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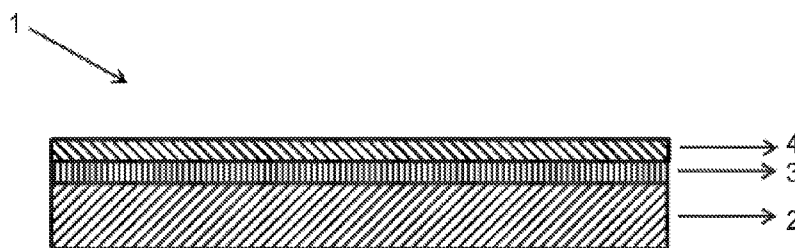


FIG. 1

(57) Abstract: A two-component curing composition for metal surface treatment, a method for mounting a film on a metal surface, and a surface structure are provided in the present invention. The two-component curing composition comprises: 15-35 wt% of a liquid epoxy resin; 20-35 wt% of a curing agent for epoxy resin; 5-15 wt% of a diluent; 10-25 wt% of a weight reducing agent; and 5-20 wt % of a flame retardant; wherein the two-component curing composition comprises a part A and a part B, the part A comprising the liquid epoxy resin, the part B comprising the curing agent for epoxy resin, and the diluent, the weight reducing agent and the flame retardant are present in one or both of the part A and the part B. The two-component curing composition for metal surface treatment has good open time and surface drying time when applied, and has a very high bonding strength to the metal surface to be treated and aging resistance. By means of the use of the composition, convenient, simple, and quick mounting of a film on the metal surface (e.g., a surface of a vehicle body) can be realized.



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**TWO-COMPONENT CURING COMPOSITION FOR METAL SURFACE
TREATMENT, METHOD FOR MOUNTING FILM ON METAL SURFACE, AND
SURFACE STRUCTURE**

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Technical Field

The present invention relates to the technical field of metal surface treatment. Specifically, a two-component curing composition for metal surface treatment, a method for mounting a film on a metal surface, and a surface structure are provided in the present invention, and are especially suitable for surface treatment of a vehicle body and mounting of a film on the surface of the vehicle body.

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Background

During the manufacturing and use of metal products (especially vehicles), graphic films are often mounted on the metal surface for purposes such as marking, warning, and advertising. The metal surface for mounting the graphic film must be flat without obvious defects, such as holes, bumps, and recesses. In order to achieve firm mounting of the graphic film on the metal surface, it is usually needed to perform multiple surface treatment steps on the metal surface. For example, the metal surface is cleaned first to remove impurities and grease. Then, multiple treatments such as sandblasting, priming, polishing, puttying, drying, and sanding in sequence are performed on the cleaned metal surface. The graphic film can be mounted only after confirming that the metal surface is flat. The above existing method is time-consuming and complicated in the process.

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Therefore, it is significant to develop a method of conveniently, simply and quickly mounting a graphic film on a metal surface (especially, a surface of a vehicle body).

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Summary

Starting from the technical problems set forth above, an objective of the present invention is to provide a two-component curing composition for metal surface treatment, a method for mounting a film on the surface of a vehicle body, and a surface structure. The two-component curing composition has good open time and surface drying time when applied, and has a very high bonding strength to the metal surface to be treated and aging

30

resistance. In addition, by means of the use of the two-component curing composition, convenient, simple, and quick mounting of a film on the metal surface can be realized.

The inventors have conducted intensive and detailed research to achieve the present invention.

5 According to one aspect of the present invention, a two-component curing composition for metal surface treatment is provided, the two-component curing composition comprising, based on 100 wt% of the two-component curing composition:

15 15-35 wt% of a liquid epoxy resin having a viscosity ranging from 200-35000 centipoises at 25°C;

10 20-35 wt% of a curing agent for epoxy resin;

5-15 wt% of a diluent;

10-25 wt% of a weight reducing agent; and

5-20 wt% of a flame retardant;

15 wherein, the two-component curing composition comprises a part A and a part B, the part A comprising the liquid epoxy resin, the part B comprising the curing agent for epoxy resin, and the diluent, the weight reducing agent and the flame retardant are present in one or both of the part A and the part B.

According to another aspect of the present invention, a method for mounting a film on a metal surface is provided, the method comprising:

20 mixing the part A with the part B of the two-component curing composition for metal surface treatment described above and applying the resulting mixture to the metal surface to form a coating;

drying the coating; and

attaching the film to the dried coating.

25 According to still another aspect of the present invention, a surface structure is provided, the surface structure comprising:

a metal surface;

a coating formed by applying the two-component curing composition for metal surface treatment described above on the metal surface; and

30 a film attached on the coating.

Compared with the existing techniques in the art, the present invention has the following advantages: The two-component curing composition for metal surface treatment

according to the technical solutions of the present invention has good open time and surface drying time when applied, and has a very high bonding strength to the metal surface to be treated and aging resistance. In addition, compared with the process in which multiple treatments such as sandblasting, priming, polishing, puttying, drying, and sanding in sequence are performed on a cleaned metal surface, and then a graphic film is applied thereto in the prior art, by means of the use of the two-component curing composition, convenient, simple, and quick mounting of a film on the metal surface can be realized.

Brief Description of the Drawings

FIG. 1 shows a schematic cross-sectional view of a surface structure obtained by mounting a graphic film on a metal surface according to the method of the present invention.

Detailed Description

It is to be understood that a person skilled in the art can envisage other various embodiments according to teachings in this description, and can make modifications thereto without departing from the scope or spirit of the present disclosure. Therefore, the following particular embodiments are not restrictive in meaning.

All figures for denoting characteristic dimensions, quantities and physicochemical properties used in this description and claims are to be understood as modified by a term “about” in all situations, unless indicated otherwise. Therefore, unless stated conversely, parameters in numerical values listed in the above description and the claims are all approximate values, and a person skilled in the art is capable of seeking to obtain desired properties by taking advantage of contents of the teachings disclosed herein, and changing these approximate values appropriately. The use of a numerical range represented by end points includes all figures within the range and any range within the range, for example, 1 to 5 includes 1, 1.1, 1.3, 1.5, 2, 2.75, 3, 3.80, 4, 5, etc.

In order to simplify the method for mounting a graphic film on a metal surface (e.g., a surface of a vehicle body) in the prior art, the inventors of the present invention have conducted intensive research. Specifically, the inventors have found that when the compositions of the surface treatment composition and contents thereof are specifically selected, it is possible to provide a surface treatment composition capable of firmly

mounting a graphic film on a metal surface without complicated operations such as priming and puttying on the substrate surface in advance.

According to one aspect of the present invention, a two-component curing composition for metal surface treatment is provided, the two-component curing composition comprising, based on 100 wt% of the two-component curing composition:

15-35 wt% of a liquid epoxy resin having a viscosity ranging from 200-35000 centipoises at 25°C;

20-35 wt% of a curing agent for epoxy resin;

5-15 wt% of a diluent;

10-25 wt% of a weight reducing agent; and

5-20 wt% of a flame retardant;

wherein, the two-component curing composition comprises a part A and a part B, the part A comprising the liquid epoxy resin, the part B comprising the curing agent for epoxy resin, and the diluent, the weight reducing agent and the flame retardant are present in one or both of the part A and the part B.

According to the technical solution of the present invention, a two-component curing composition comprising a liquid epoxy resin and a curing agent for epoxy resin is used as a surface treatment agent for a metal surface so as to subsequently mount a graphic film on the surface conveniently and firmly. The two-component curing composition forms a cured coating on the metal surface by means of a curing reaction between the liquid epoxy resin comprised in the part A and the curing agent for epoxy resin comprised in the part B, and the cured coating has good adhesion to the metal surface and firmly adheres to the graphic film mounted subsequently.

According to certain preferred embodiments of the present invention, in order to improve the reactivity between the epoxy resin and the epoxy resin accelerator and the operability of the resulting two-component curing composition, the two-component curing composition comprises 15-35 wt%, and preferably 25-30 wt% of the liquid epoxy resin, based on 100 wt% of the two-component curing composition. In addition, in order to improve the performance of sufficient mixing and reaction between the epoxy resin and the epoxy resin accelerator, the viscosity of the liquid epoxy resin at 25°C is in the range of 200-35000 centipoises, and preferably 5000-15000 centipoises.

The term “epoxy resin” according to the present invention has the general meaning generally recognized about epoxy resins in the art, and epoxy resin refers to an organic epoxy compound containing two or more epoxy groups in the molecule. Any organic compound having an oxirane ring polymerizable by ring-opening reaction can be used as the epoxy resin employed in the technical solution according to the present invention, as long as the epoxy resin is in a liquid state at room temperature and has a viscosity ranging from 200-35000 centipoises at 25°C. Preferably, the liquid epoxy resin is an aliphatic epoxy resin, an alicyclic epoxy resin, an aromatic epoxy resin, a heterocyclic epoxy resin or a combination thereof. In the present invention, an organic epoxy compound comprising 2-4 epoxy groups in the molecule is preferably used. In order to meet the above requirements regarding the liquid form and viscosity range, preferably, the epoxy equivalent of the liquid epoxy resin is in the range of 100-500, and preferably 150-300. Specifically, the liquid epoxy resin is one or more selected from the group consisting of: alkylene oxide, alkenyl oxide, glycidyl ester, glycidyl ether, epoxy novolac, glycidyl acrylate, and polyurethane polyepoxide and the like. More preferred epoxy resins include epoxy resins containing glycidyl ether or polyglycidyl ethers of monohydric, dihydric or polyhydric phenol, or epoxy resins composed of glycidyl ether or polyglycidyl ethers of monohydric, dihydric or polyhydric phenol. The monohydric, dihydric or polyhydric phenol is, for example, but not limited to bisphenol A, bisphenol F, and polymers including repeating units comprising these phenols. Most preferably, the liquid epoxy resin is bisphenol A diglycidyl ether or bisphenol F diglycidyl ether. Examples of commercially available epoxy resins useful in the present invention include: bisphenol A diglycidyl ether, e.g., EPON828 (liquid; epoxy equivalent: 185-192; viscosity at 25°C: 11000-15000 centipoises), EPON830 (liquid; epoxy equivalent: 190-198; viscosity at 25°C: 17000-22500 centipoises), and EPON1001F (liquid; epoxy equivalent: 525-550; viscosity at 25°C: 7000-9600 centipoises) available from Hexion Speciality Chemicals GmbH, Rosbach, Germany, and D.E.R-331 (liquid; epoxy equivalent 182-192; viscosity at 25°C: 11000-14000 centipoises) and D.E.R-332 (liquid; epoxy equivalent: 171-175; viscosity at 25°C: 4000-6000 centipoises) available from Dow Chemical Co.; bisphenol F diglycidyl ether, e.g., EPICLON 830 (liquid; epoxy equivalent: 165-180; viscosity at 25°C: 3000-4000 centipoises) available from Dainippon Ink and Chemicals, Inc., and D.E.R-354 (liquid; epoxy equivalent: 167-174; viscosity at 25°C: 3400-4200 centipoises)

available from Dow Chemical Co.; and other bisphenol-based epoxy resins, e.g., EPIKOTE828 (liquid; epoxy equivalent: 184-190; viscosity at 25°C: 12000-14000 centipoises) available from Hexion Speciality Chemicals, Rosbach, Germany, and EPILOX A 18-00 (liquid; epoxy equivalent: 175-185; viscosity at 25°C: 8000-10000 centipoises) available from Leuna Epilox GmbH, Leuna, Germany.

The two-component curing composition according to the present invention further comprises one or more epoxy curing agents, i.e., compounds that react with the alkylene oxide ring of the epoxy resin (i.e., epoxide) to crosslink. In order to avoid premature curing of the two-component curing composition, the liquid epoxy resin and the curing agent for epoxy resin must be placed separately. Preferably, the two-component curing composition comprises a part A and a part B, the part A comprises the liquid epoxy resin, and the part B comprises the curing agent for epoxy resin. There is no particular limitation on the specific type of the curing agent for epoxy resin that is present in part B for curing the liquid epoxy resin during mixing of part A with part B, and it can be appropriately selected from the curing agents generally used for curing epoxy resin in the prior art. According to the technical solution of the present invention, a single type of the curing agent for epoxy resin can be used. However, a mixed system of curing agent for epoxy resins, i.e., a combination of multiple curing agents, or a combination of one or more curing agents and a curing catalyst, can be used, instead of a single curing agent.

Preferably, the ratio of the curing agent for epoxy resin to the epoxy resin is selected such that they have approximately the same equivalent, i.e., the molar ratio of the reactive amino groups (or reactive anhydride groups) in the curing agent for epoxy resin to the reactive epoxy groups in the epoxy resin is about 1:1 or 0.9:1 to about 1:0.9. Based on 100 wt% of the two-component curing composition, the two-component curing composition comprises 20-35 wt%, and preferably 20-25 wt% of the curing agent for epoxy resin.

Preferably, the curing agent for epoxy resin is selected from an amine curing agent, an anhydride curing agent or a combination thereof. The amine curing agent comprises at least one primary amino ($-NH_2$) group, and a preferred amine curing agent comprises at least one modified polyamine, such as aliphatic linear polyamine or polyamide polyamine. Examples of amine curing agents useful in the present invention include, but are not limited to, ethylenediamine, diethylenediamine, diethylenetriamine, triethylenetetramine, propylenediamine, tetraethylenepentamine, hexaethyleneheptamine,

hexamethylenediamine, 2-methyl-1,5-pentylendiamine, etc. Other amine curing agents having a group selected from heteroalkylene groups, such as heteroalkylene groups with an oxygen as a heteroatom, may also be used in the present invention. For example, the amine curing agent may be: aminoethylpiperazine; 4,7,10-trioxatridecane-1,13-diamine (TTD) available from TCI America (Portland, OR), USA; or poly(alkyleneoxy)diamine (also known as polyether diamine) such as poly(ethyleneoxy)diamine, poly(propyleneoxy)diamine or a copolymer thereof. Commercially available polyether diamines are commercially available from Huntsman Corporation (The Woodlands, TX, USA) under the trade name JEFFAMINE. The anhydride curing agent useful in the present invention includes but is not limited to phthalic anhydride, among which tetrahydroxy phthalic anhydride, hexahydroxy phthalic anhydride or norbornene phthalic anhydride is preferred. Particularly preferred are methyl norbornene phthalic anhydride and methyl-tetrahydrophthalic anhydride. Particularly preferably, the amine curing agent for epoxy resin Ancamide 910 produced by Evonik Industries AG can be used.

The two-component curing composition for metal surface treatment according to the present invention further comprises at least one diluent. The diluent is used to adjust the fluidity of the two-component curing composition during the mixed use, to facilitate the application operation on the metal surface. Based on 100 wt% of the two-component curing composition, the two-component curing composition comprises 5-15 wt%, and preferably 7-10 wt% of the diluent. Preferably, the diluent is a non-reactive or reactive diluent. The non-reactive diluent is selected from benzyl alcohol, butylene orthophthalate, dioctyl phthalate, diallyl phthalate, or the like, or a combination thereof. The reactive diluent is selected from resorcinol diglycidyl ether, cyclohexane dimethanol diglycidyl ether, neopentyl glycol diglycidyl ether, 1,6-hexanediol diglycidyl ether, trimethylolpropane triglycidyl ether or a combination thereof. Examples of suitable commercially available reactive epoxy diluents are compounds of the Heloxy series of Hexion, such as Heloxy 107 (i.e., 1,4-bis[(glycidyoxy)methyl]cyclohexane).

The two-component curing composition for metal surface treatment according to the present invention further comprises at least one weight reducing agent. The weight reducing agent is used to adjust the weight of the two-component curing composition, for the purpose of reducing the mass of the cured coating applied to the metal surface without substantially affecting the mechanical properties (e.g., bonding strength) of the cured

composition. The density of the weight reducing agent is less than 0.5 g/cm^3 . Preferably, the weight reducing agent is a low-density inorganic filler having a density between $0.1-0.5 \text{ g/cm}^3$. Preferably, the weight reducing agent is hollow glass microspheres, hollow ceramic microspheres, hollow zirconia microspheres, or the like. The average particle size of the hollow glass microspheres, hollow ceramic microspheres or hollow zirconia microspheres ranges from $1-300 \text{ }\mu\text{m}$, and preferably $10-100 \text{ }\mu\text{m}$. Particularly preferred hollow inorganic microspheres are glass microspheres, for example, available from 3M China Limited under the trade names Scotchlite K37 (density: 0.37 g/cm^3 ; average particle size: $45 \text{ }\mu\text{m}$) and Scotchlite S38 (density: 0.38 g/cm^3 ; average particle size: $40 \text{ }\mu\text{m}$).

The two-component curing composition for metal surface treatment according to the present invention further comprises at least one flame retardant to impart the flame retardant performance. The flame retardant is preferably a flame retardant substantially free of halogen. Based on 100 wt% of the two-component curing composition, the two-component curing composition comprises 5-20 wt%, and preferably 10-15 wt% of the flame retardant. Preferably, the flame retardant is a phosphorus flame retardant or expanded graphite. The phosphorus flame retardant is selected from, for example, elemental red phosphorus, melamine phosphate, dimelamine phosphate, melamine pyrophosphate and inorganic phosphite such as aluminum phosphite, and preferably elemental red phosphorus and inorganic phosphite. The flame retardant system may also include optional boron-containing materials, such as barium metaborate, calcium metaborate, zinc metaborate, and a mixture thereof. The expanded graphite has a graphite intercalation structure, i.e., expandable graphite. Examples of expanded graphite useful in the present invention include ES 100 C10, ES 250 B5, and ES 350 F5 available from Germany Kropfmuehl Graphite Co., Ltd./AMG Mining Group, and expanded graphite ADT 1002 provided by Shijiazhuang Kepeng Flame Retardant Material Co. In addition, commercially available examples of phosphorus flame retardants useful in the present invention include: EXOLIT AP 750 and EXOLIT RP 6500 produced by Clariant Chemical Co., Ltd.

According to the technical solution of the present invention, in order to promote the crosslinking reaction between the liquid epoxy resin and the curing agent for epoxy resin, the two-component curing composition for metal surface treatment preferably comprises at least one epoxy resin curing accelerator. In order to avoid premature curing

of the two-component curing composition, the epoxy resin curing accelerator is present in the part B. Based on 100 wt% of the two-component curing composition, the two-component curing composition comprises 2-10 wt%, and preferably 3-7 wt% of an epoxy resin curing accelerator. Preferably, the epoxy resin curing accelerator is a tertiary amine accelerator. The tertiary amine accelerator is selected from triethylamine, triethanolamine, benzyldimethylamine, dimethylaminomethylphenol, tri(dimethylaminomethyl)phenol or a combination thereof. A specific example of a commercially available epoxy resin curing accelerator useful in the present invention is Ancamine K54 produced by Evonik Industries AG.

In order to improve the antioxidation performance of the cured product formed from the two-component curing composition, it is preferable that the two-component curing composition comprises at least one antioxidant. The antioxidant may optionally exist in one or both of the part A and the part B. Preferably, the antioxidant is a hindered phenolic antioxidant. Based on 100 wt% of the two-component curing composition, the antioxidant is present in an amount of 0.5-5 wt%, and preferably 1-2 wt% in the two-component curing composition. Commercially available products of the antioxidant useful in the two-component curing composition of the present invention include: Irganox 1135, Irganox 1726, and Irganox 1520L produced by BASF Co.

Optionally, the two-component curing composition further comprises at least one wetting agent to improve the wettability when the composition is applied to the substrate. The wetting agent may optionally exist in one or both of the part A and the part B. Based on 100 wt% of the two-component curing composition, the wetting agent is present in an amount of 0.5-5 wt%, and preferably 0.5-1 wt% in the two-component curing composition. Specific examples of the wetting agent that can be used are selected from a titanate salt, silane, a zirconate salt, a zirconium aluminate salt, a phosphate ester, or a combination thereof. Commercially available examples of the wetting agent useful in the present invention include W995 produced by BYK Co.

The method of preparing the two-component curing composition for metal surface treatment is not particularly limited, and the composition may be prepared by simple mixing. Specifically, the two-component curing composition obtained by mixing comprises separate part A and part B, wherein the part A comprises a liquid epoxy resin, the part B comprises a curing agent for epoxy resin, and a diluent, a weight reducing

agent, and a flame retardant are present in one or both of the part A and the part B. In the presence of an epoxy resin curing accelerator, the epoxy resin curing accelerator must coexist with the curing agent for epoxy resin in the part B. In the presence of an antioxidant and/or a wetting agent, the antioxidant and/or the wetting agent may be present
5 in one or both of the part A and the part B.

According to another aspect of the present invention, a method for mounting a film on a metal surface is provided, the method comprising:

mixing the part A with the part B of the two-component curing composition for metal surface treatment described above and applying the resulting mixture to the metal
10 surface to form a coating;

drying the coating; and

attaching the film to the dried coating.

The method for applying the composition onto the metal surface is not limited particularly, and methods such as roller coating, brush coating, and spraying commonly
15 used in the art may be employed. In order to ensure the sufficient cohesiveness of the composition on the metal surface and the firmness of the subsequently mounted film, the thickness of the applied coating is in the range of 0.2-1.0 mm, and preferably 0.3-0.5 mm. In addition, the method further comprises, before applying the two-component curing composition to the metal surface: cleaning the metal surface. This step includes: wiping
20 the metal surface with a clean cloth. If there is grease or wax on the surface, it is better to wipe with a solvent such as ethanol, isopropanol or ethyl acetate, to obtain a clean and dry surface after the solvent evaporates. The cleaning step is very important to achieve good bonding properties. In addition, optionally, the method further includes, after drying the coating and before attaching the film: sanding the surface of the dried coating. The
25 sanding step can planarize the surface of the dried coating so that the graphic film can be attached uniformly and firmly thereon. Then, the sanded surface is cleaned with a solvent such as ethanol or isopropanol, and after the solvent completely evaporates, the film is attached on the surface.

The specific structure of the patterned film to be mounted on the metal surface is
30 not limited particularly. Preferably, the film includes a film layer and an adhesive layer adhered to each other. The film layer has a pattern for purposes of marking, warning and advertising, and the adhesive layer is used to adhere the film layer to the treated metal

surface. The specific material constituting the film layer is not particularly limited, and can be selected from conventional materials commonly used in the art to form a graphic film. Preferably, the film layer comprises one or more of polyvinyl chloride, polyurethane and polyethylene terephthalate. The film layer optionally has a pattern for purposes of marking, warning and advertising, on the side away from the adhesive layer. Preferably, the thickness of the film layer is in the range of 50-500 μm . In addition, the specific material constituting the adhesive layer is not limited particularly. Preferably, the adhesive layer is a pressure-sensitive adhesive layer. The pressure-sensitive adhesive layer preferably comprises an acrylic pressure-sensitive adhesive, a rubber-based pressure-sensitive adhesive, or a silicone-based pressure-sensitive adhesive. Preferably, the thickness of the adhesive layer is in the range of 30-200 μm .

According to another aspect of the present invention, a surface structure is provided, the surface structure including: a metal surface; a coating formed by applying the two-component curing composition for metal surface treatment described above on the metal surface; and the film attached to the coating. Specifically, FIG. 1 shows a schematic cross-sectional view of the surface structure 1 obtained by mounting a graphic film 4 on a metal surface 2 according to the method of the present invention. The surface structure 1 includes in sequence: a metal surface 2; a coating 3 formed of the two-component curing composition for metal surface treatment described above applied on the metal surface 2; and a film 4 (i.e., a graphic film) attached on the coating 3.

In the currently commonly used process operation for mounting a graphic film on a metal surface, the metal surface for mounting the graphic film must be flat without obvious defects, such as holes, bumps, and recesses. Therefore, in order to achieve firm mounting of the graphic film on the metal surface, it is usually needed to perform multiple surface treatment steps on the metal surface. For example, it is needed to clean the metal surface first to remove impurities and grease. Then, multiple treatments such as sandblasting, priming, polishing, puttying, drying, and sanding in sequence are performed on the cleaned metal surface. The graphic film can be mounted only after confirming that the metal surface is flat. The above mounting method is time-consuming and complicated in process. According to the technical solution of the present invention, the film can be attached after only one coating operation on the clean metal surface, and the obtained graphic film has very high bonding strength to the metal surface. Therefore, the technical

solution according to the present invention can realize convenient, simple and quick mounting of the film on the metal surface.

Various exemplary embodiments of the present invention are further described by a list of embodiments below, which should not be construed as unduly limiting the present invention:

Particular embodiment 1 is a two-component curing composition for metal surface treatment, comprising, based on 100 wt% of the two-component curing composition:

15-35 wt% of a liquid epoxy resin having a viscosity ranging from 200-35000 centipoises at 25°C;

20-35 wt% of a curing agent for epoxy resin;

5-15 wt% of a diluent;

10-25 wt% of a weight reducing agent; and

5-20 wt% of a flame retardant;

wherein, the two-component curing composition comprises a part A and a part B, the part A comprising the liquid epoxy resin, the part B comprising the curing agent for epoxy resin, and the diluent, the weight reducing agent and the flame retardant are present in one or both of the part A and the part B.

Particular embodiment 2 is the two-component curing composition for metal surface treatment according to particular embodiment 1, wherein the liquid epoxy resin has a viscosity ranging from 5000-15000 centipoises at 25°C.

Particular embodiment 3 is the two-component curing composition for metal surface treatment according to particular embodiment 1, wherein the liquid epoxy resin has an epoxy equivalent ranging from 100-500.

Particular embodiment 4 is the two-component curing composition for metal surface treatment according to particular embodiment 1, wherein the liquid epoxy resin is one or more selected from the group consisting of: alkylene oxide, alkenyl oxide, glycidyl ester, glycidyl ether, epoxy novolac, glycidyl acrylate, and polyurethane polyepoxide, and preferably, the liquid epoxy resin is bisphenol A diglycidyl ether or bisphenol F diglycidyl ether.

Particular embodiment 5 is the two-component curing composition for metal surface treatment according to particular embodiment 1, wherein the curing agent for

epoxy resin is selected from an amine curing agent, an anhydride curing agent or a combination thereof.

Particular embodiment 6 is the two-component curing composition for metal surface treatment according to particular embodiment 1, wherein the diluent is a non-reactive or reactive diluent, and preferably, the non-reactive diluent is selected from benzyl alcohol, butylene orthophthalate, dioctyl phthalate, diallyl phthalate or a combination thereof, and the reactive diluent is selected from resorcinol diglycidyl ether, cyclohexane dimethanol diglycidyl ether, neopentyl glycol diglycidyl ether, 1,6-hexanediol diglycidyl ether, trimethylolpropane triglycidyl ether or a combination thereof.

Particular embodiment 7 is the two-component curing composition for metal surface treatment according to particular embodiment 1, wherein the weight reducing agent is a low-density inorganic filler having a density ranging from 0.1-0.5 g/cm³.

Particular embodiment 8 is the two-component curing composition for metal surface treatment according to particular embodiment 1, wherein the weight reducing agent is hollow glass microspheres, hollow ceramic microspheres or hollow zirconia microspheres, and preferably, the average particle size of the hollow glass microspheres, hollow ceramic microspheres or hollow zirconia microspheres ranges from 1-300 µm.

Particular embodiment 9 is the two-component curing composition for metal surface treatment according to particular embodiment 1, wherein the flame retardant is phosphorus flame retardant or expanded graphite.

Particular embodiment 10 is the two-component curing composition for metal surface treatment according to particular embodiment 1, wherein the two-component curing composition further comprises an epoxy resin curing accelerator in the part B.

Particular embodiment 11 is the two-component curing composition for metal surface treatment according to particular embodiment 10, wherein the two-component curing composition comprises 2-10 wt% of the epoxy resin curing accelerator, based on 100 wt% of the two-component curing composition.

Particular embodiment 12 is the two-component curing composition for metal surface treatment according to particular embodiment 11, wherein the epoxy resin curing accelerator is a tertiary amine accelerator, and preferably, the tertiary amine accelerator is selected from triethylamine, triethanolamine, benzyldimethylamine, dimethylaminomethylphenol, tri(dimethylaminomethyl)phenol or a combination thereof.

Particular embodiment 13 is the two-component curing composition for metal surface treatment according to particular embodiment 1, wherein the two-component curing composition further comprises 0.5-5 wt% of a hindered phenolic antioxidant.

5 Particular embodiment 14 is the two-component curing composition for metal surface treatment according to particular embodiment 1, wherein the two-component curing composition further comprises 0.5-5 wt% of a wetting agent, and the wetting agent is selected from a titanate salt, silane, a zirconate salt, a zirconium aluminate salt, a phosphate ester or a combination thereof.

10 Particular embodiment 15 is the two-component curing composition for metal surface treatment according to particular embodiment 1, wherein the metal surface is a surface of a vehicle body.

Particular embodiment 16 is a method for mounting a film on a metal surface, the method comprising:

15 mixing the part A with the part B of the two-component curing composition for metal surface treatment according to any of particular embodiments 1-15 and applying the resulting mixture onto the metal surface to form a coating;
drying the coating; and
attaching the film to the dried coating.

20 Particular embodiment 17 is the method for mounting a film on a metal surface according to particular embodiment 16, wherein the thickness of the coating is in the range of 0.2-1.0 mm.

Particular embodiment 18 is the method for mounting a film on a metal surface according to particular embodiment 16, wherein the method further comprises, before applying the two-component curing composition to the metal surface:
25 cleaning the metal surface.

Particular embodiment 19 is the method for mounting a film on a metal surface according to particular embodiment 16, wherein the method further comprises, after drying the coating and before attaching the film:
sanding the surface of the dried coating.

30 Particular embodiment 20 is the two-component curing composition for metal surface treatment according to particular embodiment 16, wherein the film comprises a film layer and an adhesive layer adhered to each other.

Particular embodiment 21 is the method for mounting a film on a surface of a vehicle body according to particular embodiment 20, wherein the film layer comprises one or more of polyvinyl chloride, polyurethane, and polyethylene terephthalate.

5 Particular embodiment 22 is the method for mounting a film on a metal surface according to particular embodiment 20, wherein the thickness of the film layer is in the range of 50-500 μm .

Particular embodiment 23 is the method for mounting a film on a metal surface according to particular embodiment 20, wherein the adhesive layer is a pressure-sensitive adhesive layer.

10 Particular embodiment 24 is the method for mounting a film on a metal surface according to particular embodiment 20, wherein the thickness of the adhesive layer is in the range of 30-200 μm .

Particular embodiment 25 is a surface structure, comprising:

15 a metal surface;
a coating formed by applying the two-component curing composition for metal surface treatment according to any of particular embodiments 1 to 15 on the metal surface; and
a film attached on the coating.

20 The present invention will be described below in more details in combination with embodiments. It needs to be pointed out that these descriptions and embodiments are all intended to make the invention easy to understand, rather than to limit the invention. The protection scope of the present invention is subject to the appended claims.

Embodiments

25 In the present invention, unless otherwise pointed out, the reagents employed are all commercially available products, which are directly used without further purification.

Table 1. List of raw materials

Component	Chemical Name	Product Name	Supplier or Manufacturer
Liquid epoxy resin	Bisphenol A diglycidyl ether	D.E.R.-331 Epoxy equivalent: 182-192; viscosity at 25°C: 11000-14000 centipoises	Dow Chemical Co.
	Bisphenol F diglycidyl ether	D.E.R.-354 Epoxy equivalent: 167-174; viscosity at 25°C: 3400-4200 centipoises	Dow Chemical Co.
Epoxy resin curing agent	Polyamide curing agent	Ancamide 910	Evonik Industries AG
Diluent	1,4-bis[(glycidoxy)methyl]cyclohexane	Heloxy 107	Hexion Co.
Weight reducing agent	Glass microspheres	Scotchlite S38 Density: 0.38 g/cm ³ ; average particle size: 40 μm	3M China Limited
	Glass microspheres	Scotchlite K37 Density: 0.37 g/cm ³ ; average particle size: 45 μm	3M China Limited
Flame retardant	Expanded graphite	ADT 1002	Shijiazhuang Kepeng Flame Retardant Material Co.
	Phosphorus flame retardant	EXOLIT AP 750	Clariant Chemical Co., Ltd.
	Phosphorus flame retardant	EXOLIT RP 6500	Clariant Chemical Co., Ltd.
Epoxy resin curing accelerator	2,4,6-tri(dimethylaminomethyl)phenol	Ancamine K54	Evonik Industries AG
Antioxidant	Isooctyl 3,5-di-tert-butyl-4-hydroxyphenylpropionate	Irganox 1135	BASF Co.
Wetting agent	Phosphoric polyester copolymer	W995	BYK Co.

Test method

Viscosity of the mixture

Separately, parts A and B of the two-component curing composition prepared in the following embodiments and comparative examples were uniformly mixed to obtain mixtures to be applied. Then, the viscosity of the mixture (in MPa·s) was measured by a viscosity tester (model HB DV2T) produced by Brookfield Co., with a No. 64 rotor, set at a rotation speed of 2 revolutions per minute.

Open time of the mixture

Separately, parts A and B of the two-component curing composition prepared in the following embodiments and comparative examples were uniformly mixed to obtain mixtures to be applied. 200 g of the mixture stood still for half hour, and sampling were performed every 5 minutes to observe whether the mixture could be uniformly coated on a stainless steel plate (dimension: 12 cm x 5 cm), until the viscosity was found to increase significantly so that the mixture could not be smoothly coated on the steel plate. The time of mixing the sample to the time when it could not be applied, i.e., the open time (unit: minute), was recorded.

Surface drying time of the mixture

Separately, parts A and B of the two-component curing composition prepared in the following embodiments and comparative examples were uniformly mixed to obtain mixtures to be applied. 200 g of the mixture was poured onto a glass plate, in a length of about 100 mm, and then the poured mixture was wiped with a scraper into a thickness of 1-2 mm, to obtain a glass plate specimen applied with the mixture. The glass plate specimen was stood still at $23\pm 2^{\circ}\text{C}$ for 50 minutes, and then a smooth glass rod was used to gently touch three different positions of the mixture coating on the glass plate specimen. The above operation was repeated every 5 minutes, until the mixture could be pulled up when the glass rod was lifted from the mixture coating, but the mixture no longer stained the glass rod. The time from application of the mixture to the time when the mixture could be lifted by the glass rod without adhering to the glass plate was recorded as the surface drying time (unit: minute).

Density

Separately, parts A and B of the two-component curing composition prepared in the following embodiments and comparative examples were uniformly mixed to obtain mixtures to be applied. 15 g of the mixture was cast into a mold having a cavity with a dimension of 1.25 cm x 1.25 cm x 10 cm. Then, curing was performed in the mold in a forced air oven at 80°C for 2 hours to prepare a test specimen. The cured specimen was removed from the mold and the precise volume thereof was recorded (unit: cm³). The weight (g) of each specimen was measured, and the density thereof was calculated and recorded in g/cm³.

Bonding strength of the cured product of the mixture to the stainless steel plate

Separately, parts A and B of the two-component curing composition prepared in the following embodiments and comparative examples were uniformly mixed to obtain mixtures to be applied. 5 g of the mixture was poured on a cleaned stainless steel plate (dimension: 12 cm x 5 cm), wiped with a scraper into a thin layer of about 1 mm, and placed at room temperature for 24 hours. The polishing is performed with an 80 grit sandpaper, the surface thereof is cleaned, and then a structural adhesive was used to bond a 1 inch wide anodized aluminum plate with the polished surface, in a bonding area of 1 square inch. Then, the resulting sample was stretched by a tensile machine (model 5965) produced by Instron at a tensile speed of 5 mm/min until the structure of the sample was damaged. The bonding strength of the cured product of the mixture to the stainless steel plate was recorded in MPa. At least 3 samples were measured each time and an average value was taken.

Surface state of the aged cured product of the mixture (weather resistance)

Separately, parts A and B of the two-component curing composition prepared in the following embodiments and comparative examples were uniformly mixed to obtain mixtures to be applied. 5 g of the mixture was poured on a cleaned stainless steel plate (dimension: 12 cm x 5 cm), wiped with a scraper into a thin layer having a thickness of about 1-2 mm, and placed at room temperature for 24 hours. Then the obtained sample was subjected to aging treatment including the following test steps in sequence: at 80°C

for 4 hours; at room temperature for 0.5 hours; at -40°C for 4 hours; at room temperature for 0.5 hours; at 70°C and 95% relative humidity for 4 hours, and the above aging treatment was repeated for 10 cycles. The aged sample was taken out and placed at room temperature for 24 hours, to observe whether there are bubbles, embrittlement and cracks appearing on the surface. The samples without bubbles, embrittlement or cracks were indicated as "PASS."

Bonding strength of the film mounted to the substrate

Separately, parts A and B of the two-component curing composition prepared in the following embodiments and comparative examples were uniformly mixed to obtain mixtures to be applied. 5 g of the mixture was poured on a cleaned stainless steel plate (dimension: 12 cm x 5 cm), wiped with a scraper into a thin layer of about 1 mm, and placed at room temperature for 24 hours. The polishing is performed with an 80 grit sandpaper, and the surface thereof is cleaned. According to the ASTM D3330 test method, a 3M180MC adhesive film produced by 3M China Limited was cut to have a width of 25 mm, and adhered to the cleaned surface of the cured product after the release paper was removed, and a 2.5-kg rubber roller was rolled back and forth once thereon. After the sample obtained through the above steps was placed for 20 minutes, a tensile machine (model 5965) produced by Instron was used to measure the peeling force of the adhesive film on the surface of the cured product at a tensile speed of 300 mm/min, and results were recorded in N/mm. At least 3 samples were measured each time and an average value was taken.

Surface state (weather resistance)/peel strength of the aged film

Separately, parts A and B of the two-component curing composition prepared in the following embodiments and comparative examples were uniformly mixed to obtain mixtures to be applied. 5 g of the mixture was poured on a cleaned stainless steel plate (dimension: 12 cm x 5 cm), wiped with a scraper into a thin layer of about 1 mm, and placed at room temperature for 24 hours. The polishing is performed with an 80 grit sandpaper, and the surface thereof is cleaned. According to the ASTM D3330 test method, a 3M180MC adhesive film produced by 3M China Limited was cut to have a width of 40

mm, and adhered to the cleaned surface of the cured product after the release paper was removed, and a 2.5-kg rubber roller was rolled back and forth once thereon.

The sample obtained through the above steps was placed in a cooling and heating cycle aging box for a weather resistance test. The aging box was set as follows: at 80°C, 95% RH for 4 hours; changing to -40°C at a rate of temperature change of 1°C/min and keeping at the condition for 4 hours; and changing to 80°C and 95% RH at a rate of temperature change of 1°C/min and keeping at the condition for 4 hours. The above 12 hours is included in a cycle, and ten cycles were repeated in total. After that, the sample was taken out and visually observed whether there are bubbles on the surface.

Subsequently, after the sample was placed for 24 hours, according to the ASTM D3330 test method, a tensile machine (model 5965) produced by Instron was used to measure the bonding strength of the adhesive film on the surface of the cured product at a tensile speed of 300 mm/min, and the results were recorded in N/mm. At least 3 samples were measured each time and an average value was taken.

Embodiment 1

In embodiment 1, a two-component curing composition 1 was prepared, and the two-component curing composition 1 included a part A and a part B that were independent of each other. The preparation of the part A included uniformly mixing 28 g of bisphenol A diglycidyl ether (D.E.R-331), 9 g of 1,4-bis[(glycidyloxy)methyl]cyclohexane (Heloxy 107), 0.5 g of a phosphoric polyester copolymer (W995), 13 g of glass microspheres (Scotchlite S38), 10 g of expanded graphite (ADT 1002) and 5 g of a phosphorus flame retardant (EXOLIT RP 6500) according to the ratio in Table 2 shown below. The preparation of the part B included uniformly mixing 1.5 g of isooctyl 3,5-di-tert-butyl-4-hydroxyphenylpropionate (Irganox 1135), 30 g of a polyamide curing agent (Ancamide 910) and 3 g of 2,4,6-tris(dimethylaminomethyl)phenol (Ancamine K54) according to the ratio in Table 2 shown below.

According to the above detailed description about the methods for the viscosity of the mixture, the open time of the mixture, the surface drying time of the mixture, the density of the cured product of the mixture, the bonding strength of the cured product of the mixture to the stainless steel plate, the surface state of the aged cured product of the mixture, the bonding strength of the film mounted to the substrate, and the surface

state/peel strength of the aged film, the two-component thermally conductive adhesive composition 1 obtained according to the above steps was tested. The test results obtained are shown in Table 3.

5 Embodiments 2-4 and comparative examples 1-3

Two-component curing compositions 2-4 and comparative two-component curing compositions 1-3 were prepared respectively in a manner similar to embodiment 1, in accordance with the ratio in Table 2 shown below.

10 According to the above detailed description about the methods for the viscosity of the mixture, the open time of the mixture, the surface drying time of the mixture, the density of the cured product of the mixture, the bonding strength of the cured product of the mixture to the stainless steel plate, the surface state of the aged cured product of the mixture, the bonding strength of the film mounted to the substrate, and the surface
15 state/peel strength of the aged film, the two-component curing compositions 2-4 and comparative two-component curing compositions 1-3 obtained according to the above steps were tested. The test results obtained are shown in Table 3.

Comparative example 4

20 In Comparative Example 4, a film was attached to a stainless steel plate by a conventional method in the art.

Specifically, a 3M PN1089 body filler produced by 3M China Limited was applied in a thickness of about 1 mm to a stainless steel plate (dimension: 12 cm x 5 cm), dried at 80°C for 2 hours, and placed at room temperature for 24 hours. The coating was polished with an 80 grit sandpaper, and the surface thereof is cleaned. A 3M180MC adhesive film
25 produced by 3M China Limited was cut to have a width of 25 mm, and adhered to the cleaned surface of the cured product after the release paper was removed, and a 2.5-kg rubber roller was rolled back and forth once thereon.

The sample obtained through the above steps was placed in a cooling and heating cycle aging box for a weather resistance test. The aging box was set as follows: at 80°C,
30 95% RH for 4 hours; changing to -40°C at a rate of temperature change of 1°C/min and keeping at the condition for 4 hours; and changing to 80°C and 95% RH at a rate of temperature change of 1°C/min and keeping at the condition for 4 hours. The above 12

hours is included in a cycle, and ten cycles were repeated in total. After that, the sample was taken out and visually observed whether there are bubbles on the surface. After the sample was placed for 24 hours, according to the ASTM D3330 test method, a tensile machine (model 5965) produced by Instron was used to measure the bonding strength of the adhesive film on the surface of the cured product at a tensile speed of 300 mm/min, and the results were recorded in N/mm. At least 3 samples were measured each time and an average value was taken.

Table 2 Ratio of components in two-component curing compositions in embodiments 1-4 and comparative examples

1-3

Part	Raw materials	Embodiment 1	Embodiment 2	Embodiment 3	Embodiment 4	Comparative Example 1	Comparative Example 2	Comparative Example 3
A	DER331	28		30	25	25	26	14
A	DER354		32					
A	Heloxy107	9	7	5	15	4	5	15
A	W995	0.5	0.5	1	1	1	1	1.5
A	S38	13	15		11			
B	K37			17	11	15	15	26
A	ADT1002	10	8			15		
A	EXOLIT RP 6500	5		12		10		15
B	EXOLIT AP 750		2		5		15	
B	Irganox 1135	1.5	0.5	2	1	0	2	0.5
B	Ancamide 910	30	28	30	28	25	25	25
B	Ancamine K54	3	7	3	3	5	11	3
Total amount (g)		100	100	100	100	100	100	100

Table 3 Test results of performance of two-component curing compositions in embodiments 1-4 and comparative examples 1-4

Test item	Embodiment 1	Embodiment 2	Embodiment 3	Embodiment 4	Comparative Example 1	Comparative Example 2	Comparative Example 3	Comparative example 4
Viscosity of the mixture (Mpa·s)	23500	21300	26700	29800	32000	22400	48900	NA
Open time of the mixture (min)	110	75	100	90	75	40	85	NA
Surface drying time of the mixture (min)	155	115	150	130	110	75	120	NA
Density of the cured product of the mixture (g/cm ³)	0.76	0.71	0.7	0.65	0.79	0.77	0.55	NA
Bonding strength of the cured product of the mixture to the stainless steel plate (Mpa)	2.02	2.36	2.05	1.92	1.42	2.36	1.24	NA
Surface state of the aged cured product of the mixture	PASS	PASS	PASS	PASS	Cracks	PASS	Embrittlement	NA
Bonding strength of the film mounted to the substrate (N/mm)	0.76	0.79	0.75	0.71	0.68	0.72	0.65	0.73
Surface state of the aged film	PASS	PASS	PASS	PASS	Bubbles	PASS	Bubbles	PASS
Peel strength of the aged film (N/mm)	0.72	0.73	0.72	0.67	0.51	0.65	0.44	0.67

It can be known from the results shown in Table 2 and Table 3 above, when the compositions of the surface treatment composition and contents thereof are specifically selected within the scope of the present invention, it is possible to provide a surface treatment composition capable of firmly mounting a graphic film on a metal surface without complicated operations such as priming and puttying on the substrate surface in advance. The two-component curing composition has good open time and surface drying time when applied, and has very high bonding strength to the surface of the stainless steel plate to be treated and aging resistance. By means of the use of the two-component curing composition, convenient, simple, and quick mounting of a film on the surface of the stainless steel plate can be realized.

By comparing the results of comparative example 1 with embodiments 1-4, it can be seen that when the content of the diluent in the two-component curing composition is low (less than 5 wt%), the bonding strength of the cured product of the mixture to the stainless steel plate is reduced, the aging performance of the cured product of the mixture becomes worse, and the bonding strength of the film adhered by the composition to the substrate is reduced and the aging performance thereof becomes worse.

By comparing the results of comparative example 2 with embodiments 1-4, it can be seen that when the content of the curing accelerator in the two-component curing composition is too high (more than 10 wt%), the mixture obtained by mixing part A with part B has a shorter open time, which is not conducive to the operation of film attachment.

By comparing the results of comparative example 3 with embodiments 1-4, it can be seen that when the content of the liquid epoxy resin in the two-component curing composition is too low (less than 15 wt%), the mixture obtained by mixing part A with part B has a viscosity that is too high, the bonding strength of the cured product of the mixture to the stainless steel plate is reduced, the aging performance of the cured product of the mixture becomes worse, and the bonding strength of the film adhered by the composition to the substrate is reduced and the aging performance thereof becomes worse.

By comparing the results of comparative example 4 with embodiments 1-4, it can be seen that the two-component curing composition for metal surface treatment prepared according to the method of the present invention provides bonding strength of the film mounted to the substrate, aging performance of the film and the like comparable to or even

better than the bonding strength and the aging performance of the film obtained according to the complicated process in the art.

Although the above particular embodiments comprise many specific details for the purpose of illustration, those skilled in the art should understand that many variations, modifications, replacements and changes to these details all fall within the scope of the present invention as claimed in the claims. Therefore, the disclosure as described in the specific embodiments does not pose any limitation to the present invention as claimed in the claims. The proper scope of the present invention should be defined by the claims and proper legal equivalents thereof. All references referred to are incorporated herein by reference in their entireties.

What is claimed is:

1. A two-component curing composition for metal surface treatment, comprising, based on 100 wt% of the two-component curing composition:

5 15-35 wt% of a liquid epoxy resin having a viscosity ranging from 200-35000 centipoises at 25°C;

20-35 wt% of a curing agent for epoxy resin;

5-15 wt% of a diluent;

10-25 wt% of a weight reducing agent; and

10 5-20 wt% of a flame retardant;

wherein, the two-component curing composition comprises a part A and a part B, the part A comprising the liquid epoxy resin, the part B comprising the curing agent for epoxy resin, and the diluent, the weight reducing agent and the flame retardant are present in one or both of the part A and the part B.

15 2. The two-component curing composition for metal surface treatment according to claim 1, wherein the liquid epoxy resin has a viscosity ranging from 5000-15000 centipoises at 25°C.

3. The two-component curing composition for metal surface treatment according to claim 1, wherein the liquid epoxy resin has an epoxy equivalent ranging from 100-500.

20 4. The two-component curing composition for metal surface treatment according to claim 1, wherein the liquid epoxy resin is one or more selected from the group consisting of: alkylene oxide, alkenyl oxide, glycidyl ester, glycidyl ether, epoxy novolac, glycidyl acrylate, and polyurethane polyepoxide, and preferably, the liquid epoxy resin is bisphenol A diglycidyl ether or bisphenol F diglycidyl ether.

25 5. The two-component curing composition for metal surface treatment according to claim 1, wherein the curing agent for epoxy resin is selected from an amine curing agent, an anhydride curing agent or a combination thereof.

30 6. The two-component curing composition for metal surface treatment according to claim 1, wherein the diluent is a non-reactive or reactive diluent, and preferably, the non-reactive diluent is selected from benzyl alcohol, butylene orthophthalate, dioctyl phthalate, diallyl phthalate or a combination thereof, and the reactive diluent is selected from resorcinol diglycidyl ether, cyclohexane dimethanol diglycidyl ether, neopentyl

glycol diglycidyl ether, 1,6-hexanediol diglycidyl ether, trimethylolpropane triglycidyl ether or a combination thereof.

[Claim 7]

7. The two-component curing composition for metal surface treatment according to claim 1, wherein the weight reducing agent is a low-density inorganic filler having a density ranging from 0.1-0.5 g/cm³.

8. The two-component curing composition for metal surface treatment according to claim 1, wherein the weight reducing agent is hollow glass microspheres, hollow ceramic microspheres or hollow zirconia microspheres, and preferably, the average particle size of the hollow glass microspheres, hollow ceramic microspheres or hollow zirconia microspheres ranges from 1-300 μm.

9. The two-component curing composition for metal surface treatment according to claim 1, wherein the flame retardant is a phosphorus flame retardant or expanded graphite.

10. The two-component curing composition for metal surface treatment according to claim 1, wherein the two-component curing composition further comprises an epoxy resin curing accelerator in the part B.

11. The two-component curing composition for metal surface treatment according to claim 10, wherein the two-component curing composition comprises 2-10 wt% of the epoxy resin curing accelerator, based on 100 wt% of the two-component curing composition.

12. The two-component curing composition for metal surface treatment according to claim 11, wherein the epoxy resin curing accelerator is a tertiary amine accelerator, and preferably, the tertiary amine accelerator is selected from triethylamine, triethanolamine, benzyldimethylamine, dimethylaminomethylphenol, tri(dimethylaminomethyl)phenol or a combination thereof.

13. The two-component curing composition for metal surface treatment according to claim 1, wherein the two-component curing composition further comprises 0.5-5 wt% of a hindered phenolic antioxidant.

14. The two-component curing composition for metal surface treatment according to claim 1, wherein the two-component curing composition further comprises 0.5-5 wt%

of a wetting agent, and preferably, the wetting agent is selected from a titanate salt, silane, a zirconate salt, a zirconium aluminate salt, a phosphate ester or a combination thereof.

15. The two-component curing composition for metal surface treatment according to claim 1, wherein the metal surface is a surface of a vehicle body.

5 16. A method for mounting a film on a metal surface, the method comprising:
mixing the part A with the part B of the two-component curing composition for metal surface treatment according to any of claims 1-15 and applying the resulting mixture to the metal surface to form a coating;

drying the coating; and
10 attaching the film to the dried coating.

17. The method for mounting a film on a metal surface according to claim 16, wherein the thickness of the coating ranges from 0.2-1.0 mm.

18. The method for mounting a film on a metal surface according to claim 16, wherein the method further comprises, before applying the two-component curing
15 composition to the metal surface:

cleaning the metal surface.

19. The method for mounting a film on a metal surface according to claim 16, wherein the method further comprises, after drying the coating and before attaching the
20 film:

sanding the surface of the dried coating.

20. The method for mounting a film on a metal surface according to claim 16, wherein the film comprises a film layer and an adhesive layer adhered to each other.

21. The method for mounting a film on a metal surface according to claim 20, wherein the film layer comprises one or more of polyvinyl chloride, polyurethane, and
25 polyethylene terephthalate.

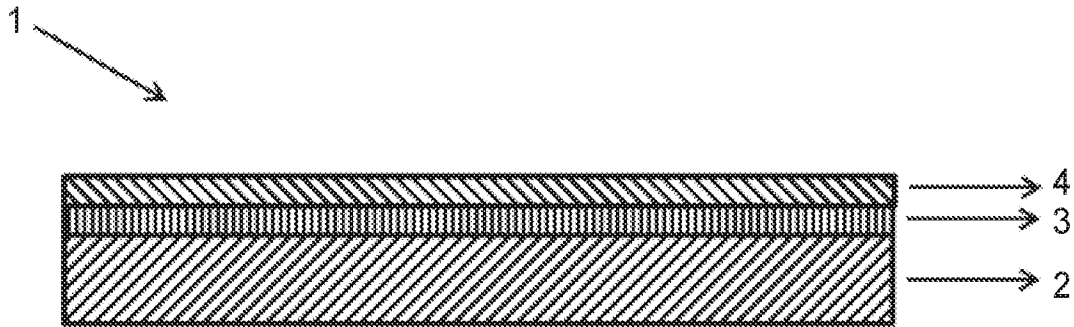
22. The method for mounting a film on a metal surface according to claim 20, wherein the thickness of the film layer ranges from 50-500 μm .

23. The method for mounting a film on a metal surface according to claim 20, wherein the adhesive layer is a pressure-sensitive adhesive layer.

24. The method for mounting a film on a metal surface according to claim 20, wherein the thickness of the adhesive layer ranges from 30-200 μm .

25. A surface structure, comprising:

a metal surface;
a coating formed by applying the two-component curing composition for metal surface treatment according to any of claims 1 to 15 on the metal surface; and
a film attached on the coating.

1/1*FIG. 1*

INTERNATIONAL SEARCH REPORT

International application No.

PCT/IB2021/055078

A. CLASSIFICATION OF SUBJECT MATTER

C09D 163/00(2006.01)i; **C09D 7/63**(2018.01)i; **C09D 7/61**(2018.01)i; **C09K 21/04**(2006.01)i; **C08K 3/32**(2006.01)i; **C08K 3/04**(2006.01)i; **C08K 5/17**(2006.01)i; **B32B 15/082**(2006.01)i; **B32B 15/09**(2006.01)i; **B32B 15/095**(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

C09D 163/00(2006.01); B29C 45/14(2006.01); B29C 65/70(2006.01); C08G 59/22(2006.01); C08G 59/38(2006.01); C08G 59/50(2006.01); C08K 7/14(2006.01); C08L 63/00(2006.01); C09J 163/00(2006.01)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPO internal) & Keywords: two-component curing composition, metal surface treatment, epoxy resin, curing agent, diluent, flame retardant, weight reducing agent, curing accelerator, antioxidant, inorganic filler, wetting agent

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2013-0230726 A1 (FRICK, KARSTEN et al.) 05 September 2013 (2013-09-05) See paragraphs [0016]-[0037], [0151]-[0187].	1-25
Y	US 2015-0065613 A1 (DOW GLOBAL TECHNOLOGIES LLC et al.) 05 March 2015 (2015-03-05) See paragraphs [0009], [0027]-[0046], [0065]-[0073], [0095].	1-25
A	JP 2006-143759 A (YOKOHAMA RUBBER CO., LTD.) 08 June 2006 (2006-06-08) See the whole document.	1-25
A	JP 5472103 B2 (OSAKA SODA CO., LTD.) 16 April 2014 (2014-04-16) See the whole document.	1-25
A	JP 2012-000810 A (KYOCERA CHEMICAL CORP. et al.) 05 January 2012 (2012-01-05) See the whole document.	1-25

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:

“A” document defining the general state of the art which is not considered to be of particular relevance
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Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
US	2013-0230726	A1	05 September 2013	CN	102844397	A	26 December 2012
				CN	102844397	B	08 July 2015
				DK	2542637	T3	03 September 2018
				EP	2365046	A1	14 September 2011
				EP	2542637	A2	09 January 2013
				EP	2542637	B1	23 May 2018
				ES	2677354	T3	01 August 2018
				JP	2013-521362	A	10 June 2013
				JP	5916634	B2	11 May 2016
				PL	2542637	T3	31 October 2018
				US	9296931	B2	29 March 2016
				WO	2011-107450	A2	09 September 2011
				WO	2011-107450	A3	09 August 2012
US	2015-0065613	A1	05 March 2015	CN	104245875	A	24 December 2014
				CN	104245875	B	28 September 2016
				EP	2841521	A1	04 March 2015
				KR	10-2015-0003373	A	08 January 2015
				WO	2013-162840	A1	31 October 2013
JP	2006-143759	A	08 June 2006	JP	4639766	B2	23 February 2011
JP	5472103	B2	16 April 2014	WO	2009-144955	A1	06 October 2011
JP	2012-000810	A	05 January 2012	CN	102291955	A	21 December 2011
				CN	102291955	B	02 December 2015
				JP	5606169	B2	15 October 2014
				TW	201146128	A	16 December 2011
				TW	1543686	B	21 July 2016