

UV LACQUER FOR DIRECT TO METAL APPLICATION

The present invention relates to UV-curable lacquer compositions that are in particular suitable for use on plasma-treated substrates like tin-free steel, tin-plated steel or aluminum. These
5 substrates can be used as industrial, food or beverage packaging materials.

For many years, metal packaging materials have been coated using heat-curable coating compositions. Such coatings contain volatile organic solvents and consume quite a lot of energy. To lower or even eliminate the amount of such organic solvents and to lower the energy consumption needed for the full cure of the coating, Applicant has developed various
10 types of UV-curable coating systems. By using these UV-curable coatings, the amount of solvent released during curing can be reduced by more than 40% in comparison to the heat-curable systems. Since UV-curing is a fast process (full cure in less than 20 seconds), the use of UV-curable coatings leads to a faster production process at lower costs.

It was found that using these UV-curable lacquers on tinplate or tin free steel showed some
15 non-consistent performance, partly due to the adhesion performance of these coatings. It is known in the art that the above-mentioned substrates need to be treated before a protective coating can be applied, since the surface of these substrates is often contaminated. This contamination reduces the adhesion of a lacquer that is applied to such surface.

It was found that by using a plasma pretreatment, the surface of such substrates shows an
20 improved adhesion of a lacquer that is applied, in comparison to the untreated surface. However, it was noted that with the available UV-curable lacquers, still defects were observed leading to poor adhesion, which makes these coated substrates less suitable for use as packaging material for industrial, food or beverages.

The present invention provides a UV-lacquer composition that shows a superior adhesion to
25 the substrates that are typically used as food or beverages packaging material, such as tin-free steel, tin-plated steel or aluminum.

The present invention relates to UV-curable lacquer composition comprising

- a) A mixture of different epoxy resins,
- b) An acrylate compound,
- 30 c) A photoinitiator,
- d) Polycaprolactone triol, and

e) Cellulose acetate butyrate.

Tin free steel (TFS) is widely used as packaging material for food and beverages, for example as a food container. TFS consists of a thin layer of chromium and a layer of chromium oxide deposited on a steel base. This material has a metallic luster and good corrosion resistance.

- 5 Tinplate or tin plated steel consists of a thin layer of tin-iron alloy, a layer of tin, a layer of tin oxide and a passivation layer deposited on a steel base. This material has a good corrosion resistance, a good formability, and is easy to weld.

Coating composition

- 10 The coating composition according to the present invention comprises the following ingredients:

Epoxy resin

- The composition according to the present invention comprises a mixture of different epoxy resins. In one embodiment, this mixture comprises an aliphatic epoxy resin and an aromatic epoxy resin. In a further embodiment, the mixture of different epoxy resins comprises at least
 - 15 85 wt.% of one or more aliphatic epoxy resins, the wt.% being calculated based on the total weight of epoxy resins present in the lacquer composition.

Suitable aliphatic epoxy resins that can be used in the composition according to the present invention include epoxy resins, which are customary in epoxy resin technology. Examples of such epoxy resins include the following:

- 20 I) Polyglycidyl ethers or poly-(p-methylglycidyl) ethers, obtainable by reacting a compound having at least one, preferably two, free alcoholic hydroxyl groups with epichlorohydrin or β -methylepichlorohydrin under alkaline conditions or in the presence of an acidic catalyst with subsequent alkali treatment. The glycidyl ethers of this type are derived for example from acyclic alcohols, such as ethylene glycol, diethylene glycol or higher poly(oxyethylene) glycols,
 - 25 propane-1,2-diol or poly(oxypropylene) glycols, propane-1,3-diol, butane-1,4-diol, poly(oxytetramethylene) glycols, pentane-1,5-diol, hexane-1,6-diol, hexane-2,4,6-triol, glycerol, C12-14OH (Araldit® DY- E) 1,1,1-trimethylolpropane, pentaerythritol, sorbitol, and also from polyepichlorohydrins. Other glycidyl ethers of this type are derived from cycloaliphatic alcohols, such as 1,4-cyclohexanedimethanol, bis(4-

hydroxycyclohexyl)methane, 2,2-bis(4-hydroxycyclohexyl)-propane or
tricyclodecanedimethanol.

II) Cycloaliphatic epoxy resins, 3,4-Epoxycyclohexylmethyl – 3,4-epoxycyclohexylcarboxylate
is a cycloaliphatic epoxy that can be synthesized by the reaction of 3-cyclohexenylmethyl 3-
5 cyclohexenecarboxylate with paracetic acid. These aliphatic resins show a number of useful
properties in the composition according to the present invention, such as thermal stability.

Suitable aromatic epoxy resins that can be used in the composition according to the present
invention include glycidyl ethers prepared by the reaction of epichlorohydrin with an aromatic
compound containing at least one hydroxyl group carried out under alkaline reaction conditions.
10 Other suitable epoxy resins can be prepared by the reaction of epichlorohydrin with
mononuclear di- and trihydroxy phenolic compounds such as resorcinol and phloroglucinol,
selected polynuclear polyhydroxy phenolic compounds such as bis(p-hydroxyphenyl)methane
and 4,4-dihydroxybiphenyl. Epoxy resins suitable for the invention compositions have
molecular weights generally within the range of 86 to 10,000, preferably 200 to 1500. The
15 commercially-available epoxy resin 2,2-bis(4-hydroxyphenylpropane) (bisphenol-A) having a
molecular weight of 400, an epoxide equivalent (ASTM D-1652) of 185-192, and an n value
(from the formula above) of 0.2, is presently the preferred epoxy resin because of its low
viscosity and commercial availability.

Generally, the composition of the present invention comprises from 30 to 60 wt.% of epoxy
20 resins, based on the total weight of the composition.

Acrylate compound

The composition according to the present invention comprises an acrylate compound. This
acrylate compound should have at least two unsaturated carbon-carbon bonds. Such
25 unsaturated bonds can open up under the influence of UV-light in the presence of a
photoinitiator.

Suitable acrylate compounds that can be used in the composition according to the present
invention include ethoxylated (3) trimethylolpropane triacrylate, glyceryl propoxy triacrylate or
trimethylolpropane triacrylate.

Generally, the composition of the present invention comprises from 25 wt.% to 35 wt.% of an acrylate compound, based on the total weight of the composition.

Photoinitiator

- 5 The composition according to the present invention comprises an effective amount of a photoinitiator or a mixture of different photoinitiators, to effect the photocure of the composition by exposure to UV light. Generally, this amount is from about 0,01 wt.% to about 10 wt.% based on the total weight of the composition. Examples of photoinitiator that can be used in the composition according to the present invention include hydroxycyclohexylphenyl ketone,
10 benzophenone, triaryl sulfonium hexafluoro phosphonium in propylene carbonate and others

Polycaprolactone triol

- Polycaprolactone triol is present in the composition according to the present invention and greatly enhances the strength of the coating film after cure. Generally, the composition
15 comprises between 5 - 10 wt.% of polycaprolactone triol, based on the total weight of the composition.

Cellulose acetate butyrate.

- Cellulose acetate butyrate is present in the composition according to the present invention to
20 improve the adhesion of the composition to various (metal) substrates. Generally, the composition comprises between 10 wt.% - 15 wt.% of Cellulose acetate butyrate, based on the total weight of the composition.

Application process

- 25 The invention also relates to a process for the application of the above-described coating composition. This process comprises the following steps:

- Prior to application of a coating composition a plasma treatment of the surface of the substrate is performed,
- Following the plasma treatment, the coating composition is applied to the plasma-treated surface of the substrate, and
- 5 • Curing of the coating composition by exposing the substrate obtained in step ii) to UV radiation.

In this process, preferably tinplate, tin free steel or aluminum is used as the substrate.

The plasma treatment of the metal substrate can be done, for example, by using the Openair-Plasma® process, developed by the company Plasmatreat.

EXAMPLES

Different types of lacquers were applied to plasma-treated and non-plasma-treated substrates. Thereafter different tests were performed and the adhesion of the lacquers to the substrate were evaluated as follows:

<u>Test result</u>	<u>Score</u>
No peeling off	1
Partial peeling off	2
Total peeling off	3

The following lacquers were used

<u>Lacquer #</u>	<u>Description</u>
Lacquer 1	Lacquer according to the present invention
Lacquer 2	State of the art UV curable lacquer supplied by ACTEGA

The following substrates were used:

<u>Substrate #</u>	<u>Description</u>
Substrate 1	Untreated tin free steel
Substrate 2	Plasma-treated tin free steel
Substrate 3	Tinplate
Substrate 4	Plasma-treated tinplate

The results of the evaluation are presented in Table 1 and Table 2 below

Table 1: Results of adhesion tests

	<u>Lacquer #</u>	1	1	2*	2*
	<u>Substrate #</u>	2	4	1	2
<u>Type of adhesion test</u>					
Stamped square box, adhesion at corners		1	1		
Normal adhesion		1	1	1	1
reverse side of impact		1	1	3	3
after pasteurization (1 hour @ 70C)		1	1		
after retort (1 hour @ 121C)		1	1		
after pH (10-11) treatment (1 hour @ 70C)		1	1	3	2
after beading deformation		1	1	3	2
after wedge bend		1	1	2	2

*) Comparative example

CLAIMS

1. UV-curable lacquer composition comprising
 - a) A mixture of different epoxy resins,
 - 5 b) An acrylate compound,
 - c) A photoinitiator,
 - d) Polycaprolactone triol, and
 - e) Cellulose acetate butyrate.
- 10 2. UV-curable lacquer composition of claim 1 wherein the mixture of different epoxy resins comprises an aliphatic epoxy resin and an aromatic epoxy resin.
3. UV-curable lacquer composition of claim 1 or 2 wherein the mixture of different epoxy resins comprises at least 85 wt.% of one or more aliphatic epoxy resins, the wt.% being
15 calculated based on the total weight of epoxy resins present in the lacquer composition.
4. UV-curable lacquer composition of claim 2 or 3 wherein the epoxy resin mixture comprises a bisphenol-A-type epoxy resin.
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5. UV-curable lacquer composition of claim 1 comprising
 - a) 30 – 60 wt.% of a mixture of different epoxy resins,
 - b) 25 – 35 wt.% of an acrylate compound or a mixture of different acrylate compounds,
 - 25 c) 0,1 – 10 wt.% of a photoinitiator or a mixture of different photoinitiators,
 - d) 5 – 10 wt.% of a Polycaprolactone triol or a mixture of different polycaprolactone triols, and
 - e) 10 – 15 wt.% of cellulose acetate butyrate,

wherein the wt.% of the components is based upon the total weight of the
30 composition.
6. A process for applying a coating to a metal substrate, comprising the following steps
 - i. Prior to application of a coating composition a plasma treatment of the surface of the substrate is performed,

- ii. Following the plasma treatment, a coating composition is applied to the plasma-treated surface of the substrate, and
 - iii. Curing of the coating composition by exposing the substrate obtained in step ii) to UV radiation,
- 5 wherein the coating composition that is applied in step ii) is the UV-curable lacquer composition according to any of claims 1 to 5.
7. Process according to claim 6, characterized in that the metal substrate is selected from the group consisting of tinplate, tin free steel and aluminum.

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