparation of clear coat compositions of Examples and Comparative Examples

[103] Clear coat compositions were prepared by mixing the first acrylic resin, the second acrylic resin, polyester resin, urethane resin, melamine resin, additives, and solvents in the contents shown in [Table 1] to [Table 3] so as to obtain a viscosity of 55 seconds based on Ford Cup No. 4.

5 **[104]** [Table 1]

Component (wt%)	Examples									
	1	2	3	4	5	6	7	8	9	10
First acrylic resin-1	38	33	47	27	53	38	38	38	38	
First acrylic resin-2										38
First acrylic resin-3										
First acrylic resin-4										
First acrylic resin-5										
First acrylic resin-6										
First acrylic resin-7										
First acrylic resin-8										
First acrylic resin-9										
Second acrylic resin-1	9.5	9.5	9.5	9.5	9.5	7	12	4	15	9.5
Second acrylic resin-2										
Second acrylic resin-3										
Second acrylic resin-4										
Second acrylic resin-5										
Second acrylic resin-6										
Second acrylic resin-7										
Second acrylic resin-8										

Second acrylic resin-9										
Polyester resin	6	6	6	6	6	6	6	6	6	6
Urethane resin	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5
Melamine resin	22	22	22	22	16	22	22	22	22	22
Light stabilizer	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Surface leveling agent	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Curing catalyst	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
First solvent	2.1	3.1	1.1	5.1	1.1	3.1	2.1	4.1	1.1	2.1
Second solvent	7.5	10.5	2.5	11.5	2.5	9	5.5	9	3.5	7.5
Third solvent	4.1	5.1	1.1	8.1	1.1	4.1	3.6	6.1	3.6	4.1
Total	100	100	100	100	100	100	100	100	100	100

[105] [Table 2]

Component (wt%)	Examples										
	11	12	13	14	15	16	17	18	19	20	21
First acrylic resin-1				38	38	38	38	38	38	38	38
First acrylic resin-2											
First acrylic resin-3	38										
First acrylic resin-4											
First acrylic resin-5											
First acrylic resin-6		38									
First acrylic resin-7			38								
First acrylic resin-8											
First acrylic resin-9											
Second acrylic resin-1	9.5	9.5	9.5					9.5	9.5	9.5	9.5

Second acrylic resin-2				9.5							
Second acrylic resin-3					9.5						
Second acrylic resin-4											
Second acrylic resin-5											
Second acrylic resin-6						9.5					
Second acrylic resin-7							9.5				
Second acrylic resin-8											
Second acrylic resin-9											
Polyester resin	6	6	6	6	6	6	6	2	9	0.5	12
Urethane resin	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5
Melamine resin	22	22	22	22	22	22	22	22	22	22	22
Light stabilizer	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Surface leveling agent	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Curing catalyst	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
First solvent	2.1	2.1	2.1	2.1	2.1	2.1	2.1	5.1	2.1	4.1	1.1
Second solvent	7.5	7.5	7.5	7.5	7.5	7.5	7.5	8.5	5.5	11	3.5
Third solvent	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	3.1	4.1	3.1
Total	100	100	100	100	100	100	100	100	100	100	100

[106] [Table 3]

Component (wt%)	Comparative Examples										
	1	2	3	4	5	6	7	8	9	10	11
First acrylic resin-1		38	38					38	38	38	38
First acrylic resin-2											
First acrylic resin-3											

First acrylic resin-4				38							
First acrylic resin-5					38						
First acrylic resin-6											
First acrylic resin-7											
First acrylic resin-8						38					
First acrylic resin-9							38				
Second acrylic resin-1	9.5		9.5	9.5	9.5	9.5	9.5				
Second acrylic resin-2											
Second acrylic resin-3											
Second acrylic resin-4								9.5			
Second acrylic resin-5									9.5		
Second acrylic resin-6											
Second acrylic resin-7											
Second acrylic resin-8										9.5	
Second acrylic resin-9											9.5
Polyester resin	6	6		6	6	6	6	6	6	6	6
Urethane resin	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5
Melamine resin	26	22	22	22	22	22	22	22	22	22	22
Light stabilizer	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Surface leveling agent	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Curing catalyst	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
First solvent	10.6	5.1	4.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1
Second solvent	25	12	11.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5
Third solvent	12.1	6.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1

Total	100	100	100	100	100	100	100	100	100	100	100
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[107] The physical properties, manufacturers, product names, or names of each component used in Examples and Comparative Examples are presented in [Table 4] below.

[108] [Table 4]

	Physical Properties, Manufacturers, or Product Names
First acrylic resin-1	Tg 2.8°C, Mw 7,900 g/mol, OHv 155 mgKOH/g, Av 4.5 mgKOH/g, NV 70 wt%
First acrylic resin-2	Tg 0.7°C, Mw 7,900 g/mol, OHv 155 mgKOH/g, Av 4.5 mgKOH/g, NV 70 wt%
First acrylic resin-3	Tg 8.2°C, Mw 7,900 g/mol, OHv 155 mgKOH/g, Av 4.5 mgKOH/g, NV 70 wt%
First acrylic resin-4	Tg -1°C, Mw 7,900 g/mol, OHv 155 mgKOH/g, Av 4.5 mgKOH/g, NV 70 wt%
First acrylic resin-5	Tg 12.8°C, Mw 7,900 g/mol, OHv 155 mgKOH/g, Av 4.5 mgKOH/g, NV 70 wt%
First acrylic resin-6	Tg 2.8°C, Mw 7,900 g/mol, OHv 145 mgKOH/g, Av 4.5 mgKOH/g, NV 70 wt%
First acrylic resin-7	Tg 2.8°C, Mw 7,900 g/mol, OHv 180 mgKOH/g, Av 4.5 mgKOH/g, NV 70 wt%
First acrylic resin-8	Tg 2.8°C, Mw 7,900 g/mol, OHv 109 mgKOH/g, Av 4.5 mgKOH/g, NV 70 wt%
First acrylic resin-9	Tg 2.8°C, Mw 7,900 g/mol, OHv 210 mgKOH/g, Av 4.5 mgKOH/g, NV 70 wt%
Second acrylic resin-1	Tg -6°C, Mw 8,700 g/mol, OHv 80 mgKOH/g, NV 65 wt%

Second acrylic resin-2	Tg -9.3°C, Mw 8,700 g/mol, OHv 80 mgKOH/g, NV 65 wt%
Second acrylic resin-3	Tg -1.5°C, Mw 8,700 g/mol, OHv 80 mgKOH/g, NV 65 wt%
Second acrylic resin-4	Tg 0°C, Mw 8,700 g/mol, OHv 80 mgKOH/g, NV 65 wt%
Second acrylic resin-5	Tg -13°C, Mw 8,700 g/mol, OHv 80 mgKOH/g, NV 65 wt%
Second acrylic resin-6	Tg -6°C, Mw 8,700 g/mol, OHv 55 mgKOH/g, NV 65 wt%
Second acrylic resin-7	Tg -6°C, Mw 8,700 g/mol, OHv 107 mgKOH/g, NV 65 wt%
Second acrylic resin-8	Tg -6°C, Mw 8,700 g/mol, OHv 42 mgKOH/g, NV 65 wt%
Second acrylic resin-9	Tg -6°C, Mw 8,700 g/mol, OHv 121 mgKOH/g, NV 65 wt%
Polyester resin	Tg 12°C, Mw 3,050 g/mol, Av 20 mgKOH/g, OHv 260 mgKOH/g, NV 65 wt%
Urethane resin	Tg 15°C, Mw 1,750 g/mol, OHv 21 mgKOH/g, NV 90 wt%,
Melamine resin	Mw: 680 g/mol, Av: 1 mgKOH/g, NV: 76 wt%, viscosity at 25°C 3,200 cps
Light stabilizer	Manufacturer: BASF, Product Name: TINUVIN 5341
Surface leveling agent	Manufacturer: BYK, Product Name: BYK-3550
Curing catalyst	Manufacturer: KING, Product Name: NACURE-5543
First solvent	ethyl 3-ethoxy propionate
Second solvent	Kocosol #100
Third solvent	<i>n</i> -butyl alcohol

[109] [Evaluation of film properties]

[110] A primer coating (manufacturer: KCC, product name: FU2290) was applied to the specimen and cured at 140°C for 20 minutes to form a primer coating film having a thickness of 40 µm. Then, a base coat (manufacturer: KCC, product name: WT3062) was applied by bell spray on the primer film, and hot air was blown at 80°C for 3 minutes to evaporate the remaining water in the paint so as to form a base film with a thickness of 15 µm. Thereafter,

each of the clear coat compositions prepared in Examples and Comparative Examples was coated on the base coating film and cured at 140°C for 25 minutes so as to form a clear coating film having a thickness of 40 µm, and then a 2K clear coat (manufacturer: KCC, product name: UT6040) was applied. The final coating was prepared by coating and curing at 140°C for 25 minutes so as to form a clear coating film having a thickness of 40 µm. The physical properties of the specimens were measured in the following manner, and the results are presented in [Table 5] to [Table 7].

[111] Specifically, the clear coating film was applied using a hand gun spray (nozzle aperture: 1.5 mm, air pressure: maintained constant around 45 kgf/cm²) while maintaining a constant distance between the nozzle inlet and the specimen at 30 cm and moving at a speed of a constant 45 cm/sec.

[112] (1) Coating film workability

[113] The coating film workability was evaluated by observing the spray state and wettability of the substrate when the paint was discharged.

[114] According to the observed state, the substrate was evaluated as excellent (◎), good (○), average (Δ), or poor (×).

[115] (2) Appearance of coating film

[116] Gloss (LU), sharpness (SH), and orange peel (OP) of the prepared final coating film were measured using the Wave Scan DOI (BYK Gardner), which is an instrument for measuring the exteriors of a vehicle, and comprehensive appearance evaluation figures (CF) were calculated by Equation 1 below using the measured physical properties.

[117] [Equation 1]

[118] $CF = LU \times 0.15 + SH \times 0.35 + OP \times 0.5$

[119] CF was measured horizontally and vertically and calculated. As a horizontal/vertical value of CF, when CF was 65 or more, the coating film was evaluated as excellent (◎); when

CF was 60 or more and less than 65, the coating film was evaluated as good (○); when CF was 55 or more and less than 60, the coating film was evaluated as average (△); and when CF was less than 55, the coating film was evaluated as poor (×).

[120] (3) Gloss

5 **[121]** In order to measure the gloss (%) reflected from a coating film, a glosser (BYK Gardner) was applied to measure the 20° gloss of the final coating film.

[122] According to the measurement results, when the gloss was 90% or more, the coating film was evaluated as excellent (◎); when the gloss was 89% or more and less than 90%, the coating film was evaluated as good (○); when the gloss was 87% or more and less than 89%,
10 the coating film was evaluated as normal (△); and when the gloss was less than 87%, the coating film was evaluated as poor (×).

[123] (4) Adhesion

[124] After curing the top coating paint and the clear coat composition, adhesion was evaluated using the baduk board method.

15 **[125]** Specifically, in the baduk board method, after preparing 100 squares with a width of 2 mm and a length of 2 mm using a knife on the surface of each clear coat film, the squares were removed using a tape to measure adhesion. In particular, the measured adhesion was evaluated as excellent (◎) when 100 squares were fully attached; the measured adhesion was evaluated as good (○) when the remaining squares were 70% or more and less than 100%; the
20 measured adhesion was evaluated as normal (△) when the remaining squares were 50% or more and less than 70%; and the measured adhesion was evaluated as defective (×) when the remaining squares were less than 50%.

[126] (5) Impact resistance

[127] The impact resistance of the final coating film was evaluated according to ASTM
25 D2794. A DuPont impact tester was used, and the appearance of the coating film was

observed when a 500g weight was dropped on the specimen while changing the drop height of the weight from 30 cm to 50 cm.

[128] As a result of observation, when the crack or peeling phenomenon of the coating film did not occur at a drop height of 50 cm or more, the coating film was evaluated as excellent (◎), when the crack or peeling phenomenon of the coating film occurred at a height of 30 cm or more and less than 50 cm, the coating film was evaluated as good (○); when the crack or peeling phenomenon of the coating film occurred at 20 cm or more and less than 30 cm, the coating film was evaluated as normal (△); and when the crack or peeling phenomenon of the coating film occurred at less than 20 cm, the coating film was evaluated as defective (×).

[129] (6) Water resistance

[130] The final coating film was immersed in a constant temperature water bath at 40°C for 240 hours, left at room temperature for 1 hour, and then adhesion was evaluated by the baduk board method, and discoloration was visually confirmed.

[131] Specifically, in the baduk board method, after preparing 100 squares with a width of 2 mm and a length of 2 mm using a knife on the surface of each clear coat film, the squares were removed using a tape to measure. In particular, the measured adhesion was evaluated as excellent (◎) when 100 squares were fully attached (◎); the measured adhesion was evaluated as good (○) when the remaining squares were 70% or more and less than 100%; the measured adhesion was evaluated as normal (△) when the remaining squares were 50% or more and less than 70%; and the measured adhesion was evaluated as defective (×) when the remaining squares were less than 50%.

[132] (7) Flowability of coating

[133] A specimen with a top coating film was vertically hung on a steel plate with a hole of 5 mm in diameter, and the clear coat compositions of Examples and Comparative Examples were coated in the same manner as described above, dried and cured, and then the surfaces of

the prepared films were observed to evaluate the flowability of coating of the compositions.

[134] Specifically, it was observed that the coating was formed at the bottom of each hole.

The thickness of the coating film at the starting point where flow generation was observed (μm) was recorded as the film thickness with a flow limit. In particular, it was determined that the

5 flowability of coating was insufficient as the value of the measured film thickness with a flow

limit became lower. In particular, when the film thickness with a flow limit was 40 μm or

more, the flowability of coating was evaluated as excellent ($\odot$); when the film thickness with

a flow limit was 35 μm or more and less than 40 μm , the flowability of coating was evaluated

as good ($\circ$); when the film thickness with a flow limit was 30 μm or more and less than 35 μm ,

10 the flowability of coating was evaluated as normal (Δ); and when the film thickness with a

flow limit was less than 30 μm , the flowability of coating was evaluated as poor ($\times$).

[135] (8) Cold chipping resistance

[136] After the final coating film was left at -20°C for 3 hours, a 50 g chipping stone (4 mm in diameter) was hit at an angle of 45° under a pressure of 4 bar. Then, foreign substances

15 such as a peeled-off coating film remaining in the final coating film were removed.

[137] Regarding the damaged part of the final coating film, when there were 10 or less

damages of 1 mm or less, the coating film was evaluated as excellent ($\odot$); when there were 10

or less damages of 1 mm or more and less than 2 mm, the coating film was evaluated as good

($\circ$); when there were 10 or less damages of 2 mm or more and less than 3 mm, the coating film

20 was evaluated as normal (Δ); and when there were more than 10 damages of 2 mm or more and

less than 3 mm, the coating film was evaluated as defective ($\times$).

[138] Re-coating adhesion

[139] After re-coating and curing the base coating film and the clear coat film, adhesion was evaluated using the baduk board method.

25 [140] Specifically, in the baduk board method, after preparing 100 squares of with a width

of 2 mm and a length of 2 mm using a knife on the surface of each clear coat films, the squares were removed using a tape to measure adhesion. In particular, the measured adhesion was evaluated as excellent (◎) when 100 squares were fully attached (◎); the measured adhesion was evaluated as good (○) when the remaining squares were 70% or more and less than 100%;

5 the measured adhesion was evaluated as normal (△) when the remaining squares were 50% or more and less than 70%; and the measured adhesion was evaluated as defective (×) when the remaining squares were less than 50%.

[141] [Table 5]

	Examples									
	1	2	3	4	5	6	7	8	9	10
Coating film workability	◎	◎	○	◎	△	○	○	△	△	◎
Appearance of coating film	◎	◎	○	◎	△	◎	○	○	△	◎
Gloss	◎	○	◎	△	◎	◎	◎	◎	△	◎
Adhesion	◎	○	◎	△	◎	◎	◎	◎	○	◎
Impact resistance	◎	○	◎	△	△	◎	◎	◎	◎	○
Water resistance	◎	◎	◎	△	◎	◎	◎	◎	◎	○
Flowability of coating	◎	◎	◎	◎	◎	○	○	△	△	◎
Cold chipping resistance	◎	◎	○	◎	△	◎	◎	◎	◎	○
Re-coating adhesion	◎	◎	◎	◎	◎	◎	◎	◎	○	◎

[142] [Table 6]

	Examples										
	11	12	13	14	15	16	17	18	19	20	21
Coating film workability	◎	◎	○	◎	◎	◎	◎	○	◎	△	◎
Appearance of coating film	○	◎	○	◎	○	◎	○	○	○	△	△
Gloss	○	◎	○	○	○	◎	◎	○	○	△	△
Adhesion	◎	○	◎	◎	○	○	◎	◎	◎	◎	◎
Impact resistance	◎	○	○	○	○	○	◎	○	○	△	△
Water resistance	◎	○	◎	◎	◎	○	○	◎	○	◎	△
Flowability of coating	◎	◎	◎	◎	◎	◎	○	◎	◎	◎	◎
Cold chipping resistance	○	○	◎	○	◎	○	○	○	○	△	△
Re-coating adhesion	◎	◎	◎	◎	◎	◎	◎	◎	○	○	○

[143] [Table 7]

	Comparative Examples										
	1	2	3	4	5	6	7	8	9	10	11
Coating film workability	○	○	○	◎	○	◎	X	○	○	○	○
Appearance of coating film	X	X	○	◎	X	◎	X	◎	X	◎	X
Gloss	X	△	○	○	X	◎	X	X	X	○	◎

Adhesion	△	○	X	△	◎	X	◎	○	X	X	○
Impact resistance	X	○	X	X	△	X	X	X	X	X	◎
Water resistance	△	○	X	X	△	X	◎	△	◎	X	X
Flowability of coating	△	X	○	△	◎	◎	△	◎	○	◎	X
Cold chipping resistance	△	○	X	X	X	X	△	X	△	X	X
Re-coating adhesion	△	○	X	△	○	△	○	○	○	△	○

[144] As shown in [Table 5] to [Table 7], it was found that the coating films prepared from the compositions of Examples had excellent physical properties compared to the coating films prepared from the compositions of Comparative Examples.

[145] Herein below, various embodiments of the present disclosure are described.

5 [146] (1) A clear coat composition, which contains a first acrylic resin, a second acrylic resin, a polyester resin, a urethane resin, and a melamine resin, in which the first acrylic resin has a glass transition temperature of 0.5°C to 10°C and a hydroxyl value of 120 mgKOH/g to 200 mgKOH/g, and the second acrylic resin has a glass transition temperature of -10°C to -1°C and a hydroxyl value of 50 mgKOH/g to 110 mgKOH/g

10 [147] (2) A clear coat composition, in which the first acrylic resin has a weight average molecular weight of 7,700 g/mol to 8,200 g/mol and the second acrylic resin has a weight average molecular weight of 8,500 g/mol to 9,000 g/mol

[148] (3) A clear coat composition, in which the polyester resin has a glass transition temperature of 8°C to 15°C, a hydroxyl value of 200 mgKOH/g to 400 mgKOH/g, and a weight
15 average molecular weight of 2,500 g/mol to 3,500 g/mol

[149] (4) A clear coat composition, in which the urethane resin has a weight average

molecular weight of 1,400 g/mol to 2,000 g/mol and a glass transition temperature of 10°C to 20°C

[150] (5) A clear coat composition, in which the melamine resin has a viscosity at 25°C of 600 cps to 1,000 cps and a weight average molecular weight of 2,000 g/mol to 3,000 g/mol

- 5 **[151]** (6) A clear coat composition, which contains 30 wt% to 50 wt% of the first acrylic resin, 6 wt% to 13wt% of the second acrylic resin, 2 wt% to 9 wt% of a polyester resin, 6 wt% to 12 wt% of a urethane resin, 15 wt% to 30 wt% a melamine resin, and a remainder of a solvent based on the total weight of the composition

What is claimed is:

1. A clear coat composition comprising a first acrylic resin, a second acrylic resin, a polyester resin, a urethane resin, and a melamine resin,

5 wherein the first acrylic resin has a glass transition temperature of 0.5°C to 10°C and a hydroxyl value of 120 mgKOH/g to 200 mgKOH/g; and

the second acrylic resin has a glass transition temperature of -10°C to -1°C and a hydroxyl value of 50 mgKOH/g to 110 mgKOH/g.

10 2. The clear coat composition of claim 1, wherein the first acrylic resin has a weight average molecular weight of 7,700 g/mol to 8,200 g/mol; and the second acrylic resin has a weight average molecular weight of 8,500 g/mol to 9,000 g/mol.

3. The clear coat composition of claim 1, wherein the polyester resin has a glass transition
15 temperature of 8°C to 15°C, a hydroxyl value of 200 mgKOH/g to 400 mgKOH/g, and a weight average molecular weight of 2,500 g/mol to 3,500 g/mol.

4. The clear coat composition of claim 1, wherein the urethane resin has a weight average
20 molecular weight of 1,400 g/mol to 2,000 g/mol and a glass transition temperature of 10°C to 20°C.

5. The clear coat composition of claim 1, wherein the melamine resin has a viscosity of 600 cps to 1,000 cps at 25°C and a weight average molecular weight of 2,000 g/mol to 3,000 g/mol.

6. The clear coat composition of claim 1, wherein the clear coat composition, based on the total weight of the composition, comprises 30 wt% to 50 wt% of the first acrylic resin, 6 wt% to 13wt% of the second acrylic resin, 2 wt% to 9 wt% of the polyester resin, 6 wt% to 12 wt% of the urethane resin, 15 wt% to 30 wt% of the melamine resin, and a remainder of a solvent.