An object of the present disclosure, accordingly, was to provide a further aqueous and largely VOC-free anti-corrosion composition based on so-called bis-aminosilane cocondensates as binders, this composition being substantially compatible with particulate additions and also, optionally, further additives, and being storage-stable as such at least for several hours to weeks before application. A particular concern, furthermore, was that such formulations can be cured at room temperature and achieve effective adhesion and corrosion control on metal substrates. Another desideratum is that anti-corrosion coatings obtainable on this basis can be applied in different film thicknesses and are readily repaintable after curing, in other words exhibiting effective adhesion to coatings, more particularly to organic (paint) coatings.

The object has been achieved in accordance with the disclosure in line with the features in the claims.

Thus it has been found, surprisingly, that on the basis of virtually completely hydrolysed cocondensates of an epoxyalkyl-functional alkoxysilane - cf. formula I below - with at least one bis-aminoalkyl-functional alkoxysilane - cf. also formulae II and IIa below - and also, optionally, further organo-functional alkoxysilanes and/or silica sol systems, it is possible to prepare specific aqueous binders for anti-corrosion formulations, having a defined pH and a defined dry residue; these formulations are largely VOC-free, cure in the air at low temperatures, i.e. preferably at room temperature, more preferably at 16 to 26 °C, more particularly at 20 °C, and, with additions from the group consisting of particulate metals, metal alloys and/or metal compounds, including metal oxides or metal salts, and also, optionally, further additives, are advantageously compatible, storage-stable and suitable for application. Using the present compositions it is possible, furthermore, to produce advantageously thin films on metal, to which further paint coats can be applied and with which at the same time it is possible to obtain effective adhesion to the primer and/or to the metal.

Binders are, generally speaking, liquids, which bond solids with a fine degree of division, additionally may have a crosslinking effect in a preparation, and allow adhesion to the substrate. In order that a formulation comprising a binder and a particulate adjuvant can be produced, the binder must be compatible with the

hydrolysed and at least partially condensed or cocondensed silanes. In order to obtain storage-stable silane systems, the solids content of the pure epoxy-functional alkoxysilane in the aqueous sol-gel system must advantageously be up to 70% by weight, while the solids content of the pure bis-amino-functional alkoxysilane ought only to be not more than approximately 10% by weight, without becoming solid. The dry residue (also designated here as solids content) of the condensates or cocondensates in the binder is situated preferably in the range from 1% to 50% by weight, more preferably between 3% and 45% by weight and very preferably between 5% and 35% by weight.

The present disclosure accordingly provides a composition comprising

- a binder comprising at least one cocondensate based on an ω-glycidyloxyalkylalkoxysilane of the formula I

$$X\text{-}Si(R^2)_x(OR^1)_{3-x} \qquad (I),$$

in which X is a 2-(3,4-epoxycyclohexyl)ethyl, 1-glycidyloxymethyl, 2-glycidyloxyethyl, 3-glycidyloxypropyl or 3-glycidyloxyisobutyl group, R^1 and R^2 independently of one another are each a linear or branched alkyl group having 1 to 4 C atoms, and x is 0 or 1,

and on at least one bis(alkoxysilylalkyl)amine of the general formula II

$$(OR^1)_3Si - A - Si(OR^1)_3 \qquad (II),$$

in which the groups R^1 are identical or different and R^1 is a linear or branched alkyl group having 1 to 4 C atoms and A is a bis-amino-functional group of the formula IIa

$$-(CH_2)_i-[NH(CH_2)_f]_gNH[(CH_2)_{f^*}NH]_{g^*}-(CH_2)_{i^*}- \qquad (IIa),$$

in which i, i*, f, f*, g or g* are identical or different, with i and/or i* = 1, 2, 3 or 4, f and/or f* = 1 or 2, g and/or g* = 0 or 1, preferably with i and i* being identical to 3 and g and g* being identical to 0 and R^1 is methyl and/or ethyl,

and also, optionally, on at least one further silicon compound from the group consisting of tetraalkoxysilane, alkylalkoxysilane, mercaptoalkylalkoxysilane, aminoalkylalkoxysilane, carboxyalkylalkoxysilane, ureidoalkylalkoxysilane, thiocyanatoalkylalkoxysilane and silica sols,

- water,
- alcohol in an amount of less than 3% by weight, preferably 0.01% to 2.5% by weight, more particularly 0.1% to 2.2% by weight, based on the composition,
- at least one addition from the group consisting of particulate metals, metal alloys and/or metal compounds, and
- optionally at least one additive,

the pH in the composition being 1 to 14, preferably 2 to 13, more particularly 3.0; 3.5; 4.0; 4.5; 5.0; 5.5; 6.0; 6.5; 7.0; 7.5; 8.0, including all positive numbers from $\geq$ 2.5 to $\leq$ 12, and

the dry residue of the binder being 1% to 50% by weight, preferably 5% to 40% by weight, more preferably 8% to 35% by weight, more particularly 10% to 25% by weight, additionally 2%, 3%, 4%, 6%, 7%, 9%, 11%, 12%, 13%, 14%, 15%, 16%, 17%, 18%, 19%, 20%, 21%, 22%, 23%, 24% by weight, based on the binder used.

In one aspect, the present disclosure refers to a composition which includes

- a binder containing at least one co-condensate, the basis of which is an ω-glycidyloxyalkylalkoxysilane indicated by formula I

$$X\text{-}Si(R^2)_x(OR^1)_{3-x} \quad (I)$$

wherein X represents a 2-(3,4-epoxycyclohexyl)ethyl group, 1-glycidyloxymethyl group, 2-glycidyloxyethyl group, 3-glycidyloxypropyl group or 3-glycidyloxyisobutyl group, R^1 and R^2 are each, independently, a C_{1-4} linear or branched-chain alkyl group, and x is equal to 0 or 1 and

at least one bis(alkoxysilylalkyl)amine represented by general formula II

$$(OR^1)_3Si\text{-}A\text{-}Si(OR^1)_3 \quad (II)$$

wherein groups R^1 are the same or different, with R^1 being a C_{1-4} linear or branched-chain alkyl group; and A represents a bisamino functional group indicated by

formula IIa

$-(CH_2)_i-[NH(CH_2)_f]_gNH[(CH_2)_{f^*}NH]_{g^*}-(CH_2)_{i^*}-$ (IIa),

where i, i*, f, f*, g and g* are the same or different, with i and/or i* = 1, 2, 3 or 4, f and/or f* = 1 or 2, and g and/or g* = 0 or 1,

or the basis of which is an ω-glycidyloxyalkylalkoxysilane of formula I and at least one bis(alkoxysilylalkyl)amine of general formula II, and at least one further silicon compound from among tetraalkoxysilanes, alkylalkoxysilanes, mecaptoalkylalkoxysilanes, carboxyalkylalkoxysilanes, aminoalkylalkoxysilanes, ureidoalkylalkoxysilanes, thiocyanatoalkylalkoxysilanes and silica sol,

- water,
- alcohol in a quantity of less than 3 mass% based on said composition, and
- at least one additive from among particulate metals, metal alloys and/or metal compounds,

wherein the pH value of said composition is 1-14, and the dry residue in said binder is 1-50 mass% based on the binder employed, and said additive of an aforementioned particulate metal, metal alloy and/or metal compound is chosen from among zinc powder, zinc lamella, zinc dust, powder or lamella or fines made of a zinc alloy or zinc-bismuth alloy, and zinc oxide.

The binder for the composition of the disclosure can be prepared advantageously by a procedure in which first of all water is introduced in a molar excess, based on the silanes of the formulae I and II and also, optionally, on the aforementioned silicon compounds used, and is adjusted to an acidic pH with addition of an organic or inorganic acid, a silica sol being added optionally,
an ω-glycidyloxyalkylalkoxysilane of the formula I is metered in and the mixture is heated,
optionally further acid is metered in,
and at least one bis(alkoxysilylalkyl)amine of the general formula II and also optionally at least one further silicon compound from the group consisting of tetraalkoxysilane, alkylalkoxysilane, aminoalkylalkoxysilane,
ureidoalkylalkoxysilane, carboxyalkylalkoxysilane and thiocyanatoalkylalkoxysilane is metered in and the system is caused to react,

subsequently the resultant hydrolysis alcohol is removed at least proportionately from the reaction mixture under reduced pressure,
the binder thus obtained is optionally diluted with water and/or an aqueous acid and is subsequently filtered,
the dry residue of the binder being 1% to 50% by weight, preferably 5% to 40% by weight, more preferably 8% to 35% by weight, more particularly 10% to 25% by weight, based on the binder used.

The composition of the disclosure may be present advantageously as a one-component system and used as such.

It is also possible, however, to use the above-described binder and at least one of the stated additions in the form of a two-component system, the components being mixed prior to the application to give such a composition. In this case it is also possible to add further additives.

A composition of the disclosure advantageously has a dry residue (solids content) of 1% to 50% by weight, preferably 3% to 45% by weight, more preferably 3% to 35% by weight, based on the composition.

Furthermore, a composition of the disclosure is characterized by an amount of particulate metals and/or metal compounds in the composition of 1% to 95% by weight, preferably 3% to 90% by weight, more preferably 5% to 85% by weight, very preferably 10% to 80% by weight.

Additions in present compositions are preferably particulate metals, metal alloys and/or metal compounds, more particularly metal oxides, selected from the group consisting of conductive and non-conductive fillers, zinc powders, zinc flakes, zinc dust, powders and flakes of zinc alloys, such as zinc-bismuth alloys, magnesium and magnesium alloys, aluminium powders, aluminium flakes, powders and flakes of aluminium alloys, titanium dioxide, red iron oxide, yellow iron oxide, calcium carbonate, talc, aluminium silicates, barium sulphate, kaolin, magnesium silicates, crystalline quartz, amorphous quartz, calcium magnesium carbonate, calcium

silicates, aluminium oxide, zeolites, wollastonites, zinc oxide, zinc phosphate, bismuth vanadate, lead chromate, silicon carbide and inorganic colour pigments.

The particulate additions here advantageously have a particle size of 5 nm to 50 µm, preferably of 10 nm to 40 µm, more preferably of 15 nm to 30 µm. The particle size may be determined by means, for example, of a Camsizer, Horiba LA-30, LB-550, and also LA-950 from Retsch Technology. The particle size may be determined accordingly from 1 nm wet and from 100 nm dry.

The conductive additions more particularly provide protection from corrosion when they are used in sufficient concentration and are in contact with the metal substrate. Hence metal substrates protected against corrosion with a coating comprising particulate metals can advantageously be welded.

Furthermore, compositions of the disclosure may additionally comprise additives advantageously selected from the group consisting of defoamers, thickeners, rheological assistants, dispersion assistants, anti-settling agents, rust inhibitors, wetting agents, organic pigments, polymers and polymer dispersions, and catalysts for the condensation and curing. As polymers, accordingly, it is possible for example, but not exclusively, to use acrylate dispersions, PU dispersions, epoxy resin dispersions, functionalized polyesters, water-soluble polymers, such as, for example, PVA, and polyacrylic acid - to name but a few suitable polymers. As additives or polymers or cobinders it is possible, furthermore, to use organic film-formers and also adhesion promoters based on acrylic esters, acrylic-polyester-polyurethane copolymers, ethylene-acrylic copolymers, and polyester resins having free carboxyl groups.

Compositions of the disclosure, accordingly, may be characterized by an amount of additives of in each case 0% to 5% by weight, more particularly of thickener of 0% to 5% by weight and/or of anti-settling agent of 0% to 5% by weight and/or of wetting agent of 0% to 3% by weight and/or of corrosion inhibitor of 0% to 1% by weight, based in each case on the composition, the sum of all the constituents present in the composition making 100% by weight.

Typical thickeners are, for example, polyacrylic acid polymers, cellulose ethers, polyurethanes, acrylate polymers, hydroxyethylcellulose, which are used at concentrations of 0.005% to 4,0% by weight, preferably of 0.008% to 3.0% by weight and very preferably of 0.01% to 2.0% by weight. Examples of thickeners and rheology modifiers include Coapur 6050 and Coapur XS 71 from Coatex.

Examples of anti-settling agents include laponites, bentonites, glycerol stearates, polyamides, xanthan, polyethylene waxes, modified and non-modified fumed silica, as for example Aerosil® R 812 S or Aerosil® R 805, which are used likewise at concentrations of up to 4% by weight, preferably 0.01% to 3% by weight, more particularly from 0.1% to 2% by weight.

Typical wetting agents are, for example, BYK 348 and also ethoxylated alcohols, which are used at concentrations of up to 3% by weight, preferably from 0.01% to 2.5% by weight or very preferably from 0.1% to 1.5% by weight.

Typical corrosion inhibitors are molybdates, phosphates, chromates, borates and also, in particular, organic corrosion inhibitors. These organic corrosion inhibitors are used at lower concentrations, suitably up to 1.0% by weight, preferably 0.8% by weight, more preferably 0.5% by weight, more particularly from 0.00001% to 0.1% by weight, based in each case on the composition, with the sum of all the constituents present in the composition making 100% by weight.

Possible catalysts for the condensation and curing are, for example, Tyzor LA (DuPont), titanium acetylacetonate and tetrakis(triethanolamine)zirconate.

The present disclosure further provides a process for preparing a composition of the disclosure, which is characterized in that first of all a binder is prepared, comprising at least one cocondensate based on an ω-glycidyloxyalkylalkoxysilane of the formula I

$$X\text{-}Si(R^2)_x(OR^1)_{3-x} \qquad (I),$$

in which X is a 2-(3,4-epoxycyclohexyl)ethyl, 1-glycidyloxymethyl, 2-glycidyloxyethyl, 3-glycidyloxypropyl or 3-glycidyloxyisobutyl group, R^1 and R^2

aminoalkylalkoxysilane, carboxyalkylalkoxysilane , ureidoalkylalkoxysilane and thiocyanatoalkylalkoxysilane is metered in and the system is caused to react, subsequently the resultant hydrolysis alcohol is removed at least proportionately from the reaction mixture under reduced pressure,

the binder thus obtained is optionally diluted with water and/or an aqueous acid and is subsequently filtered,

and

at least one addition from the group consisting of particulate metals, metal alloys and/or metal compounds is dispersed into the resulting binder and also, optionally, at least one additive is incorporated with stirring.

In another aspect, the present disclosure refers to a process for producing a composition as disclosed herein, wherein

first, a binder containing at least one co-condensate, the basis of which is an ω-glycidyloxyalkylalkoxysilane indicated by formula I

$X\text{-}Si(R^2)_x(OR^1)_{3-x}$ (I)

wherein X represents a 2-(3,4-epoxycyclohexyl)ethyl group, 1-glycidyloxymethyl group, 2-glycidyloxyethyl group, 3-glycidyloxypropyl group or 3-glycidyloxyisobutyl group, R^1 and R^2 are each, independently, a C_{1-4} linear or branched-chain alkyl group, and x is equal to 0 or 1 and

at least one bis(alkoxysilylalkyl)amine represented by general formula II

$(OR^1)_3Si\text{-}A\text{-}Si(OR^1)_3$ (II)

wherein groups R^1 are the same or different, with R^1 being a C_{1-4} linear or branched-chain alkyl group; and A represents a bisamino functional group indicated by

formula IIa

$-(CH_2)_i\text{-}[NH(CH_2)_f]_gNH[(CH_2)_{f^*}NH]_{g^*}\text{-}(CH_2)_{i^*}\text{-}$ (IIa),

where i, i*, f, f*, g and g* are the same or different, with i and/or i* = 1, 2, 3 or 4, f and/or f* = 1 or 2, and g and/or g* = 0 or 1,

or the basis of which is an ω-glycidyloxyalkylalkoxysilane of formula I and at least one bis(alkoxysilylalkyl)amine of general formula II, and at least one further silicon compound from among tetraalkoxysilanes, alkylalkoxysilanes, mecaptoalkyl-alkoxysilanes, carboxyalkylalkoxysilanes, aminoalkylalkoxysilanes, ureidoalkylalkoxy-silanes, thiocyanatoalkylalkoxysilanes and silica sol, is produced by

introducing water in a molar excess based on the silanes of formulae I and II that are used or the silanes of formulae I and II and the aforementioned silicon compound(s) that are used,

adjusting to an acidic pH value by addition of an organic acid or an inorganic acid,

supplying a metered quantity of ω-glycidyloxyalkylalkoxysilane of formula I, and heating,

then supplying a metered quantity of acid,

and supplying a metered quantity of at least one bis(alkoxysilylalkyl)amine of general formula II, or at least one bis(alkoxysilylalkyl)amine of general formula II and at least one further silicon compound from among tetraalkoxysilanes, alkylalkoxysilanes, mercaptoalkylalkoxysilanes, carboxyalkylalkoxysilanes, amino-alkylalkoxysilanes, ureidoalkylalkoxysilanes, and isocyanatoalkylalkoxysilanes, and reacting,

and then, at least partially removing the hydrolysis alcohol produced thereby from said reaction mixture under reduced pressure,

diluting the binder thus obtained with water and/or an acidic aqueous solution and/or a basic aqueous solution, or adjusting said pH value, and then filtering,

and

dispersing at least one additive from among particulate metals, metal alloys and/or metal compounds into the binder thus obtained,

where said additive of aforementioned particulate metal, metal alloy and/or metal compound is selected from zinc powder, zinc lamella, zinc dust, powder or lamella or fines made of a zinc alloy or zinc-bismuth alloy, and zinc oxide.

For the preparation of the binder in this context it is preferred to use the ω-glycidyloxyalkylalkoxysilane of the formula I in a molar ratio to the bis(alkoxysilylalkyl)amine of the general formula II of 0.1:99.9 to 99:1, preferably of 1:99 to 95:5, more preferably up to 80:20, very preferably up to 70:30, more particularly the ω-glycidyloxyalkylalkoxysilane is used in the binder at 0.001 to 42 mol%, preferably from 0.01 to 30 mol%, more preferably from 0.1 to 15 mol%, very preferably from 0.2 to 1.5 mol%.

The procedure more particularly in the process of the disclosure is that water is introduced in a molar excess, based on the silanes of the formulae I and II and also, optionally, the aforementioned silicon compounds that are used, of suitably 2 to 1000 mol of water, preferably 5 to 500 mol, more particularly 10 to 100 mol of water per mole of the Si-bonded alkoxy groups present in the silanes used, under inert gas. The inert gas used in the reaction is generally nitrogen or argon.

Furthermore, when carrying out the process of the disclosure, it is possible to use an organic or inorganic acid, this acid being advantageously selected from the group consisting of formic acid, acetic acid, propionic acid, hydrochloric acid, nitric acid, sulphuric acid and phosphoric acid. Said acids may be used in aqueous form or else in concentrated form. Using one of said acids, preferably with formic acid, it is possible more particularly to adjust the pH of the reaction mixtures and/or product mixtures, particularly of the binder, during and/or after the reaction, to 1 to 6.5,

preferably 2 to 6, more particularly to 2.5; 3; 3.5; 4; 4.5; 5 and also 5.5, advantageously.

Surprisingly it has been found that certain of the binders used in accordance with the disclosure can also be stabilized in the neutral and alkaline ranges. For examples, by adding an aqueous alkali or a suitable base, it is possible to set the pH advantageously to a neutral or alkaline value, more particular to 7; 7.5, 8; 8.5; 9; 9.5; 10; 10.5; 11; 11.5; 12; 12.5; 13 and also 14 - cf. the examples. Further bases besides alkalis, such as aqueous NaOH or KOH, which can be used advantageously are preferably N,N-dimethylethanolamine or else Tyzor TEAZ [tetrakis(triethanolamine)zirconate].

In the process of the disclosure, furthermore, it is preferred to use 3-glycidyloxypropyltrimethoxysilane and/or 3-glycidyloxypropyltriethoxysilane as ω-glycidyloxyalkylalkoxysilane of the formula I and to meter it into the acidic aqueous mixture obtained before, and to heat the mixture over 0.1 to 3 hours, preferably 0,5 to 1.5 or 2 hours, with stirring and/or mixing, to a temperature of 50 to 90 °C, preferably 55 to 70 °C, more particularly 60 to 65 °C.

Subsequently the heated, acidic and ω-glycidyloxyalkylalkoxysilane-containing mixture is admixed preferably with bis(trimethoxysilylpropyl)amine and/or bis(triethoxysilylpropyl)amine. Additionally the following can be used, for example together with the bis(alkoxysilylalkyl)amine, optionally as further silicon compound: a tetraalkoxysilane, preferably tetramethoxysilane, tetraethoxysilane, an alkylalkoxysilane, preferably C1-C16-alkylalkoxysilanes, more particularly methyltrimethoxysilane, methyltriethoxysilane, n-propyltrimethoxysilane (PTMO), n-propyltriethoxysilane (PTEO), isobutyltrimethoxysilane (IBTMO), isobutyltriethoxysilane (IBTEO), octyltrimethoxysilane (OCTMO), octyltriethoxysilane (OCTEO), mercaptoalkylalkoxysilane, preferably 3-mercaptopropyltrimethoxysilane (MTMO), mercaptopropyltrimethoxysilane (MTEO), aminoalkylalkoxysilane, preferably 3-aminopropyltrimethoxysilane (AMMO), 3-aminopropyltriethoxysilane (AMEO), N-(2-aminoethyl)-3-aminopropyltrimethoxysilane (DAMO), N-(2-aminoethyl)-3-aminopropyltriethoxysilane, N,N'-diaminoethyl-3-aminopropyltrimethoxysilane (TriAMO), N,N'-diaminoethyl-3-aminopropyltriethoxysilane, a ureidoalkylalkoxysilane,

preferably 3-ureidopropyltrimethoxysilane, 3-ureidopropyltriethoxysilane, and/or a thiocyanatoalkylalkoxysilane, preferably 3-thiocyanatopropyltrimethoxysilane, 3-thiocyanatopropyltrimethoxysilane, carboxyalkyltrialkoxysilanes, preferably 4-(trimethoxysilyl)butanoic acid, 5-(trimethoxysilyl)pentanoic acid and 5-(triethoxysilyl)pentanoic acid. The metered addition of the aforementioned silanes here takes place advantageously at a pH of 2 to 6, preferably 3 to 5, and with stirring at 50 to 90 °C, preferably 60 to 65 °C. Subsequently the mixture is advantageously caused to react over 0.3 to 6 hours, preferably 2 to 4 hours, possibly accompanied by further stirring; that is, the alkoxysilanes used hydrolyse substantially completely hydrolysed and condensed or cocondensed.

From the product mixture thus obtained it is possible subsequently for the hydrolysis alcohol formed in the reaction, generally with fractions of water, to be removed at least proportionately from the reaction mixture under reduced pressure (vacuum distillation).

The binder thus present may optionally be diluted with water and/or an aqueous acid or aqueous base in order, for example, to adjust the pH, the amount of dry residue and/or the viscosity. The binder, subsequently, is suitably filtered, preference being given to the use of a fine-pored filter plate, in order to remove relatively coarse aggregates that may have formed during the reaction. A binder obtainable in this way possesses at room temperature a generally oil-like consistency, is slightly cloudy to clear, and ranges from yellowish to colourless.

Into the resulting binder it is now possible to disperse at least one addition from the group consisting of the particulate metals, metal alloys and/or metal compounds already disclosed above and also, optionally, to incorporate at least one additive, as likewise set out above, with stirring.

Furthermore, in accordance with the disclosure, an organic or inorganic acid selected from the group consisting of formic acid, acetic acid, propionic acid, hydrochloric acid, nitric acid, sulphuric acid and phosphoric acid and also an aqueous base selected from the group consisting of sodium hydroxide, potassium hydroxide or else Tyzor TEAZ [tetrakis(triethanolamine)zirconate] or N,N-dimethylethanolamine or

other bases are preferably used, with the pH being adjusted during and/or after the reaction in the binder and/or after formulation in the composition to 1 to 14, preferably 2 to 12, more preferably 2.5 to 9, very preferably 3 to 8, more particularly to 3.5; 4; 4.5; 5; 5.5; 6; 6.5; 7; 7.5; 8 and also 8.5, in which context the addition of at least one of the aforementioned particulate metals, metal alloys and/or metal compounds to the binder may also result in a change in the pH, more particularly the addition of zinc, zinc oxide, zinc alloys, magnesium, aluminium, magnesium alloys, aluminium alloys or a micaceous iron ore, such as Miox Micron, to an acidified binder.

A composition of the disclosure can be produced in corresponding mixers or mixing assemblies which are known per se to the skilled person.

Further provided by the present disclosure is the use of a composition of the disclosure or composition obtainable in accordance with the disclosure for coatings which cure in the air at a temperature of 16 to 26 °C, with more particular advantage for coatings on metals and metal alloys for protection from corrosion.

In yet another aspect, the present disclosure refers to the use of a composition as disclosed herein, or produced by a process as disclosed herein, for a coating which hardens in air at a temperature of 16-26 °C.

Accordingly, these specific compositions of the disclosure are notable with particular advantage for a comparatively excellent processing stability and outstanding user properties and also eco-friendly properties for corrosion control applications on metal substrates.

The present disclosure is elucidated in more detail by the examples which follow, without restriction on the subject matter of thedisclosure.

Examples:

Chemicals and abbreviations used:

Trade name	Description	Manufacturer

Trade name	Description	Manufacturer
Dynasylan® GLYMO	3-Glycidyloxypropyltrimethoxysilane (GLYMO)	Evonik Degussa
Dynasylan® 1122	Bis(triethoxysilylpropyl)amine (Bis-AMEO)	Evonik Degussa
Dynasylan® AMEO	3-Aminopropyltriethoxysilane	Evonik Degussa

Claims:

1. Composition which includes:

- a binder containing at least one co-condensate, the basis of which is an ω-glycidyloxyalkylalkoxysilane indicated by formula I

$X\text{-}Si(R^2)_x(OR^1)_{3-x}$ (I)

wherein X represents a 2-(3,4-epoxycyclohexyl)ethyl group, 1-glycidyloxymethyl group, 2-glycidyloxyethyl group, 3-glycidyloxypropyl group or 3-glycidyloxyisobutyl group, R^1 and R^2 are each, independently, a C_{1-4} linear or branched-chain alkyl group, and x is equal to 0 or 1 and

at least one bis(alkoxysilylalkyl)amine represented by general formula II

$(OR^1)_3Si\text{-}A\text{-}Si(OR^1)_3$ (II)

wherein groups R^1 are the same or different, with R^1 being a C_{1-4} linear or branched-chain alkyl group; and A represents a bisamino functional group indicated by

formula IIa

$-(CH_2)_i\text{-}[NH(CH_2)_f]_gNH[(CH_2)_{f^*}NH]_{g^*}\text{-}(CH_2)_{i^*}\text{-}$ (IIa),

where i, i*, f, f*, g and g* are the same or different, with i and/or i* = 1, 2, 3 or 4, f and/or f* = 1 or 2, and g and/or g* = 0 or 1,

or the basis of which is an ω-glycidyloxyalkylalkoxysilane of formula I and at least one bis(alkoxysilylalkyl)amine of general formula II, and at least one further silicon compound from among tetraalkoxysilanes, alkylalkoxysilanes, mecaptoalkyl-alkoxysilanes, carboxyalkylalkoxysilanes, aminoalkylalkoxysilanes, ureidoalkylalkoxy-silanes, thiocyanatoalkylalkoxysilanes and silica sol,

- water,
- alcohol in a quantity of less than 3 mass% based on said composition, and
- at least one additive from among particulate metals, metal alloys and/or metal compounds,

wherein the pH value of said composition is 1-14, and the dry residue in said binder is 1-50 mass% based on the binder employed, and said additive of an aforementioned particulate metal, metal alloy and/or metal compound is chosen from among zinc powder, zinc lamella, zinc dust, powder or lamella or fines made of a zinc alloy or zinc-bismuth alloy, and zinc oxide.

2. Composition according to claim 1 which, based on said composition, is 1-50 mass% dry residue (solid matter).

3. Composition according to claim 1 or 2, wherein the content of particulate metal, metal alloy and/or metal compound in said composition is 1-95 mass%.

4. Composition according to any one of claims 1 to 3 which further contains at least one additive, with said additive(s) being selected from defoaming agents, thickeners, rheology aids, dispersion aids, precipitation-preventing agents, rust-preventing agents, wetting agents, organic pigments, polymers or polymer dispersions, and catalysts for said condensation and hardening.

5. Composition according to any one of claims 1 to 4, wherein the respective contents based on said composition are 0-5 mass% for thickeners and/or 0-5 mass% for precipitation-preventing agents and/or 0-3 mass% for wetting agents and/or 0-1 mass% for corrosion-suppressing agents, when the total of all constituents present in said composition is 100 mass%.

6. Process for producing a composition according to any one of claims 1 to 5, which is a process for producing a composition according to any one of claims 1 to 5, wherein

first, a binder containing at least one co-condensate, the basis of which is an ω-glycidyloxyalkylalkoxysilane indicated by formula I

$X\text{-}Si(R^2)_x(OR^1)_{3-x}$ (I)

wherein X represents a 2-(3,4-epoxycyclohexyl)ethyl group, 1-glycidyloxymethyl group, 2-glycidyloxyethyl group, 3-glycidyloxypropyl group or 3-glycidyloxyisobutyl group, R^1 and R^2 are each, independently, a C_{1-4} linear or branched-chain alkyl group, and x is equal to 0 or 1 and

at least one bis(alkoxysilylalkyl)amine represented by general formula II

$(OR^1)_3Si\text{-}A\text{-}Si(OR^1)_3$ (II)

wherein groups R^1 are the same or different, with R^1 being a C_{1-4} linear or branched-chain alkyl group; and A represents a bisamino functional group indicated by

formula IIa

$-(CH_2)_i-[NH(CH_2)_f]_gNH[(CH_2)_{f^*}NH]_{g^*}-(CH_2)_{i^*}-$ (IIa),

where i, i*, f, f*, g and g* are the same or different, with i and/or i* = 1, 2, 3 or 4, f and/or f* = 1 or 2, and g and/or g* = 0 or 1,

or the basis of which is an ω-glycidyloxyalkylalkoxysilane of formula I and at least one bis(alkoxysilylalkyl)amine of general formula II, and at least one further silicon compound from among tetraalkoxysilanes, alkylalkoxysilanes, mecaptoalkyl-alkoxysilanes, carboxyalkylalkoxysilanes, aminoalkylalkoxysilanes, ureidoalkylalkoxy-silanes, thiocyanatoalkylalkoxysilanes and silica sol, is produced by

introducing water in a molar excess based on the silanes of formulae I and II that are used or the silanes of formulae I and II and the aforementioned silicon compound(s) that are used,

adjusting to an acidic pH value by addition of an organic acid or an inorganic acid,

supplying a metered quantity of ω-glycidyloxyalkylalkoxysilane of formula I, and heating,

then supplying a metered quantity of acid,

and supplying a metered quantity of at least one bis(alkoxysilylalkyl)amine of general formula II, or at least one bis(alkoxysilylalkyl)amine of general formula II and at least one further silicon compound from among tetraalkoxysilanes, alkylalkoxysilanes, mercaptoalkylalkoxysilanes, carboxyalkylalkoxysilanes, amino-alkylalkoxysilanes, ureidoalkylalkoxysilanes, and isocyanatoalkylalkoxysilanes, and reacting,

and then, at least partially removing the hydrolysis alcohol produced thereby from said reaction mixture under reduced pressure,

diluting the binder thus obtained with water and/or an acidic aqueous solution and/or a basic aqueous solution, or adjusting said pH value, and then filtering,

and

dispersing at least one additive from among particulate metals, metal alloys and/or metal compounds into the binder thus obtained,

where said additive of aforementioned particulate metal, metal alloy and/or metal compound is selected from zinc powder, zinc lamella, zinc dust, powder or lamella or fines made of a zinc alloy or zinc-bismuth alloy, and zinc oxide.

7. Process according to claim 6, wherein, when adjusting to an acidic pH value by adding an organic acid or inorganic acid, silica sol is added with stirring.

8. Process according to claim 6 or 7, wherein the ω-glycidyloxy-alkylalkoxysilane of formula I is employed in a mol ratio of 0.1/99.9-99/1 relative to the bis(alkoxysilylalkyl)amine of general formula II.

9. Process according to claim 8, wherein said ω-glycidyloxy-alkylalkoxysilane is employed at 0.001-42 mol% in said binder.

10. Process according to any one of claims 6 to 9, wherein a molar excess of water, based on the silanes of formulae I and II that are used or the silanes of formulae I and II and the aforementioned silicon compound(s) that are used, is introduced at 2-1000 moles of water to 1 mole of Si-bound alkoxy groups present in the silanes that are used, under a protective gas.

11. Process according to any one of claims 6 to 10, wherein said organic acid or inorganic acid is selected from formic acid, acetic acid, propionic acid, hydrochloric acid, nitric acid, sulphuric acid, and phosphoric acid, and said basic aqueous solution is selected from caustic soda, caustic potash, *N,N*-dimethylethanolamine, and tetrakis(triethanolamine) zirconate, and said pH value is adjusted to 1-14 during reaction in the binder and/or after said reaction and/or after inclusion in said composition, and addition of said particulate metal, metal alloy and/or metal compound to said binder at this time can change the pH value.

12. Process according to any one of claims 6 to 11, wherein 3-glycidyloxy-propyltrimethoxysilane and/or 3-glycidyloxypropyltriethoxysilane is used or supplied in a measured quantity as the ω-glycidyloxyalkylalkoxysilane of formula I, and the resulting acidic aqueous mixture is heated for 0.1-3 hours at a temperature of 50-90°C, with stirring or mixing.

13. Process according to any one of claims 6 to 12, wherein bis(trimethoxysilylpropyl)amine and/or bis(triethoxysilylpropyl)amine is supplied in a

measured quantity at a pH value of 2-6 to a heated acidic mixture containing an ω-glycidyloxyalkylalkoxysilane, and reacted at 50-90°C for 0.3-6 hours with stirring.

14. Process according to any one of claims 6 to 12, wherein bis(trimethoxysilylpropyl)amine and/or bis(triethoxysilylpropyl)amine and *n*-propyltrimethoxysilane (PTMO), *n*-propyltriethoxysilane (PTEO), isobutyltrimethoxysilane (IBTMO), isobutyltriethoxysilane (IBTEO), octyltrimethoxysilane (OCTMO), octyltriethoxysilane (OCTEO), 3-mercaptopropyltrimethoxysilane (MTMO), mercaptopropyltrimethoxysilane (MTEO), 3-aminopropyltrimethoxysilane (AMMO), 3-aminopropyltriethoxysilane (AMEO), *N*-(2-aminoethyl)-3-aminopropyltrimethoxysilane (DAMO), *N*-(2-aminoethyl)-3-aminopropyltriethoxysilane, *N*,*N*'-diaminoethyl-3-aminopropyltrimethoxysilane (TriAMO), *N*,*N*'-diaminoethyl-3-aminopropyltriethoxysilane, carboxyalkyltrialkoxysilane, 3-ureidopropyltrimethoxysilane, 3-ureidopropyltriethoxysilane, 3-thiocyanatopropyltrimethoxysilane and/or 3-thiocyanatopropyltrimethoxysilane, as (a) further silicon compound(s), are supplied in a measured quantity at a pH value of 2-6 to a heated acidic mixture containing an ω-glycidyloxyalkylalkoxysilane, and reacted at 50-90°C for 0.3-6 hours with stirring.

15. Use of a composition described in any one of claims 1 to 5, or produced by a process described in any one of claims 6 to 14, for a coating which hardens in air at a temperature of 16-26°C.

16. Use according to claim 15 for a coating to protect metal and metal alloy from corrosion.