(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 693 323 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
24.01.1996 Bulletin 1996/04

(51) Int Cl.^{6}: **B05D 5/06**, B05D 5/12

(21) Application number: **95304997.0**

(22) Date of filing: **18.07.1995**

(84) Designated Contracting States:
AT DE ES FR GB IT

(30) Priority: **20.07.1994 US 278478**

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(54) Conductive color-keyed automotive primers

(57) An inexpensive, two coat primer system for the electrostatic coating of plastic parts is provided in which hiding of the substrate is achieved with a coloured non-conductive first coat and the conductivity is supplied by a thin translucent coat containing the conductive pigment.

Printed by Jouve (FR), 18, rue Saint-Denis, 75001 PARIS

Description

This invention relates to the electrostatic coating of plastic substrates. More particularly, it relates to a two coat primer system comprising a non-conductive, chromatically pigmented first coat and a relatively thin translucent conductive second coat. It relates still more particularly to a conductive primer that is color-keyed to the hue of the topcoat.

Until recently, conductive black primers were the only primers available for the electrostatic coating of plastic parts. This made it difficult to hide the primer with white or colored topcoats and also made chips in the topcoat quite visible. The introduction of conductive white or clear pigments in recent years has allowed the development of conductive primers in chromatic colors to match the topcoat but these pigments are very expensive and the cost of primers made therefrom is prohibitive.

The creation of a one-coat non-black conductive coating capable of both good substrate hiding and conductivity is fraught with a number of problems. To obtain hiding with a colored system, a substantial number of non-conductive pigment particles must be present in the coating composition but then it must be converted into a conductive coating. To do this, one must add the expensive conductive pigment in an amount sufficient to overcome the insulating effect of the hiding pigments. The cost of such a one-coat coating system is very high because the amount of conductive pigment which is sufficient is very large indeed.

It is an object of this invention, therefore, to provide an inexpensive, two coat primer system for the electrostatic coating of plastic parts in which hiding of the substrate is achieved with a colored non-conductive first coat and the conductivity is supplied by a thin translucent coat containing the conductive pigment.

It is a related object of this invention to provide a color-keyed primer for electrostatically coated plastic parts.

It is another related object of this invention to provide a wet-on-wet method for applying a two-coat, colored primer suitable for the electrostatic application of a topcoat.

These and other objects of this invention which will become apparent from the following description are achieved by a method comprising applying a non-conductive, colored primer coating composition to hide the substrate and then applying a translucent conductive primer coating to the wet surface of the non-conductive primer and baking the coated substrate. In the context of this invention, the word color and all derivatives of it are used to mean a chromatic color as opposed to white and black, which actually are the absence of color and the combination of all colors of the spectrum, respectively. The substrate may be metal as well as plastic but the invention finds its reason in the coating of plastic parts. The translucency of the conductive coating is an attribute of the poor hiding power of the conductive pigment; as well as the relatively thin layer of the conductive primer as compared to the first layer which hides the substrate.

The preferred binder for both the non-conductive and conductive primer coating compositions is a hydroxyl-functional polyester having an OH value of from 170 to 240, preferably from 190 to 220. The polyesters are preferably made from saturated aliphatic acids and polyols by methods which are well known by and routinely practiced by those of ordinary skill in the art. The reactants may be heated to a temperature in the range of from 135 to 220°C (275 to 430°F) while being sparged with a stream of inert gas such as nitrogen to remove water as it forms. Vacuum or an azeotrope-forming solvent may be used at the appropriate temperature to assist the removal of water. Examples of suitable dicarboxylic acids include malonic, succinic, adipic, methyladipic, sebacic, and suberic acid. Among the suitable polyols are ethylene glycol, 1,3-propylene glycol, diethylene glycol, neopentyl glycol, and trimethylolpropane. Mixtures of the acids and of the polyols may be used. The use of vacuum to assist the removal of water must take into account the potential loss of polyol through sublimation. A catalyst may be used but satisfactory results are achieved without one.

The weight average molecular weight (Mw) may range from about 500 to about 20,000, preferably between about 600 and about 1000. The hydroxy functionality of a preferred resin is about 3/molecule and the carboxy functionality is about 0.1/molecule. The Brookfield viscosity of the resin, using a # 3 spindle at 20 rpm, is from about 3600 to about 7200 centipoises. Its density is about 1.09 grams/cc or about 9.06 pounds per gallon. Suitable polyesters for the practice of this invention are available from Ruco and Miles under the trademarks Rucoflex and Desmophen.

Dispersions in a solvent of one or more non-conductive pigments and from about 20 to about 40 per cent by weight of the polyester and, optionally the appropriate amount of curing agent and/or an epoxy resin, are made in a sand mill to a Hegman grind of about 6.5 + or a particle size on the order of about 20 microns or less.

Epoxy resins suitable for this invention are generally known and are prepared by well known techniques. They are conpounds or mixtures of compounds containing at least one, but typically more than one, 1,2-epoxy group. They may be saturated or unsaturated, aliphatic, cycloaliphatic, aromatic, or heterocyclic. Examples of suitable epoxy resins include polyglycidyl ethers of polyphenols such as bisphenol A and bisphenol F, polyglycidyl ethers of mononuclear polyhydric phenols such as resorcinol and pyrogallol, polyglycidyl ethers of polyhydric alcohols such as ethylene glycol and pentaerythritol, and glycidyl esters of acrylic and methacrylic acid. Minimal amounts of up to about 2 % by weight of the coating composition are useful in certain formulations.

These dispersions are then blended with a curing agent, flatteners, flow agents, and other additives such as dispersants, surfactants, UV absorbers and, sufficient additional amounts of the polyester to make the first or non-conductive coating composition and the second, conductive coating composition having the desired properties.

The non-conductive coating composition of this invention may be made from about 1 to about 55 per cent by weight of the non-conductive dispersion and from about 5 to about 20 per cent by weight of additional polyester. Titanium dioxide is the major ingredient in the non-conductive dispersion mentioned above and it becomes the major pigment in the non-conductive primer coating compositions for its hiding power. In order to provide a color-keyed primer for electrostatically coated plastic parts, the colored pigments preferably are the same as those present in the topcoat and may be organic or inorganic and are exemplified by phthalocyanine blue, phthalocyanine green, quinacridone red, perylene red, isoindolenone yellow, and the various iron oxides. Very small amounts, on the order of about 0.15 per cent by weight of the total weight of the non-conductive composition, of these pigments are sufficient to impart the desired color. About 0.1 per cent by weight of a conductive pigment such as carbon black may be present in the non-conductive composition. The non-conductive coating composition may also contain up to about 4 % by weight of a microgel solution.

The conductive primer coating composition contains from about 15 to about 25 % by weight of a conductive white or clear pigment as exemplified by an antimony doped tin oxide on a mica support sold under the trademark MINATEC by EM Industries, Inc. Another example of a suitable conductive pigment is the potassium titanate fiber sold by Otsuka Chemical Co., Ltd. under the trademark TISMO. The TISMO 200B powder is a particular example of such pigments. Antimony/tin oxides are described in U. S. Patent Nos. 4,655,966 and 5,104,583, which are incorporated herein by reference. It is preferred to add colored pigments like those given above to tint the conductive composition to approximate the color of the non-conductive primer coat and maintain the color match between the primer and the topcoat that is the object of this invention. Again, small amounts of conductive black pigments may be tolerated. The pigment to binder ratio in the conductive composition is about 1:1.7 or less by weight; in terms of percent, the weight of the pigment is about 60 % or less of the weight of the binder. The final conductive coating composition of this invention may be made with from about 15 to about 25 per cent by weight of the conductive pigment and from about 20 to about 30 per cent by weight of the polyester beyond that which comes from the pigmented dispersions.

The polyesters are curable through the hydroxyl groups, preferably with aminoplasts, which are oligomers that are the reaction products of aldehydes, particularly formaldehyde, with amino- or amido-group-carrying substances exemplified by melamine, urea, dicyanodiamide, and benzoguanamine. Especially advantageous are the aminoplasts, which are modified with alkanols having from one to four carbon atoms. Other suitable aminoplast resins include the alkoxymethyl glycourils such as tetra (methoxymethyl) glycouril. Thus, a wide variety of commercially available aminoplasts and their precursors can be used for combining with the linear polyesters of this invention. Particularly preferred are the amino crosslinking agents sold by American Cyanamid under the trademark Cymel and by Monsanto under the trademark Resimene. In particular, the Cymel 301, Cymel 303, Cymel 385, Resimene 745 and Resimene 755 alkylated melamine-formaldehyde resins are useful. Of course, it is possible to use mixtures of all of the above N-methylol products. Hydroxyl-reactive cross-linking is generally provided in an amount sufficient to react with at least one-half the hydroxyl groups of the polyester, i.e., be present at at least one-half the stoichiometric equivalent of the hydroxyl functionality. Preferably, the cross-linking agent is sufficient to substantially completely react with all of the hydroxyl functionality of the polyester, and cross-linking agents having nitrogen cross-linking functionality are provided in amounts of from about 1 to about 12 equivalents of nitrogen cross-linking functionality per equivalent of hydroxyl functionality of the polyester. The first, non-conductive coating composition contains from about 10 to about 20 per cent by weight of the curing agent while the conductive coating composition contains from about 12 to about 25 per cent by weight.

The solvent used in making the dispersions and further in making the coating compositions from them is one that will give good wet out and flow properties to the coatings and at the same time it is one that will not attack the plastic substrate being coated. N-methyl-2-pyrrolidone (NMP) , ethyl benzene, isobutanol, xylene, ethyl-3-ethoxypropionate, aromatic naphtha, dipropylene glycol monomethyl ether acetate (DPMA), propylene glycol methyl ether acetate (PM acetate), and mineral spirits are examples of suitable solvents. Often a mixture of selected solvents is used to meet such requirements. The dispersions contain from about 15 to about 65 per cent by weight of solvent and the solvent content of the coating compositions is from about 20 to about 40 per cent by weight.

A preferred thixotrope is a fumed silica such as is available under the trademarks Cab-O-Sil and Aerosil. When present in a coating composition, it is used in amounts of less than 1 per cent of the total weight. An amorphous silica available from SCM Corporation is useful at less than 2 per cent by weight as a flattening agent. The dispersants, surfactants, UV absorbers, and other additives are all as conventionally used in coating compositions. A conventional curing catalyst is added to each of the primer compositions prior to use. The amount of active catalyst may be from about 0.2 to about 1.2 % by weight of the total composition. The catalyst may be most any organic soluble acid as exemplified by p-toluene sulfonic acid and phenyl acid phosphate. A catalyst solution containing 17.5 % p-toluene sulfonic acid and 13.1 % phenyl acid phosphate, by weight, is suitable but other ratios of the two may also be used to meet the demands of particular coating compositions.

The following examples illustrate the invention. Unless otherwise indicated, all amounts, parts, and percentages are by weight.

EXAMPLE I

A dispersion of a non-conductive pigment was made from the following constituents in a water cooled sand mill, Model No.Red Head L3J standard, sold by Chicago Boiler Company. The Hegman grind of the non-conductive dispersion was 7+.

Constituents	Concentration (wt %)
Solvent *	22.2
OH-functional polyester **	27.3
Thixotrope	0.5
TiO_2	50.0

* 18.9 % isobutanol
81.9 % ethyl-3-ethoxypropionate
** OH No. ~220

EXAMPLE II

A non-conductive coating composition was made from the dispersion of Example I according to the formula:

Constituent	Concentration (wt %)
Solvent †	25.2
OH-functional polyester ***	10.5
Aminoplast resin ****	16.4
Example I Dispersion	45.4
Flattener	1.6
Thixotrope	0.3
U.V. absorber	0.4
Iron oxide Carbon black Phthalocyanine blue	0.2

† 47.1 % isobutanol
17.3 % DPMA
18.3 % NMP
17.3 % PM Acetate

*** OH No. ~220

**** Butoxymethyl, poly-methoxymethyl melamine (Resimene)

EXAMPLE III

A conductive coating composition was made according to the formula:

Constituent	Concentration (wt%)
Solvent [††]	32.2
OH-functional polyester [***]	26.2
Aminoplast resin of Example II	17.9
Example I Dispersion	5.9
Minatec 31 CM conductive pigment	16.9
U. V. absorber	0.4
Butyrate	0.5
	100

Colored pigments

[***] OH No. ~220

[††] 16.8 % DPMA
34.6 % Xylene
34.6 % isobutanol
14.0 % methyl ethyl ketone
16.6 % mineral spirits

Shortly before the first primer coat is to be applied, the non-conductive composition is reduced with 3 parts of catalyst per 100 parts of the product of Example II. Likewise, the conductive composition is reduced with 3 parts of catalyst per 100 parts of the product of Example III.

In this invention, the two primer compositions are preferably applied wet-on-wet by spray gun in order to increase the throughput of coated parts. The first coat is sprayed onto the plastic part from a gun at an air pressure of about 60 psi to build a film having a dry thickness sufficient to hide the substrate, e.g., from about 0.7 to 0.8 mil, and then allowed to stand at ambient temperature for about 1 minute to flash off a portion of the solvent. The conductive coat is then sprayed in similar fashion to a dry film thickness of from about 0.3to about 0.4 mil. After air drying at ambient temperature for about 10 minutes, the coated part is baked at about 250°F for about 30 minutes to cure both primer coats. The coated part has a conductivity of from about 130 to about 165 Ransburg units as measured with a Ransburg Sprayability Meter No. 8333-00.

Claims

1. A method for adapting a plastic substrate for an electrostatic deposition of a topcoat, said method comprising applying a non-conductive, coloured primer coating composition to the substrate to hide the substrate and then applying an amount of a conductive, primer coating composition sufficient to give a dry film thickness of from 7.6 to 10.2 µm (0.3 to 0.4 mil) to the surface of the non-conductive primer and baking the coated substrate.

2. A method according to claim 1 wherein the non-conductive coating is still wet when the conductive coating is applied.

3. A method according to claim 1 or claim 2 wherein the non-conductive primer is colour-keyed to the topcoat.

4. A method according to any preceding claim wherein the conductive primer composition contains a coloured pigment.

5. A method according to claim 3 wherein the coloured pigment is chosen to approximate the colour of the non-conductive primer.

6. A method according to any preceding claim wherein the conductive coating composition comprises a binder and a conductive pigment in a ratio of 1:4 or less by weight.

7. A plastic article having a coloured, non-conductive first primer coat and a translucent conductive second primer coat having a thickness of 7.6 to 10.2 µm (0.3 to 0.4 mil).

8. A plastic article according to claim 7 wherein the conductive primer coat is tinted to approximate the non-conductive primer coat.

9. A plastic article having a coloured, non-conductive first primer coat, a conductive second primer coat having a thickness of 7.6 to 10.2 µm (0.3 to 0.4 mil), and an electrostatically applied topcoat colour matched to the non-conductive primer coat.

10. A plastic article according to any one of claims 7 to 9 wherein the conductive second primer coat has a pigment to binder ratio of 1:1.7 or less by weight.

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EUROPEAN SEARCH REPORT

Application Number
EP 95304997.0

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. 6)
A	DE - A - 3 334 961 (NIPPON PAINT) * Claim 1; page 4, lines 6-12; page 11, lines 16-21 * --	1,4,8	B 05 D 5/06 B 05 D 5/12
A	DE - A - 3 334 960 (NIPPON PAINT) * Abstract; claim 1; page 4, lines 5-12; page 15, lines 30-35; page 16, lines 1-11. --	1,2,8	
A	EP - A - 0 217 385 (NIPPON PAINT) * Abstract; column 1, lines 10-12; column 3, lines 22-24; column 9, lines 14-16; column 10, lines 15-18. --	1,2	
A	EP - A - 0 328 710 (E.I. DU PONT) * Abstract; page 2, lines 20, 25-27; page 4, lines 55-57; page 5, lines 1-3 * ----	1,3, 4,8	TECHNICAL FIELDS SEARCHED (Int. Cl.6) B 05 D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	12-10-1995	KOLLER

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
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T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
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& : member of the same patent family, corresponding document