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(54) Title: AQUEOUS ANTI-CORROSIVE PRIMER COMPOSITION

(57) Abstract: The invention relates to an aqueous coating composition comprising water as liquid diluent and a) 15-50% by weight of an organic polymeric binder which is obtainable by the reaction of i) an organic polymeric binder having crosslinkable functional groups and ii) a silane, b) 2-30% by weight of an epoxide-functional material c) 2-30% by weight of a silane-modified silica sol d) 0-30% by weight of pigments and fillers, e) 0-10% by weight of usual additives, and f) 1-15% by weight of a crosslinker capable of reacting with the crosslinkable functional groups of the organic polymeric binder, wherein the % by weight are calculated on the weight of the entire composition, and wherein the composition has a pH in the range of 4.0 to 7.5.



WO 2013/135751 A1

AQUEOUS ANTI-CORROSIVE PRIMER COMPOSITION

The invention relates to an aqueous coating composition suitable as primer for metal substrates, to a process of preparing the coating composition, to a process
5 of applying an anti-corrosive primer layer to a metal substrate, and to the use of the coating composition.

A coating composition of the above-mentioned type is known from United States patent application US 2010/006220 A1. This document describes an aqueous
10 composition comprising an organic film former, a long-chain alcohol as film-forming aid, a crosslinker, a lubricant, a silanol and/or siloxane and/or an inorganic compound in particle form. It is important that the organic film former comprises at least 10% of polyurethane and polycarbonate. The pH of the composition is preferably in the range of 6.5 to 11, in particular in the range of 8 to 9.5. The
15 coatings can be used as primer coats. The non-volatile content of compositions described in this document is rather low. This makes it difficult to achieve higher dry film thicknesses.

Canadian patent application CA 2661432 A1 relates to a curable corrosion
20 protection composition for primary coating of metallic substrates, which has a pH in the range from 1 to 3 and contains water and fluorocomplex ions of titanium and/or zirconium, at least one corrosion protection pigment, and at least one organic polymer which is soluble or dispersible in water in the specified pH range and on its own in aqueous solution at a concentration of 50% by weight has a pH in the range
25 from 1 to 3. The polymer suitably possesses phosphoric acid groups or phosphoric acid ester groups. A drawback of the composition is the limited potlife, which may be as low as 12 hours or 24 hours. This imposes high demands on the logistics required to prepare and deliver the composition. Furthermore, the low pH of the composition is considered a disadvantage in terms of industrial safety. The strongly

acidic composition also leads to specific requirements for the equipment used in applying and curing the composition, such as storage tanks, pipes, and ovens. The low pH of the primer coating may impact the adhesion and/or colour stability of subsequent coating layers.

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There is a need for an aqueous coating composition suitable as primer for metal substrates having an increased non-volatile content to allow for high film build. The coating composition should further have sufficient storage stability to allow for simple logistics and delivery of the composition. Furthermore, the composition should be acceptable in terms of industrial safety and it should be possible to use the composition with standard equipment. The composition should provide a very good corrosion protection to metals after application and curing, also in the absence of hexavalent chromium compounds. Subsequent coating layers should not be negatively impacted by the primer layer.

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The invention now provides an aqueous coating composition comprising water as liquid diluent and

- a) 15-50% by weight of an organic polymeric binder which is obtainable by the reaction of
 - 20 i) an organic polymeric binder having crosslinkable functional groups and
 - ii) a silane,
- b) 2-30%, preferably 2-15% by weight of an epoxide-functional material
- c) 2-30%, preferably 5-20% by weight of a silane-modified silica sol
- 25 d) 0-30%, preferably 0-20% by weight of pigments and fillers,
- e) 0-10%, preferably 0-8% by weight of usual additives, and
- f) 1-15%, preferably 1-10% by weight of a crosslinker capable of reacting with the crosslinkable functional groups of the organic polymeric binder.

The % by weight of the mentioned constituents is calculated on the weight of the entire composition. It is to be understood that the % by weight mentioned above refer to the non-volatile matter of the specified components. Naturally, the fractions of the individual components are to be chosen such that they add up to 100%. This is also applies when further components in addition to the cited components a) to f) are present.

The composition has a pH in the range of 4.0 to 7.5. Preferably, the composition is slightly acidic, i.e. the pH preferably is below 7, for example in the range of 5.0 to 6.7.

10

The organic polymeric binder

The coating composition of the invention comprises an organic polymeric binder which is obtainable by the reaction of an organic polymeric binder having functional groups and a silane.

15 Examples of suitable types of polymers are polyesters, polyurethanes, polyacrylates, and mixtures and hybrids thereof. The binders may have stabilising groups to facilitate the formation of a stable aqueous polymer dispersion or emulsion. Examples of suitable stabilising groups are ionic groups, such as carboxylate groups or sulfonate groups, and non-ionic polar groups based on
20 polyethylene oxide. Alternatively, external emulsifiers may be added to facilitate the formation of an aqueous polymer dispersion.

The organic polymeric binder has crosslinkable functional groups. Examples of crosslinkable functional groups are hydroxyl groups, carboxylic acid groups, epoxide groups, as well as primary and secondary amino groups. Preferred
25 crosslinkable functional groups are hydroxyl groups.

In a preferred embodiment, the organic polymeric binder is a polyacrylate.

In one embodiment, the hydroxyl-substituted polyacrylate is a copolymer manufactured from a hydroxyl-containing monomer and at least one compatible

monomer. Hydroxyl-containing monomers having a water solubility greater than 10% may be utilised in the manufacture of the hydroxyl-substituted polymer. Alternatively, the hydroxyl-containing monomer is selected from the group consisting of hydroxyl ethyl methacrylate (HEMA), hydroxyl ethyl acrylate (HEA),
5 hydroxyl propyl acrylate (HPA), and hydroxyl propyl methacrylate (HPMA). Preferably, the hydroxyl-containing monomer is present in an amount of up to 15% of the total monomer combination, i.e. the total amount of the hydroxyl-containing monomer and the compatible monomer. The at least one compatible monomer is not intended to be limited in any way. Preferably, the compatible monomer is
10 selected from the group consisting of styrene, methyl methacrylate, butyl acrylate, 2-ethylhexyl acrylate, ethyl acrylate, methyl acrylate, vinyl acetate, butadiene, and ethylene. More than one compatible monomer may be used. Preferably, two or three compatible monomers are utilised.

It is preferred that the hydroxyl-substituted polymer is manufactured at slightly
15 acidic or neutral pH. Furthermore, it is also preferred that the hydroxyl substituted polymer is manufactured in the absence of unsaturated carboxylic acids such as acrylic acid and methacrylic acid, unsaturated amides such as acrylamide and methacrylamide, polymerisable carboxylic acids, polymerisable amides and any other water-soluble monomers or potentially water-soluble monomers, other than
20 the hydroxyl-containing monomer described above. Manufacturing the hydroxyl-substituted polymer in the absence of unsaturated carboxylic acids like acrylic acid and methacrylic acid, unsaturated amides such as acrylamide and methacrylamide, or other water-soluble monomers avoids any unnecessary neutralisation step.

25 The hydroxyl-substituted polyacrylate is preferably manufactured in an aqueous based medium. For example, the hydroxyl-substituted polyacrylate is manufactured in water. Even more preferably, however, the hydroxyl-substituted polyacrylate is manufactured in water using emulsion polymerisation

The polymerisation may be conducted using conventional water based polymerisation techniques such as seeded polymerisation using a monomer emulsion feed. Alternatively, the hydroxyl-substituted polyacrylate may be manufactured by any conventional latex polymer dispersion polymerisation technique. For example, it has proven advantageous to use a seeded polymerisation technique for consistent particle size reproducibility and to reduce batch to batch variation. Generally, part of the monomer is introduced into the reaction vessel at the start along with a shot dose of initiator for initial particle formation. The reaction vessel will usually contain some of the aqueous phase (usually water) along with the initial surfactants, buffer systems chelating agents along with some of the monomer and the initiator solution as a shot dose at the desired seed temperature. The remainder of the monomer feed is generally added as a "pre-emulsion" with the remaining monomer, surfactant for stabilisation, and water being continually added with the initiator.

The surfactants used in the polymerisation are generally conventional surfactants (anionic and non-ionic) that are stable at both the reaction pH and the final pH. Minimal surfactants should be used to aid water resistance.

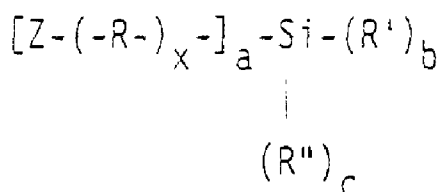
The initiator systems used are generally either persulfate types (ammonium persulfate, potassium persulfate, sodium persulfate) or organic types such as TBHP (tert-butyl hydroperoxide). Hydrogen peroxide may also be used as well as reducing systems such as sodium metabisulfite (usually as a separate feed). However, other initiator systems are also possible.

Once polymer has formed, it is cooled and further reacted if desired to lower any residual monomers that may remain. Adjustments such as biocide addition may also be made if desired.

The organic polymeric binder generally has a glass transition temperature (T_g) between about -10 to 90°C. Preferably, the glass transition temperature (T_g) of the compositions will be between about -5 to 5, 5 to 30, 30 to 50, 50 to 70 or 70 to

90°C. Even more preferably, the glass transition temperature (T_g) will be between about -5 to 5, 40 to 50 or 50 to 60°C. In the case of polyacrylates, the glass transition temperature is calculated according to the Fox equation.

- 5 The organic polymeric binder may subsequently be reacted with a silane. Examples of suitable silanes may be of the following general formula



wherein Z is an amino group, an amino-containing group, an epoxy group, an epoxy-containing group, a mercapto group, a mercapto-containing group, a vinyl group, a vinyl-containing group, an isocyanate group, an isocyanate-containing group, an ureido group, an ureido-containing group, an imidazole group or an imidazole-containing group. R is an aliphatic, alicyclic or aromatic group, R' is an alkoxy group or alkoxyalkoxy groups, R'' is an alkyl group having 1 to about 8 carbon atoms, x is 0 to about 20, a is 0 to 3, preferably 0 to 2, b is 1 to 4, preferably 1 to 3, c is 0 to 3, and preferably 0 to 2, and the sum of a + b + c is 4. Preferred organosilanes are aminosilanes, epoxysilanes, mercaptosilanes, vinylsilanes, ureidosilanes, imidazolsilanes, and isocyanatosilanes.

Epoxysilanes generally have an epoxy-functional group on one end of the silane molecule and an alkoxyalkoxy group, dialkoxyalkoxy group or trialkoxyalkoxy group on the other end of the silane molecule. The epoxy-functional group may be substituted or unsubstituted. In use it is believed the alkoxyalkoxy group, dialkoxyalkoxy group or trialkoxyalkoxy group hydrolyses to a silanol group. Examples of preferred epoxysilanes include epoxytrimethoxysilane or epoxytriethoxysilane. Other preferred epoxysilanes include Silane Z6040 (as available from Dow Corning),

Momentive A187 or Evonik Glymo silanes. Even more preferably, the epoxysilane is 3-glycidyloxypropyltrimethoxysilane (DYNASYLAN® GLYMO).

The reaction between the organic polymeric binder and the silane may be performed in any suitable manner. For instance, the silane may be added to the polymer neat, diluted or as a hydrolysed solution. Preferably, the silane is added at temperatures lower than the temperatures at which the polymerisation reaction is performed. Alternatively, the silane may also be added during the preparation of the polymer. More specifically, the silane may be added as part of the monomer feed in an emulsion polymerisation process.

It is also preferred that the amount of silane reacted with the polymer is up to the same weight as the polymer.

The epoxide-functional material

The coating composition also comprises an epoxide-functional material which is different from the organic polymeric binder mentioned above.

The epoxide-functional material of the composition can in general be any of the epoxy resins generally known to the skilled person. Many of these are commercially available. Specifically mentioned may be the glycidyl-type epoxy resins containing glycidyl ether or ester groups. The epoxide-functional material can for example be a glycidyl ether of an aromatic or aliphatic polyol, such as a bisphenol, or can be a condensed or extended glycidyl ether of a bisphenol. Such glycidyl ethers derived from a bisphenol generally have an epoxy functionality of 2 or slightly less, for example 1.5 to 2. The epoxide-functional material can alternatively be a glycidyl ether of a polyhydric phenol, for example an epoxy novolak resin, or an aliphatic or cycloaliphatic di- or polyglycidyl ether. Examples of epoxide-functional material containing glycidyl ester groups are homopolymers or copolymers of a glycidyl ester of an ethylenically unsaturated carboxylic acid such

as glycidyl methacrylate or glycidyl acrylate, or the diglycidyl ester of dimerised fatty acid.

5 The epoxide-functional material may suitably be provided in the form of an aqueous dispersion or emulsion. In order to facilitate the formation of an aqueous dispersion, an external emulsifier may be used. Alternatively, the epoxide-functional material may be modified by covalent attachment of stabilising groups, for example in the form of polyethylene oxide groups.

10 *The silane-modified silica sol*

The composition also comprises a silane-modified silica sol. Preferably, this is an aqueous based silica sol, which comprises water as primary liquid diluent, also referred to as colloidal silica. Colloidal silica is a stable dispersion of amorphous silica particles. The silica particles are formed by a network of silicon dioxide or silica. Generally, in silica the silicon atom is surrounded by oxygen atoms, with each oxygen atom attached to two Si-atoms. Dependent on the surface of the silica particle it can be either hydrophilic or hydrophobic. If the surface is primarily covered with silanol groups, Si-OH, these groups have the main interaction with water molecules, thus giving a hydrophilic surface.

15 20 In silane-modified silica sols the silanol groups have been at least partially reacted with silanes, for example an epoxysilane. This treatment renders the surface of the silica particles less hydrophilic.

Suitable silane-modified silica sols are commercially available, for example from Evonik Industries under the trade designation Dynasylan® SIVO 110, or from Eka
25 Chemicals under the trade designation Bindzil® CC.

The pigments and fillers

The pigment/filler component may comprise one or more pigments and/or fillers. If a filler is used, it may also comprise an additional organic coating, for the purpose

of hydrophobising or hydrophilising. Suitable fillers include on the one hand electrically conductive pigments and fillers. Additives of this kind serve to improve the weldability and to improve subsequent coating with electrocoat materials. Examples of suitable electrically conducting fillers and/or pigments comprise phosphides, vanadium carbide, titanium nitride, molybdenum sulfide, graphite, carbon black or doped barium sulfate. Preference is given to using metal phosphides of Zn, Al, Si, Mn, Cr, Fe or Ni. Examples of preferred metal phosphides comprise CrP, MnP, Fe₃ P, Fe₂ P, Ni₂ P, NiP₂ or NiP₃. Iron phosphides are available commercially, for example, under the name Ferrophos®.

It is also possible to use non-conducting pigments or fillers, such as finely divided amorphous silicon oxides, aluminium oxides or titanium oxides, for example, which may also have been doped with further elements. For example, it is possible to use amorphous silicon dioxide modified with calcium ions. Further examples of pigments include anticorrosion pigments such as zinc phosphates and zinc silicates, zinc metaborate or barium metaborate monohydrate, nanodisperse oxides, and other anticorrosion pigments familiar to the skilled person.

In one embodiment, the amount of fillers and pigment in the coating composition does not exceed 10% by weight, calculated on the non-volatile content of the composition. However, the amount of pigment and filler may also be higher.

Generally, the amount of pigment and filler does not exceed 30% by weight, calculated on the non-volatile content of the composition.

In a preferred embodiment, the at least one pigment or filler has been treated with a silane, silane-modified silica sol, or mixtures thereof. Suitable silanes and silane-modified silica sols are those described above. Generally, the amount of the treatment agent does not exceed 10% by weight of the amount of pigment. In many cases, an amount of 5% by weight or less is sufficient. Treated pigments are particularly beneficial when the amount of pigment in the coating composition exceeds 10% by weight.

It is preferred that the coating composition does not contain pigments or other components comprising hexavalent chromium.

The crosslinker

- 5 The coating composition of the invention further comprises a crosslinker capable of reacting with the crosslinkable functional groups of the organic polymeric binder. Examples of suitable crosslinkers include crosslinkers include adipic dihydrazide, those based on aziridine such as e.g. polyfunctional polyaziridine, those based on an azo compound, those based on diamine, those based on diimide, such as e.g.
- 10 polyfunctional polycarbodiimides, those based on formaldehyde such as e.g. urea-formaldehyde or/and melamine-formaldehyde, those based on imidazole such as e.g. 2-ethyl-4-methyl imidazole, those based on isocyanate, those based on isocyanurate, those based on melamine such as e.g. methoxymethylmethylol melamine and/or hexamethoxymethyl melamine, those based on triazine such as
- 15 e.g. tris(alkoxycarbonylamino)triazine and/or those based on triazole.

Blocked polyisocyanates are preferred crosslinkers. Suitable blocking agents are phenols, oximes, or caprolactam. The blocked polyisocyanate may be based on aromatic or aliphatic isocyanates. Suitable blocked polyisocyanates for aqueous

20 coating compositions are commercially available, for example from Bayer under the trade designation Bayhydur.

The coating composition of the invention is an aqueous coating composition. This means that the majority of the volatile liquid carrier of the composition is water. It is

25 possible to add organic co-solvents to the liquid carrier, for example to improve the stability of the composition or to facilitate film forming. Examples of such organic co-solvents are alcohols, such as ethanol, n-propanol, 2-propanol, and butanol, dimethyl dipropylene glycol, methyl ether of diacetone alcohol, ethylacetate, butylacetate, ethylglycolacetate, butylglycolacetate, 1-methoxy-2-propylacetate,

butylpropionate, ethoxyethylpropionate, toluene, xylene, acetone, methylethylketone, methylisobutyl etone, methylisoamylketone, ethylamylketone, dioxolane, N-methyl-2-pyrrolidone, dimethylcarbonate, propylenecarbonate, butyrolactone, caprolactone, and mixtures thereof. It is generally preferred that the
5 coating composition contains a low amount of such volatile organic solvents. Suitably, the composition comprises at most 15% by weight, or at most 10% by weight, or at most 5% by weight of volatile organic solvents. In a preferred embodiment, the composition is essentially free of volatile organic solvents. This means that such solvents are preferably present in an amount of at most 2% by
10 weight, calculated on the weight of the entire composition.

The composition preferably has a high non-volatile content in order to allow a relatively high coating layer thickness to be formed. Generally, the non-volatile content of the composition is at least 25% by weight, preferably at least 35% by weight. Typically, the non-volatile content is in the range of 40 to 60% by weight.
15 Generally, the non-volatile content does not exceed 70% by weight. The non-volatile content is suitably determined according to ISO 3251.

In addition to the constituents mentioned above, the composition optionally contains usual additives, generally in an amount up to 10% by weight. Examples of
20 suitable additives are rheological assistants, light stabilisers, free-radical scavengers, crosslinking catalysts, slip additives, polymerisation inhibitors, defoamers, emulsifiers, degassing agents, wetting agents and dispersants, adhesion promoters, flow control agents, film-forming assistants, rheological control additives (thickeners), flame retardants, anti-skinning agents, corrosion
25 inhibitors, waxes, and matting agents.

As mentioned above, the aqueous coating composition has a pH in the range of 4 to 7.5. If required, acids, bases, or buffers can be added to the coating composition

in order to bring the pH up to the required range. The pH is determined according to DIN 19261 and DIN 19268 (water-based solutions).

The invention also relates to a process for preparing the coating composition of the invention. The process comprises the steps of mixing, in any workable order,

- a) an aqueous emulsion of an epoxide-functional material,
- b) an aqueous dispersion of an organic polymeric binder which is obtainable by the reaction of
 - i) an organic polymeric binder having crosslinkable functional groups and
 - ii) a silane
- c) a crosslinker capable of reacting with the crosslinkable functional groups of the organic polymeric binder, and
- d) an aqueous silane-modified silica sol.

In one embodiment, the process comprises the further steps of

- e) dispersing at least one pigment or filler in a suitable dispersing medium and
- f) including the dispersed at least one pigment or filler in the coating composition.

The coating composition of the invention is very suitable for use as a primer for metal substrates, for example as a primer for steel coils, or as a primer for automobile parts, for both, repair and factory application. The composition can likewise be used with great advantage as a coating for cans for food and beverages, as shop primer for steel, and as an anti-corrosive primer for aluminium alloys, in particular in the aircraft industry. The composition can also be used as insulating coating for components of electric appliances and equipment, such as components of transformers and electric engines. The invention also relates to a

process of applying an anti-corrosive primer layer to a metal substrate, wherein the aqueous coating composition of the invention is applied to a metal substrate and subsequently cured. Curing is preferably carried out at increased temperature, for example in the range of 60 to 200°C. In a preferred embodiment, the cured primer layer has a thickness in the range of 3 to 15 µm.

Although the coating composition of the invention is highly suitable for metal substrates, it can also be applied to non-metal substrates, if so desired. Examples of suitable non-metal substrates are organic polymers, such as polyesters, polyamides, and polyvinyl chloride, as well as wood or wood-based materials.

In one embodiment, the metal substrate is an untreated metal substrate which has not been subjected to specific pretreatment steps. Alternatively, the metal substrate may be pretreated in one or more pretreatment steps. Examples of known pretreatments include degreasing or cleaning with aqueous or organic solvent based liquids, treatment with alkaline or acidic pretreatment liquids, or rinsing with phosphate or silane containing liquids, to prepare and condition the metal surface for application of the coating composition of the invention. Also physical pretreatments, such as sanding, corona treatment, brushing, or waltzing (skin-passing) may be applied. It is also possible to use combinations of the above-mentioned pretreatment methods.

Examples

Preparation of a silane-modified acrylic dispersion

1,210.6 g of deionised water were added to a flask with 3.6 g of Rhodafac PE510 surfactant. The flask was equipped with a stirrer and a nitrogen blanket and heated to 80 °C. A solution of 2.56 g of ammonium persulfate in 50 g of deionised water was added. Then a premixed solution of 240 g styrene, 666 g of methylmethacrylate, 270 g of butylacrylate, 12 g of hydroxyethylmethacrylate, 12 g

of methacrylic acid, 30 g of Dow Corning Z-6040 (glycidoxypyriltrimethoxysilane), and 20.4g of Rhodafac PE 510, was fed into the flask over a 3 hour period, via a sub-surface feed. 30 minutes before the end of the monomer feed, a solution of 1.2 g of methacrylic acid in 5 g of deionised water was added. A second feed,
 5 consisting of 26.4 g of Rhodocal DSB, 0.26 g ammonium sulfate, and 37.6 g deionised water, was also started and continued for 30 minutes. At the completion of the feeds, the temperature was maintained for 1 hour before cooling the dispersion.

- 10 A coating composition according to the invention was prepared by mixing the following components indicated in Table 1. The amounts are given in parts by weight (pbw):

Component	Amount (pbw)
Silane-modified acrylic dispersion	55.00
Aqueous emulsion of epoxide resin	9.50
Water-dilutable blocked polyisocyanate	2.50
Pigments and fillers	7.70
Silane-modified silica sol	19.00
Additives	0.60
Water	4.70
Total	100.00

- 15 The non-volatile content of the coating compositions was 50% by weight. The pH of the composition was 6.5. The storage stability was at least 3 months.

- A steel coil having a Zn-Mg treated surface was degreased with commercial degreaser Ridoline C-72 ex Henkel. The above-described composition was applied in a coil coating installation to one surface of the substrate and cured at a peak metal temperature of 105°C for 5 s. The dry layer thickness of the primer layer was
 20 3 to 4 μm . A commercially available polyester topcoat was applied on the primer

layer and cured at a peak metal temperature of 241°C for 35 s. The dry layer thickness of the topcoat was 18 µm.

5 The properties of the coated substrate were tested after 24 h storage at ambient temperature.

Gloss (ISO3270): 37 gloss units

Cross cut adhesion (DIN 53151): 0

Impact resistance (DIN 13523-5): 2x80

T-bend (DIN 13523-7) crack free: 1.5 T

10 After 2h/120°C: 1.5 T

It can be concluded that the aqueous coating composition of the invention is very suitable as primer for metal substrates. The composition has an increased non-volatile content and sufficient storage stability to allow for simple logistics and
15 delivery of the composition. Furthermore, the composition is acceptable in terms of industrial safety and it is possible to apply the composition with standard equipment. Subsequent coating layers are not negatively impacted by the primer layer.

CLAIMS

1. An aqueous coating composition comprising water as liquid diluent and
 - a) 15-50% by weight of an organic polymeric binder which is obtainable
5 by the reaction of
 - i) an organic polymeric binder having crosslinkable functional groups and
 - ii) a silane,
 - b) 2-30% by weight of an epoxide-functional material
 - 10 c) 2-30% by weight of a silane-modified silica sol
 - d) 0-30% by weight of pigments and fillers,
 - e) 0-10% by weight of usual additives, and
 - f) 1-15% by weight of a crosslinker capable of reacting with the crosslinkable functional groups of the organic polymeric binder,
 - 15 wherein the % by weight are calculated on the weight of the entire composition, and wherein the composition has a pH in the range of 4.0 to 7.5.
2. The aqueous coating composition according to claim 1, wherein the
20 organic polymeric binder is a polyacrylate.
3. The aqueous coating composition according to claim 1 or 2, wherein the crosslinkable functional groups are hydroxyl groups and wherein the crosslinker is a blocked polyisocyanate.
- 25 4. The aqueous coating composition according to any one of the preceding claims, wherein the composition comprises at most 5% by weight of volatile organic solvents.

5. The aqueous coating composition according to any one of the preceding claims, wherein the non-volatile content of the composition is at least 35% by weight.
- 5 6. The aqueous coating composition according to any one of the preceding claims, wherein the composition comprises at least one pigment or filler which is present in an amount of 10% by weight or less, calculated on the weight of the entire composition.
- 10 7. The aqueous coating composition according to any one of the preceding claims, wherein the composition comprises at least one pigment or filler which has been treated with an additive selected from silane, silane-modified silica sol, and mixtures thereof.
- 15 8. A process of preparing a composition according to any one of the preceding claims comprising the steps of mixing, in any workable order,
a) an aqueous emulsion of an epoxide-functional material,
b) an aqueous dispersion of an organic polymeric binder which is obtainable by the reaction of
20 i) an organic polymeric binder having crosslinkable functional groups and
 ii) a silane
c) a crosslinker capable of reacting with the crosslinkable functional groups of the organic polymeric binder, and
25 d) an aqueous silane-modified silica sol.
9. The process according to claim 8, comprising the further steps of
e) dispersing at least one pigment or filler in a suitable dispersing medium and

- f) including the dispersed at least one pigment or filler in the coating composition.

5 10. A process of applying an anti-corrosive primer layer to a metal substrate comprising the steps of

- a) applying the aqueous coating composition according to any one of the preceding claims 1 to 7 to a metal substrate and
- b) curing the applied coating composition.

10 11. The process according to claim 10, wherein the anti-corrosive primer layer has a thickness after curing in the range of 3 to 15 μm .

12. Use of the coating composition according to any one of the preceding claims 1 to 7 as a primer for metal substrates.

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13. A metal substrate having an anti-corrosive primer coating layer on at least a part of the surface, wherein the anti-corrosive primer coating layer has been prepared from an aqueous coating composition according to any one of the preceding claims 1 to 7.

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2013/055097

A. CLASSIFICATION OF SUBJECT MATTER
INV. C09D5/00
ADD.

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

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

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

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2005/123849 A1 (HENKEL KGAA [DE]; KOCH MATTHIAS [US]; MOTZKAT KERSTIN [DE]; LORENZ WOL) 29 December 2005 (2005-12-29) page 6, line 18 - page 11, line 9 claims 1-4,9-12; examples 1-7 -----	1-13
X	US 2006/225612 A1 (LEJEUNE ALAIN [FR] ET AL) 12 October 2006 (2006-10-12) paragraph [0010] - paragraph [0014] claims 1,8-18,35-37; figures 1-7; examples 1-6,33-41 -----	1-13
X	WO 2006/069376 A2 (UNIV CINCINNATI [US]; VAN OOIJ WIM JOHAN [US]; MUGADA TRILOK [US]; SUR) 29 June 2006 (2006-06-29) paragraph [0004] - paragraph [0018] claims 1,8,11,16,27-39; examples 1-32 ----- -/-	1-13



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

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International application No

PCT/EP2013/055097

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
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X	US 2005/137298 A1 (SCHNEIDER JOHN R [US]) 23 June 2005 (2005-06-23) paragraph [0008] - paragraph [0012] claims 1,5,6,8-14 -----	1-13

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Information on patent family members

International application No

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