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(54) **Titre : SYSTEME DE REVETEMENT AMELIORE, UTILISATION DUDIT REVETEMENT POUR REVETIR DES COMPOSANTES ET COMPOSANTES AINSI REVETUES DESTINEES A DES EOLIENNES**

(54) **Title: IMPROVED COATING SYSTEM, USE THEREOF FOR COATING COMPONENTS AND THUS COATED COMPONENTS FOR WIND TURBINES**

(57) **Abrégé/Abstract:**
The invention relates to improved coating materials based on RMA systems, which cross-link with the aid of the classic Michael addition. The coating materials comprise at least 10 - 70wt.% of one or more CH-acidic compounds A, 4 - 40 wt.% of one or more vinylogous carbonyl compounds B, 1.5 - 15wt.% of one or more latent-basic catalysts C, up to 10wt.% one or more light protective agents, up to 20wt.% of one or more open time extenders, up to 20wt.% of one or more pot life extenders, up to 70 wt.% of one or more inorganic and/or organic pigments and 0.1 - 40wt.% of one or more anti-corrosion agents, respectively with respect to the total amount of the coating material. The invention also relates to thus produced coatings, in particular matt finish top coat and coated components, in particular for components for wind power plants, such as for example, vanes or rotor blades.

ABSTRACT

The invention relates to improved coating materials based on RMA systems, which cross-link with the aid of the classic Michael addition. The coating materials comprise at least 10 - 70wt.% of one or more CH-acidic compounds A, 4 - 40 wt.% of one or more vinylogous carbonyl compounds B, 1.5 - 15wt.% of one or more latent-basic catalysts C, up to 10wt.% one or more light protective agents, up to 20wt.% of one or more open time extenders, up to 20wt.% of one or more pot life extenders, up to 70 wt.% of one or more inorganic and/or organic pigments and 0.1 - 40wt.% of one or more anti-corrosion agents, respectively with respect to the total amount of the coating material. The invention also relates to thus produced coatings, in particular matt finish top coat and coated components, in particular for components for wind power plants, such as for example, vanes or rotor blades.

IMPROVED COATING SYSTEM, USE THEREOF FOR COATING COMPONENTS AND THUS COATED COMPONENTS FOR WIND TURBINES

The present invention relates to improved coating materials based on RMA systems, which cross-link with the aid of a classic Michael addition. The invention also relates to coatings produced therefrom and coated components, in particular components for wind turbines, for example, machine housings or rotor blades.

Coating materials, which cross-link in a Michael addition reaction, are known. The coatings produced therefrom have high weathering stability and chemical resistances. The rapid curing of these coating materials is achieved by the use of high catalyst content, whereby, however, the processing time or the pot life of the coating material is strongly reduced.

Rapid curing is particularly advantageous primarily in the case of coating or painting large components, for example, rotor blades for wind turbines. Merely due to the size of the surfaces, a relatively long time is required for coating the entire component, so that the coating materials used must have long pot lives and long open times. In the following, pot life is designated as the time interval between mixing all components of a coating material and the time at which the cross-linking reaction in the coating material has progressed to the extent that the coating material may no longer be processed. In the following, open time is designated as the time interval in which a coating material film

applied to a surface may be corrected without impairing the gradient properties.

During application of the coating material, the already coated areas must additionally be able to absorb the overspray that occurs during painting of the adjacent areas, without surface defects forming, for example, due to a poor progression. In the following, overspray is designated as material loss of the coating material caused during spray painting. The material loss may be caused by spraying past caused by an unfavourable orientation of the spray gun toward the workpiece or by strongly interrupted workpieces, like grids. Overspray may also occur due to coating material drops flowing off laterally from the workpiece surfaces. Overspray absorption is thereby the property of an applied coating material to absorb material from an overspray such that the desired smooth surface of the film or coating is retained.

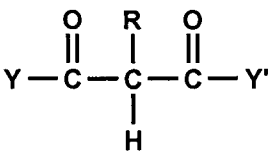
After application of the coating material film or the coating material layer, a very fast drying or curing is desired for the coating. Forced drying at increased temperature is generally not possible for large components, as correspondingly large ovens would be required for this. Therefore, fast drying at room temperature is particularly desirable primarily for coating or painting very large components.

Binder systems cross-linking in a Michael addition, designated in the following as RMA systems, are known from EP 2374836 A1 and have a favourable ratio of pot life to drying time. The described binder systems show

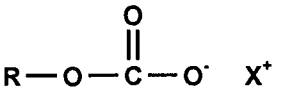
short drying times with long pot lives even at room temperature. Reference is thus specifically made to EP 2374836 A1 as a part of the description. The disadvantage of the known RMA systems is that the coating materials and coatings produced therefrom, in particular flexible matte gloss coatings, do not show the necessary and conventional properties.

It is desirable to provide improved coating materials, coatings, and coating systems based on RMA systems which are particularly suitable for coating large components like rotor blades.

In one aspect, the present invention provides a coating material for producing a coating having at least 15 to 70 wt.% of one or more CH acidic compounds A, 4 to 40 wt.% of one or more vinylogous carbonyl compounds B,0.1 to 15 wt.% of one or more latent-basic catalysts C, 0.00001 to 10 wt.% of one or more light stabilizers, 0.00001 to 20 wt.% of one or more open time extenders, 0.00001 to 20 wt.% of one or more pot life extenders, 0.00001 to 70 wt.% of one or more inorganic and/or organic pigments, and 0.00001 to 25 wt.% of one or more matting agents, wherein each wt.% is based on the total amount of the coating material, wherein the CH acidic compounds A are compounds of the general Formula I



wherein R is hydrogen, an alkyl- or aryl radical, Y is an alkyl-, aralkyl-, aryl-, alkoxy radical or an amino group, and Y' is an alkyl-, aralkyl-, aryl-, alkoxy radical or an amino group, wherein the vinylogous compounds B are acrylates and/or maleates, and wherein the latent-basic catalysts C are substituted carboxylic acid salts of the Formula



wherein R is hydrogen, an alkyl- or aralkyl-, or a polymer radical, X^+ is an alkali or an alkaline earth metal cation, a quaternary ammonium- or phosphonium salt of the formula $(R')_4Z+$, wherein Z is nitrogen or phosphorus, and R' is the same or different, is hydrogen, an alkyl-, aryl-, or aralkyl radical, or a polymer.

In a further aspect, the present invention provides a use of the coating material as defined herein for producing at least one coating.

In another aspect, the present invention provides a method for coating a component comprising (a) applying the coating material as defined herein to a substrate, and (b) curing the applied coating material for 0.5 to 12 hours at temperatures between 5 and 45ºC.

In a further aspect, the present invention provides a component coated with at least one coating produced from the coating material as defined herein.

The coating materials according to the invention comprise an RMA system which has one or more CH acidic compounds A, one or more vinylogous carbonyl compounds B, and one or more catalysts C. In addition, they contain at least one or more light stabilizers, one or more pot life extenders, one or more open time extenders, one or more inorganic and/or organic pigments, and one or more matting agents.

In the following, the expression light stabilizer is understood to refer to

additives and adjuvants which, as components of the ready to be used mixed coating material, delay the curing of the coating material prior to application. They evaporate during application so that the curing of the applied coating material is not affected, in particular, is not extended. The expression open time extenders is understood to refer to additives and adjuvants which also remain in the coating material after application and delay curing for the coating. The expression matting agent is understood to refer to additives and adjuvants that reduce the gloss of a coating or generate a matte gloss. Matting agents generate the surface structure necessary for this in the coating without affecting other features and properties.

The coating materials according to the invention contain at least

- 10 through 70, preferably 15 through 60, particularly preferably 20 through 55 wt.% CH acidic compounds A,
- 4 through 40, preferably 8 through 35, particularly preferably 10 through 30 wt.% vinylogous carbonyl compounds B,
- 0.1 through 15, preferably 0.2 through 10, particularly preferably 0.3 through 5 wt.% latent-basic catalysts C,
- 0.00001 through 10, preferably 0.5 through 5, particularly preferably 1 through 3 wt.% light stabilizers,
- 0.00001 through 20, preferably 0.01 through 10, particularly preferably 0.1 through 5 wt.% open time extenders,
- 0.00001 through 20, preferably 0.01 through 15, particularly preferably 0.1 through 10 wt.% pot life extenders,

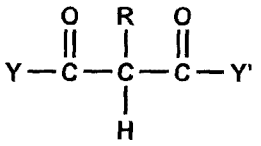
- 0.00001 through 70, preferably 10 through 65, particularly preferably 15 through 40 wt.% inorganic and/or organic pigments,
- 0.00001 through 25, preferably 1 through 25, particularly preferably 5 through 20, more particularly preferably 8 through 15 wt.% matting agents,

wherein the indicated amounts respectively relate to the total amount of the coating material.

According to the invention, the compounds A and B are used in a molar ratio A:B of 0.5:1 through 2:1, preferably of 0.75:1 through 1.6:1, particularly preferably of 0.9:1 through 1.3:1, especially preferably of 0.95:1 through 1.1:1, wherein the molar amounts refer to the acidic protons of the compounds A and to the vinylogous carbonyl groups of the compounds B.

According to the invention, the catalysts C and compounds A are used in a molar ratio C:A of 0.8:1 through 2.5:1, particularly 1.1:1 through 1.9:1, particularly preferably 1.3:1 through 1.7:1, wherein the molar amounts refer to the cation X^+ of catalyst C and the acidic protons of the compounds A.

Suitable CH acidic compounds A are compounds with the general Formula I



I

where

R is hydrogen, an alkyl- or aryl radical, and

Y, Y' are alkyl-, aralkyl-, aryl-, alkoxy radicals or amino groups, preferably primary amino groups, and Y and Y' may be the same or different.

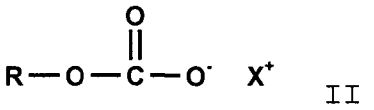
Furthermore, the -C(=O)-Y and/or -C(=O)-Y' groups from Formula I may be replaced by CN- or aryl groups.

According to the invention, malonic acid esters, acetoacetic acid esters, or mixtures thereof are preferably used. Malonic acid esters are particularly preferred with oligomer and polymer substituents, for example, based on polyesters, polyurethanes, polyacrylates, epoxy resins, polyamides, or polycarbonates. Malonic acid esters are particularly preferred with oligomer and polymer substituents based on polyesters, polyurethanes, and/or polycarbonates. The acetoacetic acid esters used preferably contain oligomer and polymer substituents, for example, based on polyalcohols, polyvinyl alcohols, epoxy resins, hydroxy-functional polyethers, polyesters, or polyacrylates. Acetoacetic acid esters with oligomer and polymer substituents based on polyesters and/or polyacrylates are particularly preferred. Compounds are more particularly preferred that are selected from the group containing malonic acid esters with oligomer and polymer substituents based on polyesters, which are obtained from the reaction of at least malonic acid, malonic acid dimethyl ester, and/or malonic acid diethyl ester with hexahydrophthalic acid and/or its anhydride and neopentyl glycol, and acetoacetic acid esters with oligomer and polymer substituents based on polyesters, which are obtained from the reaction of at least acetoacetic acid, acetoacetic acid methyl ester, and/or acetoacetic acid

ethyl ester with hexahydrophthalic acid and/or its anhydride and neopentyl glycol.

Suitable vinylogous carbonyl compounds B are, for example, acrylates and/or maleates, in particular unsaturated acryloyl-functional compounds. According to the invention, acrylesters are preferred that are made from compounds containing 1 through 20 carbon atoms and at least 2, preferably 2 through 6 hydroxyl groups. According to the invention, polyesters are additionally preferred that are obtained from reacting maleic acid, fumaric acid, and/or itaconic acid, or anhydrides thereof with di- or polyvalent hydroxyl compounds which may contain a monovalent hydroxyl- or carboxyl compound. Resins are additionally preferred, like polyesters, polyurethanes, polyethers, and/or alkyd resins which correspondingly contain activated unsaturated groups, for example, urethane acrylates, polyether acrylates, polyfunctional polyacrylates, polyalkylmaleates, and polyacrylates that are obtained from the reaction of acrylic acid with epoxy resins. According to the invention, butanediol diacrylate, hexanediol diacrylate, trimethylolpropane triacrylate, pentaerythritol tetraacrylate, di(trimethylolpropane)tetraacrylate, and dipentaerythritol hexaacrylate, and also dipropylene glycol diacrylate and tripropylene glycol diacrylate, are particularly preferred.

Suitable latent-basic compounds for the catalysts C are, for example, substituted carboxylic acid salts of Formula II:



II

where

R is hydrogen, an alkyl or aralkyl (Ar-R), or a polymer,

X^+ is an alkali or alkaline earth metal cation, in particular lithium, sodium, or potassium,
or a quaternary ammonium or phosphonium salt of the formula $(R')_4Z^+$,
where

Z is nitrogen or phosphorus,

R' is the same or different, is hydrogen, an alkyl-, aryl-, or aralkyl radical, or a polymer,

and where

R and R' may form a ring structure

or

R and R' may be a polymer.

According to the invention, R is preferably an alkyl group or an aralkyl group, particularly preferably an alkyl group with 1 through 4 carbon atoms. The carbonate group and the cation X^+ may also additionally be present on a molecule with the corresponding structure. Furthermore, R' is preferably an alkyl group, particularly preferably an alkyl group with 1 through 4 carbon atoms, particularly preferably with 3 through 4 carbon atoms. According to the invention, ammonium and/or phosphonium carbonate are preferably used. Suitable ammonium carbonates are, for example, tetrahexylammonium methyl carbonate, tetrahexylammonium hydrogen carbonate, tetradecanyl trihexylammonium methyl carbonate,

tetradecylammonium methyl carbonate, tetrabutylammonium methyl carbonate, tetrabutylammonium ethyl carbonate, tetrabutylammonium hydrogen carbonate, tetrapropylammonium methyl carbonate, tetrapropylammonium ethyl carbonate, tetrapropylammonium hydrogen carbonate, benzyltrimethylammonium methyl carbonate, trihexylmethylammonium methyl carbonate, or trioctylmethylammonium methyl carbonate. Tetrabutylammonium methyl carbonate, tetrabutylammonium ethyl carbonate, tetrabutylammonium hydrogen carbonate, tetrapropylammonium methyl carbonate, tetrapropylammonium ethyl carbonate, tetrapropylammonium hydrogen carbonate, and mixtures thereof are particularly preferably used.

Suitable light stabilizers are radical scavengers like sterically inhibited aliphatic amines, e.g., based on substituted 2,2,6,6-tetramethylpiperidines, UV absorbers like 2-hydroxyphenyl benzotriazoles, 2-hydroxybenzophenones, 2-hydroxyphenyltriazines, or oxalanilides, and quenchers like organic nickel compounds and peroxide decomposers like thioethers or phosphites. Radical scavengers, for example, sterically inhibited aliphatic amines based on substituted 2,2,6,6-tetramethylpiperidines, and/or UV absorbers, for example, 2-hydroxyphenyl benzotriazoles, 2-hydroxybenzophenones, 2-hydroxyphenyltriazines, and oxalanilides are preferably used. Substituted 2,2,6,6-tetramethylpiperidines, 2-hydroxyphenyltriazines, 2-hydroxybenzophenones, and mixtures thereof are particularly preferably used.

Suitable pot life extenders are short-chain alcohols which have an evaporation number below 35, preferably below 20. Alcohols are particularly suitable which have

up to 6, preferably up to 4, particularly up to 3 carbon atoms. Thus, for example, methanol, ethanol, n-propanol, i-propanol, n-butanol, i-butanol, and mixtures thereof may be used according to the invention.

Suitable open time extenders are basic NH-functional compounds with a pK_a value between 4 and 14. Succinimides, 1,2,4,-triazoles, 1,2,3,-benzotriazoles, 5,5-diphenylhydantoins, hydantoins, (RS)-3-ethyl-3-methylpyrrolidine-2,5-dione, and mixtures thereof are preferred. Succinimides, 1,2,4,-triazoles, 1,2,3,-benzotriazoles, and mixtures thereof are particularly preferred.

Suitable inorganic pigments are, for example, titanium dioxide, iron oxides, chromium oxides, chromium titanates, bismuth vanadate, cobalt blue, and carbon blacks. Titanium dioxide, iron oxides, and carbon blacks are preferred inorganic pigments. Suitable organic pigments are, for example, pigment yellow 151, pigment yellow 213, pigment yellow 83, pigment orange 67, pigment orange 62, pigment orange 36, pigment red 170, pigment violet 19, pigment violet 23, pigment blue 15:3, pigment blue 15:6, pigment green 7. Preferred pigments are pigment yellow 151, pigment orange 67, pigment red 170, pigment violet 19, pigment blue 15:3, pigment green 7.

Suitable matting agents are, for example, micronized amorphous silicas, like silica gels or precipitated silicas, micronized and precipitated waxes, like polyethylene waxes, polypropylene waxes, polyamide waxes, or PTFE waxes, and also micronized polymers, like urea aldehyde resin. Preferred matting agents used are

micronized and precipitated polyethylene waxes, polypropylene waxes, polyamide waxes, PTFE waxes, and micronized urea aldehyde resin.

In another embodiment of the present invention, additional additives and adjuvants may be added to the coating materials, like dispersing additives, functional fillers, and/or flow additives, in order to improve the required properties of the coating material and/or of the coating.

The coating materials according to the invention may additionally contain up to 25, preferably 0.00001 through 8, particularly preferably 0.00001 through 5 wt.% dispersing agents, wherein the indicated amounts respectively relate to the total amount of the coating material. Suitable dispersing agents are, for example, high molecular weight block copolymers with pigment affinic groups, highly branched polyesters, and acrylate polyester copolymers with pigment affinic groups. Preferably used dispersing additives are high molecular weight block copolymers with pigment affinic groups.

The coating materials may additionally contain up to 60, preferably 0.00001 through 50, particularly preferably 0.00001 through 40 wt.% functional fillers, wherein the indicated amounts respectively relate to the total amount of the coating material. Suitable fillers are, for example, carbonates like chalk, limestone, calcite, precipitated calcium carbonate, dolomite, barium carbonate, sulphates like barite, blanc fixe, calcium sulphate, silicates like talc, pyrophyllite, chlorite, hornblende, mica, china clay, wollastonite, powdered

slate, precipitated calcium silicates, precipitated aluminium silicates, precipitated calcium aluminium silicates, precipitated sodium aluminium silicates, feldspars, mullite, silicas like quartz, fused silica, cristobalite, diatomaceous earth, siliceous earth, precipitated silica, pumice powder, perlite, calcium metasilicate, fibres from melts of glass or basalts, glass powder, glass beads, and slags. The preferred fillers used are barium sulphate, calcium carbonate, and/or talc.

The coating materials according to the invention may additionally contain up to 10, preferably 0.00001 through 5, particularly preferably 0.00001 through 2 wt.% flow additives, wherein the indicated amounts respectively relate to the total amount of the coating material. Suitable flow additives are, for example, medium- to highly viscous polyacrylates with average molecular weight (i.e. mid-range molecular weight), silicones, modified silicones, fluorosurfactants, and low-volatile solvents with evaporation numbers from 150 through 200. Preferably used flow additives are silicones, modified silicones, and fluorosurfactants.

In another embodiment according to the invention, the coating materials contain up to 50, preferably 0.00001 through 40, particularly preferably 0.00001 through 30 wt.% aprotic solvents, wherein the indicated amounts respectively relate to the total amount of the coating material. The expression aprotic solvents is understood in the following to refer to solvents that contain no ionisable protons in the molecule. Suitable aprotic solvents are, for example, aliphatic hydrocarbons, cycloaliphatic hydrocarbons, aromatic hydrocarbons,

ketones, esters, ethers, ether esters, in particular, ethylacetate, butyl acetate, acetone, n-butanone, methyl isobutyl ketone, methoxypropyl acetate, and dimethyl sulfoxide. Preferably used solvents are ethylacetate, butyl acetate, acetone, n-butanone, methyl isobutyl ketone, methoxypropyl acetate, and mixtures thereof.

The compounds used as catalysts C according to the invention are latent bases, as the carbonate salt according to Formula II is in equilibrium with its disassociation products, carbon dioxide and the corresponding hydroxide- or alkoxy base. As long as carbon monoxide may not escape from the system, the equilibrium lies more strongly in favour of the carbonate salt. Only when a carbon dioxide is removed, and thus a sufficient amount of base is present, does the cross-linking begin with the aid of the Michael addition. With respect to storage of the coating materials according to the invention in closed containers, from which carbon dioxide may not escape, the coating material according to the invention may be basically formulated as a single component system. The shelf life may, however, be increased if the individual components of the coating material according to the invention are formulated in multicomponent systems. Thus, for example, a catalyst component, which contains the catalysts C, is only mixed shortly before processing with the binder components, which contain the CH acidic compounds A and the vinylogous carbonyl compounds B.

According to the invention, the CH acidic compounds A and the vinylogous carbonyl compounds B may be contained in a binder component together with the light stabilizers,

open time extenders, and pot life extenders used. This binder component may additionally contain pigments, fillers, additionally other additives, and solvents. The catalysts C and, if necessary, additional solvents and pot life extenders, may be contained in a catalyst component. In one preferred embodiment, the CH acidic compounds A may be present in a first binder component, the vinylogous carbonyl compounds B in a second binder component, and the catalysts C in a catalyst component. In one such three-component system, the CH acidic compounds A are contained in the first binder component together with the open time extenders and light stabilizers. If necessary, this first binder component may additionally contain pigments and fillers, and additional additives. The vinylogous carbonyl compounds B are preferably contained in the second binder component. Furthermore, the second binder component may also contain pigments, fillers, and additional additives. The catalysts C are contained in the catalyst component. Furthermore, the catalyst component may contain solvents and pot life extenders.

It is known that the addition of additional components, which are customary for producing a coating, reduces the shelf life of RMA systems. The coating materials according to the invention with their particular selection of light stabilizers, open time extenders, pot life extenders, pigments, matting agents, dispersing agents, flow additives, functional fillers, and aprotic solvents have an unexpectedly high shelf life in comparison to previously known coating materials based on RMA systems.

Furthermore, the properties of coatings, which are produced from coating materials based on RMA systems, are strongly compromised by the presence of other components of the coating material, in contrast to coatings which are produced from coating materials based on conventional binders, for example, epoxy resins or polyurethanes. It has been surprisingly demonstrated that the coating materials according to the invention result in coatings which have the properties necessary for use for components of wind turbines, like rotor blades, in particular weathering stability, low-temperature elasticity, abrasion resistance, and resistance to erosion caused by rain or sand.

In one particularly preferred embodiment, the coating materials according to the invention comprise at least:

- 10 through 70, preferably 16 through 60, particularly preferably 20 through 55 wt.% of CH acidic compounds A, for example, malonic acid esters with oligomer and polymer substituents based on polyesters, which are obtained from the reaction of at least malonic acid, malonic acid dimethyl ester, and/or malonic acid diethyl ester with hexahydrophthalic acid and/or its anhydride and neopentyl glycol, and acetoacetic acid esters with oligomer and polymer substituents based on polyesters, which are obtained from the reaction of at least acetoacetic acid, acetoacetic acid methyl ester, and/or acetoacetic acid ethyl ester with hexahydrophthalic acid and/or its anhydride and neopentyl glycol,
- 4 through 40, preferably 8 through 35, particularly preferably 10 through 30 wt.% vinylogous carbonyl compounds B, for example, butanediol diacrylate,

hexanediol diacrylate, trimethylolpropane triacrylate, pentaerythritol tetraacrylate, di(trimethylolpropane)tetraacrylate, and/or dipentaerythritol-hexaacrylate,

- 0.1 through 15, preferably 0.2 through 10, particularly preferably 0.3 through 5 wt.% catalysts C, for example, tetrabutylammonium methyl carbonate, tetrabutylammonium ethyl carbonate, tetrabutylammonium hydrogen carbonate, tetrapropylammonium methyl carbonate, tetrapropylammonium ethyl carbonate, tetrapropylammonium hydrogen carbonate, and mixtures thereof,
- 0.00001 through 10, preferably 0.5 through 5, particularly preferably 1 through 3 wt.% light stabilizers, for example, substituted 2,2,6,6-tetramethylpiperidines, 2-hydroxyphenyltriazines, 2-hydroxybenzophenones, and mixtures thereof,
- 0.00001 through 20, preferably 0.01 through 10, particularly preferably 0.1 through 5 wt.% open time extenders, for example, succinimides, 1,2,4,-triazoles, 1,2,3,-benzotriazoles, and mixtures thereof,
- 0.00001 through 20, preferably 0.01 through 15, particularly preferably 0.1 through 10 wt.% pot life extenders, for example, methanol, ethanol, n-propanol, i-propanol, n-butanol, i-butanol, and mixtures thereof,
- 0.00001 through 70, preferably 10 through 65, particularly preferably 15 through 40 wt.% inorganic and/or organic pigments, for example, titanium dioxide, iron oxides, carbon blacks, pigment yellow 151, pigment orange 67, pigment red 170, pigment violet 19, pigment blue 15:3, pigment green 7, and mixtures thereof,
- 0.00001 through 25, preferably 1 through 25, particularly preferably 5 through 20, more particularly

preferably 8 through 15 wt.% matting agents, for example, micronized and precipitated polyethylene waxes, polypropylene waxes, polyamide waxes, PTFE waxes, and micronized urea aldehyde resin, and mixtures thereof,

- 0 through 25, preferably 0.00001 through 8, particularly preferably 0.00001 through 5 wt.% dispersing additives, for example, high molecular weight block copolymers with pigment affinic groups,
- 0 through 10, preferably 0.00001 through 5, particularly preferably 0.00001 through 2 wt.% flow additives, silicones, modified silicones, and fluorosurfactants,
- 0 through 60, preferably 0.00001 through 40, particularly preferably 0.00001 through 30 wt.% functional fillers, for example, barium sulphate, calcium carbonate, and/or talc, and
- 0 through 50, preferably 0.00001 through 40, particularly preferably 0.00001 through 30 wt.% aprotic solvents, for example, ethylacetate, butyl acetate, acetone, n-butanone, methyl isobutyl ketone, methoxypropyl acetate, and mixtures thereof,

wherein the indicated amounts respectively relate to the total amount of the coating material.

The coating materials according to the invention may be used to produce flexible coatings, for example, for coating rotor blades of wind turbines. The coating materials according to the invention have a surprisingly higher shelf life in comparison to previously known RMA coating materials and RMA coatings. They also show improved drying behaviour. The coatings obtained from the coating materials according to the invention additionally

have an improved light stability, in particular less yellowing and higher gloss retention.

The coating materials according to the invention have pot lives greater than or equal to 1 hour, preferably greater than or equal to 2 hours, particularly preferably between 2 and 4 hours. The pot life is generally determined via the flow time from a flow cup. The end of the pot life is determined as the point at which the flow time shows double the value of the starting flow time. The testing method is described below in detail in the Examples. Furthermore, the coating materials according to the invention demonstrate open times of greater than or equal to 15 minutes, preferably greater than or equal to 20 minutes, particularly preferably greater than or equal to 25 minutes. In addition to the long pot lives and open times, the coating materials according to the invention surprisingly demonstrate an unusually broad climate window in which they may be processed without deterioration. They are processable, for example, at temperatures up to 45°C and at relative air humidity of up to 99%. In addition, they demonstrate a long overspray absorption, for example, over a time interval of more than 15 minutes. In contrast to conventionally used coating materials based on polyurethane, the coating materials according to the invention have significantly reduced drying times.

In one preferred embodiment, the coating materials according to the invention are used to produce a topcoat for substrates made from fibre reinforced plastic materials. Components made from fibre reinforced plastic materials must be sufficiently weather resistant, i.e.,

resistant to UV radiation and moisture, for use in exterior areas. Therefore, components in exterior areas, for example, rotor blades for wind turbines, are generally protected through the application of a corresponding topcoat. Topcoats for rotor blades must additionally be sufficiently flexible and sufficiently strong at ambient temperatures between -40 through +60°C in order to prevent or at least reduce erosion effects caused by dust, ice particles, or rain drops. The coatings according to the invention have the necessary low-temperature elasticities, abrasion resistances, and resistances to erosion caused by rain or sand, in addition to high weathering stability.

Due to their properties, the coating materials according to the invention are suitable primarily for a use for coating large components. They are used in particular for coating large surface area components made from fibre reinforced plastic substrates, as are used, for example, to construct rotor blades in wind turbines.

The present invention also relates to a method for coating components. The method according to the invention thereby comprises the steps: (a) applying the coating material according to the invention to a surface of a substrate, and (b) curing the applied coating material for 0.5 through 12, preferably 1 through 6, particularly preferably 1 through 4 hours at temperatures between 5 and 45, preferably 15 and 40, particularly preferably 20 and 35°C.

The coating materials according to the invention have an above-average high solids content and correspondingly

contain low proportions of volatile organic substances, for example, solvents. The solids content is defined as the proportion by mass of a coating material that remains as residue after 30 minutes during evaporation at 105°C. Essentially, the solids generally comprise binders, non-volatile additives, pigments, and fillers. The solids content of the coating materials according to the invention lie between 65 and 95, preferably 70 and 90, particularly preferably between 75 and 85 wt.%, relative to the total weight of the coating materials.

Coating materials with high solids contents are usually poorly processable using conventional spraying methods. In contrast, the coating materials according to the invention are easily applied with the aid of hydraulic very high pressure spraying (airless), airless spraying with air support (airmix), and with the aid of pneumatic spraying or compressed air spraying. High quality surfaces are surprisingly obtained even using these application methods. Airless and airmix spraying methods and application by means of a roller are particularly suitable according to the invention.

Components made from fibre reinforced plastic materials usually have very rough surfaces that must be smoothed prior to coating, for example, by filling in or grinding the surface. These pre-treatment methods are known and familiar to the person skilled in the art. The coatings according to the invention are usually applied to a thus pre-treated surface. They may thereby be applied with a high coating thickness such that the cured coating shows no impairment to its surface quality even in the case of insufficiently pre-treated substrate surfaces. The

coatings according to the invention may thereby have dry coating thicknesses between 80 and 150 µm.

In another embodiment of the method, all components of the coating material used are mixed prior to application. The mixing may thereby be carried out manually or by machine. In another embodiment, a coating system may be produced with at least one additional coating, in that additional coating materials are applied and cured on the first coating. This second coating may thereby also be only partially applied in order to generate colour patterns, like glow-in-the-dark warning strips, or particularly reinforcements, like an edge protection.

Since the coating materials according to the invention may be cured at room temperature, they are suitable primarily for coating large components, like rotor blades of wind turbines. In currently operating wind turbines, rotor blades with blade lengths up to 65 meters are used in onshore applications, and up to 85 meters in offshore applications.

Examples

The production of the coating materials is carried out according to coating technology standards, which are known and familiar to the person skilled in the art. The catalyst solution used in Example Recipe 1 is produced in that 42.8 g diethyl carbonate and 26.1 g i-propanol are added to a solution of 17.1 g tetrabutylammonium hydroxide in 14 g water.

Example Recipe 1: Topcoat

Substance	**Amount [wt.%]**
Filler component 1	
Malonate functional polyester with a concentration of acidic protons of 5.66 mol/kg relative to the solvent-free polyester, 85% in butyl acetate.	27
Titanium dioxide	25
High molecular weight block copolymer with pigment affinic groups	1
Bis(1,2,2,6,6-pentamethyl-4-piperidinyl)-sebacate	1
Succinimide	0.8
Butyl acetate	11
Polyester modified polydimethylsiloxane	0.2
Micronized urea aldehyde resin	11
Filler component 2	
Di(trimethylolpropane)tetraacrylate	11
Hexanediol diacrylate	4
Catalyst component	
Catalyst solution	3
Ethanol	3
Methyl ethyl ketone	2

To evaluate the shelf life of the coating materials, the pot life and the drying time of Example Recipe 1 were determined. Samples were thereby tested or used to produce a coating after 1 day of storage at 23°C, after 28 days of storage at 40°C, and after 1 year of storage at 20 through 23°C respectively.

Determination of pot life: The pot life is determined using a flow cup. In this method, a liquid is filled into a cup with a defined volume, which has a defined nozzle in its bottom. The coating material runs out through the nozzle, wherein the time from the discharge of the liquid jet up until the liquid jet breaks off is measured as the flow time. All preparations and measurements are carried out at a temperature of 23°C. Initially, all components of the coating material are mixed and the flow time of the mixture is immediately measured (initial flow time). The measurement is repeated at regular intervals. The end of the pot life is reached when the flow time is double the initial flow time.

Determination of drying time: To determine the drying time, a drying time recorder, a drying time measurement device from BYK Gardner, is used. For this purpose, the coating material to be examined is uniformly applied on glass strips with the aid of a film drawer. The glass strips are subsequently laid in a linear recorder. Needles are then applied to the coating and drawn across the drying film at a defined, constant speed. A characteristic drying image of the coating is thereby created, in which the individual time segments show the different curing states: flow or open time, initial trace, film tearing, and surface track. The curing of the

coating material thereby begins at the end of the open time, i.e., at the point at which the track etched by the needle remains visible in the applied film. It ends with the surface track, i.e., at the time at which the needle no longer leaves a visible track in the applied film.

The quality of the coatings which are produced from the differently stored coating materials from Example Recipe 1 was also examined to determine shelf life of the coating material. For this purpose, elongation at rupture and weathering stability were determined. Samples were used to produce a coating after 1 day of storage at 23°C, after 28 days of storage at 40°C, and after 1 year of storage at 20 through 23°C respectively. To produce the sample bodies, Example Recipe 1 was applied to primed aluminium plates using cup guns and cured at room temperature.

Determination of elongation at break: The elongation at break is determined using the cylindrical mandrel bend test. The sample bodies are bent around a mandrel for this purpose. The smaller the radius of the mandrel, around which the plate may be bent without damaging or breaking the coating, the greater the elongation at break of the coating. The diameter of the mandrel is indicated as the measured value.

Determination of weathering stability: To evaluate the weathering stability of the coatings, the change in the colour (ΔE) and the change in the gloss value (residual gloss value) are used. For this purpose, the colour and gloss of the sample bodies are initially determined. The sample bodies are subsequently exposed to artificial

weathering, which simulates weather conditions through the cyclical application of radiation, moisture, and increased temperatures. The test cycle, made of a drying phase and a condensation phase, is repeated for 500 hours. In the drying phase of the test cycle, the sample bodies are irradiated at a black panel temperature of 60ºC for 4 hours using a QUV-B (313) lamp; in the subsequent condensation phase, the water vapour condenses on the sample bodies for 4 hours at a black panel temperature of 50ºC. After the weathering, the colour and gloss of the sample bodies are determined again. The colour changes of the coatings were determined using the CIELab system and indicated as ΔE values. The changes in gloss are indicated as residual gloss values. For this purpose, the gloss of the coating surface was determined as a reflectometer value. The reflectometer value of a sample is defined as the ratio of the light beams reflected by the sample surface and a glass surface with a refractive index of 1,567 in the mirror direction. The measurement values are determined with the aid of a conventional refractometer at an angle of 60º. The difference of the reflector values of the sample bodies prior to the weather and after the weathering are provided as the residual gloss values, normalized to the reflector value prior to the weathering.

Table: Shelf life of Example Recipe 1

Storage	1 day, 23°C	28 days, 40°C	1 year, 20 - 23°C
Pot life	3 h	3 h	3 h
Open time	16 min	17 min	15 min
Surface track ends	45 min	43 min	47 min
Elongation at rupture	20 mm	20 mm	20 mm
Colour change (ΔE)	0.28	0.26	0.30
Residual gloss value	96%	96%	97%

As the table shows, the coating materials according to the invention have a high shelf life. After longer storage at increased temperatures, the coating materials themselves do not demonstrate a deterioration in their processability. The coatings produced therefrom also show no impairment to their properties.

CLAIMS:

1. A coating material for producing a coating having at least

15 to 70 wt.% of one or more CH acidic compounds A,

4 to 40 wt.% of one or more vinylogous carbonyl compounds B,

0.1 to 15 wt.% of one or more latent-basic catalysts C,

0.00001 to 10 wt.% of one or more light stabilizers,

0.00001 to 20 wt.% of one or more open time extenders,

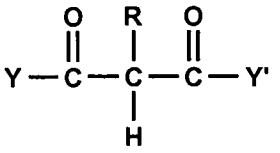
0.00001 to 20 wt.% of one or more pot life extenders,

0.00001 to 70 wt.% of one or more inorganic and/or organic pigments, and

0.00001 to 25 wt.% of one or more matting agents,

wherein each wt.% is based on the total amount of the coating material,

wherein the CH acidic compounds A are compounds of the general Formula I



wherein

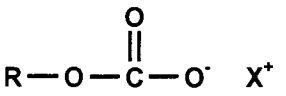
R is hydrogen, an alkyl- or aryl radical,

Y is an alkyl-, aralkyl-, aryl-, alkoxy radical or an amino group, and

Y' is an alkyl-, aralkyl-, aryl-, alkoxy radical or an amino group,

wherein the vinylogous compounds B are acrylates and/or maleates, and

wherein the latent-basic catalysts C are substituted carboxylic acid salts of the Formula



wherein

R is hydrogen, an alkyl- or aralkyl-, or a polymer radical,

X^+ is an alkali or an alkaline earth metal cation, a quaternary ammonium- or phosphonium salt of the formula $(R')_4Z+$,

wherein

Z is nitrogen or phosphorus, and

R' is the same or different, is hydrogen, an alkyl-, aryl-, or aralkyl radical, or a polymer.

2. The coating material according to claim 1, wherein the light stabilizers are selected from the group consisting of radial scavengers, UV absorbers, quenchers, and peroxide decomposers.

3. The coating material according to claim 1 or 2, wherein the pot life extenders are selected from the group consisting of alcohols which have up to 6 carbon atoms and an evaporation number below 35.

4. The coating material according to any one of claims 1 to 3, wherein the open time extenders are selected from the group

consisting of basic NH-functional compounds with a pK_a value between 4 and 14.

5. The coating material according to any one of claims 1 to 4, wherein the pigments are selected from the group consisting of titanium dioxide, iron oxides, chromium oxides, chromium titanates, bismuth vanadate, cobalt blue, carbon blacks, pigment yellow 151, pigment yellow 213, pigment yellow 83, pigment orange 67, pigment orange 62, pigment orange 36, pigment red 170, pigment violet 19, pigment violet 23, pigment blue 15:3, pigment blue 15:6, and pigment green 7.

6. The coating material according to any one of claims 1 to 5, wherein the matting agents are selected from the group consisting of silica gels, precipitated silicas, micronized waxes, precipitated waxes, and micronized polymers.

7. The coating material according to any one of claims 1 to 6, which further comprises up to 25 wt.% of one or more dispersing additives.

8. The coating material according to claim 7, wherein the dispersing additives are selected from the group consisting of block copolymers with pigment affinic groups, branched polyesters, and acrylate polyester copolymers with pigment affinic groups.

9. The coating material according to any one of claims 1 to 8, which further comprises up to 60 wt.% of one or more functional fillers.

10. The coating material according to claim 9, wherein the one or more functional fillers are selected from the group consisting of carbonates, sulphates, silicates, and silicas.

11. The coating material according to any one of claims 1 to 10, which further comprises up to 50 wt.% of one or more aprotic solvents.

12. The coating material according to claim 11, wherein the one or more aprotic solvents are selected from the group consisting of aliphatic hydrocarbons, cycloaliphatic hydrocarbons, aromatic hydrocarbons, ketones, esters, ethers, and ether esters.

13. The coating material according to claim 12, wherein the one or more aprotic solvents are selected from the group consisting of ethyl acetate, butyl acetate, acetone, n-butanone, methyl isobutyl ketone, methoxypropyl acetate, and dimethyl sulfoxide.

14. The coating material according to any one of claims 1 to 13, which further comprises up to 10 wt.% of one or more flow additives.

15. The coating material according to claim 14, wherein the one or more flow additives are selected from the group consisting of polyacrylates, silicones, modified silicones, fluorosurfactants, and low-volatile solvents with evaporation numbers from 150 to 200.

16. A use of the coating material as defined in any one of claims 1 to 15 for producing at least one coating.

17. The use according to claim 16, wherein the at least one coating comprises a topcoat.

18. A method for coating a component comprising (a) applying the coating material as defined in any one of claims 1 to 15 to a substrate, and (b) curing the applied coating material for 0.5 to 12 hours at temperatures between 5 and 45°C.

19. The method according to claim 18, wherein the coating material is applied by means of hydraulic spraying methods, pneumatic spraying methods, compressed air spraying methods, or with the aid of rollers.

20. The method according to claim 18 or 19, wherein all components of the coating material are mixed prior to step (a).

21. A component coated with at least one coating produced from the coating material as defined in any one of claims 1 to 15.

22. The component according to claim 21, which is a rotor blade of a wind turbine.