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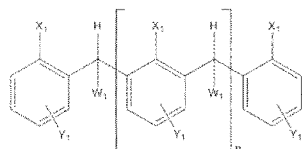
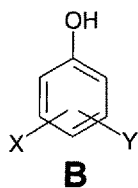
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(54) Title: CURING AGENT AND COATING COMPOSITION



(57) Abstract: The invention pertains to a curing agent comprising (a) one or more fatty amine selected from the group consisting of an alkylated polyamine, bisalkylated amine, alkylated primary amine, an alkoxyated polyamine, bisalkoxyated amine and alkoxyated primary amine; and (b) a substituted phenol having formula (B): (B) wherein X and Y are individually selected from the group of COOH, carboxylate, OH, NH₂, NO₂, SO₃H, PO₃H, Cl, F, B, I, alkyl, alkenyl, COOR, OR, COR and aldehyde, and/or a substituted phenyl having formula (B1): (B1) wherein n is a number from 0 to 1000, X₁ is selected from hydrogen, hydroxyl and carboxylic acid, and Y₁ is selected from hydrogen, alkyl, alkenyl, alkynyl, aryl, substituted alkyls, substituted alkenyl, substituted alkynyl, substituted aryls, polycyclic aromatics, substituted polycyclic aromatics, polar functional groups, such as alcohol, amines, ketones, aldehydes, ethers, carboxylic acids, sulfonates, sulfonic acids, phosphonic acids and heterocyclics; and W₁ is independently selected from hydrogen, alkyl, alkenyl, alkynyl, aryl, substituted alkyl, substituted alkenyl, substituted alkynyl, substituted aryls, polycyclic aromatics, substituted polycyclic aromatics, polar functional groups, such as alcohol, amines, ketones, aldehydes, amides, esters, carbonyls, epoxies, oxetanes, oxiranes, ethers, carboxylic acids, sulfonates, sulfonic acids, phosphonic acids and heterocyclics; and a low temperature cure agent; wherein the molar ratio of the alkylated polyamine and the substituted phenol and/or the substituted phenyl is at least 0.2 and at most 5.



Curing Agent and Coating Composition

The present invention relates to curing agents, coating compositions, coated substrates and processes for preparing the coated substrate.

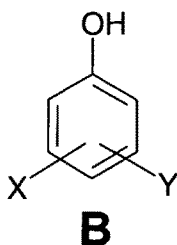
Curing agents for epoxy coating compositions are well known in the art. A specific curing agent is disclosed in WO 2012/177121, in which fatty (poly)amines are liquefied upon mixing with a substituted phenol. The fatty (poly)amines interact with the substituted phenol to form a novel curing agent which is stable and highly reactive. The epoxy resins cured with this curing agent further exhibit good properties like good chemical resistance. These properties of the novel cured epoxy coatings are described in WO 2012/177120. The curing agents disclosed in these patent publications are very reactive which generally reveals a short pot life. Also tuning of the cure speed as well as performing the curing at low temperature (preferably below 10 °C) is a challenge.

The objective of the present invention is to provide novel curing agents.

The present invention pertains to a curing agent comprising (a) one or more fatty amines selected from the group consisting of an alkylated polyamine, bisalkylated amine, alkylated primary amine, an alkoxyated polyamine, bisalkoxyated amine and alkoxyated primary amine; and

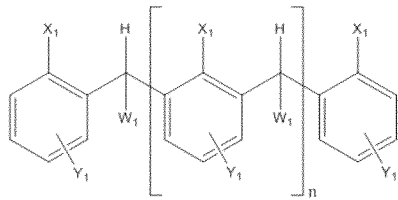
(b) a substituted phenol having formula (B):

20



wherein X and Y are individually selected from the group of COOH, carboxylate, OH, NH₂, NO₂, SO₃H, PO₃H, Cl, F, B, I, alkyl, alkenyl, COOR, OR, COR and aldehyde, and/or a substituted phenyl having formula (B1):

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(B1)

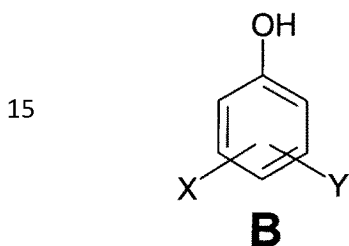
wherein n is a number from 0 to 1000, X₁ is selected from hydrogen, hydroxyl and carboxylic acid, and Y₁ is selected from hydrogen, alkyl, alkenyl, alkynyl, aryl, substituted alkyls, substituted alkenyl, substituted alkynyl, substituted aryls, polycyclic aromatics, substituted polycyclic aromatics, polar functional groups, such as alcohol, amines, ketones, aldehydes, ethers, carboxylic acids, sulfonates, sulfonic acids, phosphonic acids and heterocyclics; and W₁ is independently selected from hydrogen, alkyl, alkenyl, alkynyl, aryl, substituted alkyl, substituted alkenyl, substituted alkynyl, substituted aryls, polycyclic aromatics, substituted polycyclic aromatics, polar functional groups, such as alcohol, amines, ketones, aldehydes, amides, esters, carbonyls, epoxies, oxetanes, oxiranes, ethers, carboxylic acids, sulfonates, sulfonic acids, phosphonic acids and heterocyclics; and

(c) a low temperature cure agent;

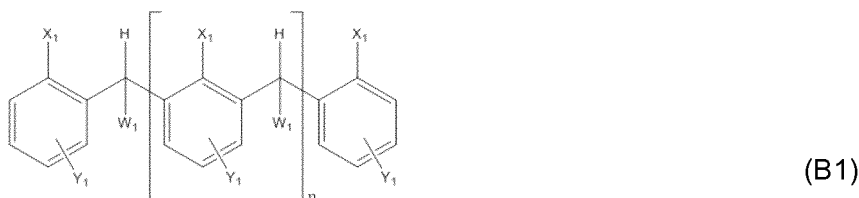
wherein the molar ratio of the fatty amine and the substituted phenol and/or the substituted phenyl is at least 0.2 and at most 5. In the context of the present application, the term “heterocyclics” refers to a cyclic structure which has at least one heteroatom in its ring; a heteroatom can be N, P, S or O, for instance. The fatty amine and the substituted phenol and/or phenyl combine to form a liquid curing agent which is liquid at low temperatures e.g. 5°C, in particular liquid at temperatures where the fatty amine is solid, i.e. below the melting point of the fatty amine. The liquid curing agent is moreover compatible with cationically polymerizable building blocks like epoxy resins, and is capable of curing these building blocks. The film forming properties of coating compositions comprising the curing agent and the cationically polymerizable building blocks is generally good, with good wetting properties, and generally spreads well over a wide variety of surfaces, even surfaces that have aged, are rusty or unclean. The resulting cured coating has generally very good chemical resistance, corrosion resistance, scratch resistance and good adhesion to a wide variety of surfaces. The low temperature cure agent of the invention enables curing at low temperatures, even at temperatures as low as 5°C or below. The cure speed is furthermore relatively fast as generally within 24 hours tack free coatings are obtained.

In one embodiment of the invention, the curing agent comprises the fatty amine in an amount of at least 50 % by weight (wt%), based on the total weight of the curing agent. Preferably, the fatty amine is present in an amount of at least 55 wt%, more preferably at least 60 wt%, even more preferably at least 65 wt% and most preferably at least 70 wt%, and preferably at most 99 wt%, more preferably at most 95 wt%, even more preferably at most 90 wt% and most preferably at most 80 wt%, based on the total weight of the curing agent.

The present invention further pertains to a curing agent comprising an alkylated polyamine having the formula $R_1-N((CH_2)_x-N)_n-(CH_2)_x-NH_2$, wherein R_1 is selected from the group consisting of linear or branched C_6-C_{50} alkyl, linear or branched C_6-C_{50} alkenyl, linear or branched C_6-C_{50} arylalkyl and linear or branched C_6-C_{50} alkylaryl, x is 2 to 5, and n is 0 to 10; a substituted phenol having formula (B):



wherein X and Y are individually selected from the group of $COOH$, carboxylate, OH , NH_2 , NO_2 , SO_3H , PO_3H , Cl , F , B , I , alkyl, alkenyl, $COOR$, OR , COR and aldehyde, and/or a substituted phenyl having formula (B1):



wherein n is a number from 0 to 1000, X_1 is selected from hydrogen, hydroxyl and carboxylic acid, and Y_1 is selected from hydrogen, alkyl, alkenyl, alkynyl, aryl, substituted alkyls, substituted alkenyl, substituted alkynyl, substituted aryls, polycyclic aromatics, substituted polycyclic aromatics, polar functional groups, such as alcohol, amines, ketones, aldehydes, ethers, carboxylic acids, sulfonates, sulfonic acids, phosphonic acids and heterocyclics; and W_1 is independently selected from hydrogen, alkyl, alkenyl, alkynyl, aryl, substituted alkyl, substituted alkenyl, substituted alkynyl, substituted aryls, polycyclic aromatics, substituted

polycyclic aromatics, polar functional groups, such as alcohol, amines, ketones, aldehydes, amides, esters, carbonyls, epoxies, oxetanes, oxiranes, ethers, carboxylic acids, sulfonates, sulfonic acids, phosphonic acids and heterocyclics; and a low temperature cure agent;

5 wherein the molar ratio of the alkylated polyamine and the substituted phenol and/or the substituted phenyl is at least 0.2 and at most 5.

The alkylated polyamine of the invention may be any alkylated polyamine known in the art. The number of amino groups may vary; the value for n is generally from 0 to 10. Preferably, n is from 0 to 5, more preferably n is from 0 to 2, and most preferably n is 0 or 1.

10 The amino groups are connected via linear alkyl $((\text{CH}_2)_x)$, branched alkyl $((\text{CH}_2)_x)$, alkylaryl $((\text{CH}_2)_x(\text{aryl}))$, poly(aryl), alkylene or poly(alkylene) groups, and x is 2 to 5. Preferably, the amino groups are connected via linear alkyl $((\text{CH}_2)_x)$, branched alkyl $((\text{CH}_2)_m)$, alkylene or poly(alkylene) groups, more preferably the amino groups are connected via linear alkyl $((\text{CH}_2)_x)$, branched alkyl $((\text{CH}_2)_x)$, alkylene or poly(alkylene) groups and most preferably the amino groups
15 are connected via linear alkyl $((\text{CH}_2)_x)$. Preferably, x is from 2 to 4, more preferably x is from 2 to 3, and most preferably x is 3.

The R_1 substituent in the alkylated polyamine is selected from the group of linear or branched C_6 - C_{50} alkyl, linear or branched C_6 - C_{50} alkenyl, linear or branched C_6 - C_{50} arylalkyl and linear or branched C_6 - C_{50} alkylaryl. Preferably, the R_1 substituent is selected from the group of linear or
20 branched C_6 - C_{50} alkyl and linear or branched C_6 - C_{50} alkenyl. More preferably, the R_1 substituent is linear or branched C_6 - C_{50} alkyl. Preferably, the R_1 substituent in the alkylated polyamine is a C_6 - C_{50} alkyl. Preferably, the R_1 substituent is a C_6 - C_{30} alkyl, more preferably R_1 is a C_6 - C_{24} alkyl, even more preferably R_1 is C_8 - C_{18} alkyl.

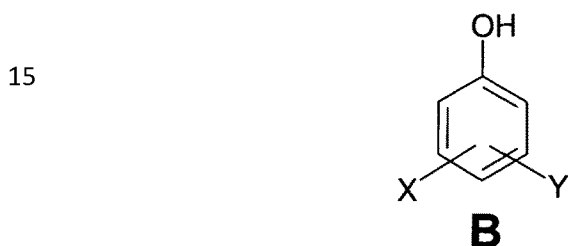
Examples of alkylated polyamines include propylene diamines such as coco propylene diamine,
25 oleyl propylene diamine, arachidyl behenyl propylene diamine, soya propylene diamine, (partially) hydrogenated tallow propylene diamine, N,N,N'-trimethyl-N'-tallow propylene diamine and tallow propylene diamine; dipropylene triamines such as dodecyl dipropylene triamine, oleyl dipropylene triamine, octyl dipropylene triamine, stearyl dipropylene triamine and tallow dipropylene triamine and other polyamines such as N-tallowalkyl dipropylene tetramine, N-
30 tallowalkyl tripropylene triamine, N-(3-aminopropyl)-N-cocoalkyl propylene diamine, N-(3-aminopropyl)-N-tallowalkyl propylene diamine, N-(3-aminopropyl)-N-cocoalkyl

trimethylenediamine, N-(3-aminopropyl)-N-tallowalkyl trimethylenediamine and dendrimers containing propylene diamines.

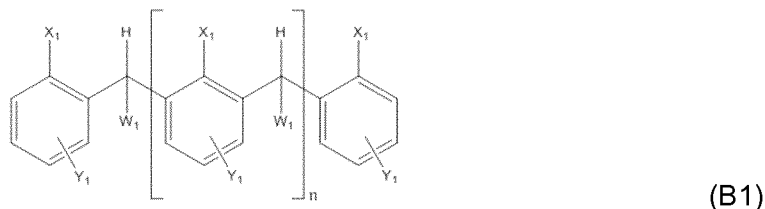
In one embodiment of the invention, the curing agent comprises the alkylated polyamine in an amount of at least 50 % by weight (wt%), based on the total weight of the curing agent.

5 Preferably, the alkylated polyamine is present in an amount of at least 55 wt%, more preferably at least 60 wt%, even more preferably at least 65 wt% and most preferably at least 70 wt%, and preferably at most 99 wt%, more preferably at most 95 wt%, even more preferably at most 90 wt% and most preferably at most 80 wt%, based on the total weight of the curing agent.

The invention further pertains to a curing agent comprising a bisalkylated amine having the
 10 formula R_2-NH-R_3 , wherein R_2 and R_3 are individually selected from the group consisting of linear or branched C_6-C_{50} alkyl, linear or branched C_6-C_{50} alkenyl, linear or branched C_6-C_{50} arylalkyl and linear or branched C_6-C_{50} alkylaryl; and a substituted phenol having formula (B):



wherein X and Y are individually selected from the group of COOH, carboxylate, OH, NH_2 , NO_2 , SO_3H , PO_3H , Cl, F, B, I, alkyl, alkenyl, COOR, OR, COR and aldehyde, and/or
 20 a substituted phenyl having formula (B1):



wherein n is a number from 0 to 1000, X_1 is selected from hydrogen, hydroxyl and carboxylic
 25 acid, and Y_1 is selected from hydrogen, alkyl, alkenyl, alkynyl, aryl, substituted alkyls, substituted alkenyl, substituted alkynyl, substituted aryls, polycyclic aromatics, substituted polycyclic aromatics, polar functional groups, such as alcohol, amines, ketones, aldehydes, ethers, carboxylic acids, sulfonates, sulfonic acids, phosphonic acids and heterocyclics; and

W₁ is independently selected from hydrogen, alkyl, alkenyl, alkynyl, aryl, substituted alkyl, substituted alkenyl, substituted alkynyl, substituted aryls, polycyclic aromatics, substituted polycyclic aromatics, polar functional groups, such as alcohol, amines, ketones, aldehydes, amides, esters, carbonyls, epoxies, oxetanes, oxiranes, ethers, carboxylic acids, sulfonates, sulfonic acids, phosphonic acids and heterocyclics; and
5 a low temperature cure agent;
wherein the molar ratio of the bisalkylated amine and the substituted phenol and/or the substituted phenyl is at least 0.2 and at most 5.

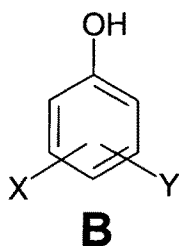
10 The R₂ and R₃ substituents in the alkylated polyamine are individually selected from the group of linear or branched C₆-C₅₀ alkyl, linear or branched C₆-C₅₀ alkenyl, linear or branched C₆-C₅₀ arylalkyl and linear or branched C₆-C₅₀ alkylaryl. Preferably, the R₂ and R₃ substituents are individually selected from the group of linear or branched C₆-C₅₀ alkyl and linear or branched C₆-C₅₀ alkenyl. More preferably, the R₂ and R₃ substituents are individually linear or branched C₆-C₅₀ alkyl. Preferably, the R₂ and R₃ substituents are individually a C₆-C₃₀ alkyl, more preferably R₂ and R₃ substituents are individually a C₆-C₂₄ alkyl, even more preferably R₂ and R₃ substituents are individually C₈-C₁₈ alkyl.

Examples of bisalkylated amines include di(dodecyl) amine, di(oleyl) amine, di(arachidyl behenyl) amine, di(tallow) amine, di(octyl) amine, di(stearyl) amine and di(coco) amine.
20

In one embodiment of the invention, the curing agent comprises the bisalkylated amine in an amount of at least 50 % by weight (wt%), based on the total weight of the curing agent. Preferably, the bisalkylated amine is present in an amount of at least 55 wt%, more preferably at least 60 wt%, even more preferably at least 65 wt% and most preferably at least 70 wt%, and preferably at most 99 wt%, more preferably at most 95 wt%, even more preferably at most 90 wt% and most preferably at most 80 wt%, based on the total weight of the curing agent.
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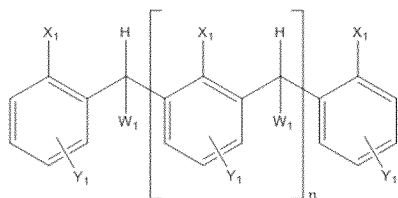
The invention further pertains to a curing agent comprising an alkylated primary amine having the formula R₄-NH₂, wherein R₄ is selected from the group consisting of linear or branched C₆-C₅₀ alkyl, linear or branched C₆-C₅₀ alkenyl, linear or branched C₆-C₅₀ arylalkyl and linear or branched C₆-C₅₀ alkylaryl; and
30

a substituted phenol having formula (B):



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wherein X and Y are individually selected from the group of COOH, carboxylate, OH, NH₂, NO₂, SO₃H, PO₃H, Cl, F, B, I, alkyl, alkenyl, COOR, OR, COR and aldehyde, and/or a substituted phenyl having formula (B1):



(B1)

- 10 wherein n is a number from 0 to 1000, X₁ is selected from hydrogen, hydroxyl and carboxylic acid, and Y₁ is selected from hydrogen, alkyl, alkenyl, alkynyl, aryl, substituted alkyls, substituted alkenyl, substituted alkynyl, substituted aryls, polycyclic aromatics, substituted polycyclic aromatics, polar functional groups, such as alcohol, amines, ketones, aldehydes, ethers, carboxylic acids, sulfonates, sulfonic acids, phosphonic acids and heterocyclics; and
- 15 W₁ is independently selected from hydrogen, alkyl, alkenyl, alkynyl, aryl, substituted alkyl, substituted alkenyl, substituted alkynyl, substituted aryls, polycyclic aromatics, substituted polycyclic aromatics, polar functional groups, such as alcohol, amines, ketones, aldehydes, amides, esters, carbonyls, epoxies, oxetanes, oxiranes, ethers, carboxylic acids, sulfonates, sulfonic acids, phosphonic acids and heterocyclics; and
- 20 a low temperature cure agent;
- wherein the molar ratio of the alkylated primary amine and the substituted phenol and/or the substituted phenyl is at least 0.2 and at most 5.

- The R₄ substituent in the alkylated primary amine is selected from the group of linear or
- 25 branched C₆-C₅₀ alkyl, linear or branched C₆-C₅₀ alkenyl, linear or branched C₆-C₅₀ arylalkyl and linear or branched C₆-C₅₀ alkylaryl. Preferably, the R₄ substituent is selected from the group of linear or branched C₆-C₅₀ alkyl and linear or branched C₆-C₅₀ alkenyl. More preferably, the R₄

substituent is linear or branched C₆-C₅₀ alkyl. Preferably, the R₄ substituent in the alkylated polyamine is a C₆-C₅₀ alkyl. Preferably, the R₄ substituent is a C₆-C₃₀ alkyl, more preferably R₄ is a C₆-C₂₄ alkyl, even more preferably R₄ is C₈-C₁₈ alkyl.

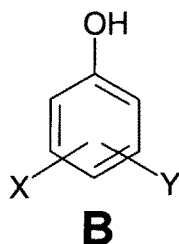
- 5 Examples of alkylated primary amines include dodecyl amine, oleyl amine, hexadecyl amine, arachidyl behenyl amine, hydrogenated tallowalkyl amine, tallowalkyl amine, rapeseedalkyl amine, hydrogenated rapeseedalkyl amine, soyaalkyl amine, octyl amine, octadecyl amine, stearyl amine and coco amine.

10 In the context of this application, the wording "primary amine" refers to a fatty amine comprising at least one primary amine (-NH₂) group.

In one embodiment of the invention, the curing agent comprises the alkylated primary amine in an amount of at least 50 % by weight (wt%), based on the total weight of the curing agent. Preferably, the alkylated primary amine is present in an amount of at least 55 wt%, more preferably at least 60 wt%, even more preferably at least 65 wt% and most preferably at least
15 70 wt%, and preferably at most 99 wt%, more preferably at most 95 wt%, even more preferably at most 90 wt% and most preferably at most 80 wt%, based on the total weight of the curing agent.

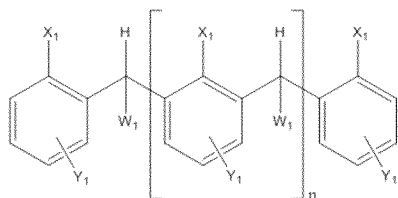
The present invention further pertains to a curing agent comprising an alkoxyated polyamine having the formula R₅-N-((CH₂)_x-N)_n-(CH₂)_x-NH₂
20 wherein R₅ is -R₆-O-R₇ wherein R₆ is selected from the group consisting of C₁-C₂₄ alkylene, arylalkylene and alkylarylene, and R₇ is selected from the group consisting of linear or branched C₆-C₅₀ alkyl, linear or branched C₆-C₅₀ alkenyl, linear or branched C₆-C₅₀ arylalkyl and linear or branched C₆-C₅₀ alkylaryl, x is 2 to 5, and n is 0 to 10; and a substituted phenol having formula (B):

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30 wherein X and Y are individually selected from the group of COOH, carboxylate, OH, NH₂, NO₂, SO₃H, PO₃H, Cl, F, B, I, alkyl, alkenyl, COOR, OR, COR and aldehyde, and/or

a substituted phenyl having formula (B1):



(B1)

wherein n is a number from 0 to 1000, X₁ is selected from hydrogen, hydroxyl and carboxylic acid, and Y₁ is selected from hydrogen, alkyl, alkenyl, alkynyl, aryl, substituted alkyls,
 5 substituted alkenyl, substituted alkynyl, substituted aryls, polycyclic aromatics, substituted polycyclic aromatics, polar functional groups, such as alcohol, amines, ketones, aldehydes, ethers, carboxylic acids, sulfonates, sulfonic acids, phosphonic acids and heterocyclics; and W₁ is independently selected from hydrogen, alkyl, alkenyl, alkynyl, aryl, substituted alkyl,
 10 substituted alkenyl, substituted alkynyl, substituted aryls, polycyclic aromatics, substituted polycyclic aromatics, polar functional groups, such as alcohol, amines, ketones, aldehydes, amides, esters, carbonyls, epoxies, oxetanes, oxiranes, ethers, carboxylic acids, sulfonates, sulfonic acids, phosphonic acids and heterocyclics; and
 a low temperature cure agent;
 wherein the molar ratio of the alkoxyated polyamine and the substituted phenol and/or
 15 the substituted phenyl is at least 0.2 and at most 5.

The alkoxyated polyamine of the invention may be any alkoxyated polyamine known in the art. The number of amino groups may vary; the value for n is generally from 0 to 10. Preferably, n is from 0 to 5, more preferably n is from 0 to 2, and most preferably n is 0 or 1.

The amino groups are connected via linear alkyl ((CH₂)_x), branched alkyl ((CH₂)_x), alkylaryl ((CH₂)_x(aryl)), poly(aryl), alkylene or poly(alkylene) groups, and x is 2 to 5. Preferably, the amino
 20 groups are connected via linear alkyl ((CH₂)_x), branched alkyl ((CH₂)_m), alkylene or poly(alkylene) groups, more preferably the amino groups are connected via linear alkyl ((CH₂)_x), branched alkyl ((CH₂)_x), alkylene or poly(alkylene) groups and most preferably the amino groups are connected via linear alkyl ((CH₂)_x). Preferably, x is from 2 to 4, more preferably x is from 2 to
 25 3, and most preferably x is 3.

The R₆ substituent in the alkoxyated polyamine is a C₁-C₂₄ alkylene, arylalkylene and alkylarylene. Preferably, the R₆ substituted is a C₁-C₂₄ alkylene, more preferably R₆ is a C₂-C₈ alkylene, even more preferably R₆ is C₂-C₆ alkylene.

The R₇ substituent in the alkoxyated polyamine is selected from the group of linear or branched C₆-C₅₀ alkyl, linear or branched C₆-C₅₀ alkenyl, linear or branched C₆-C₅₀ arylalkyl and linear or branched C₆-C₅₀ alkylaryl. Preferably, the R₇ substituent is selected from the group of linear or branched C₆-C₅₀ alkyl and linear or branched C₆-C₅₀ alkenyl. More preferably, the R₇ substituent is linear or branched C₆-C₅₀ alkyl. Preferably, the R₇ substituent in the alkoxyated polyamine is a C₆-C₅₀ alkyl. Preferably, the R₇ substituent is a C₆-C₃₀ alkyl, more preferably R₇ is a C₆-C₂₄ alkyl, even more preferably R₇ is C₈-C₁₈ alkyl.

Examples of alkoxyated polyamines include propylene diamines such as octyl/decyloxypropyl-1,3-diaminopropane, isodecyloxypropyl-1,3-diaminopropane, isododecyloxypropyl-1,3-diaminopropane, dodecyl/tetradecyloxypropyl-1,3-diaminopropane, isotridecyloxypropyl-1,3-diaminopropane and tetradecyloxypropyl-1,3-diaminopropane; and dipropylene triamines such as dodecyl dipropylene triamine, dodecyl dipropylene triamine, octyl/decyl dipropylene triamine, isotridecyl dipropylene triamine and tetradecyl dipropylene triamine.

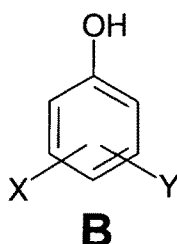
Further examples of alkoxyated polyamines include branched propylene diamines such as 2-hexyl-decyloxypropyl-1,3-diaminopropane, 2-hexyl-isodecyloxypropyl-1,3-diaminopropane, 2-octyl-isododecyloxypropyl-1,3-diaminopropane, 2-decyl-tetradecyloxypropyl-1,3-diaminopropane, 2-nonyl-isotridecyloxypropyl-1,3-diaminopropane and 2-decyl-tetradecyloxypropyl-1,3-diaminopropane; and branched dipropylene triamines such as 2-hexyl-decyl dipropylene triamine, 2-octyl-dodecyl dipropylene triamine, 2-nonyl-isotridecyl dipropylene triamine and 2-decyl-tetradecyl dipropylene triamine. These branched alkoxyated polyamines can be obtained through conversion of Guerbet alcohols. Further details on such polyamines and their production can be found in US 5,094,667.

In one embodiment of the invention, the curing agent comprises the alkoxyated polyamine in an amount of at least 50 % by weight (wt%), based on the total weight of the curing agent. Preferably, the alkoxyated polyamine is present in an amount of at least 55 wt%, more preferably at least 60 wt%, even more preferably at least 65 wt% and most preferably at least 70 wt%, and preferably at most 99 wt%, more preferably at most 95 wt%, even more preferably at most 90 wt% and most preferably at most 80 wt%, based on the total weight of the curing agent.

The invention further pertains to a curing agent comprising a bisalkoxyated amine having the formula R₁₀-O-R₈-NH-R₉-O-R₁₁, wherein R₈ and R₉ are individually selected from the group consisting of C₁-C₂₄ alkylene, arylalkylene and alkylarylene; and R₁₀ and R₁₁ are individually

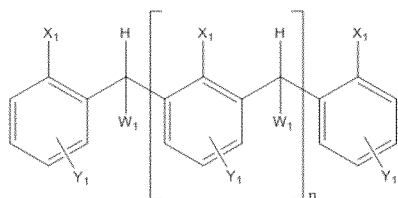
selected from the group consisting of linear or branched C₆-C₅₀ alkyl, linear or branched C₆-C₅₀ alkenyl, linear or branched C₆-C₅₀ arylalkyl and linear or branched C₆-C₅₀ alkylaryl; and a substituted phenol having formula (B):

5



wherein X and Y are individually selected from the group of COOH, carboxylate, OH, NH₂, NO₂, SO₃H, PO₃H, Cl, F, B, I, alkyl, alkenyl, COOR, OR, COR and aldehyde, and/or a substituted phenyl having formula (B1):

10



(B1)

wherein n is a number from 0 to 1000, X₁ is selected from hydrogen, hydroxyl and carboxylic acid, and Y₁ is selected from hydrogen, alkyl, alkenyl, alkynyl, aryl, substituted alkyls, substituted alkenyl, substituted alkynyl, substituted aryls, polycyclic aromatics, substituted polycyclic aromatics, polar functional groups, such as alcohol, amines, ketones, aldehydes, ethers, carboxylic acids, sulfonates, sulfonic acids, phosphonic acids and heterocyclics; and W₁ is independently selected from hydrogen, alkyl, alkenyl, alkynyl, aryl, substituted alkyl, substituted alkenyl, substituted alkynyl, substituted aryls, polycyclic aromatics, substituted polycyclic aromatics, polar functional groups, such as alcohol, amines, ketones, aldehydes, amides, esters, carbonyls, epoxies, oxetanes, oxiranes, ethers, carboxylic acids, sulfonates, sulfonic acids, phosphonic acids and heterocyclics; and a low temperature cure agent;

15

20

wherein the molar ratio of the bisalkoxylated amine and the substituted phenol and/or the substituted phenol is at least 0.2 and at most 5.

25

The R₈ and R₉ substituents in the bisalkoxylated amine are individually selected from the group consisting of a C₁-C₂₄ alkylene, arylalkylene and alkylarylene. Preferably, the R₈ and R₉

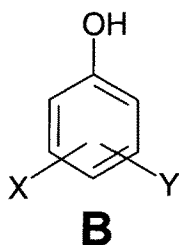
substituents are individually a C₁-C₂₄ alkylene, more preferably the R₈ and R₉ substituents are individually a C₂-C₈ alkylene, even more preferably the R₈ and R₉ substituents are individually a C₂-C₆ alkylene.

The R₁₀ and R₁₁ substituents in the bisalkoxylated amine are individually selected from the group consisting of linear or branched C₆-C₅₀ alkyl, linear or branched C₆-C₅₀ alkenyl, linear or branched C₆-C₅₀ arylalkyl and linear or branched C₆-C₅₀ alkylaryl. Preferably, the R₈ and R₉ substituents are individually selected from the group consisting of linear or branched C₆-C₅₀ alkyl and linear or branched C₆-C₅₀ alkenyl. More preferably, the R₈ and R₉ substituents are linear or branched C₆-C₅₀ alkyl. Preferably, the R₈ and R₉ substituents in the bisalkoxylated amine are individually a C₆-C₅₀ alkyl. Preferably, the R₈ and R₉ substituents are individually a C₆-C₃₀ alkyl, more preferably, the R₈ and R₉ substituents are individually a C₆-C₂₄ alkyl, even more preferably, the R₈ and R₉ substituents are individually C₈-C₁₈ alkyl.

Examples of bisalkoxylated amines include di(dodecyloxypropyl) amine, di(oleyloxypropyl) amine, di(arachidyl behenyloxypropyl) amine, di(tallowoxypropyl) amine, di(octyloxypropyl) amine, di(stearilyoxypropyl) amine and di(cocoalkyloxy) amine.

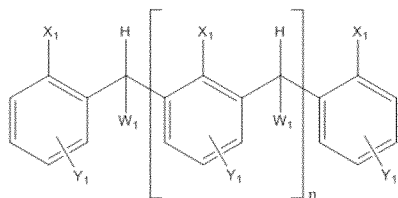
In one embodiment of the invention, the curing agent comprises the bisalkoxylated amine in an amount of at least 50 % by weight (wt%), based on the total weight of the curing agent. Preferably, the bisalkoxylated amine is present in an amount of at least 55 wt%, more preferably at least 60 wt%, even more preferably at least 65 wt% and most preferably at least 70 wt%, and preferably at most 99 wt%, more preferably at most 95 wt%, even more preferably at most 90 wt% and most preferably at most 80 wt%, based on the total weight of the curing agent.

The invention further pertains to a curing agent comprising an alkoxyated primary amine having the formula R₁₃-O-R₁₂-NH₂, wherein R₁₂ is individually selected from the group consisting of C₁-C₂₄ alkylene, arylalkylene and alkylarylene, and R₁₃ is selected from the group consisting of linear or branched C₆-C₅₀ alkyl, linear or branched C₆-C₅₀ alkenyl, linear or branched C₆-C₅₀ arylalkyl and linear or branched C₆-C₅₀ alkylaryl; and a substituted phenol having formula (B):



wherein X and Y are individually selected from the group of COOH, carboxylate, OH, NH₂, NO₂, SO₃H, PO₃H, Cl, F, B, I, alkyl, alkenyl, COOR, OR, COR and aldehyde, and/or

5 a substituted phenyl having formula (B1):



(B1)

wherein n is a number from 0 to 1000, X₁ is selected from hydrogen, hydroxyl and carboxylic acid, and Y₁ is selected from hydrogen, alkyl, alkenyl, alkynyl, aryl, substituted alkyls,

substituted alkenyl, substituted alkynyl, substituted aryls, polycyclic aromatics, substituted polycyclic aromatics, polar functional groups, such as alcohol, amines, ketones, aldehydes, ethers, carboxylic acids, sulfonates, sulfonic acids, phosphonic acids and heterocyclics; and W₁ is independently selected from hydrogen, alkyl, alkenyl, alkynyl, aryl, substituted alkyl, substituted alkenyl, substituted alkynyl, substituted aryls, polycyclic aromatics, substituted polycyclic aromatics, polar functional groups, such as alcohol, amines, ketones, aldehydes, amides, esters, carbonyls, epoxies, oxetanes, oxiranes, ethers, carboxylic acids, sulfonates, sulfonic acids, phosphonic acids and heterocyclics; and

a low temperature cure agent;

wherein the molar ratio of the alkoxyated primary amine and the substituted phenol and/or the substituted phenyl is at least 0.2 and at most 5.

20 The R₁₂ substituent in the alkoxyated primary amine is a C₁-C₂₄ alkylene, arylalkylene and arylarylene. Preferably, the R₁₂ substituted is a C₁-C₂₄ alkylene, more preferably R₁₂ is a C₂-C₈ alkylene, even more preferably R₁₂ is C₂-C₆ alkylene.

The R₁₃ substituent in the alkoxyated primary amine is selected from the group of linear or branched C₁-C₅₀ alkyl, linear or branched C₁-C₅₀ alkenyl and linear or branched C₁-C₅₀ alkylaryl.

25 Preferably, the R₁₃ substituent is selected from the group of linear or branched C₁-C₅₀ alkyl and linear or branched C₁-C₅₀ alkenyl. More preferably, the R₁₃ substituent is linear or branched C₁-C₅₀ alkyl. Preferably, the R₁₃ substituent in the alkoxyated primary amine is a C₁-C₅₀ alkyl.

Preferably, the R₁₃ substituent is a C₄-C₃₀ alkyl, more preferably R₁₃ is a C₆-C₂₄ alkyl, even more preferably R₁₃ is C₈-C₁₈ alkyl.

Examples of alkoxyated amines include isopropoxypropyl amine, hexyloxypropyl amine, 2-ethylhexyloxypropyl amine, octyl/decyloxypropyl amine, isodecyloxypropyl amine,
5 dodecyl/tetradecyloxypropyl amine, isotridecyloxypropyl amine, tetradecyloxypropyl amine, tetradecyl/dodecyloxypropyl amine, linear alkyloxypropyl amine and octadecyl/hexadecyloxypropyl amine.

In one embodiment of the invention, the curing agent comprises the alkoxyated primary amine in an amount of at least 50 % by weight (wt%), based on the total weight of the curing agent.
10 Preferably, the alkoxyated primary amine is present in an amount of at least 55 wt%, more preferably at least 60 wt%, even more preferably at least 65 wt% and most preferably at least 70 wt%, and preferably at most 99 wt%, more preferably at most 95 wt%, even more preferably at most 90 wt% and most preferably at most 80 wt%, based on the total weight of the curing agent.

15 In a further embodiment of the invention, the curing agent comprises an adduct of one or more fatty amines. Preferably, the curing agent comprises an adduct of a cationically polymerizable building block and one or more fatty amines selected from the group consisting of an alkylated polyamine, bisalkylated amine, alkylated primary amine, an alkoxyated polyamine, bisalkoxyated amine and alkoxyated primary amine.

20 In the context of this application the wording "adduct" refers to reaction products of the cationically polymerizable building block and fatty amine, preferably of monomers of the cationically polymerizable building block and the fatty amine wherein the resulting adduct maintains at least two functional groups enabling polymerization and/or cross-linking of the adduct.

25 The invention further pertains to a coating composition comprises the adduct alone, and also combinations of an adduct and a cationically polymerizable building block, combinations of an adduct and a cationically polymerizable building block, and combinations of adduct, cationically polymerizable building block and curing agent. Examples of such adducts include reaction products of the monomers of the cationically polymerizable building block and the curing agent
30 as described below. Such adducts are typically formed under conditions where only the adduct is formed and no or only to a small extent polymerization and/or cross-linking occurs. The

coating composition of the invention preferably comprises adducts of the cationically polymerizable building block and the curing agent, wherein the amount of polymerized and/or cross-linked product is at most 5 wt%, based on the total weight of the cationically polymerizable building block and the curing agent. Preferably, the polymerized and/or cross-linked product of the the cationically polymerizable building block and/or the curing agent is present in an amount of at most 2 wt%, more preferably at most 1 wt%, even more preferably at most 0.5 wt%. Even more preferably, the coating composition is substantially free from polymerized and/or cross-linked product, and most preferably the coating composition is completely free from polymerized and/or cross-linked product. The term "substantially free" means that less than 100 parts per million of the polymerized and/or cross-linked product is present in the coating composition. The term "completely free" means that the cured coating contains less than 20 parts per billion (ppb) of polymerized and/or cross-linked product.

In one embodiment of the invention, the molar ratio of the cationically polymerizable building block and fatty amine is at least 0.01. Preferably, the molar ratio is at least 0.05, more preferably at least 0.1, even more preferably at least 0.2 and most preferably at least 0.5, and preferably at most 2, more preferably at most 1.5, even more preferably at most 1.2 and most preferably at most 1.

The fatty amine of the invention can be liquefied by the substituted phenol of the invention or the substituted phenyl of the invention. The substituted phenol of the invention may be any substituted phenol known in the art. The X and Y are individually selected from the group of COOH, carboxylate, OH, NH₂, NO₂, SO₃H, PO₃H, Cl, F, B, I, alkyl, alkenyl, COOR, OR, COR and aldehyde. The R substituent in OR, COR and COOR is selected from the group of linear or branched C₁-C₅₀ alkyl, (poly) C₂-C₅ alkoxyalkyl, (poly) C₂-C₅ alkoxy with terminal hydroxyl, linear or branched C₁-C₅₀ alkenyl, linear or branched C₁-C₅₀ arylalkyl and linear or branched C₁-C₅₀ alkylaryl. The X and/or Y substituents may be positioned in the meta, para or ortho position. Preferably, the X or Y substituent is in the ortho position. In an embodiment, the X substituent is COOH, carboxylate or OH. Preferably, the X substituent is COOH, carboxylate or OH and the Y substituent is H, COOH, carboxylate or OH. More preferably, the X substituent is COOH, carboxylate or OH and the Y substituent is H. The substituted phenol may be substituted at the hydroxyl to form a precursor of the hydroxyl. With "precursor" is meant that upon curing of a coating composition with the curing agent of the invention the hydroxyl moiety can be formed, e.g. through hydrolyses. Such substituents can be the same as for the R substituent; the substituent is selected from the group of linear or branched C₁-C₅₀ alkyl, (poly) C₂-C₅

alkoxyalkyl, (poly) C₂-C₅ alkoxy with terminal hydroxyl, linear or branched C₁-C₅₀ alkenyl, linear or branched C₁-C₅₀ arylalkyl and linear or branched C₁-C₅₀ alkylaryl.

Examples of substituted phenol include catechol, salicylic acid, 2-phenol phosphinic acid, 2-phenol phosphonic acid, 2-phenol sulphonic acid, 2-nitrophenol and 2-aminophenol. Preferably, the substituted phenol is catechol or salicylic acid. Most preferred, the substituted phenol is salicylic acid.

In one embodiment of the invention, the curing agent comprises the substituted phenol in an amount of at most 50 % by weight (wt%), based on the total weight of the curing agent.

Preferably, the substituted phenol is present in an amount of at most 45 wt%, more preferably at most 40 wt%, even more preferably at most 35 wt% and most preferably at most 30 wt%, and preferably at least 0.1 wt%, more preferably at least 1 wt%, even more preferably at least 5 wt% and most preferably at least 10 wt%, based on the total weight of the curing agent.

In one embodiment of the invention, the curing agent comprises the substituted phenol in an amount of at most 50 % by weight (wt%), based on the total weight of the fatty amine.

Preferably, the substituted phenol is present in an amount of at most 45 wt%, more preferably at most 40 wt%, even more preferably at most 35 wt% and most preferably at most 30 wt%, and preferably at least 0.1 wt%, more preferably at least 1 wt%, even more preferably at least 5 wt% and most preferably at least 10 wt%, based on the total weight of the fatty amine.

The substituted phenyl of the invention may be any substituted phenyl known in the art.

Preferably, X₁ is hydroxyl. Preferably, Y₁ is selected from hydrogen, hydroxyl and carboxylic acids. More preferably, Y₁ is carboxylic acid. Preferably, W₁ is hydrogen. In another embodiment, n is from 0 to 500, more preferably from 0 to 100.

The substituted phenyl of the invention is generally prepared under acidic conditions and with a stoichiometric or below-stoichiometric amount of the formaldehyde or corresponding reactants.

In this way, the substituted phenyl will generally comprise the methylene groups on the ortho position of the X or X₁ substituent rendering a substituted phenyl of the novolac type (instead of the resol type). It is further noted that under these conditions no or hardly any ether groups are being formed. Alternatively, a substituted phenyl is a substituted phenyl of the resol type.

Examples of substituted phenol compounds that may react to form a substituted phenyl according to formula (B1) generally are the substituted phenol of formula (B) or a copolymer or terpolymer of the substituted phenol of formula (B) with any other suitable substituted phenyl

monomer and/or oligomer. Examples of substituted phenol include catechol, salicylic acid, 2-phenol phosphinic acid, 2-phenol phosphonic acid, 2-phenol sulphonic acid, 2-nitrophenol and 2-aminophenol. Preferably, the substituted phenol is catechol or salicylic acid. Most preferred, the substituted phenol is salicylic acid.

5 Examples of suitable substituted phenyl monomers and/or oligomers include triphenyl methane, diphenyl methane, phenyl chloromethane, diphenyl chloromethane, bis(2-hydroxyphenyl) methane, bis(3-hydroxyphenyl) methane, bis(4-hydroxyphenyl) methane, 2-hydroxyphenyl-3-hydroxyphenyl methane, 2-hydroxyphenyl-4-hydroxyphenyl methane, bis(2-hydroxyphenyl) chloromethane, bis(3-hydroxyphenyl) chloromethane, bis(4-hydroxyphenyl) chloromethane, 2-10 hydroxyphenyl-3-hydroxyphenyl chloromethane, 2-hydroxyphenyl-4-hydroxyphenyl chloromethane, bis(2-hydroxyphenyl) phenylmethane, bis(3-hydroxyphenyl) phenylmethane, bis(4-hydroxyphenyl) phenylmethane, 2-hydroxyphenyl-3-hydroxyphenyl phenylmethane, 2-hydroxyphenyl-4-hydroxyphenyl phenylmethane, bis(2-aminophenyl) methane, bis(3-aminophenyl) methane, bis(4-aminophenyl) methane, 2-aminophenyl-3-aminophenyl methane, 15 2-aminophenyl-4-aminophenyl methane, bis(2-aminophenyl) chloromethane, bis(3-aminophenyl) chloromethane, bis(4-aminophenyl) chloromethane, 2-aminophenyl-3-aminophenyl chloromethane, 2-aminophenyl-4-aminophenyl chloromethane, bis(2-aminophenyl) phenylmethane, bis(3-aminophenyl) phenylmethane, bis(4-aminophenyl) phenylmethane, 2-aminophenyl-3-aminophenyl phenylmethane, 2-aminophenyl-4-aminophenyl phenylmethane, 20 bis(2-mercaptophenyl) methane, bis(3-mercaptophenyl) methane, bis(4-mercaptophenyl) methane, 2-mercaptophenyl-3-mercaptophenyl methane, 2-mercaptophenyl-4-mercaptophenyl methane, bis(2-mercaptophenyl) chloromethane, bis(3-mercaptophenyl) chloromethane, bis(4-mercaptophenyl) chloromethane, 2-mercaptophenyl-3-mercaptophenyl chloromethane, 2-mercaptophenyl-4-mercaptophenyl chloromethane, bis(2-mercaptophenyl) phenylmethane, 25 bis(3-mercaptophenyl) phenylmethane, bis(4-mercaptophenyl) phenylmethane, 2-mercaptophenyl-3-mercaptophenyl phenylmethane, 2-mercaptophenyl-4-mercaptophenyl phenylmethane, alkylated phenols, such as 2-methylphenol, 2-ethylphenol, 2-propylphenol, 2-butylphenol, 3-methylphenol, 3-ethylphenol, 3-propylphenol, 3-butylphenol, 4-methylphenol, 4-ethylphenol, 4-propylphenol and 4-butylphenol and phenoplasts having from 2 to 1000 repeating 30 units (*i.e.* a phenol compound with n is from 0 to 1000, X_1 is hydroxyl, Y_1 , and W_1 are hydrogen). Also corresponding anthracene and naphthalene derivatives of the aforementioned substituted phenyl monomers and/or oligomers are envisaged.

The substituted phenyl of the invention can be any substituted phenyl known in the art. The substituted phenyl of the invention can be prepared by condensation reaction of the substituted phenol compounds and an aldehyde. Suitable aldehydes include formaldehyde, acetaldehyde, crotonaldehyde, glutaraldehyde, glyoxal, acrolein, benzaldehyde, and furfural. Formaldehyde is
5 the preferred aldehyde.

The molar ratio of the fatty amine of the invention and the substituted phenol and/or substituted phenyl is at least 0.2, preferably at least 0.5, more preferably at least 0.7, even more preferably at least 0.8, even more preferably at least 0.85, even more preferably at least 0.9 and most preferably at least 0.95, and at most 5, preferably at most 3, more preferably at most 2, even
10 more preferably at most 1.5, even more preferably at most 1.2, even more preferably at most 1.15, even more preferably at most 1.1 and most preferably at most 1.05.

The molar ratio of the functional primary amine groups in the fatty amine of the invention and the functional groups in the substituted phenol and/or substituted phenyl is at least 0.2, preferably at least 0.5, more preferably at least 0.7, even more preferably at least 0.8, even
15 more preferably at least 0.85, even more preferably at least 0.9 and most preferably at least 0.95, and at most 5, preferably at most 3, more preferably at most 2, even more preferably at most 1.5, even more preferably at most 1.2, even more preferably at most 1.15, even more preferably at most 1.1 and most preferably at most 1.05. The functional groups in the substituted phenol and/or substituted phenyl comprise the hydroxyl and substituents X, X₁, Y and/or Y₁. When primary amines are absent e.g. in the bisalkylated amine and bisalkoxylated amine, the functional secondary amine groups should be taken (instead of the primary amine
20 groups).

In one embodiment, the curing agent of the invention generally is homogeneous, i.e. does not contain solid deposits of any one of the fatty amine and/or substituted phenol or phenyl, and/or
25 reveals any phase separation.

In a further embodiment, the curing agent of the invention generally has a (Brookfield) viscosity of at least 5 cP and at most 12,000 cP. Preferably, the viscosity of the curing agent is at least 50 cP and most preferably at least 100 cP, and preferably at least 200 cP, and preferably at most 10,000 cP, more preferably at most 8,000 cP, and preferably at most 6,000 cP.

30 The low temperature cure agent can be any low temperature cure agent known in the art. The low temperature cure agent is generally selected from an aliphatic polyamine, an alicyclic

polyamine, a Mannich base curing agent such as a phenalkamine and a phenalkamide, and a mercaptan-terminated compound. The mercaptan-terminated compound can be any mercaptan-terminated compound known in the art and suitable for curing at low temperatures, i.e. at temperatures as low as 5°C and below. Examples of such mercaptan-terminated compound
5 include mercaptan-terminated polypropoxylene polymers such as Capcure 3-800 (ex BASF), mercaptan-terminated molecules such as pentaerythrytol tetrakismercaptopacetate (PETMA); and polysulfides such as Thioplast G131 (ex AkzoNobel).

The alicyclic polyamine of the invention can be any alicyclic polyamine known in the art and suitable for curing at low temperatures, i.e. at temperatures as low as 5°C and below. Examples
10 of such alicyclic polyamines include isophorone diamine (IPDA), N-aminopiperazine, menthane diamine, methylene di(cyclohexylamine), 3,3'-dimethyl-methylenedi(cyclohexylamine), 3-aminomethyl cyclopentylamine, 3-aminomethyl cyclohexylamine, 3-aminomethyl-5-methylcyclohexylamine, 3-aminomethyl cycloheptylamine, 3-aminomethyl-5,5'-dimethyl cyclohexylamine, 3-aminomethyl cyclooctylamine, 3-aminomethyl-5-methyl cyclooctylamine and
15 5-phenyl-3-aminomethyl cyclohexylamine. The preferred alicyclic polyamine is isophoronediamine.

The Mannich base curing agent can be any Mannich base curing agent known in the art and suitable for curing at low temperatures, i.e. at temperatures as low as 5°C and below. The Mannich base curing agent may be a phenalkamine and can be obtained as a reaction product
20 of a polyamine and a phenol or a cardol, e.g. a distilled cashew nut shell. The phenalkamine can be further modified using a polyamide to obtain a phenalkamide.

The phenalkamine of the invention can be any phenalkamine known in the art and suitable for curing at low temperatures, i.e. at temperatures as low as 5°C and below. Examples of such phenalkamines include Cardolite® NL541 (ex Cardolite), Ancamine® K54 (ex Evonik) and PPA
25 7040 ex Paladin.

The phenalkamide of the invention can be any phenalkamide known in the art and suitable for curing at low temperatures, i.e. at temperatures as low as 5°C and below. Examples of such phenalkamides include Lite® 3000 and 3100 (ex Cardolite) and PPA 7115 and 7140 ex Paladin.

The aliphatic polyamine of the invention can be any aliphatic polyamine known in the art. The
30 aliphatic polyamine of the invention generally does not contain consecutive chains with 6 or more carbon atoms. Typically, the aliphatic polyamine contains C₁-C₅ alkylene or cycloalkylene

groups. Preferably the aliphatic polyamine contains C₂-C₄ alkylene groups. Examples of aliphatic polyamines include EDA homologues such as linear, branched and cyclic EDA homologues including tetraethylene pentamine (TEPA), triethylene tetramine (TETA), diethylene triamine (DETA), hexaethylene pentamine (HEPA) and N-aminoethyl piperazine (NAEP);
5 propylene homologues such as dipropylene triamine (DPTA); methylene homologues such as hexamethylene pentamine (HMPA); polyether monoamines such as Jeffamine® M-600 amine, Jeffamine® M-1000 amine, Jeffamine® M-2005 amine and Jeffamine® M-2070 amine; polyether diamines such as Jeffamine® D-230 amine, Jeffamine® D-2300 amine, Jeffamine® D-400 amine, Jeffamine® D-4000 amine, Jeffamine® ED-600 amine, Jeffamine® ED-900
10 amine, Jeffamine® ED-2003 amine, Jeffamine® EDR-148 amine and Jeffamine® EDR-176 amine; polyether triamines such as Jeffamine® T-403 amine, Jeffamine® T-3000 amine and Jeffamine® T-5000 amine. Preferably, the aliphatic polyamine is an EDA homologue or a polyether amine. More preferably, the aliphatic polyamine is an EDA homologue. Even more preferably, the aliphatic polyamine is triethylene tetramine, N-aminoethyl piperazine and
15 tetraethylene pentamine. Most preferred is triethylene tetramine.

In one embodiment, the curing agent comprises the low temperature cure agent in an amount of at most 10 wt%, based on the total weight of the curing agent. In a further embodiment of the invention, the curing agent comprises the low temperature cure agent in an amount of at least 0.01 % by weight (wt%), based on the total weight of the curing agent. Preferably, the low
20 temperature cure agent is present in an amount of at least 0.05 wt%, more preferably at least 0.1 wt%, even more preferably at least 0.5 wt% and most preferably at least 1 wt%, and preferably at most 5 wt%, more preferably at most 4 wt%, even more preferably at most 3 wt% and most preferably at most 2 wt%, based on the total weight of the curing agent.

In a further embodiment, the curing agent may further comprise a pot life extender selected from
25 the group consisting of secondary alcohols, ketones and triphenyl phosphines. Preferably, the pot life extender is selected from secondary alcohols and ketones. More preferably, the pot life extender is a secondary alcohol.

Examples of pot life extenders include secondary alcohols such as 3-methyl-1,5-pentanediol, isopentanediol and isotridecyl alcohol; ketones such as acetylacetonate, methyl acetylacetonate
30 and ethyl acetylacetonate; and triphenyl phosphines such as triphenyl phosphine and triphenyl phosphine oxides.

In one embodiment, the curing agent comprises the pot life extender in an amount of at most 10 wt%, based on the total weight of the curing agent. In a further embodiment of the invention, the curing agent comprises the pot life extenders in an amount of at least 0.01 % by weight (wt%), based on the total weight of the curing agent. Preferably, the pot life extender is present in an amount of at least 0.05 wt%, more preferably at least 0.1 wt%, even more preferably at least 0.5 wt% and most preferably at least 1 wt%, and preferably at most 5 wt%, more preferably at most 4 wt%, even more preferably at most 3 wt% and most preferably at most 2 wt%, based on the total weight of the curing agent.

The curing agent of the invention may further comprise a solvent. The solvent may be any suitable solvent known in the art. Depending on the application and performance of the coating composition in which the curing agent is used, one can choose between a non-reactive (*e.g.* to lower viscosity, flow improvement etc.) and/or a reactive solvent (*e.g.* to lower viscosity, improve final performance of the coating etc.). The solvent may comprise functional groups selected from hydroxyl, amine and thiol. Preferably, the functional group is a hydroxyl or an amine. Such solvents may be referred to as reactive solvents as these will be built into the coating composition upon curing. Examples of reactive solvents include the glycidyl ethers from alcohols, such as glycidyl ethers from methanol, ethanol, diethanol, aminoethanol, glycol, n-propanol, iso-propanol, trimethylol propane, ethanethiol, ethylene glycol, propylene glycol and neopentyl glycol; and acrylates such as acrylate, methacrylate, ethyl acrylate, 2-chloroethyl vinyl ether, 2-ethylhexyl acrylate, 2-hydroxyethyl methacrylate, butyl acrylate, butyl methacrylate, 2-hydroxypropyl methacrylate, 3-hydroxypropyl methacrylate, 2-hydroxypropyl methacrylate, and 3-hydroxypropyl methacrylate.

Examples of non-reactive solvents include Solvent Naphtha®, heavy benzene, various Solvesso® grades, various Shellsol® grades and Deasol®, various white spirits, mineral turpentine oil, tetralin, decalin, methyl ethyl ketone, acetone and methyl n-propyl ketone. If the solvent is not preferred to be present in the final coating, a volatile solvent should be selected, such as methyl ethyl ketone. In case, presence of inert solvents in the coating is an aim, the non-reactive solvent has a boiling point above 250 °C, therewith meeting the generally accepted criterium for non-VOC classification. The coating composition of the invention may comprise a reactive solvent and a non-reactive solvent, a combination of two or more solvents, or a combination of two or more reactive solvents. Curing agent comprising a reactive solvent are preferred.

The curing agent of the invention may comprise the non-reactive solvent and/or the reactive solvent in an amount of at most 30 % by weight (wt%), based on the total weight of the curing agent. Preferably, the non-reactive solvent and/or the reactive solvent is present in an amount of at most 25 wt%, more preferably at most 20 wt%, even more preferably at most 15 wt% and most preferably at most 30 wt%, and preferably at least 1 wt%, more preferably at least 2 wt%, even more preferably at least 5 wt% and most preferably at least 10 wt%, based on the total weight of the curing agent.

The remaining part of the curing agent may be comprised of other components commonly used in curing agents. With the fatty amine, the substituted phenol and/or substituted phenyl, the aliphatic polyamine and the other components add up to 100 wt% of the total weight of the curing agent.

The invention further pertains to a coating composition comprising a cationically polymerizable building block and a curing agent according to the invention.

In one embodiment of the invention, the coating composition generally comprises the cationically polymerizable building block in an amount of at least 5 % by weight (wt%), based on the total weight of the coating composition. Preferably, the cationically polymerizable building block is present in an amount of at least 20 wt%, more preferably at least 40 wt%, even more preferably at least 50 wt% and most preferably at least 60 wt%, and preferably at most 95 wt%, more preferably at most 90 wt%, even more preferably at most 85 wt% and most preferably at most 80 wt%, based on the total weight of the coating composition.

In one embodiment of the invention, the coating composition generally comprises the curing agent in an amount of at least 5 % by weight (wt%), based on the total weight of the coating composition. Preferably, the curing agent is present in an amount of at least 10 wt%, more preferably at least 15 wt%, even more preferably at least 20 wt% and most preferably at least 25 wt%, and preferably at most 95 wt%, more preferably at most 70 wt%, even more preferably at most 60 wt% and most preferably at most 40 wt%, based on the total weight of the coating composition.

The cationically polymerizable building blocks can be any cationically polymerizable building block known in the art. The cationically polymerizable building block can be a glycidyl ether or ester or a (cyclo)aliphatic compound. The coating composition may comprise two or more cationically polymerizable building blocks. Preferably, the coating composition comprises a

glycidyl ether or ester and a (cyclo)aliphatic compound. More preferably, the coating composition comprises a glycidyl ether or ester and an epoxy-containing (cyclo)aliphatic compound. In the context of this application, the wordings “(cyclo)aliphatic” or “(cyclo)aliphatic compounds” refer to compounds that are either aliphatic or cycloaliphatic. These (cyclo)aliphatic compounds have functional groups, that are cationically polymerizable, and an aliphatic or cycloaliphatic part.

The glycidyl ethers suitable for the inventive composition can be any glycidyl ether known in the art. The glycidyl ether of the invention may be a monomer, an oligomer or polymer. In one embodiment, the glycidyl ether is preferably a monomer. Oligomers of the glycidyl ether or ester refer to dimers, trimers and tetramers of the monomers of the glycidyl ether or ester. Examples of suitable glycidyl ethers include aliphatic glycidyl ethers like 1,4-butyl diglycidyl ether, 1,6-hexyl diglycidyl ether, 2-ethylhexyl glycidyl ether, n-butyl glycidyl ether, t-butyl glycidyl ether, i-butyl glycidyl ether, lauryl glycidyl ether, tetradecyl glycidyl ether and hexadecyl glycidyl ether; glycidyl ethers of polyols like trimethylol propane triglycidyl ether, glycerol triglycidyl ether, polyethylene glycol diglycidyl ether, ethylene glycol diglycidyl ether, polypropylene glycol diglycidyl ether and propylene glycol diglycidyl ether; and aromatic glycidyl ethers like bisphenol-containing glycidyl ethers such as bisphenol A diglycidyl ether, hydrogenated bisphenol A diglycidyl ether, 2,2'-bis(4-hydroxyphenyl)propane bis(2,3-epoxypropylether), bisphenol F diglycidyl ether, hydrogenated bisphenol F diglycidyl ether and novolac glycidyl ethers. Preferred glycidyl ethers are aromatic glycidyl ethers and hydrogenated aromatic glycidyl ethers. More preferred glycidyl ethers are bisphenol A diglycidyl ether, hydrogenated bisphenol A diglycidyl ether, bisphenol F diglycidyl ether and hydrogenated bisphenol F diglycidyl ether.

The glycidyl esters suitable for the inventive composition can be any glycidyl ester known in the art. The glycidyl ester of the invention may be a monomer, an oligomer or polymer. In one embodiment, the glycidyl ester is preferably a monomer. Examples of suitable glycidyl esters include glycidyl ester of versatic acid, 2,2-dimethyl-3,3-dimethylpentanoic acid glycidyl ester, 2,2-dimethyl-4,4-dimethylpentanoic acid glycidyl ester, 2-methyl-2-ethyl-3,3-dimethylbutanoic acid glycidyl ester, 2-methyl-2-isopropyl-3-methylbutanoic acid glycidyl ester, glycidyl ester of neodecanoic acid, glycidyl ester of neononanoic acid, hexahydro-m-phthalic acid bisglycidyl ester, hexahydro-o-phthalic acid bisglycidyl ester and hexahydro-p-phthalic acid bisglycidyl ester.

The (cyclo)aliphatic compound of the invention may be a monomer, an oligomer or polymer. In one embodiment, the (cyclo)aliphatic compound is preferably a monomer. Oligomers of the (cyclo)aliphatic compound refer to dimers, trimers and tetramers of the monomers of the (cyclo)aliphatic compound. The (cyclo)aliphatic compound suitable for the inventive composition can be any (cyclo)aliphatic compound known in the art. Examples of suitable (cyclo)aliphatic compound include oxetanes, cyclic carbonates, cyclic acetals, vinyl ethers, allyl ethers, acrylates, lactones, thiiranes, thietanes, silyl ethers, oxiranes and thioethers.

Examples of oxetanes include trimethylene oxide, 3,3-dimethyloxetane, 3,3-dichloromethyloxetane, 3-ethyl-3-phenoxy-methyloxetane and bis(3-ethyl-3-methoxy) butane. Examples of cyclic carbonates include reaction products of epoxy rings with carbon dioxide such as reaction products of bisphenol A diglycidyl ether, hydrogenated bisphenol A diglycidyl ether, bisphenol F diglycidyl ether and/or hydrogenated bisphenol F diglycidyl ether with CO₂. Examples of cyclic acetals include trioxane and 1,3-dioxalane and 1,3,6-trioxanecyclooctane. Examples of cyclic lactones include γ -propiolactone and ϵ -caprolactone. Examples of thiiranes include ethylenesulfide, 1,2-propylene sulfide and thioepichlorohydrin. Examples of thietanes include 3,3-dimethylthietane. Examples of vinyl ethers include ethylene glycol divinyl ether, triethylene glycol divinyl ether and trimethylolpropane triglycidyl ether. Examples of oxiranes include ethylene oxide.

The coating composition may further comprise a pigment. Examples of pigments and dyes include metal oxides like titanium dioxide, iron oxide, zinc oxide and chromium oxide; metal hydroxides; metal sulfides, metal sulfates, metal carbonates such as calcium carbonate; carbon black and china clay.

The coating composition of the invention comprises the pigment in an amount of at most 30 % by weight (wt%), based on the total weight of the coating composition. Preferably, the pigment is present in an amount of at most 25 wt%, more preferably at most 20 wt%, even more preferably at most 15 wt% and most preferably at most 10 wt%, and preferably at least 0.1 wt%, more preferably at least 0.5 wt%, even more preferably at least 1 wt% and most preferably at least 1.5 wt%, based on the total weight of the coating composition.

In another embodiment of the invention, the coating composition comprises solids in an amount of at least 40 % by weight (wt%), based on the total weight of the coating composition. Preferably, the solids are present in an amount of at least 50 wt%, more preferably at least 60 wt%, even more preferably at least 65 wt% and most preferably at least 70 wt%, and preferably

at most 100 wt%, more preferably at most 95 wt%, even more preferably at most 90 wt% and most preferably at most 80 wt%, based on the total weight of the coating composition. The term “solids” is known to the man skilled in the art, and generally refers to the solid or non-volatile material in the coating composition; typically the solids include the resins, pigments, dyes, catalyst, etc. and does not include solvents that evaporate during the curing process. The amount of solids may also be referred to as “solids content”.

The remaining part of the coating composition may be comprised of other components commonly used in coating compositions. With the cationically polymerizable building block, curing agent and the other components add up to 100 wt% of the total weight of the coating composition.

In an embodiment of the invention, the coating composition of the invention can be further diluted by a solvent to obtain a solids content below 40 wt%. For certain applications, such as the application of extremely thin coating layers, this may be warranted. In such case, the solids content in the coating composition of the invention may be preferably at most 35 wt%, more preferably at most 30 wt% and most preferably at most 25 wt%, and preferably at least 1 wt%, more preferably at least 2 wt%, even more preferably at least 5 wt%, and most preferably at least 10 wt%.

Alternatively, the coating compositions with the higher solids content (above 50 wt%) may be diluted with a suitable solvent, and optionally additives, just prior to application to a substrate. The dilution level may be used as desired, and the skilled person is well capable of diluting in an appropriate manner.

The coating composition of the invention may further comprise a solvent. The solvent may be any suitable solvent known in the art. Depending on the application and performance of the coating, one can choose between a non-reactive (e.g. to lower viscosity, flow improvement etc.) and/or a reactive solvent (e.g. to lower viscosity, improve final performance of the coating etc.). The solvent may comprise functional groups selected from hydroxyl, amine and thiol. Preferably, the functional group is a hydroxyl or an amine. Such solvents may be referred to as reactive solvents as these will be built into the coating composition upon curing. Examples of reactive solvents include the glycidyl ethers from alcohols, such as glycidyl ethers from methanol, ethanol, diethanol, aminoethanol, glycol, n-propanol, iso-propanol, trimethylol propane, ethanethiol, ethylene glycol, propylene glycol and neopentyl glycol; and acrylates such as acrylate, methacrylate, ethyl acrylate, 2-chloroethyl vinyl ether, 2-ethylhexyl acrylate, 2-

hydroxyethyl methacrylate, butyl acrylate, butyl methacrylate, 2-hydroxypropyl methacrylate, 3-hydroxypropyl methacrylate, 2-hydroxypropyl methacrylate, and 3-hydroxypropyl methacrylate.

Examples of non-reactive solvents include Solvent Naphtha®, heavy benzene, various Solvesso® grades, various Shellsol® grades and Deasol®, various white spirits, mineral
5 turpentine oil, tetralin, decalin, methyl ethyl ketone, acetone and methyl n-propyl ketone. If the solvent is not preferred to be present in the final coating, a volatile solvent should be selected, such as methyl ethyl ketone. In case, presence of inert solvents in the coating is an aim, the non-reactive solvent has a boiling point above 250 °C, therewith meeting the generally accepted criterium for non-VOC classification. The coating composition of the invention may comprise a
10 reactive solvent and a non-reactive solvent, a combination of two or more solvents, or a combination of two or more reactive solvents. Coating compositions comprising a reactive solvent are preferred.

The coating composition of the invention may comprise the non-reactive solvent and/or the reactive solvent in an amount of at most 30 % by weight (wt%), based on the total weight of the
15 coating composition. Preferably, the non-reactive solvent and/or the reactive solvent is present in an amount of at most 25 wt%, more preferably at most 20 wt%, even more preferably at most 15 wt% and most preferably at most 30 wt%, and preferably at least 1 wt%, more preferably at least 2 wt%, even more preferably at least 5 wt% and most preferably at least 10 wt%, based on the total weight of the coating composition.

20 The coating composition may further comprise additives commonly used in coating compositions including dyes, surfactants, flow controlling agents, thixotropic agents, anti-gassing agents, ultraviolet light stabilizers, adhesion enhancing promoters, waxes, filling agents, matting agents, defoamers and curing catalysts. The additives can be any additive known in the art. Examples of dyes include phthalo blues and greens, organo reds and other organic dyes.

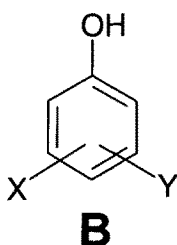
25 Examples of ultraviolet light stabilizers include benzophenone, such as hydroxydodecyl benzophenone, 2,4-dihydroxy-3',5'-di-t-butylbenzophenone, 2-hydroxy-4-acryloxyethoxybenzophenone and 2-hydroxy-4-methoxy-2'-carboxybenzophenone.

The coating composition of the invention may comprise the additives in an amount of at most 30 % by weight (wt%), based on the total weight of the coating composition. Preferably, the
30 additive is present in an amount of at most 25 wt%, more preferably at most 20 wt%, even more preferably at most 15 wt% and most preferably at most 30 wt%, and preferably at least 1 wt%,

more preferably at least 2 wt%, even more preferably at least 5 wt% and most preferably at least 10 wt%, based on the total weight of the coating composition.

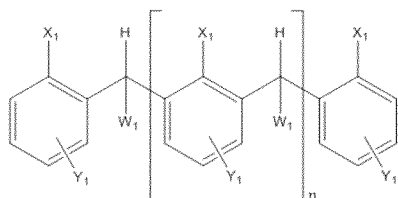
The invention further pertains to a kit of parts comprising (a) a cationically polymerizable building block; and (b) a curing agent comprising one or more fatty amine selected from the group consisting of an alkylated polyamine, bisalkylated amine, alkylated primary amine, an alkoxyalkylated polyamine, bisalkoxyalkylated amine and alkoxyalkylated primary amine;
 5 a substituted phenol having formula (B):

10



wherein X and Y are individually selected from the group of COOH, carboxylate, OH, NH₂, NO₂, SO₃H, PO₃H, Cl, F, Br, I, alkyl, alkenyl, COOR, OR, COR and aldehyde, and/or a substituted phenyl having formula (B1):

15



(B1)

wherein n is a number from 0 to 1000, X₁ is selected from hydrogen, hydroxyl and carboxylic acid, and Y₁ is selected from hydrogen, alkyl, alkenyl, alkynyl, aryl, substituted alkyls, substituted alkenyl, substituted alkynyl, substituted aryls, polycyclic aromatics, substituted polycyclic aromatics, polar functional groups, such as alcohol, amines, ketones, aldehydes, ethers, carboxylic acids, sulfonates, sulfonic acids, phosphonic acids and heterocyclics; and
 20 W₁ is independently selected from hydrogen, alkyl, alkenyl, alkynyl, aryl, substituted alkyl, substituted alkenyl, substituted alkynyl, substituted aryls, polycyclic aromatics, substituted polycyclic aromatics, polar functional groups, such as alcohol, amines, ketones, aldehydes, amides, esters, carbonyls, epoxies, oxetanes, oxiranes, ethers, carboxylic acids, sulfonates,
 25 sulfonic acids, phosphonic acids and heterocyclics; and a low temperature cure agent;

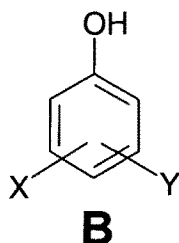
wherein the molar ratio of the fatty amine and the substituted phenol and/or the substituted phenyl is at least 0.2 and at most 5. The curing agent and the cationically polymerizable building block are generally stored separately to prevent pre-mature curing. These 2K systems should be mixed before applying the resulting coating composition to a substrate.

- 5 The invention further pertains to a kit of parts comprising (a) a cationically polymerizable building block; and (b) a curing agent comprising an alkylated polyamine having the formula $R_1-N((CH_2)_x-N)_n-(CH_2)_x-NH_2$,

wherein R_1 is selected from the group consisting of linear or branched C_6-C_{50} alkyl, linear or branched C_6-C_{50} alkenyl, linear or branched C_6-C_{50} arylalkyl and linear or branched C_6-C_{50}

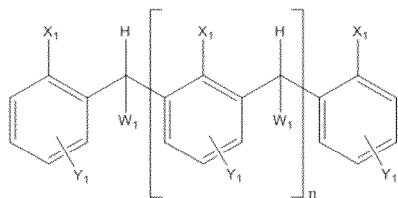
- 10 alkylaryl, x is 2 to 5, and n is 0 to 10;

a substituted phenol having formula (B):



15

wherein X and Y are individually selected from the group of $COOH$, carboxylate, OH , NH_2 , NO_2 , SO_3H , PO_3H , Cl , F , B , I , alkyl, alkenyl, $COOR$, OR , COR and aldehyde, and/or a substituted phenyl having formula (B1):



(B1)

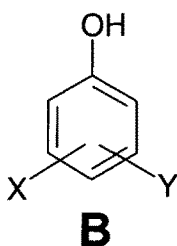
- 20 wherein n is a number from 0 to 1000, X_1 is selected from hydrogen, hydroxyl and carboxylic acid, and Y_1 is selected from hydrogen, alkyl, alkenyl, alkynyl, aryl, substituted alkyls, substituted alkenyl, substituted alkynyl, substituted aryls, polycyclic aromatics, substituted polycyclic aromatics, polar functional groups, such as alcohol, amines, ketones, aldehydes, ethers, carboxylic acids, sulfonates, sulfonic acids, phosphonic acids and heterocyclics; and
- 25 W_1 is independently selected from hydrogen, alkyl, alkenyl, alkynyl, aryl, substituted alkyl, substituted alkenyl, substituted alkynyl, substituted aryls, polycyclic aromatics, substituted

polycyclic aromatics, polar functional groups, such as alcohol, amines, ketones, aldehydes, amides, esters, carbonyls, epoxies, oxetanes, oxiranes, ethers, carboxylic acids, sulfonates, sulfonic acids, phosphonic acids and heterocyclics; and a low temperature cure agent;

5 wherein the molar ratio of the alkylated polyamine and the substituted phenol and/or the substituted phenyl is at least 0.2 and at most 5.

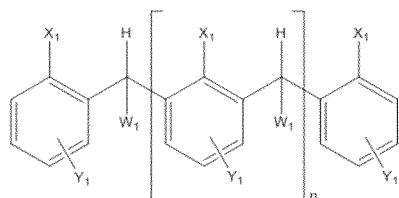
The invention further pertains to a kit of parts comprising (a) a cationically polymerizable building block; and (b) a curing agent comprising a bisalkylated amine having the formula R_2-NH-R_3 , wherein R_2 and R_3 are individually selected from the group of linear or branched C_6-C_{50} alkyl, linear or branched C_6-C_{50} alkenyl, linear or branched C_6-C_{50} arylalkyl and linear or branched C_6-C_{50} alkylaryl; and a substituted phenol having formula (B):

15



wherein X and Y are individually selected from the group of COOH, carboxylate, OH, NH_2 , NO_2 , SO_3H , PO_3H , Cl, F, B, I, alkyl, alkenyl, COOR, OR, COR and aldehyde, and/or a substituted phenyl having formula (B1):

20



(B1)

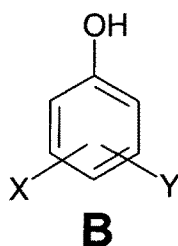
wherein n is a number from 0 to 1000, X_1 is selected from hydrogen, hydroxyl and carboxylic acid, and Y_1 is selected from hydrogen, alkyl, alkenyl, alkynyl, aryl, substituted alkyls, substituted alkenyl, substituted alkynyl, substituted aryls, polycyclic aromatics, substituted polycyclic aromatics, polar functional groups, such as alcohol, amines, ketones, aldehydes, ethers, carboxylic acids, sulfonates, sulfonic acids, phosphonic acids and heterocyclics; and

25

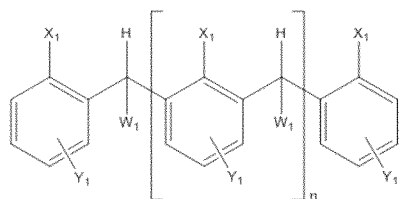
W_1 is independently selected from hydrogen, alkyl, alkenyl, alkynyl, aryl, substituted alkyl, substituted alkenyl, substituted alkynyl, substituted aryls, polycyclic aromatics, substituted polycyclic aromatics, polar functional groups, such as alcohol, amines, ketones, aldehydes, amides, esters, carbonyls, epoxies, oxetanes, oxiranes, ethers, carboxylic acids, sulfonates, sulfonic acids, phosphonic acids and heterocyclics; and
 5 a low temperature cure agent;
 wherein the molar ratio of the bisalkylated amine and the substituted phenol and/or the substituted phenyl is at least 0.2 and at most 5.

The invention further pertains to a kit of parts comprising (a) a cationically polymerizable
 10 building block; and (b) a curing agent comprising an alkylated primary amine having the formula R_4-NH_2 , wherein R_4 is individually selected from the group of linear or branched C_6-C_{50} alkyl, linear or branched C_6-C_{50} alkenyl, linear or branched C_6-C_{50} arylalkyl and linear or branched C_6-C_{50} alkylaryl; and
 a substituted phenol having formula (B):

15



wherein X and Y are individually selected from the group of COOH, carboxylate, OH, NH_2 , NO_2 ,
 20 SO_3H , PO_3H , Cl, F, B, I, alkyl, alkenyl, COOR, OR, COR and aldehyde, and/or
 a substituted phenyl having formula (B1):



(B1)

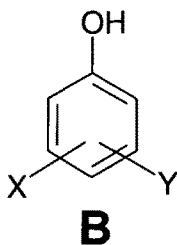
wherein n is a number from 0 to 1000, X_1 is selected from hydrogen, hydroxyl and carboxylic acid, and Y_1 is selected from hydrogen, alkyl, alkenyl, alkynyl, aryl, substituted alkyls,
 25 substituted alkenyl, substituted alkynyl, substituted aryls, polycyclic aromatics, substituted

polycyclic aromatics, polar functional groups, such as alcohol, amines, ketones, aldehydes, ethers, carboxylic acids, sulfonates, sulfonic acids, phosphonic acids and heterocyclics; and W_1 is independently selected from hydrogen, alkyl, alkenyl, alkynyl, aryl, substituted alkyl, substituted alkenyl, substituted alkynyl, substituted aryls, polycyclic aromatics, substituted polycyclic aromatics, polar functional groups, such as alcohol, amines, ketones, aldehydes, amides, esters, carbonyls, epoxies, oxetanes, oxiranes, ethers, carboxylic acids, sulfonates, sulfonic acids, phosphonic acids and heterocyclics; and a low temperature cure agent;

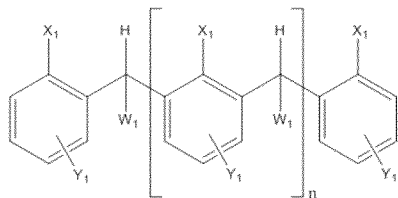
wherein the molar ratio of the alkylated primary amine and the substituted phenol and/or the substituted phenyl is at least 0.2 and at most 5.

The invention further pertains to a kit of parts comprising (a) a cationically polymerizable building block; and (b) a curing agent comprising an alkoxyated polyamine having the formula $R_5-N-((CH_2)_x-N)_n-(CH_2)_x-NH_2$,

wherein R_5 is $-R_6-O-R_7$ wherein R_6 is selected from the group consisting of C_1-C_{24} alkylene, arylalkylene and alkylarylene, and R_7 is selected from the group consisting of linear or branched C_6-C_{50} alkyl, linear or branched C_6-C_{50} alkenyl, linear or branched C_6-C_{50} arylalkyl and linear or branched C_6-C_{50} alkylaryl, x is 2 to 5, and n is 0 to 10; and a substituted phenol having formula (B):



wherein X and Y are individually selected from the group of $COOH$, carboxylate, OH , NH_2 , NO_2 , SO_3H , PO_3H , Cl , F , B , I , alkyl, alkenyl, $COOR$, OR , COR and aldehyde, and/or a substituted phenyl having formula (B1):

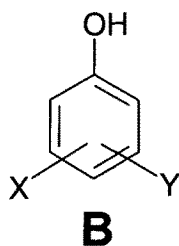


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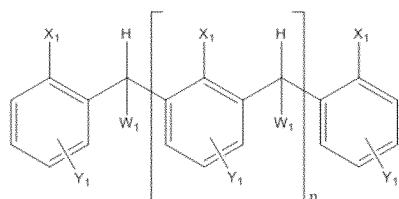
wherein n is a number from 0 to 1000, X₁ is selected from hydrogen, hydroxyl and carboxylic acid, and Y₁ is selected from hydrogen, alkyl, alkenyl, alkynyl, aryl, substituted alkyls, substituted alkenyl, substituted alkynyl, substituted aryls, polycyclic aromatics, substituted polycyclic aromatics, polar functional groups, such as alcohol, amines, ketones, aldehydes, ethers, carboxylic acids, sulfonates, sulfonic acids, phosphonic acids and heterocyclics; and
 5 W₁ is independently selected from hydrogen, alkyl, alkenyl, alkynyl, aryl, substituted alkyl, substituted alkenyl, substituted alkynyl, substituted aryls, polycyclic aromatics, substituted polycyclic aromatics, polar functional groups, such as alcohol, amines, ketones, aldehydes, amides, esters, carbonyls, epoxies, oxetanes, oxiranes, ethers, carboxylic acids, sulfonates,
 10 sulfonic acids, phosphonic acids and heterocyclics; and
 a low temperature cure agent;

wherein the molar ratio of the alkoxyated polyamine and the substituted phenol and/or the substituted phenyl is at least 0.2 and at most 5.

The invention further pertains to a kit of parts comprising (a) a cationically polymerizable
 15 building block; and (b) a curing agent comprising a bisalkoxyated amine having the formula R₁₀-O-R₈-NH-R₉-O-R₁₁, wherein R₈ and R₉ are individually selected from the group consisting of C₁-C₂₄ alkylene, arylalkylene and alkylarylene; and R₁₀ and R₁₁ are individually selected from the group consisting of linear or branched C₆-C₅₀ alkyl, linear or branched C₆-C₅₀ alkenyl, linear or branched C₆-C₅₀ arylalkyl and linear or branched C₆-C₅₀ alkylaryl; and
 20 a substituted phenol having formula (B):



25 wherein X and Y are individually selected from the group of COOH, carboxylate, OH, NH₂, NO₂, SO₃H, PO₃H, Cl, F, B, I, alkyl, alkenyl, COOR, OR, COR and aldehyde, and/or
 a substituted phenyl having formula (B1):



(B1)

wherein n is a number from 0 to 1000, X_1 is selected from hydrogen, hydroxyl and carboxylic acid, and Y_1 is selected from hydrogen, alkyl, alkenyl, alkynyl, aryl, substituted alkyls, substituted alkenyl, substituted alkynyl, substituted aryls, polycyclic aromatics, substituted polycyclic aromatics, polar functional groups, such as alcohol, amines, ketones, aldehydes, ethers, carboxylic acids, sulfonates, sulfonic acids, phosphonic acids and heterocyclics; and

5 W_1 is independently selected from hydrogen, alkyl, alkenyl, alkynyl, aryl, substituted alkyl, substituted alkenyl, substituted alkynyl, substituted aryls, polycyclic aromatics, substituted polycyclic aromatics, polar functional groups, such as alcohol, amines, ketones, aldehydes, amides, esters, carbonyls, epoxies, oxetanes, oxiranes, ethers, carboxylic acids, sulfonates, sulfonic acids, phosphonic acids and heterocyclics; and

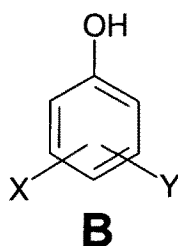
10 a low temperature cure agent;

wherein the molar ratio of the bisalkylated amine and the substituted phenol and/or the substituted phenyl is at least 0.2 and at most 5.

15 The invention further pertains to a kit of parts comprising (a) a cationically polymerizable building block; and (b) a curing agent comprising an alkoxyated primary amine having the the formula $R_{13}-O-R_{12}-NH_2$, wherein R_{12} is individually selected from the group consisting of C_1-C_{24} alkylene, arylalkylene and alkylarylene, and R_{13} is selected from the group consisting of linear or branched C_6-C_{50} alkyl, linear or branched C_6-C_{50} alkenyl, linear or branched C_6-C_{50} arylalkyl and

20 linear or branched C_6-C_{50} alkylaryl; and

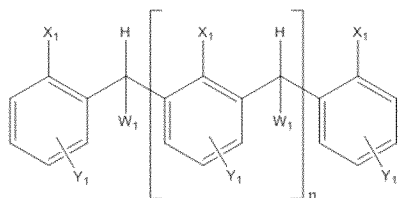
a substituted phenol having formula (B):



25

wherein X and Y are individually selected from the group of $COOH$, carboxylate, OH , NH_2 , NO_2 , SO_3H , PO_3H , Cl , F , B , I , alkyl, alkenyl, $COOR$, OR , COR and aldehyde, and/or

a substituted phenyl having formula (B1):



(B1)

wherein n is a number from 0 to 1000, X₁ is selected from hydrogen, hydroxyl and carboxylic acid, and Y₁ is selected from hydrogen, alkyl, alkenyl, alkynyl, aryl, substituted alkyls,

5 substituted alkenyl, substituted alkynyl, substituted aryls, polycyclic aromatics, substituted polycyclic aromatics, polar functional groups, such as alcohol, amines, ketones, aldehydes, ethers, carboxylic acids, sulfonates, sulfonic acids, phosphonic acids and heterocyclics; and
 10 W₁ is independently selected from hydrogen, alkyl, alkenyl, alkynyl, aryl, substituted alkyl, substituted alkenyl, substituted alkynyl, substituted aryls, polycyclic aromatics, substituted polycyclic aromatics, polar functional groups, such as alcohol, amines, ketones, aldehydes, amides, esters, carbonyls, epoxies, oxetanes, oxiranes, ethers, carboxylic acids, sulfonates, sulfonic acids, phosphonic acids and heterocyclics; and

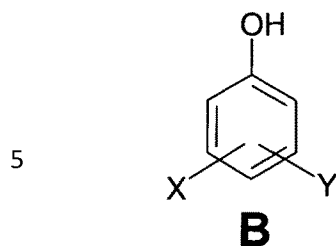
a low temperature cure agent;

wherein the molar ratio of the alkoxyated polyamine and the substituted phenol and/or the
 15 substituted phenyl is at least 0.2 and at most 5.

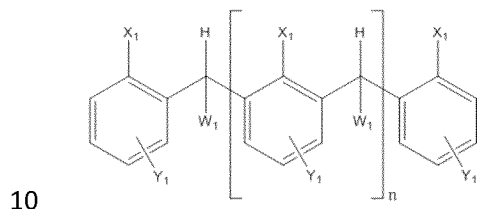
The invention further pertains to a process for preparing a coated substrate comprising the steps of: (a) applying the coating composition according to the invention to a substrate; and (b) curing the coating composition. In an embodiment of the invention, the cationically
 20 polymerizable building block and the curing agent are contacted to form the coating compositions of the invention, which is subsequently applied to a substrate according to step (a). The process of the invention can be conducted in the presence of further water, e.g. the process is performed in a moist environment or even under liquid water. The presence of water may enable a faster curing of the coating composition.

The invention further pertains to a process for preparing a coated substrate comprising the
 25 steps of: (a) applying the coating composition comprising a cationically polymerizable building block and a curing agent comprising one or more fatty amine selected from the group consisting of an alkylated polyamine, bisalkylated amine, alkylated primary amine, an alkoxyated polyamine, bisalkoxyated amine and alkoxyated primary amine;

a substituted phenol having formula (B):



wherein X and Y are individually selected from the group of COOH, carboxylate, OH, NH₂, NO₂, SO₃H, PO₃H, Cl, F, B, I, alkyl, alkenyl, COOR, OR, COR and aldehyde, and/or a substituted phenyl having formula (B1):



wherein n is a number from 0 to 1000, X₁ is selected from hydrogen, hydroxyl and carboxylic acid, and Y₁ is selected from hydrogen, alkyl, alkenyl, alkynyl, aryl, substituted alkyls, substituted alkenyl, substituted alkynyl, substituted aryls, polycyclic aromatics, substituted polycyclic aromatics, polar functional groups, such as alcohol, amines, ketones, aldehydes, ethers, carboxylic acids, sulfonates, sulfonic acids, phosphonic acids and heterocyclics; and W₁ is independently selected from hydrogen, alkyl, alkenyl, alkynyl, aryl, substituted alkyl, substituted alkenyl, substituted alkynyl, substituted aryls, polycyclic aromatics, substituted polycyclic aromatics, polar functional groups, such as alcohol, amines, ketones, aldehydes, amides, esters, carbonyls, epoxies, oxetanes, oxiranes, ethers, carboxylic acids, sulfonates, sulfonic acids, phosphonic acids and heterocyclics; and a low temperature cure agent;

15

20

wherein the molar ratio of the fatty amine and the substituted phenol and/or the substituted phenyl is at least 0.2 and at most 5, to a substrate; and (b) curing the coating composition.

25 Step (b) of the process of the invention can be performed in a moist or humid atmosphere, i.e. in an environment comprising gaseous water. The gaseous water can positively influence the curing speed of the coating composition.

Step (b) can further be performed while the coated substrate is submerged in water. The coating composition continues its curing while being under water and is capable of curing completely.

The invention further pertains to the use of a low temperature cure agent, preferably an aliphatic polyamine, in a curing agent to cure cationically polymerizable building blocks at temperatures
5 below room temperature, preferably at a temperature below 20°C, more preferably at a temperature below 15°C, and most preferably at a temperature below 10°C. In a further embodiment of the invention, low temperature cure agent, preferably the aliphatic polyamine, is combined with the fatty amine of the invention.

10 In one embodiment, the curing agent comprises the low temperature cure agent, preferably the aliphatic polyamine, in an amount of at most 10 wt%, based on the total weight of the curing agent. In a further embodiment of the invention, the curing agent comprises the aliphatic polyamine in an amount of at least 0.01 % by weight (wt%), based on the total weight of the curing agent. Preferably, the low temperature cure agent, preferably the aliphatic polyamine, is
15 present in an amount of at least 0.05 wt%, more preferably at least 0.1 wt%, even more preferably at least 0.5 wt% and most preferably at least 1 wt%, and preferably at most 5 wt%, more preferably at most 4 wt%, even more preferably at most 3 wt% and most preferably at most 2 wt%, based on the total weight of the curing agent.

The invention also pertains to a coated substrate comprising a substrate and a
20 cured coating composition applied to at least part of the substrate, the coating composition being in accordance with the invention. In an embodiment of the invention the coated substrate is a metal surface. The cured coating composition has all the advantages as described above for the cured coating composition. A further advantage of the cured coating composition is that the volatile organic compounds (VOC) level is generally very low. The VOC level is typically
25 determined using standard method ASTM D3960-05(2013). The amount of VOC in the coating composition of the invention is generally at most 100 g/l, preferably at most 75 g/l, more preferably at most 60 g/l, and most preferably at most 50 g/l.

The substrate of the invention can be any substrate known in the art. The substrate may be porous or non-porous. Examples of suitable substrates include metals, such as aluminum,
30 aluminum alloys, steel, steel alloys, tin, tin alloys, zinc, zinc alloys, chrome and chrome alloys; glass such as fused silica glass, aluminosilicate glass, soda-lime-silica glass, borosilicate glass and lead-oxide glass; ceramics, such as porcelain, bone china, alumina, ceria, zirconia,

carbides, borides, nitrides and silicides; plastic such as functionalized polyethylene (PE), functionalized polypropylene (PP), polyethylene terephthalate (PET), polyvinyl chloride (PVC) and nylons; and wood. Preferably, the substrate is metal, in particular steel and aluminum. Most preferably the substrate is steel.

5 In the context of the present application the term “cure” or “cured” refers to the process of hardening of the coating composition by polymerization and/or crosslinking. This curing process can be initiated by admixture of the curing agent and the cationically polymerizable building blocks. The coating compositions of the invention may cure through exposure to heat. The curing can proceed at temperatures commonly used in the art. The coating compositions of the
10 invention generally cure at room temperature; the curing may even proceed at temperatures as low as 5°C.

In the context of the present application the term “molar ratio” refers to the ratio between two components as is commonly used in the art. When one of these components is an oligomeric or polymeric component only the moles of their corresponding monomers having functional groups
15 capable of coordinating and/or reacting with the fatty amine should be taken in the calculation of the molar ratio. The monomer typically comprises hydroxyl and a second functional group as expressed by substituent X₁ and/or Y₁ in the substituted phenyl. The amount of active groups, and thus the amount of monomers with functional groups, in the polymer can be determined by well-known techniques, such as acid-base titration and NMR spectroscopy.

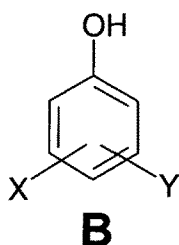
20 In a further embodiment of the invention, the coating composition of the invention can be used in application where corrosion protection and/or cured coating flexibility and formability are required. Examples of such applications include flooring, steel construction applications like in bridges or buildings, marine protective applications, coil coating applications, car refinish, and automotive applications.

25 New curing agents

The invention further pertains to the curing agents as defined above but then without the low temperature cure agent. Each of the specified curing agents and their embodiments (without the low temperature curing agent) – including the embodiments for the various substituents, the phenol and the substituted phenyl, the presence of a solvent and the various amounts – are
30 considered as explicitly disclosed embodiments of the present invention. In particular, the invention pertains to such a curing agent comprising alkylated primary amine having the formula

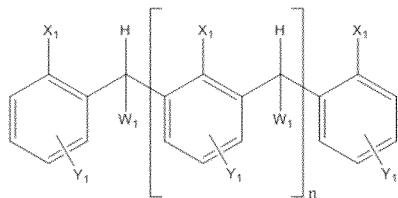
R₄-NH₂, wherein R₄ is individually selected from the group of linear or branched C₆-C₅₀ alkyl, linear or branched C₆-C₅₀ alkenyl, linear or branched C₆-C₅₀ arylalkyl and linear or branched C₆-C₅₀ alkylaryl. The invention pertains to a curing agent comprising alkylated primary amine having the formula R₄-NH₂, wherein R₄ is individually selected from the group of linear or branched C₆-C₅₀ alkyl, linear or branched C₆-C₅₀ alkenyl, linear or branched C₆-C₅₀ arylalkyl and linear or branched C₆-C₅₀ alkylaryl; and a substituted phenol having formula (B):

10



wherein X and Y are individually selected from the group of COOH, carboxylate, OH, NH₂, NO₂, SO₃H, PO₃H, Cl, F, Br, I, alkyl, alkenyl, COOR, OR, COR and aldehyde, and/or a substituted phenyl having formula (B1):

15



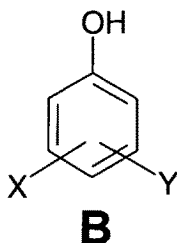
(B1)

wherein n is a number from 0 to 1000, X₁ is selected from hydrogen, hydroxyl and carboxylic acid, and Y₁ is selected from hydrogen, alkyl, alkenyl, alkynyl, aryl, substituted alkyls, substituted alkenyl, substituted alkynyl, substituted aryls, polycyclic aromatics, substituted polycyclic aromatics, polar functional groups, such as alcohol, amines, ketones, aldehydes, ethers, carboxylic acids, sulfonates, sulfonic acids, phosphonic acids and heterocyclics; and W₁ is independently selected from hydrogen, alkyl, alkenyl, alkynyl, aryl, substituted alkyl, substituted alkenyl, substituted alkynyl, substituted aryls, polycyclic aromatics, substituted polycyclic aromatics, polar functional groups, such as alcohol, amines, ketones, aldehydes, amides, esters, carbonyls, epoxies, oxetanes, oxiranes, ethers, carboxylic acids, sulfonates, sulfonic acids, phosphonic acids and heterocyclics; and wherein the molar ratio of the alkylated primary amine and the substituted phenol and/or the substituted phenyl is at least 0.2 and at most 5. The alkylated primary amine and the substituted

phenol and/or phenyl combine to form a novel liquid curing agent which is liquid at low temperatures e.g. 5°C, in particular liquid at temperatures where the fatty amine is solid, i.e. below the melting point of the fatty amine. The liquid curing agent is moreover compatible with cationically polymerizable building blocks like epoxy resins, and is capable of curing these building blocks. The film forming properties of coating compositions comprising the curing agent and the cationically polymerizable building blocks is generally good, with good wetting properties, and generally spreads well over a wide variety of surfaces, even surfaces that have aged, are rusty or unclean. The resulting cured coating has generally very good chemical resistance, corrosion resistance, scratch resistance and good adhesion to a wide variety of surfaces.

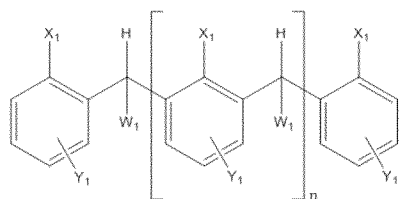
The invention further pertains to such a curing agent comprising one or more fatty amines selected from the group consisting of an alkoxyated polyamine, bisalkoxyated amine and alkoxyated primary amine. the fatty amine and the substituted phenol and/or substituted phenyl is at least 0.2 and at most 5. The fatty alkoxyated amine and the substituted phenol and/or phenyl combine to form a novel liquid curing agent which is liquid at low temperatures e.g. 5°C. The liquid curing agent is moreover compatible with cationically polymerizable building blocks like epoxy resins, and is capable of curing these building blocks. The film forming properties of coating compositions comprising the curing agent and the cationically polymerizable building blocks is generally good, with good wetting properties, and generally spreads well over a wide variety of surfaces, even surfaces that have aged, are rusty or unclean. The resulting cured coating has generally very good chemical resistance, corrosion resistance, scratch resistance, high gloss, and good adhesion to a wide variety of surfaces.

The present invention further pertains to a curing agent comprising an alkoxyated polyamine having the formula $R_5-N((CH_2)_x-N)_n-(CH_2)_x-NH_2$ wherein R_5 is $-R_6-O-R_7$ wherein R_6 is selected from the group consisting of C_1-C_{24} alkylene, arylalkylene and alkylarylene, and R_7 is selected from the group consisting of linear or branched C_6-C_{50} alkyl, linear or branched C_6-C_{50} alkenyl, linear or branched C_6-C_{50} arylalkyl and linear or branched C_6-C_{50} alkylaryl, x is 2 to 5, and n is 0 to 10; and a substituted phenol having formula (B):



wherein X and Y are individually selected from the group of COOH, carboxylate, OH, NH₂, NO₂, SO₃H, PO₃H, Cl, F, B, I, alkyl, alkenyl, COOR, OR, COR and aldehyde, and/or

5 a substituted phenyl having formula (B1):



(B1)

wherein n is a number from 0 to 1000, X₁ is selected from hydrogen, hydroxyl and carboxylic acid, and Y₁ is selected from hydrogen, alkyl, alkenyl, alkynyl, aryl, substituted alkyls, substituted alkenyl, substituted alkynyl, substituted aryls, polycyclic aromatics, substituted polycyclic aromatics, polar functional groups, such as alcohol, amines, ketones, aldehydes, ethers, carboxylic acids, sulfonates, sulfonic acids, phosphonic acids and heterocyclics; and

10 W₁ is independently selected from hydrogen, alkyl, alkenyl, alkynyl, aryl, substituted alkyl, substituted alkenyl, substituted alkynyl, substituted aryls, polycyclic aromatics, substituted polycyclic aromatics, polar functional groups, such as alcohol, amines, ketones, aldehydes,

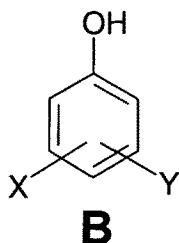
15 amides, esters, carbonyls, epoxies, oxetanes, oxiranes, ethers, carboxylic acids, sulfonates, sulfonic acids, phosphonic acids and heterocyclics;

wherein the molar ratio of the alkoxyated polyamine and the substituted phenol and/or the substituted phenyl is at least 0.2 and at most 5.

The invention further pertains to a curing agent comprising a bisalkoxyated amine having the

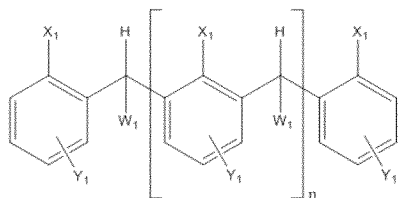
20 formula R₁₀-O-R₈-NH-R₉-O-R₁₁, wherein R₈ and R₉ are individually selected from the group consisting of C₁-C₂₄ alkylene, arylalkylene and alkylarylene; and R₁₀ and R₁₁ are individually selected from the group consisting of linear or branched C₆-C₅₀ alkyl, linear or branched C₆-C₅₀ alkenyl, linear or branched C₆-C₅₀ arylalkyl and linear or branched C₆-C₅₀ alkylaryl; and a substituted phenol having formula (B):

25



wherein X and Y are individually selected from the group of COOH, carboxylate, OH, NH₂, NO₂, SO₃H, PO₃H, Cl, F, B, I, alkyl, alkenyl, COOR, OR, COR and aldehyde, and/or

5 a substituted phenyl having formula (B1):



(B1)

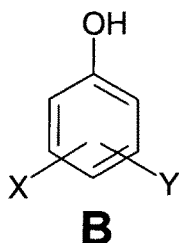
wherein n is a number from 0 to 1000, X₁ is selected from hydrogen, hydroxyl and carboxylic acid, and Y₁ is selected from hydrogen, alkyl, alkenyl, alkynyl, aryl, substituted alkyls,

10 substituted alkenyl, substituted alkynyl, substituted aryls, polycyclic aromatics, substituted polycyclic aromatics, polar functional groups, such as alcohol, amines, ketones, aldehydes, ethers, carboxylic acids, sulfonates, sulfonic acids, phosphonic acids and heterocyclics; and W₁ is independently selected from hydrogen, alkyl, alkenyl, alkynyl, aryl, substituted alkyl, substituted alkenyl, substituted alkynyl, substituted aryls, polycyclic aromatics, substituted polycyclic aromatics, polar functional groups, such as alcohol, amines, ketones, aldehydes, 15 amides, esters, carbonyls, epoxies, oxetanes, oxiranes, ethers, carboxylic acids, sulfonates, sulfonic acids, phosphonic acids and heterocyclics;

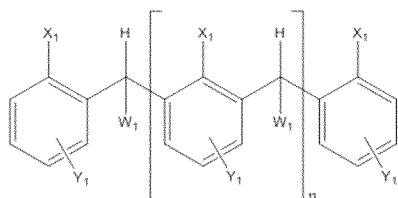
wherein the molar ratio of the bisalkoxylated amine and the substituted phenol and/or the substituted phenol is at least 0.2 and at most 5.

20 The invention further pertains to a curing agent comprising an alkoxyated primary amine having the formula R₁₃-O-R₁₂-NH₂, wherein R₁₂ is individually selected from the group consisting of C₁-C₂₄ alkylene, arylalkylene and alkylarylene, and R₁₃ is selected from the group consisting of linear or branched C₆-C₅₀ alkyl, linear or branched C₆-C₅₀ alkenyl, linear or branched C₆-C₅₀ arylalkyl and linear or branched C₆-C₅₀ alkylaryl; and

25 a substituted phenol having formula (B):



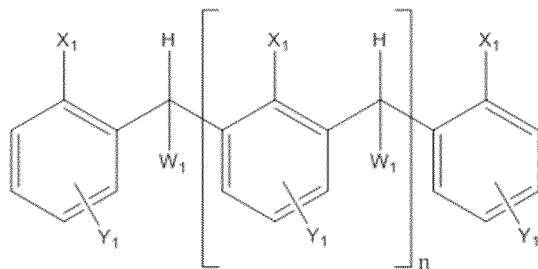
wherein X and Y are individually selected from the group of COOH, carboxylate, OH, NH₂, NO₂,
 5 SO₃H, PO₃H, Cl, F, B, I, alkyl, alkenyl, COOR, OR, COR and aldehyde, and/or
 a substituted phenyl having formula (B1):



(B1)

wherein n is a number from 0 to 1000, X₁ is selected from hydrogen, hydroxyl and carboxylic
 acid, and Y₁ is selected from hydrogen, alkyl, alkenyl, alkynyl, aryl, substituted alkyls,
 10 substituted alkenyl, substituted alkynyl, substituted aryls, polycyclic aromatics, substituted
 polycyclic aromatics, polar functional groups, such as alcohol, amines, ketones, aldehydes,
 ethers, carboxylic acids, sulfonates, sulfonic acids, phosphonic acids and heterocyclics; and
 W₁ is independently selected from hydrogen, alkyl, alkenyl, alkynyl, aryl, substituted alkyl,
 substituted alkenyl, substituted alkynyl, substituted aryls, polycyclic aromatics, substituted
 15 polycyclic aromatics, polar functional groups, such as alcohol, amines, ketones, aldehydes,
 amides, esters, carbonyls, epoxies, oxetanes, oxiranes, ethers, carboxylic acids, sulfonates,
 sulfonic acids, phosphonic acids and heterocyclics;
 wherein the molar ratio of the alkylated primary amine and the substituted phenol and/or the
 substituted phenyl is at least 0.2 and at most 5.

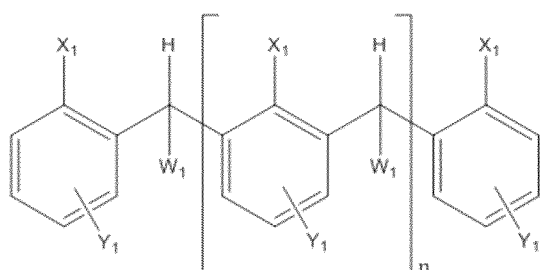
20 The present invention pertains to a curing agent comprising (a) one or more fatty amines
 selected from the group consisting of an alkylated polyamine and bisalkylated amine; and
 a substituted phenyl having formula (B):



(B).

The curing agent comprising the substituted phenol is generally liquid. The advantages mentioned in WO 2012/177121 and WO 2012/177120 also apply to the curing agent of the present invention. Moreover, the substituted phenol enables an improved adhesion of the cured
 5 coating composition to a substrate. The fatty amine and the substituted phenol and/or phenyl combine to form a liquid curing agent which is liquid at low temperatures e.g. 5°C, in particular liquid at temperatures where the fatty amine is solid, i.e. below the melting point of the fatty amine. The liquid curing agent is moreover compatible with cationically polymerizable building blocks like epoxy resins, and is capable of curing these building blocks. The film forming
 10 properties of coating compositions comprising the curing agent and the cationically polymerizable building blocks is generally good, with good wetting properties, and generally spreads well over a wide variety of surfaces, even surfaces that have aged, are rusty or unclean. The resulting cured coating has generally very good chemical resistance, corrosion resistance, scratch resistance, high gloss, and good adhesion to a wide variety of surfaces. It is
 15 noted that these advantages also apply to the curing agents mentioned above wherein the substituted phenyl is present.

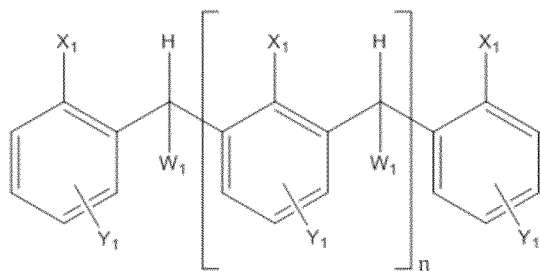
The present invention further pertains to a curing agent comprising an alkylated polyamine having the formula $R_1-N-((CH_2)_x-N)_n-(CH_2)_x-NH_2$,
 20 wherein R_1 is selected from the group consisting of linear or branched C_6-C_{50} alkyl, linear or branched C_6-C_{50} alkenyl, linear or branched C_6-C_{50} arylalkyl and linear or branched C_6-C_{50} alkylaryl, x is 2 to 5, and n is 0 to 10;
 a substituted phenyl having formula (B):



(B)

wherein n is a number from 0 to 1000, X₁ is selected from hydrogen, hydroxyl and carboxylic acid, and Y₁ is selected from hydrogen, alkyl, alkenyl, alkynyl, aryl, substituted alkyls, substituted alkenyl, substituted alkynyl, substituted aryls, polycyclic aromatics, substituted polycyclic aromatics, polar functional groups, such as alcohol, amines, ketones, aldehydes, ethers, carboxylic acids, sulfonates, sulfonic acids, phosphonic acids and heterocyclics; and W₁ can be independently selected from hydrogen, alkyl, alkenyl, alkynyl, aryl, substituted alkyl, substituted alkenyl, substituted alkynyl, substituted aryls, polycyclic aromatics, substituted polycyclic aromatics, polar functional groups, such as alcohol, amines, ketones, aldehydes, amides, esters, carbonyls, epoxies, oxetanes, oxiranes, ethers, carboxylic acids, sulfonates, sulfonic acids, phosphonic acids and heterocyclics; wherein the molar ratio of the alkylated polyamine and the substituted phenyl is at least 0.2 and at most 5.

The invention further pertains to a curing agent comprising a bisalkylated amine having the formula R₂-NH-R₃, wherein R₂ and R₃ are individually selected from the group consisting of linear or branched C₆-C₅₀ alkyl, linear or branched C₆-C₅₀ alkenyl, linear or branched C₆-C₅₀ arylalkyl and linear or branched C₆-C₅₀ alkylaryl; and a substituted phenyl having formula (B):



(B)

wherein n is a number from 0 to 1000, X₁ is selected from hydrogen, hydroxyl and carboxylic acid, and Y₁ is selected from hydrogen, alkyl, alkenyl, alkynyl, aryl, substituted alkyls, substituted alkenyl, substituted alkynyl, substituted aryls, polycyclic aromatics, substituted

polycyclic aromatics, polar functional groups, such as alcohol, amines, ketones, aldehydes, ethers, carboxylic acids, sulfonates, sulfonic acids, phosphonic acids and heterocyclics; and W_1 can be independently selected from hydrogen, alkyl, alkenyl, alkynyl, aryl, substituted alkyl, substituted alkenyl, substituted alkynyl, substituted aryls, polycyclic aromatics, substituted polycyclic aromatics, polar functional groups, such as alcohol, amines, ketones, aldehydes, amides, esters, carbonyls, epoxies, oxetanes, oxiranes, ethers, carboxylic acids, sulfonates, sulfonic acids, phosphonic acids and heterocyclics;

wherein the molar ratio of the bisalkylated amine and the substituted phenyl is at least 0.2 and at most 5.

10 Also the kit of parts comprising the above curing agents are part of the invention, and included as separate and explicit embodiments. In particular, the kit of parts comprising (a) a cationically polymerizable building block, and (b) a curing agent comprising the alkylated monoamine, the alkoxyated polyamine, the bisalkoxyated amine and/or the alkoxyated primary amine; and a substituted phenol and/or substituted phenyl are included. The embodiments of the kit of parts
15 are disclosed above, and also apply to the present kit of parts, except that the low temperature cure agent is absent.

The invention further pertains to a coating composition comprising a cationically polymerizable building block and a curing agent according to the invention. The embodiments of the coating
20 composition are disclosed above, and also apply to the present coating composition, except that the low temperature cure agent is absent.

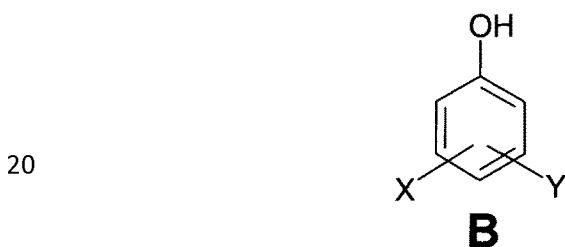
The invention further pertains to a process for preparing a coated substrate comprising the steps of: (a) applying the coating composition according to the invention to a substrate; and (b)
25 curing the coating composition. The embodiments of the process for preparing a coated substrate are disclosed above, and also apply to the present process, except that the low temperature cure agent is absent.

In a further embodiment of the invention, the coating composition of the invention can be used
30 in application where corrosion protection and/or cured coating flexibility and formability are required. Examples of such applications include flooring, steel construction applications like in bridges or buildings, marine protective applications, coil coating applications, car refinish, and automotive applications.

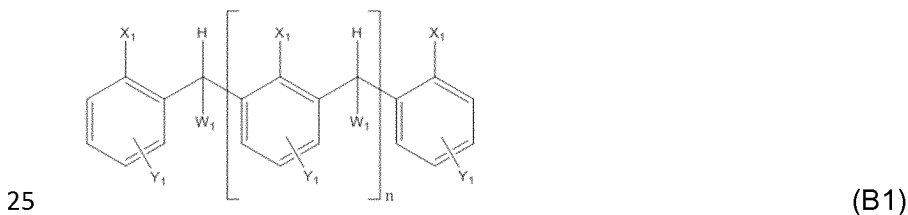
Curing agents comprising an adduct

The present invention pertains to a curing agent comprising an adduct of a reactive building block and one or more fatty amines selected from the group consisting of an alkylated polyamine, bisalkylated amine, alkylated primary amine, an alkoxyated polyamine, bisalkoxyated amine and alkoxyated primary amine. Each of the specified curing agents and their embodiments (without the low temperature curing agent) – including the embodiments for the various substituents, the phenol and the substituted phenyl, the presence of a solvent and the various amounts – are considered as explicitly disclosed embodiments of the present invention. Moreover, the adducts of each of the individual fatty amines are also disclosed individually and explicitly.

The present invention pertains to a curing agent comprising a) an adduct of a reactive building block and one or more fatty amines selected from the group consisting of an alkylated polyamine, bisalkylated amine, alkylated primary amine, an alkoxyated polyamine, bisalkoxyated amine and alkoxyated primary amine; and b) a substituted phenol having formula (B):



wherein X and Y are individually selected from the group of COOH, carboxylate, OH, NH₂, NO₂, SO₃H, PO₃H, Cl, F, B, I, alkyl, alkenyl, COOR, OR, COR and aldehyde, and/or a substituted phenyl having formula (B1):



wherein n is a number from 0 to 1000, X₁ is selected from hydrogen, hydroxyl and carboxylic acid, and Y₁ is selected from hydrogen, alkyl, alkenyl, alkynyl, aryl, substituted alkyls, substituted alkenyl, substituted alkynyl, substituted aryls, polycyclic aromatics, substituted

polycyclic aromatics, polar functional groups, such as alcohol, amines, ketones, aldehydes, ethers, carboxylic acids, sulfonates, sulfonic acids, phosphonic acids and heterocyclics; and W_1 is independently selected from hydrogen, alkyl, alkenyl, alkynyl, aryl, substituted alkyl, substituted alkenyl, substituted alkynyl, substituted aryls, polycyclic aromatics, substituted polycyclic aromatics, polar functional groups, such as alcohol, amines, ketones, aldehydes, amides, esters, carbonyls, epoxies, oxetanes, oxiranes, ethers, carboxylic acids, sulfonates, sulfonic acids, phosphonic acids and heterocyclics;

wherein the molar ratio of the fatty amine and the substituted phenol and/or

the substituted phenyl is at least 0.2 and at most 5. The advantage of the adduct of the

invention is that it can easily be mixed with a reactive building block without an induction time.

The adduct of the fatty amine and the substituted phenol and/or phenyl combine to form a liquid curing agent which is liquid at low temperatures e.g. 5°C, in particular liquid at temperatures where the fatty amine is solid, i.e. below the melting point of the fatty amine. The liquid curing agent is moreover compatible with reactive building blocks like epoxy resins, and is capable of curing these building blocks. The film forming properties of coating compositions comprising the curing agent and the reactive building blocks is generally good, with good wetting properties, and generally spreads well over a wide variety of surfaces, even surfaces that have aged, are rusty or unclean. The resulting cured coating has generally very good chemical resistance, corrosion resistance, scratch resistance and good adhesion to a wide variety of surfaces.

In the context of this application the wording "adduct" refers to reaction products of the reactive building block and fatty amine, preferably of monomers of the reactive building block and the fatty amine wherein the resulting adduct maintains at least two functional groups enabling polymerization and/or cross-linking of the adduct.

The invention further pertains to a coating composition comprises the adduct alone, and also combinations of an adduct and a reactive building block, combinations of an adduct and a reactive building block, and combinations of adduct, reactive building block and curing agent.

Examples of such adducts include reaction products of the monomers of the reactive building block and the curing agent as described below. Such adducts are typically formed under conditions where only the adduct is formed and no or only to a small extent polymerization and/or cross-linking occurs. The coating composition of the invention preferably comprises adducts of the reactive building block and the curing agent, wherein the amount of polymerized and/or cross-linked product is at most 5 wt%, based on the total weight of the reactive building block and the curing agent. Preferably, the polymerized and/or cross-linked product of the the

reactive building block and/or the curing agent is present in an amount of at most 2 wt%, more preferably at most 1 wt%, even more preferably at most 0.5 wt%. Even more preferably, the coating composition is substantially free from polymerized and/or cross-linked product, and most preferably the coating composition is completely free from polymerized and/or cross-linked product. The term "substantially free" means that less than 100 parts per million of the polymerized and/or cross-linked product is present in the coating composition. The term "completely free" means that the cured coating contains less than 20 parts per billion (ppb) of polymerized and/or cross-linked product.

The reactive building block used to form the adduct of the invention can be any reactive building block known in the art. Reactive building blocks can be compounds having at least one functional group capable of reacting with the fatty amine. Such reactive building blocks are selected from the group consisting of oxirane, oxetane, isocyanate, anhydrides, ketones, aldehyde, carbon disulfide, isothiocyanate, acrylate, methacrylate, lactone, lactam, carbonate, carboxylic acid, acid halide, sulfonyl chloride, allylic group, urea and aziridines. Preferred reactive building blocks are cationically polymerizable building blocks (vide infra).

In one embodiment of the invention, the molar ratio of the reactive building block and fatty amine is at least 0.01. Preferably, the molar ratio is at least 0.05, more preferably at least 0.1, even more preferably at least 0.2 and most preferably at least 0.5, and preferably at most 2, more preferably at most 1.5, even more preferably at most 1.2 and most preferably at most 1.

The primary amines in the curing agent generally react first with the reactive building block. Therefore, in one embodiment, the molar ratio of the reactive building block and the primary amines in the fatty amine is at least 0.01. Preferably, the molar ratio is at least 0.05, more preferably at least 0.1, even more preferably at least 0.2 and most preferably at least 0.5, and preferably at most 2, more preferably at most 1.5, even more preferably at most 1.2 and most preferably at most 1.

The present invention pertains to an adduct of a reactive building block and curing agent comprising one or more fatty amines selected from the group consisting of an alkylated polyamine, bisalkylated amine, alkylated primary amine, an alkoxyated polyamine, bisalkoxyated amine and alkoxyated primary amine. This adduct may be used in combination with the curing agent and/or the adduct in according with the invention. The adduct may also be combined with the substituted phenol of the invention, whereby preferably the molar ratio of the fatty amine and the substituted phenol is at least 0.2 and at most 5

In one embodiment of the invention, the curing agent comprises an adduct of one or more fatty amines selected from the group consisting of an alkylated polyamine, bisalkylated amine, alkylated primary amine, an alkoxyated polyamine, bisalkoxyated amine and alkoxyated primary amine in an amount of at least 50 % by weight (wt%), based on the total weight of the curing agent. Preferably, the fatty amine is present in an amount of at least 55 wt%, more preferably at least 60 wt%, even more preferably at least 65 wt% and most preferably at least 70 wt%, and preferably at most 99 wt%, more preferably at most 95 wt%, even more preferably at most 90 wt% and most preferably at most 80 wt%, based on the total weight of the curing agent.

Also the kit of parts comprising the above curing agents are part of the invention, and included as separate and explicit embodiments. In particular, the kit of parts comprising (a) a cationically polymerizable building block, and (b) a curing agent comprising the alkylated polyamine, the bisalkylated amine, the alkylated monoamine, the alkoxyated polyamine, the bisalkoxyated amine and/or the alkoxyated primary amine; and a substituted phenol and/or substituted phenyl are included. The embodiments of the kit of parts are disclosed above, and also apply to the present kit of parts, except that the low temperature cure agent is absent.

The invention further pertains to a coating composition comprising a cationically polymerizable building block and a curing agent according to the invention. The embodiments of the coating composition are disclosed above, and also apply to the present coating composition, except that the low temperature cure agent is absent.

The invention further pertains to a process for preparing a coated substrate comprising the steps of: (a) applying the coating composition according to the invention to a substrate; and (b) curing the coating composition. The embodiments of the process for preparing a coated substrate are disclosed above, and also apply to the present process, except that the low temperature cure agent is absent.

In a further embodiment of the invention, the coating composition of the invention can be used in application where corrosion protection and/or cured coating flexibility and formability are required. Examples of such applications include flooring, steel construction applications like in

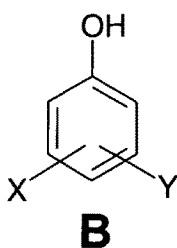
bridges or buildings, marine protective applications, coil coating applications, car refinish, and automotive applications.

Curing agent and water

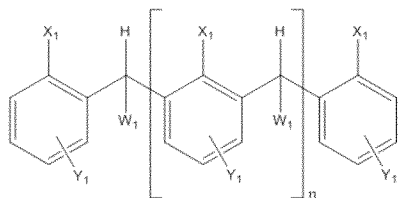
5 The present invention pertains to a curing agent comprising (a) one or more fatty amines selected from the group consisting of an alkylated polyamine, bisalkylated amine, alkylated primary amine, an alkoxyated polyamine, bisalkoxyated amine and alkoxyated primary amine; and
 (b) a substituted phenol and/or substituted phenyl; and wherein the curing agent further
 10 comprises water. Each of the specified curing agents and their embodiments (without the low temperature curing agent) – including the embodiments for the various substituents, the phenol and the substituted phenyl, the presence of a solvent and the various amounts – are considered as explicitly disclosed embodiments of the present invention. Moreover, the adducts of each of the individual fatty amines are also disclosed individually and explicitly.

15 The present invention pertains to a curing agent comprising (a) one or more fatty amines selected from the group consisting of an alkylated polyamine, bisalkylated amine, alkylated primary amine, an alkoxyated polyamine, bisalkoxyated amine and alkoxyated primary amine; and
 (b) a substituted phenol having formula (B):

20



25 wherein X and Y are individually selected from the group of COOH, carboxylate, OH, NH₂, NO₂, SO₃H, PO₃H, Cl, F, B, I, alkyl, alkenyl, COOR, OR, COR and aldehyde, and/or a substituted phenyl having formula (B1):



(B1)

wherein n is a number from 0 to 1000, X_1 is selected from hydrogen, hydroxyl and carboxylic acid, and Y_1 is selected from hydrogen, alkyl, alkenyl, alkynyl, aryl, substituted alkyls, substituted alkenyl, substituted alkynyl, substituted aryls, polycyclic aromatics, substituted polycyclic aromatics, polar functional groups, such as alcohol, amines, ketones, aldehydes, ethers, carboxylic acids, sulfonates, sulfonic acids, phosphonic acids and heterocyclics; and
5 W_1 is independently selected from hydrogen, alkyl, alkenyl, alkynyl, aryl, substituted alkyl, substituted alkenyl, substituted alkynyl, substituted aryls, polycyclic aromatics, substituted polycyclic aromatics, polar functional groups, such as alcohol, amines, ketones, aldehydes, amides, esters, carbonyls, epoxies, oxetanes, oxiranes, ethers, carboxylic acids, sulfonates,
10 sulfonic acids, phosphonic acids and heterocyclics; and
wherein the molar ratio of the fatty amine and the substituted phenol and/or substituted phenyl is at least 0.2 and at most 5; and wherein the curing agent further comprises water. The addition of water has the advantage that the curing speed can be tuned. Generally, the addition of water leads to a shortening of the pot life and an increase of the cure speed. However, when a low
15 temperature cure agent is added to the curing agent the pot life may be prolonged and cure speed may decrease. The curing agent of the invention is also capable of curing water-based cationically polymerizable building blocks. The liquid curing agent is moreover compatible with cationically polymerizable building blocks like epoxy resins, and is capable of curing these building blocks. The film forming properties of coating compositions comprising the curing agent
20 and the cationically polymerizable building blocks is generally good, with good wetting properties, and generally spreads well over a wide variety of surfaces, even surfaces that have aged, are rusty or unclean. The resulting cured coating has generally very good chemical resistance, corrosion resistance, scratch resistance, high gloss, and good adhesion to a wide variety of surfaces. Also curing at temperature as low as 5°C is possible.

25 Addition of water in curing agents and/or (non-water based) coating compositions is generally avoided as water may quench and/or inactivate the curing agent and/or cationically polymerizable building blocks. Water may also cause blushing of the cured coating. In the curing agent of the invention this inactivation is not observed, in fact water is observed as an influencer of potlife and/or curing speed. Cured coating compositions with the curing agent of
30 the invention do not reveal blushing. The advantages indicated in WO 2012/177120 are also observed for the curing agent and coating compositions of the invention.

In one embodiment, the curing agent of the invention, the curing agent may comprise water in an amount of at most 30 % by weight (wt%), based on the total weight of the curing agent. In

one embodiment of the invention, the curing agent comprises water in an amount of at least 0.01 % by weight (wt%), based on the total weight of the curing agent. Preferably, water is present in an amount of at most 25 wt%, more preferably at most 20 wt%, even more preferably at most 15 wt% and most preferably at most 30 wt%, and preferably at least 0.1 wt%, more preferably at least 0.5 wt%, even more preferably at least 1 wt% and most preferably at least 2 wt%, based on the total weight of the curing agent.

In one embodiment, the curing agent of the invention generally is homogeneous, i.e. does not contain solid deposits of any one of the fatty amine and/or substituted phenol or phenyl, and/or reveals any phase separation.

10 In a further embodiment, the curing agent of the invention generally has a viscosity of at least 5 cP and at most 12,000 cP. Preferably, the viscosity of the curing agent is at least 50 cP and most preferably at least 100 cP, and preferably at least 200 cP, and preferably at most 10,000 cP, more preferably at most 8,000 cP, and preferably at most 6,000 cP.

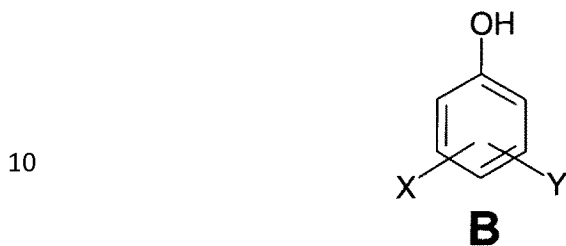
The curing agent of the invention may further comprise a low temperature cure agent. The low temperature cure agent can be any low temperature cure agent known in the art. The low temperature cure agent is generally selected from an aliphatic polyamine and a mercaptan-terminated compound. Examples and amounts of the low temperature cure agent are disclosed above and also apply.

20 The remaining part of the curing agent may be comprised of other components commonly used in curing agents. With the fatty amine, the substituted phenol and/or substituted phenyl, water and the other components add up to 100 wt% of the total weight of the curing agent.

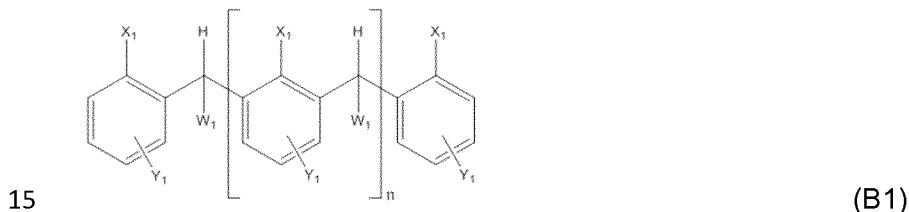
The invention further pertains to a coating composition comprising a cationically polymerizable building block and a curing agent according to the invention. The embodiments of the coating composition are disclosed above, and also apply to the present coating composition, except that the low temperature cure agent is absent.

30 The invention further pertains to a (waterborne) coating composition comprising a cationically polymerizable building block and a curing agent according to the invention wherein the cationically polymerizable building block is waterborne. The wording "waterborne" refers to cationically polymerizable building blocks that are diluted and/or dissolved in water. The curing

agent of the invention is capable of curing waterborne cationically polymerizable building blocks. Consequently, the invention pertains to a coating composition comprising water, a cationically polymerizable building block and a curing agent comprising one or more fatty amines selected from the group consisting of an alkylated polyamine, bisalkylated amine, alkylated primary amine, an alkoxyated polyamine, bisalkoxyated amine and alkoxyated primary amine; and
 5 a substituted phenol having formula (B):



wherein X and Y are individually selected from the group of COOH, carboxylate, OH, NH₂, NO₂, SO₃H, PO₃H, Cl, F, B, I, alkyl, alkenyl, COOR, OR, COR and aldehyde, and/or a substituted phenyl having formula (B1):

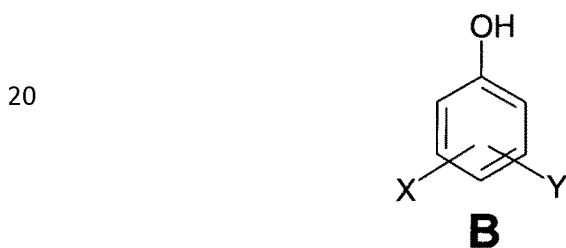


wherein n is a number from 0 to 1000, X₁ is selected from hydrogen, hydroxyl and carboxylic acid, and Y₁ is selected from hydrogen, alkyl, alkenyl, alkynyl, aryl, substituted alkyls, substituted alkenyl, substituted alkynyl, substituted aryls, polycyclic aromatics, substituted polycyclic aromatics, polar functional groups, such as alcohol, amines, ketones, aldehydes,
 20 ethers, carboxylic acids, sulfonates, sulfonic acids, phosphonic acids and heterocyclics; and W₁ is independently selected from hydrogen, alkyl, alkenyl, alkynyl, aryl, substituted alkyl, substituted alkenyl, substituted alkynyl, substituted aryls, polycyclic aromatics, substituted polycyclic aromatics, polar functional groups, such as alcohol, amines, ketones, aldehydes,
 25 amides, esters, carbonyls, epoxies, oxetanes, oxiranes, ethers, carboxylic acids, sulfonates, sulfonic acids, phosphonic acids and heterocyclics;
 wherein the molar ratio of the fatty amine and the substituted phenol and/or the substituted phenyl is at least 0.2 and at most 5.

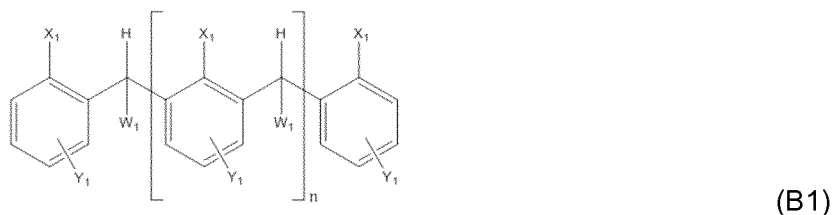
In one embodiment of the invention, the (waterborne) coating composition generally comprises water in an amount of at least 1 % by weight (wt%), based on the total weight of the coating composition. Preferably, water is present in an amount of at least 2 wt%, more preferably at least 5 wt%, even more preferably at least 10 wt% and most preferably at least 15 wt%, and preferably at most 60 wt%, more preferably at most 50 wt%, even more preferably at most 30 wt% and most preferably at most 20 wt%, based on the total weight of the coating composition.

The invention further pertains to a process for preparing a coated substrate comprising the steps of: (a) applying the coating composition according to the invention to a substrate; and (b) curing the coating composition. The embodiments of the process for preparing a coated substrate are disclosed above, and also apply to the present process, except that the low temperature cure agent is absent.

The invention further pertains to a kit of parts comprising (a) a cationically polymerizable building block; and (b) a curing agent comprising one or more fatty amines selected from the group consisting of an alkylated polyamine, bisalkylated amine, alkylated primary amine, an alkoxyated polyamine, bisalkoxyated amine and alkoxyated primary amine; a substituted phenol having formula (B):



wherein X and Y are individually selected from the group of COOH, carboxylate, OH, NH₂, NO₂, SO₃H, PO₃H, Cl, F, B, I, alkyl, alkenyl, COOR, OR, COR and aldehyde, and/or a substituted phenyl having formula (B1):



wherein n is a number from 0 to 1000, X_1 is selected from hydrogen, hydroxyl and carboxylic acid, and Y_1 is selected from hydrogen, alkyl, alkenyl, alkynyl, aryl, substituted alkyls, substituted alkenyl, substituted alkynyl, substituted aryls, polycyclic aromatics, substituted polycyclic aromatics, polar functional groups, such as alcohol, amines, ketones, aldehydes, ethers, carboxylic acids, sulfonates, sulfonic acids, phosphonic acids and heterocyclics; and
5 W_1 is independently selected from hydrogen, alkyl, alkenyl, alkynyl, aryl, substituted alkyl, substituted alkenyl, substituted alkynyl, substituted aryls, polycyclic aromatics, substituted polycyclic aromatics, polar functional groups, such as alcohol, amines, ketones, aldehydes, amides, esters, carbonyls, epoxies, oxetanes, oxiranes, ethers, carboxylic acids, sulfonates,
10 sulfonic acids, phosphonic acids and heterocyclics; and
wherein the molar ratio of the fatty amine and the substituted phenol and/or the substituted phenyl is at least 0.2 and at most 5; and wherein the curing agent further comprises water. The curing agent and the cationically polymerizable building block are generally stored separately to prevent pre-mature curing. These 2K systems should be mixed before applying the resulting
15 coating composition to a substrate. The embodiments of the kit of parts are disclosed above, and also apply to the present kit of parts, except that the low temperature cure agent is absent.

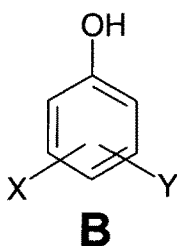
In a further embodiment of the invention, the coating composition of the invention can be used in application where corrosion protection and/or cured coating flexibility and formability are
20 required. Examples of such applications include flooring, steel construction applications like in bridges or buildings, marine protective applications, coil coating applications, car refinish, and automotive applications.

Polyurethane-containing coating compositions

25 The present invention pertains to a coating composition comprising a di- or polyisocyanate and a curing agent comprising one or more fatty amines selected from the group consisting of an alkylated polyamine, bisalkylated amine, alkylated primary amine, an alkoxyated polyamine, bisalkoxyated amine and alkoxyated primary amine; and a substituted phenol and/or substituted phenyl. Each of the specified curing agents and their embodiments (without the low
30 temperature curing agent) – including the embodiments for the various substituents, the phenol and the substituted phenyl, the presence of a solvent and the various amounts – are considered as explicitly disclosed embodiments of the present invention. Moreover, the adducts of each of the individual fatty amines are also disclosed individually and explicitly.

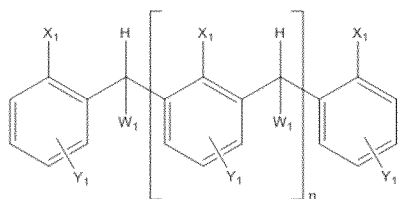
The present invention pertains to a coating composition comprising a di- or polyisocyanate and a curing agent comprising one or more fatty amines selected from the group consisting of an alkylated polyamine, bisalkylated amine, alkylated primary amine, an alkoxyated polyamine, bisalkoxyated amine and alkoxyated primary amine; and

5 (b) a substituted phenol having formula (B):



10

wherein X and Y are individually selected from the group of COOH, carboxylate, OH, NH₂, NO₂, SO₃H, PO₃H, Cl, F, B, I, alkyl, alkenyl, COOR, OR, COR and aldehyde, and/or a substituted phenyl having formula (B1):



(B1)

15 wherein n is a number from 0 to 1000, X₁ is selected from hydrogen, hydroxyl and carboxylic acid, and Y₁ is selected from hydrogen, alkyl, alkenyl, alkynyl, aryl, substituted alkyls, substituted alkenyl, substituted alkynyl, substituted aryls, polycyclic aromatics, substituted polycyclic aromatics, polar functional groups, such as alcohol, amines, ketones, aldehydes, ethers, carboxylic acids, sulfonates, sulfonic acids, phosphonic acids and heterocyclics; and

20 W₁ is independently selected from hydrogen, alkyl, alkenyl, alkynyl, aryl, substituted alkyl, substituted alkenyl, substituted alkynyl, substituted aryls, polycyclic aromatics, substituted polycyclic aromatics, polar functional groups, such as alcohol, amines, ketones, aldehydes, amides, esters, carbonyls, epoxies, oxetanes, oxiranes, ethers, carboxylic acids, sulfonates, sulfonic acids, phosphonic acids and heterocyclics;

25 wherein the molar ratio of the fatty amine and the substituted phenol and/or the substituted phenyl is at least 0.2 and at most 5. The inventors have found that the curing agents of the invention can also react with isocyanates to form polyurea and/or polyurethane. The fatty amine and the substituted phenol and/or phenyl combine to form a liquid curing agent

which is liquid at low temperatures e.g. 5°C, in particular liquid at temperatures where the fatty amine is solid, i.e. below the melting point of the fatty amine. The liquid curing agent is moreover compatible with di- or polyisocyanates, and is capable of curing these building blocks. The film forming properties of coating compositions comprising the curing agent and the di- or polyisocyanates is generally good, with good wetting properties, and generally spreads well over a wide variety of surfaces, even surfaces that have aged, are rusty or unclean. The resulting cured coating has generally very good chemical resistance, corrosion resistance, scratch resistance and good adhesion to a wide variety of surfaces.

10 In one embodiment of the invention, the coating composition generally comprises the curing agent in an amount of at least 5 % by weight (wt%), based on the total weight of the coating composition. Preferably, the curing agent is present in an amount of at least 10 wt%, more preferably at least 15 wt%, even more preferably at least 20 wt% and most preferably at least 25 wt%, and preferably at most 95 wt%, more preferably at most 70 wt%, even more preferably at most 60 wt% and most preferably at most 40 wt%, based on the total weight of the coating composition.

The di-or polyisocyanate can be any di-or polyisocyanate known in the art. The di-or polyisocyanate of the invention may be a dimer, an oligomer or polymer. Oligomers of the di-or polyisocyanate refer to dimers, trimers and tetramers of the monomers of the di-or polyisocyanates. Examples of suitable diisocyanates include 1,2-propylene diisocyanate, trimethylene diisocyanate, tertamethylene diisocyanate, 2,3-butylene diisocyanate, hexamethylene diisocyanate, octamethylene diisocyanate, 2,2,4-trimethyl hexamethylene diisocyanate, dodecamethylene diisocyanate, o,o'-dipropylether diisocyanate, 1,3-cyclopentane diisocyanate, 1,2-cyclohexane diisocyanate, 1,4-cyclohexane diisocyanate, isophorone diisocyanate, 4-methyl-1,3-diisocyanatocyclohexane, trans-vinylidene diisocyanate, dicyclohexylmethane-4,4'-diisocyanate (Desmodur® W), toluene diisocyanate, 1,3-bis(isocyanatomethyl) benzene, a,a,a',a'-tetramethyl xylylene diisocyanate (TMXDI®), 1,5-dimethyl-2,4-bis(2-isocyanatoethyl) benzene, 1,3,5-triethyl-2,4-bis(isocyanatomethyl) benzene, 4,4'-diisocyanato-diphenyl, 3,3'-dichloro-4,4'-diisocyanato-diphenyl, 3,3'-diphenyl-4,4'-diisocyanato-diphenyl, 3,3'-dimethoxy-4,4'-diisocyanato-diphenyl, 4,4'-diisocyanato-diphenyl methane, 3,3'-dimethoxy-4,4'-diisocyanato-diphenylmethane and diisocyanatotoluene. Examples of triisocyanates include 1,3,5-triisocyanatobenzene, 1,8-diisocyanato-4-(isocyanatomethyl) octane and lysine triisocyanate. Examples of adducts and oligomers of

polyisocyanates include biurets, isocyanates, allophanates, uretdiones, urethanes and iminoxadiazine diones. In the context of this application the wording "adduct" refers to reaction products of a polyol and a di- or polyisocyanate, preferably of monomers of a polyol and a di- or polyisocyanate, wherein the resulting adduct maintains at least two functional groups enabling
5 polymerization and/or cross-linking of the adduct.

In one embodiment of the invention, the coating composition generally comprises the di- or polyisocyanate in an amount of at least 5 % by weight (wt%), based on the total weight of the coating composition. Preferably, the di- or polyisocyanate is present in an amount of at least 20 wt%, more preferably at least 40 wt%, even more preferably at least 50 wt% and most
10 preferably at least 60 wt%, and preferably at most 95 wt%, more preferably at most 90 wt%, even more preferably at most 85 wt% and most preferably at most 80 wt%, based on the total weight of the coating composition.

The coating composition may further comprise a polyol and/or a carbamate and/or a urethane. The carbamate or urethane can be any carbamate or urethane known in the art. The carbamate
15 or urethane of the invention may be a monomer, an oligomer or polymer. In one embodiment, the carbamate or urethane is preferably a monomer. The carbamate or urethane may have the formula $R_{14}-O-C(O)-NR_{15}R_{16}$ wherein R_{14} , R_{15} and R_{16} are individually chosen from hydrogen, alkyl, alkenyl, alkynyl, aryl, substituted alkyl, substituted alkenyl, substituted alkynyl, substituted aryls, polycyclic aromatics, substituted polycyclic aromatics, polar functional groups, such as
20 ketones, aldehydes, amides, esters, epoxies, oxetanes, oxiranes, ethers, sulfonates, sulfonic acids, phosphonic acids and heterocyclics, and salts thereof.

Examples of carbamates or urethanes include methyl carbamate, ethyl carbamate, carbamic acid, 2-hydroxyethylcarbamate, 2-hydroxypropylcarbamate, 3-hydroxypropylcarbamate, 2-hydroxybutylcarbamate, 3-hydroxybutylcarbamate, 4-hydroxybutylcarbamate, 2-hydroxy-1,1-
25 dimethylethylcarbamate, 2-hydroxy-1,2-dimethylethylcarbamate, 6-hydroxy-hexylcarbamate, 8-hydroxy-octylcarbamate, 10-hydroxy-decylcarbamate, N-methyl-2-hydroxyethylcarbamate, , N-ethyl-2-hydroxyethylcarbamate, N-propyl-2-hydroxyethylcarbamate, N-methyl-2-hydroxypropylcarbamate, , N-ethyl-2-hydroxypropylcarbamate, N-propyl-2-hydroxypropylcarbamate, N,N'-dimethyl-2-hydroxyethylcarbamate, , N,N'-diethyl -2-
30 hydroxyethylcarbamate and N,N'-dipropyl -2-hydroxyethylcarbamate.

In one embodiment of the invention, the coating composition generally comprises the carbamate and/or urethane in an amount of at least 5 % by weight (wt%), based on the total weight of the

coating composition. Preferably, the carbamate and/or urethane is present in an amount of at least 20 wt%, more preferably at least 40 wt%, even more preferably at least 50 wt% and most preferably at least 60 wt%, and preferably at most 95 wt%, more preferably at most 90 wt%, even more preferably at most 85 wt% and most preferably at most 80 wt%, based on the total weight of the coating composition.

The polyol can be any polyol known in the art. The polyol of the invention may be a monomer, an oligomer or polymer. In one embodiment, the polyol is preferably a monomer. Polymeric polyols may include polyesters, polysiloxanes, polyamides and copolymers thereof. Of these polymeric polyols polyesters are preferred. Oligomers of the polyol refer to dimers, trimers and tetramers of the monomers of the polyol. Oligomeric polyols include dimers, trimers and tetramers of monomeric diols and/or triols. In one embodiment, the polyol may be modified by monomers, dimers or polymers having no functional groups. Modifications with monomers, dimers or polymers that are capable of hydrolyzing after curing are less preferred. Examples of suitable monomeric polyols comprising hydroxyl functional groups include 1,4-butanediol, 1,3-butanediol, 1,5-pentanediol, 1,6-hexanediol, 2,5-hexanediol, 2-methyl-1,3-pentanediol, 2-ethyl-1,3-hexanediol, 2,2-dimethyl-1,3-pentanediol, 1,4-cyclohexanediol, trimethylolethane, trimethylolpropane, pentaerythritol, dipentaerythritol, 1,4-cyclohexanedimethanol, 1,2-bis(hydroxymethyl)cyclohexane, 1,2-bis(hydroxyethyl)cyclohexane, trimethylolpropane, 2,2-dimethyl-3-hydroxypropyl-2,2-dimethyl-hydroxypropionate, diethylene glycol, triethylene glycol, dipropylene glycol, tetraethylene glycol, trimethylolethane, glycerol, and sorbitol; and polyols comprising oxirane functional groups bisphenol A, bisphenol F, bisphenol S, alkoxyated bisphenol A such as ethoxyated bisphenol A and propoxyated bisphenol A and alkoxyated bisphenol F, such as ethoxyated bisphenol F and propoxyated bisphenol F; polyols comprising oxirane functional groups bisphenol A diglycidyl ether, 2,2'-bis(4-hydroxyphenyl)propane bis(2,3-epoxypropylether, bisphenol F diglycidyl ether, novolac glycidyl ether, ethoxyated bisphenol A and propoxyated bisphenol A. Of these polyol monomers the monomers comprising bisphenol A are preferred, in particular bisphenol A, the ethoxyated and/or propoxyated bisphenol A are preferred. It is contemplated that two or more polyols can be used in the coating compositions of the invention. When two or more polyols are present in the coating composition, the total number of second functional groups in the two or more first resins is used in the calculation of the molar ratio of first and second functional groups.

The polyol may preferably have a weight average molecular weight (Mw) of at most 100,000, more preferably at most 50,000, even more preferably at most 20,000 and most preferably at

most 10,000, and preferably at least 200, more preferably at least 250 and most preferably at least 300. When the first resin, preferably a polyol, is a monomer, the first resin may preferably have a weight average molecular weight (Mw) of at most 10,000, more preferably at most 5,000, even more preferably at most 2,000 and most preferably at most 1,000, and preferably at least
5 200, more preferably at least 250 and most preferably at least 300.

In one embodiment of the invention, the coating composition generally comprises the polyol in an amount of at least 5 % by weight (wt%), based on the total weight of the coating composition. Preferably, the polyol is present in an amount of at least 20 wt%, more preferably at least 40 wt%, even more preferably at least 50 wt% and most preferably at least 60 wt%, and preferably
10 at most 95 wt%, more preferably at most 90 wt%, even more preferably at most 85 wt% and most preferably at most 80 wt%, based on the total weight of the coating composition.

The coating composition may further comprise a pigment. Examples of pigments and dyes include metal oxides like titanium dioxide, iron oxide, zinc oxide and chromium oxide; metal hydroxides; metal sulfides, metal sulfates, metal carbonates such as calcium carbonate; carbon
15 black and china clay.

The coating composition of the invention comprises the pigment in an amount of at most 30 % by weight (wt%), based on the total weight of the coating composition. Preferably, the pigment is present in an amount of at most 25 wt%, more preferably at most 20 wt%, even more preferably at most 15 wt% and most preferably at most 10 wt%, and preferably at least 0.1 wt%, more
20 preferably at least 0.5 wt%, even more preferably at least 1 wt% and most preferably at least 1.5 wt%, based on the total weight of the coating composition.

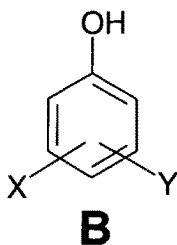
In another embodiment of the invention, the coating composition comprises solids in an amount of at least 40 % by weight (wt%), based on the total weight of the coating composition. Preferably, the solids are present in an amount of at least 50 wt%, more preferably at least 60 wt%, even more preferably at least 65 wt% and most preferably at least 70 wt%, and preferably
25 wt%, even more preferably at least 65 wt% and most preferably at least 70 wt%, and preferably at most 100 wt%, more preferably at most 95 wt%, even more preferably at most 90 wt% and most preferably at most 80 wt%, based on the total weight of the coating composition. The term “solids” is known to the man skilled in the art, and generally refers to the solid or non-volatile material in the coating composition; typically the solids include the resins, pigments, dyes,
30 catalyst, etc. and does not include solvents that evaporate during the curing process. The amount of solids may also be referred to as “solids content”.

The remaining part of the coating composition may be comprised of other components commonly used in coating compositions. With the di- or polyisocyanate, curing agent and the other components add up to 100 wt% of the total weight of the coating composition.

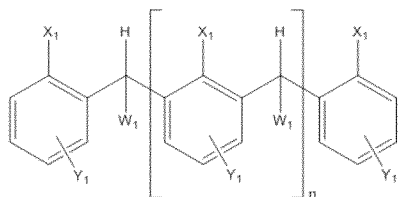
The invention also pertains to a coated substrate comprising a substrate and a cured coating composition applied to at least part of the substrate, the coating composition being in accordance with the invention. In an embodiment of the invention the coated substrate is a metal substrate. The cured coating composition has all the advantages as described above for the cured coating composition. A further advantage of the cured coating composition is that the volatile organic compounds (VOC) level is generally very low. The VOC level is typically determined using standard method ASTM D3960-05(2013). The amount of VOC in the coating composition of the invention is generally at most 100 g/l, preferably at most 75 g/l, more preferably at most 60 g/l, and most preferably at most 50 g/l.

The substrate of the invention can be any substrate known in the art. The substrate may be porous or non-porous. Examples of suitable substrates include metals, such as aluminum, aluminum alloys, steel, steel alloys, tin, tin alloys, zinc, zinc alloys, chrome and chrome alloys; glass such as fused silica glass, aluminosilicate glass, soda-lime-silica glass, borosilicate glass and lead-oxide glass; ceramics, such as porcelain, bone china, alumina, ceria, zirconia, carbides, borides, nitrides and silicides; plastic such as functionalized polyethylene (PE), functionalized polypropylene (PP), polyethylene terephthalate (PET), polyvinyl chloride (PVC) and nylons; and wood. Preferably, the substrate is metal, in particular steel and aluminum. Most preferably the substrate is steel.

The invention further pertains to a kit of parts comprising (a) a di- or polyisocyanate; and (b) a curing agent comprising one or more fatty amine selected from the group consisting of an alkylated polyamine, bisalkylated amine, alkylated primary amine, an alkoxyated polyamine, bisalkoxyated amine and alkoxyated primary amine; a substituted phenol having formula (B):



wherein X and Y are individually selected from the group of COOH, carboxylate, OH, NH₂, NO₂, SO₃H, PO₃H, Cl, F, B, I, alkyl, alkenyl, COOR, OR, COR and aldehyde, and/or a substituted phenyl having formula (B1):



(B1)

5

wherein n is a number from 0 to 1000, X₁ is selected from hydrogen, hydroxyl and carboxylic acid, and Y₁ is selected from hydrogen, alkyl, alkenyl, alkynyl, aryl, substituted alkyls, substituted alkenyl, substituted alkynyl, substituted aryls, polycyclic aromatics, substituted polycyclic aromatics, polar functional groups, such as alcohol, amines, ketones, aldehydes, ethers, carboxylic acids, sulfonates, sulfonic acids, phosphonic acids and heterocyclics; and W₁ is independently selected from hydrogen, alkyl, alkenyl, alkynyl, aryl, substituted alkyl, substituted alkenyl, substituted alkynyl, substituted aryls, polycyclic aromatics, substituted polycyclic aromatics, polar functional groups, such as alcohol, amines, ketones, aldehydes, amides, esters, carbonyls, epoxies, oxetanes, oxiranes, ethers, carboxylic acids, sulfonates, sulfonic acids, phosphonic acids and heterocyclics;

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wherein the molar ratio of the fatty amine and the substituted phenol and/or the substituted phenyl is at least 0.2 and at most 5. The curing agent and the cationically polymerizable building block are generally stored separately to prevent pre-mature curing. These 2K systems should be mixed before applying the resulting coating composition to a substrate.

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The invention further pertains to a process for preparing a coated substrate comprising the steps of: (a) applying the coating composition according to the invention to a substrate; and (b) curing the coating composition. In an embodiment of the invention, the cationically polymerizable building block and the curing agent are contacted to form the coating compositions of the invention, which is subsequently applied to a substrate according to step (a). The process of the invention can be conducted in the presence of further water, e.g. the process is performed in a moist environment or even under liquid water. The presence of water may enable a faster curing of the coating composition.

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In a further embodiment of the invention, the coating composition of the invention can be used in application where corrosion protection and/or cured coating flexibility and formability are required. Examples of such applications include flooring, steel construction applications like in bridges or buildings, marine protective applications, coil coating applications, car refinish, and
5 automotive applications.

The invention is exemplified in the following Examples.

Examples

Examples 1 to 10: cocopropylene diamine/salicylic acid (1:1 molar ratio)

Cocopropylene diamine (Duomeen® CD ex Akzo Nobel) is molten at 27°C. 50 grams Duomeen CD is transferred into a glass beaker, equipped with a magnetic stirring bar, followed by slow addition of 27 grams salicylic acid (1:1 molar ratio). Stirring is continued until a clear light yellow solution is obtained. To the liquid curing agent triethylene tetramine (TETA), an aliphatic polyamine of the invention, and/or various alcohols, ketones and phosphines were added in amounts indicated in the Table below.

Table 1: Compositions of curing agents of the invention

Compound\Example	Amount (wt%)									
	1	2	3	4	5	6	7	8	9	10
triethylene tetramine (TETA)	10	5	5	5	5	5	5	5	5	5
n-butyl diethanol amine (BDEA)		5								
3-methyl-1,5-pentanediol (MPD)			5							
Isopentenediol (IPD)				5						
methyl acetoacetate (MAA)					5					
ethyl acetoacetate (EAA)						5				
isotridecylalcohol (Wal)							5			
triphenyl phosphine (TPP)								5		
acetylacetonate (AA)									5	
Dimethyl ethanolamine (DMEA)										5

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The curing agents of Examples 1 to 10 were mixed with Epikote® 827 in weight ratios indicated in Table 2. Also the observed pot life is indicated. The coating composition were cured at room temperature.

Table 2: coating composition and observed pot life

Example	Ratio Epikote® 827/Curing agent	Pot life (min)
1	2.99	30
2	2.83	41
3	2.83	79
4	2.83	69
5	2.83	62
6	2.83	58
7	2.83	74
8	2.83	55
9	2.83	65
10	2.83	34

From Table 2 it can be deduced that the potlife can be prolonged with the addition of the alcohol, ketone or aromatic phosphine. With all coating compositions films could be easily formed, the films were homogeneously distributed and transparent. The coating compositions could be applied immediately after mixing of the curing agent of Examples 1 to 10 and the epoxy resin, i.e. without an induction time. All films were tack-free within 24 hours curing at room temperature. No blushing was observed.

Additionally, the curing agents of Example 1 was mixed with Epikote® 827 in weight ratio of 2.99 (epoxy resin to curing agent). The coating composition were cured at 6°C. The film was tack-free within 24 hours curing. No blushing was observed.

Examples 11 and 12: cocoamine/salicylic acid (1:1 molar ratio)

50 grams Cocoamine (Armeen® C ex Akzo Nobel) is transferred into a glass beaker, equipped with a magnetic stirring bar, followed by slow addition of 17.25 grams salicylic acid (1:1 molar ratio). Stirring is continued until a clear light yellow solution is obtained. To the liquid curing agent triethylene tetramine (TETA), an aliphatic polyamine of the invention, was added in amounts of 5 wt% (Example 11) and 10 wt% (Example 12) based on the total weight of the curing agent.

The curing agents of Examples 11 and 12 were mixed with Epikote® 827 both in weight ratios of 3.11 (epoxy resin to curing agent). The coating composition were cured at room temperature.

The pot lives of Examples 11 and 12 are 41 and 42 minutes, respectively. With all coating compositions films of the invention could be easily formed, the films were homogeneously distributed and transparent. All films were tack-free within 24 hours curing at room temperature. No blushing was observed.

Additionally, the curing agents of Examples 11 and 12 were mixed with Epikote® 827 both in weight ratios of 3.11 (epoxy resin to curing agent). The coating composition were cured at 6°C. All films were tack-free within 24 hours curing. No blushing was observed.

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Examples 13 and 14: Isotridecyloxypropyl 1,3-diaminopropane/salicylic acid (1:1 molar ratio)

50 gram Isotridecyloxypropyl 1,3-diaminopropane (Tomamine® DA-17 ex Evonik) is transferred into a glass beaker, equipped with a magnetic stirring bar, followed by slow addition of 21.93 grams salicylic acid (1:1 molar ratio). Stirring is continued until a clear light yellow solution is obtained. To the liquid curing agent triethylene tetramine (TETA), an aliphatic polyamine of the invention, was added in amounts of 5 wt% (Example 13) and 10 wt% (Example 14) based on the total weight of the curing agent.

The curing agents of Examples 13 and 14 were mixed with Epikote® 827 in weight ratios of 2.95 and 2.55, respectively (epoxy resin to curing agent). The coating composition were cured at room temperature.

The pot lives of Examples 13 and 14 are 57 and 42 minutes, respectively. With all coating compositions films of the invention could be easily formed, the films were homogeneously distributed and transparent. The coating compositions could be applied immediately after mixing of the curing agent of Examples 13 and 14 and the epoxy resin, i.e. without an induction time. All films were tack-free within 24 hours curing at room temperature. No blushing was observed.

Examples 15 and 16: cocopropylene diamine/salicylic acid (70:30 weight ratio)

Cocopropylene diamine (Duomeen® CD ex Akzo Nobel) is molten at 27°C. 50 grams Duomeen CD is transferred into a glass beaker, equipped with a magnetic stirring bar, followed by slow addition of 21.43 grams salicylic acid. Stirring is continued until a clear light yellow solution is obtained. To the liquid curing agent triethylene tetramine (TETA), an aliphatic polyamine of the

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invention, was added in an amount of 10 wt% (Example 15), based on the total weight of the curing agent. To the liquid curing agent triethylene tetramine (TETA), an aliphatic polyamine of the invention, was added in an amount of 5 wt% and n-butyl diethanol amine in an amount of 5 wt% (Example 16), based on the total weight of the curing agent.

- 5 The curing agents of Examples 15 and 16 were mixed with Epikote® 827 in weight ratios of 2.96 and 2.80, respectively (epoxy resin to curing agent). The coating composition were cured at room temperature.

The pot lives of Examples 15 and 16 are 47 and 50 minutes, respectively. With all coating compositions films of the invention could be easily formed, the films were homogeneously distributed and opaque to transparent. All films were tack-free within 24 hours curing at room temperature. No blushing was observed.

Examples 17 and 18: cocopropylene diamine/salicylic acid (80:20 weight ratio)

Cocopropylene diamine (Duomeen® CD ex Akzo Nobel) is molten at 27°C. 50 grams Duomeen CD is transferred into a glass beaker, equipped with a magnetic stirring bar, followed by slow addition of 12.5 grams salicylic acid. Stirring is continued until a clear light yellow solution is obtained. To the liquid curing agent triethylene tetramine (TETA), an aliphatic polyamine of the invention, was added in an amount of 10 wt% (Example 17), based on the total weight of the curing agent. To the liquid curing agent triethylene tetramine (TETA), an aliphatic polyamine of the invention, was added in an amount of 5 wt% and n-butyl diethanol amine in an amount of 5 wt% (Example 18), based on the total weight of the curing agent.

The curing agents of Examples 17 and 18 were mixed with Epikote® 827 in weight ratios of 2.96 and 2.80, respectively (epoxy resin to curing agent). The coating composition were cured at room temperature.

- 25 The pot lives of Examples 17 and 18 are 28 and 40 minutes, respectively. With all coating compositions films of the invention could be easily formed, the films were homogeneously distributed and transparent. All films were tack-free within 24 hours curing at room temperature. No blushing was observed.

Example 19: cocopropylene diamine/salicylic acid (80:20 weight ratio)

Cocopropylene diamine (Duomeen® CD ex Akzo Nobel) is molten at 27°C. 50 grams Duomeen CD is transferred into a glass beaker, equipped with a magnetic stirring bar, followed by slow addition of 12.5 grams salicylic acid. Stirring is continued until a clear light yellow solution is obtained. To the liquid curing agent demineralised water and Jeffamine® D-230 amine (ex Huntsman) were added in amounts of 5 wt% (Example 19), based on the total weight of the curing agent. A clear light yellow solution is obtained.

The curing agents of Example 19 was mixed with Epikote® 827 in weight ratios of 3.12 (epoxy resin to curing agent). The coating composition was cured at room temperature.

10 The pot life of Example 19 is 64 minutes. With the coating composition of the invention a film could be easily formed, the film was homogeneously distributed. The film was tack-free within 24 hours curing at room temperature. No blushing was observed.

15 Additionally, the curing agent of Example 19 was mixed with Epikote® 827 in weight ratio of 3.12 (epoxy resin to curing agent). The coating compositions was cured at 6°C. The film was tack-free within 24 hours curing. No blushing was observed.

Additionally, the curing agent of Example 19 was mixed with Epikote® 827 in weight ratio of 3.12 (epoxy resin to curing agent). The coating composition was cured at room temperature in a humidity chamber. The film was tack-free within 24 hours curing. No blushing was observed.

20 Example 20: cocopropylene diamine/salicylic acid (1:1 molar ratio)

Cocopropylene diamine (Duomeen® CD ex Akzo Nobel) is molten at 27°C. 50 grams Duomeen CD is transferred into a glass beaker, equipped with a magnetic stirring bar, followed by slow addition of 27 grams salicylic acid (1:1 molar ratio). Stirring is continued until a clear light yellow solution is obtained. To the liquid curing agent demineralised water and Jeffamine® D-230 amine were added in amounts of 5 wt% (Example 20), based on the total weight of the curing agent. A clear light yellow solution is obtained.

The curing agents of Example 20 was mixed with Epikote® 827 in weight ratios of 3.22 (epoxy resin to curing agent). The coating composition was cured at room temperature.

The pot life of Example 20 is 64 minutes. With the coating composition of the invention a film could be easily formed, the film was homogeneously distributed. The film was tack-free within 24 hours curing at room temperature. No blushing was observed.

5 Additionally, the curing agent of Example 20 was mixed with Epikote® 827 in weight ratio of 3.22 (epoxy resin to curing agent). The coating compositions was cured at 6°C. The film was tack-free within 24 hours curing. No blushing was observed.

Additionally, the curing agent of Example 20 was mixed with Epikote® 827 in weight ratio of 3.22 (epoxy resin to curing agent). The coating composition was cured at room temperature in a humidity chamber. The film was tack-free within 24 hours curing. No blushing was observed.

10 Example 21: Isotridecyloxypropyl 1,3-diaminopropane /salicylic acid (1:1 molar ratio)

50 gram Isotridecyloxypropyl 1,3-diaminopropane (Tomamine® DA-17 ex Evonik) is transferred into a glass beaker, equipped with a magnetic stirring bar, followed by slow addition of 21.93 grams salicylic acid (1:1 molar ratio). Stirring is continued until a clear light yellow solution is obtained (Example 21). The curing agent of Example 21 is liquid at room temperature. The
15 curing agent was subsequently kept at a temperature of 6°C for 16 hours. The resulting sample remained liquid.

Example 22 and Comparative Example A: cocoamine/salicylic acid (1:1 molar ratio)

50 gram cocoamine (Armeen® C ex Akzo Nobel) is transferred into a glass beaker, equipped with a magnetic stirring bar, followed by slow addition of 17.25 grams salicylic acid (1:1 molar
20 ratio). Stirring is continued until a clear light yellow solution is obtained (Example 22). The curing agent of Example 22 is liquid at room temperature. The curing agent was subsequently kept at a temperature of 6°C for 16 hours. The resulting sample remained liquid.

For comparison, pure cocoamine (Comparative Example A) is liquid and turned solid after keeping the sample at a temperature of 6°C for 16 hours.

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Example 23: cocopropylene diamine/salicylic acid-formal condensate (1:1 molar ratio)

Formaldehyde salicylic acid condensation products have been synthesized according to the procedure described in Example 1 of US 4,245,083.

Cocopropylene diamine (Duomeen® CD ex Akzo Nobel) is molten at 27°C. 50 grams Duomeen CD is transferred into a glass beaker, equipped with a magnetic stirring bar, followed by slow addition of 27 grams the condensate (1:1 molar ratio). Stirring is continued until a clear light yellow solution is obtained.

- 5 The curing agents of Example 23 was mixed with Epikote® 827 in weight ratio of 3.32 (epoxy resin to curing agent). The coating composition was cured at room temperature.

The pot lives of Example 23 is 85 minutes, respectively. With the coating composition a film of the invention could be easily formed, the film was homogeneously distributed and transparent. The film was tack-free within 24 hours curing at room temperature. No blushing was observed.

- 10 Additionally, the curing agents of Example 23 was mixed with Epikote® 827 in weight ratio of 3.32 (epoxy resin to curing agent). The coating compositions were cured at 6°C. The film was tacky within 24 hours curing. No blushing was observed.

- 15 Additionally, the curing agent of Example 23 was mixed with Epikote® 827 in weight ratio of 3.32 (epoxy resin to curing agent). The coating compositions were cured at room temperature in a humidity chamber. All films were light tacky within 24 hours curing. No blushing was observed.

Example 24: cocopropylene diamine/salicylic acid-formal condensate (1:1 molar ratio)

Formaldehyde salicylic acid condensation products have been synthesized according to the procedure described in Example 1 of US 4,245,083.

- 20 Cocopropylene diamine (Duomeen® CD ex Akzo Nobel) is molten at 27°C. 50 grams Duomeen CD is transferred into a glass beaker, equipped with a magnetic stirring bar, followed by slow addition of 27 grams the condensate (1:1 molar ratio). Stirring is continued until a clear light yellow solution is obtained. To the liquid curing agent triethylene tetramine (TETA), an aliphatic polyamine of the invention, was added in amounts of 5 wt% (Example 24), based on the total
25 weight of the curing agent.

The curing agents of Example 24 was mixed with Epikote® 827 in weight ratio of 3.34 (epoxy resin to curing agent). The coating composition was cured at room temperature.

The pot lives of Example 24 is 61 minutes, respectively. With the coating composition a film of the invention could be easily formed, the film was homogeneously distributed and transparent. The film was tack-free within 24 hours curing at room temperature. No blushing was observed.

5 Additionally, the curing agents of Example 24 was mixed with Epikote® 827 in weight ratio of 3.34 (epoxy resin to curing agent). The coating compositions were cured at 6°C. The film was tack-free within 24 hours curing. No blushing was observed.

Additionally, the curing agent of Example 24 was mixed with Epikote® 827 in weight ratio of 3.34 (epoxy resin to curing agent). The coating compositions were cured at room temperature in a humidity chamber. All films were light tacky within 24 hours curing. No blushing was observed.

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Example 25: cocopropylene diamine/salicylic acid (80:20 weight ratio)

Cocopropylene diamine (Duomeen® CD ex Akzo Nobel) is molten at 27°C. 50 grams Duomeen CD is transferred into a glass beaker, equipped with a magnetic stirring bar, followed by slow addition of 12.5 grams salicylic acid. Stirring is continued until a clear light yellow solution is
15 obtained. The resulting liquid was mixed with 10 wt% Epikote® 827, based on the total weight of the curing agent. A clear light yellow solution is obtained (Example 25).

The curing agent of Example 25 was mixed with Epikote® 827 in a weight ratio of 2.82 (epoxy resin to curing agent). The coating composition was cured at room temperature.

20 The pot life of Example 25 is 78 minutes. With the coating composition of the invention a film could be easily formed, the film was homogeneously distributed and transparent. The film was tack-free within 24 hours curing at room temperature. No blushing was observed.

Additionally, the curing agent of Example 25 was mixed with Epikote® 827 both in weight ratios of 2.82 (epoxy resin to curing agent). The coating composition were cured at 6°C. All films were tack-free within 24 hours curing. No blushing was observed.

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Example 26: cocopropylene diamine/salicylic acid (80:20 weight ratio)

Cocopropylene diamine (Duomeen® CD ex Akzo Nobel) is molten at 27°C. 50 grams Duomeen CD is transferred into a glass beaker, equipped with a magnetic stirring bar, followed by slow

addition of 12.5 grams salicylic acid. Stirring is continued until a clear light yellow solution is obtained. The resulting liquid was mixed with 20 wt% Epikote® 827, based on the total weight of the curing agent. A clear light yellow solution is obtained (Example 26).

5 The curing agent of Example 26 was mixed with Epikote® 827 in a weight ratio of 2.42 (epoxy resin to curing agent). The coating composition was cured at room temperature.

The pot life of Example 26 is 75 minutes. With the coating composition of the invention a film could be easily formed, the film was homogeneously distributed and transparent. The film was tack-free within 24 hours curing at room temperature. No blushing was observed.

10 Additionally, the curing agent of Example 26 was mixed with Epikote® 827 both in weight ratios of 2.42 (epoxy resin to curing agent). The coating composition were cured at 6°C. All films were tack-free within 24 hours curing. No blushing was observed.

Examples 27 and 28: cocopropylene diamine/salicylic acid (1:1 molar ratio)

15 Cocopropylene diamine (Duomeen® CD ex Akzo Nobel) is molten at 27°C. 50 grams Duomeen CD is transferred into a glass beaker, equipped with a magnetic stirring bar, followed by slow addition of 27 grams salicylic acid (1:1 molar ratio). Stirring is continued until a clear light yellow solution is obtained. To the liquid curing agent demineralised water was added in an amount of 5 wt% (Example 27) and 10 wt% (Example 28), based on the total weight of the curing agent.

20 The curing agents of Examples 27 to 28 were mixed with Epikote® 827 in weight ratios of 2.81 and 2.67, respectively (epoxy resin to curing agent). The coating composition were cured at room temperature.

25 The pot lives of Examples 27 and 28 are 86 and 75 minutes, respectively. With all coating compositions films of the invention could be easily formed, the films were homogeneously distributed. All films were tack-free within 24 hours curing at room temperature. No blushing was observed.

Examples 29 and 30: cocopropylene diamine/salicylic acid (80:20 weight ratio)

Cocopropylene diamine (Duomeen® CD ex Akzo Nobel) is molten at 27°C. 50 grams Duomeen CD is transferred into a glass beaker, equipped with a magnetic stirring bar, followed by slow addition of 12.5 grams salicylic acid. Stirring is continued until a clear light yellow solution is

obtained. To the liquid curing agent triethylene tetramine (TETA), an aliphatic polyamine, was added in amounts of 5 wt%, based on the total weight of the curing agent. To the resulting liquid curing agent demineralised water was added in an amount of 1 wt% (Example 29) and 15 wt% (Example 30), based on the total weight of the curing agent. A clear light yellow solution is
5 obtained.

The curing agents of Examples 29 and 30 were mixed with Epikote® 827 in weight ratios of 3.20 and 2.75, respectively (epoxy resin to curing agent). The coating composition was cured at room temperature.

The pot lives of Examples 29 and 30 are 48 and 59 minutes, respectively. With all coating
10 compositions films of the invention could be easily formed, the films were homogeneously distributed. All films were tack-free within 24 hours curing at room temperature. No blushing was observed.

Additionally, the curing agents of Examples 29 to 30 were mixed with Epikote® 827 in weight ratios of 3.20 and 2.75, respectively (epoxy resin to curing agent). The coating compositions
15 were cured at 5°C (relative humidity 75%). All films were tack-free within 24 hours curing. No blushing was observed.

Additionally, the curing agents of Examples 29 to 30 were mixed with Epikote® 827 in weight ratios of 3.20 and 2.75, respectively (epoxy resin to curing agent). The coating compositions
20 were cured at room temperature in a humidity chamber (relative humidity 80%, 20°C). All films were tack-free within 24 hours curing. No blushing was observed.

Examples 31 and 32: cocopropylene diamine/salicylic acid (1:1 molar ratio)

Cocopropylene diamine (Duomeen® CD ex Akzo Nobel) is molten at 27°C. 50 grams Duomeen CD is transferred into a glass beaker, equipped with a magnetic stirring bar, followed by slow addition of 27 grams salicylic acid (1:1 molar ratio). Stirring is continued until a clear light yellow
25 solution is obtained. To the liquid curing agent triethylene tetramine (TETA), an aliphatic polyamine, was added in amounts of 5 wt%, based on the total weight of the curing agent. To the resulting liquid curing agent demineralised water was added in an amount of 1 wt% (Example 31) and 15 wt% (Example 32), based on the total weight of the curing agent.

The curing agents of Examples 31 and 32 were mixed with Epikote® 827 in weight ratios of 3.30 and 2.84, respectively (epoxy resin to curing agent). The coating composition was cured at room temperature.

5 The pot lives of Examples 31 and 32 are 38 and 68 minutes, respectively. With all coating compositions films of the invention could be easily formed, the films were homogeneously distributed. All films were tack-free within 24 hours curing at room temperature. No blushing was observed.

10 The curing agents of Examples 31 and 32 were mixed with Epikote® 827 in weight ratios of 3.30 and 2.84, respectively (epoxy resin to curing agent). The coating compositions were cured at 5°C (relative humidity 75%). All films were tack-free within 24 hours curing. No blushing was observed.

15 The curing agents of Examples 31 and 32 were mixed with Epikote® 827 in weight ratios of 3.30 and 2.84, respectively (epoxy resin to curing agent). The coating compositions were cured at room temperature in a humidity chamber (relative humidity 80%, 20°C). All films were tack-free within 24 hours curing. No blushing was observed.

Example 33: coco amine/salicylic acid (1:1 molar ratio)

20 50 gram cocoamine (Armeen® C ex Akzo Nobel) is transferred into a glass beaker, equipped with a magnetic stirring bar, followed by slow addition of 17.25 grams salicylic acid (1:1 molar ratio). Stirring is continued until a clear light yellow solution is obtained. To the liquid curing agent triethylene tetramine (TETA), an aliphatic polyamine, was added in amounts of 5 wt% (Example 33), based on the total weight of the curing agent.

25 The curing agent of Example 33 was mixed with D.E.R.® 916, a water-based epoxy resin, in a weight ratio of 3.68 (epoxy resin to curing agent). To the resulting mixture 2-butanone oxime (MEKO) was added in an amount of 7 wt%, based on the total weight of the coating composition. The coating composition was cured at room temperature. With all coating compositions films of the invention could be easily formed, the films were homogeneously distributed and transparent. All films were light tacky within 24 hours curing at room temperature. No blushing was observed.

30 The curing agent of Examples 33 was mixed with D.E.R.® 916, a water-based epoxy resin, in a weight ratio of 3.68 (epoxy resin to curing agent). To the resulting mixture 2-butanone oxime

(MEKO) was added in an amount of 7 wt%, based on the total weight of the coating composition. The coating composition was cured at 5°C (relative humidity 75%). The film was light tacky within 24 hours curing. No blushing was observed.

Example 34: Isotridecyloxypropyl 1,3-diaminopropane/salicylic acid (1:1 molar ratio)

5 50 gram Isotridecyloxypropyl 1,3-diaminopropane (Tomamine® DA-17 ex Evonik) is transferred into a glass beaker, equipped with a magnetic stirring bar, followed by slow addition of 21.93 grams salicylic acid (1:1 molar ratio). Stirring is continued until a clear light yellow solution is obtained. To the liquid curing agent triethylene tetramine (TETA), an aliphatic polyamine, was added in amounts of 5 wt% (Example 34), based on the total weight of the curing agent.

10 The curing agent of Example 34 was mixed with D.E.R.® 916, a water-based epoxy resin, in a weight ratio of 3.68 (epoxy resin to curing agent). To the resulting mixture 2-butanone oxime (MEKO) was added in an amount of 7 wt%, based on the total weight of the coating composition. The coating composition was cured at room temperature. With all coating compositions films of the invention could be easily formed, the films were homogeneously distributed and transparent. All films were light tacky within 24 hours curing at room
15 temperature. No blushing was observed.

The curing agent of Examples 34 was mixed with D.E.R.® 916, a water-based epoxy resin, in a weight ratio of 3.68 (epoxy resin to curing agent). To the resulting mixture 2-butanone oxime (MEKO) was added in an amount of 7 wt%, based on the total weight of the coating
20 composition. The coating composition was cured at 5°C (relative humidity 75%). The film was light tacky within 24 hours curing. No blushing was observed.

Example 35: cocopropylene diamine/salicylic acid (1:1 molar ratio)

Cocopropylene diamine (Duomeen® CD ex Akzo Nobel) is molten at 27°C. 50 grams Duomeen
25 CD is transferred into a glass beaker, equipped with a magnetic stirring bar, followed by slow addition of 27 grams salicylic acid (1:1 molar ratio). Stirring is continued until a clear light yellow solution is obtained (Example 35).

The curing agent of Example 35 was mixed with hexamethylene diisocyanate (HDI) in a weight ratio of 2.5 (isocyanate to curing agent). Simultaneously, 1,4-diazabicyclo[2.2.2]octane
30 (DABCO) and dipropylene glycol dimethyl ether (DPGDME) were added in amounts of 2 wt%

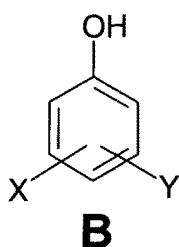
and 5 wt%, respectively, based on the total weight of the curing agent. The coating composition was cured at room temperature.

The temperature of the coating composition increased to 75°C. With the coating composition of the invention a film could be formed, the film was homogeneously distributed and transparent.

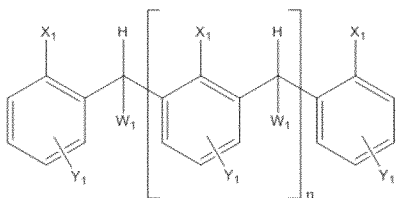
- 5 The film was tack-free within 24 hours curing at room temperature.

CLAIMS

1. A curing agent comprising (a) one or more fatty amine selected from the group consisting of
 5 an alkylated polyamine, bisalkylated amine, alkylated primary amine, an alkoxyated
 polyamine, bisalkoxyated amine and alkoxyated primary amine; and
 (b) a substituted phenol having formula (B):



wherein X and Y are individually selected from the group of COOH, carboxylate, OH, NH₂,
 NO₂, SO₃H, PO₃H, Cl, F, B, I, alkyl, alkenyl, COOR, OR, COR and aldehyde, and/or
 15 a substituted phenyl having formula (B1):



(B1)

wherein n is a number from 0 to 1000, X₁ is selected from hydrogen, hydroxyl and
 20 carboxylic acid, and Y₁ is selected from hydrogen, alkyl, alkenyl, alkynyl, aryl, substituted
 alkyls, substituted alkenyl, substituted alkynyl, substituted aryls, polycyclic aromatics,
 substituted polycyclic aromatics, polar functional groups, such as alcohol, amines, ketones,
 aldehydes, ethers, carboxylic acids, sulfonates, sulfonic acids, phosphonic acids and
 heterocyclics; and

25 W₁ is independently selected from hydrogen, alkyl, alkenyl, alkynyl, aryl, substituted alkyl,
 substituted alkenyl, substituted alkynyl, substituted aryls, polycyclic aromatics, substituted
 polycyclic aromatics, polar functional groups, such as alcohol, amines, ketones, aldehydes,
 amides, esters, carbonyls, epoxies, oxetanes, oxiranes, ethers, carboxylic acids,
 sulfonates, sulfonic acids, phosphonic acids and heterocyclics; and

(c) a low temperature cure agent;

wherein the molar ratio of the fatty amine and the substituted phenol and/or the substituted phenyl is at least 0.2 and at most 5.

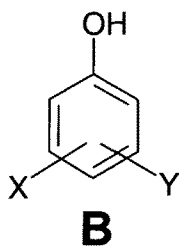
- 5 2. Curing agent according to claim 1 wherein the alkylated polyamine is an alkylated polyamine having the formula $R_1-N-((CH_2)_x-N)_n-(CH_2)_x-NH_2$, wherein R_1 is selected from the group consisting of linear or branched C_6-C_{50} alkyl, linear or branched C_6-C_{50} alkenyl, linear or branched C_6-C_{50} arylalkyl and linear or branched C_6-C_{50} alkylaryl, x is 2 to 5, and n is 0 to 10.

10

3. Kit of parts comprising (a) a cationically polymerizable building block; and (b) a curing agent comprising one or more fatty amines selected from the group consisting of an alkylated polyamine, bisalkylated amine, alkylated primary amine, an alkoxyated polyamine, bisalkoxyated amine and alkoxyated primary amine;

15

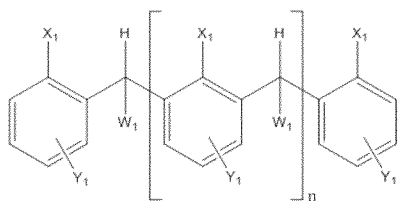
a substituted phenol having formula (B):



20

wherein X and Y are individually selected from the group of $COOH$, carboxylate, OH , NH_2 , NO_2 , SO_3H , PO_3H , Cl , F , B , I , alkyl, alkenyl, $COOR$, OR , COR and aldehyde, and/or a substituted phenyl having formula (B1):

25



(B1)

30

wherein n is a number from 0 to 1000, X_1 is selected from hydrogen, hydroxyl and carboxylic acid, and Y_1 is selected from hydrogen, alkyl, alkenyl, alkynyl, aryl, substituted alkyls, substituted alkenyl, substituted alkynyl, substituted aryls, polycyclic aromatics, substituted polycyclic aromatics, polar functional groups, such as alcohol, amines, ketones,

aldehydes, ethers, carboxylic acids, sulfonates, sulfonic acids, phosphonic acids and heterocyclics; and W_1 is independently selected from hydrogen, alkyl, alkenyl, alkynyl, aryl, substituted alkyl, substituted alkenyl, substituted alkynyl, substituted aryls, polycyclic aromatics, substituted polycyclic aromatics, polar functional groups, such as alcohol, amines, ketones, aldehydes, amides, esters, carbonyls, epoxies, oxetanes, oxiranes, ethers, carboxylic acids, sulfonates, sulfonic acids, phosphonic acids and heterocyclics; and a low temperature cure agent;

wherein the molar ratio of the fatty amine and the substituted phenol and/or the substituted phenyl is at least 0.2 and at most 5.

4. Coating composition comprising a cationically polymerizable building block and a curing agent according to any one of the preceding claims.
5. Coating composition according to claim 4 wherein the cationically polymerizable building block is selected from the group consisting of glycidyl ether or ester or a (cyclo)aliphatic compound, preferably the cationically polymerizable building block is a glycidyl ether.
6. A coated substrate comprising a substrate and a cured coating composition applied to at least part of the substrate, the coating composition being in accordance with any one of the claims 4 and 5.
7. Coated substrate according to claim 6 wherein the substrate is a metal, preferably aluminum, iron or steel.
8. Process for preparing a coated substrate comprising steps of:
 - (a) applying the coating composition according to any one of claims 4 and 5 to a substrate; and
 - (b) curing the coating composition.

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2019/050663

A. CLASSIFICATION OF SUBJECT MATTER
 INV. C08G59/50 C08G59/62 C08G59/68 C08G59/56
 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)
 C08G
 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, CHEM ABS Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2007/144425 A1 (HUNTSMAN ADV MAT SWITZERLAND [CH]; MULLER-FRISCHINGER ISABELLE MA [FR]) 21 December 2007 (2007-12-21) table 4 page 5, line 30 - line 33; table 1.11 page 1, paragraph 1	1-8
A	WO 2015/077918 A1 (DOW GLOBAL TECHNOLOGIES LLC [US] ET AL.) 4 June 2015 (2015-06-04) claims 1,4,7 table II	1-8
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Further documents are listed in the continuation of Box C. See patent family annex.

* Special categories of cited documents :

<p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier application or patent but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p>	<p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</p> <p>"&" document member of the same patent family</p>
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Date of the actual completion of the international search 17 April 2019	Date of mailing of the international search report 02/05/2019
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Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer O'Sullivan, Timothy
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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2019/050663

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	US 3 853 812 A (HELM D) 10 December 1974 (1974-12-10) claim 1 examples 1-7	1-8
A	US 2015/344406 A1 (KASEMI EDIS [CH] ET AL) 3 December 2015 (2015-12-03) claim 1 column 8, line 14 - line 15 column 5, line 42 - line 43	1-8

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Information on patent family members

International application No

PCT/EP2019/050663

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