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(54) **Title:** COMPOSITION AND PROCESS FOR SEMI-PERMANENT STRAIGHTENING OF HAIR

(57) **Abstract:** The present invention provides a hair straightening composition with improved ease of use, which leads to an enhanced smoothness of the straightened hair. The composition comprises at least one carboxylic acid of the formula (I) in combination with at least one quaternary ammonium compound having two long-chain hydrocarbon groups: R-CO-COOH Formula (I). In further aspects, the present invention concerns a process for semi-permanent straightening of the hair, utilizing said composition, the use of the composition for straightening hair, and a kit comprising the composition and a straightening iron.

Composition and Process for semi-permanent straightening of  
hair

5 The present invention relates to a composition and a process for semi-permanent straightening of the hair.

Background of the Invention

10 A known method for straightening curly or frizzy hair involves the use of straightening irons. The high temperature of the iron leads to a breakage of hydrogen bonds in the keratin of the hair, achieving a temporary straightening. The hydrogen bonds are formed again by the action of moisture, so  
15 that the hair reverts back to its original shape over the time because of air humidity, and the straightening effect vanishes after washing the hair.

The shape of the hair is largely determined by the disulfide  
20 bonds linking two cysteine moieties of the hair keratin. In order to achieve a more permanent shaping of the hair, known methods involve the cleavage of the disulfide bonds by the action of a sulfide- or thio group containing reducing agent. After the hair has been brought into the desired shape, new  
25 disulfide bonds are formed by applying an oxidizing agent such as hydrogen peroxide, thus fixing the shape of the hair. The use of such agents, however, may cause damage to the hair.

30 As an example for this kind of hair shaping treatment, reference is made to GB 1 416 564, describing reducing compositions comprising thioglycolates or thiolactates as

reducing agents and fixing compositions comprising hydrogen peroxide as an oxidizing agent. The reducing compositions may further comprise a salt of an acid such as glyoxylic acid as a buffering agent.

5

As an alternative to the above-described two-step reduction and oxidation process, the disulfide bridges can be cleaved by the action of an alkaline agent such as sodium hydroxide at a pH of about 11 or higher. Under these conditions, the disulfide (or cystin) moiety can undergo a disproportionation reaction under the elimination of sulfur, and is cleaved into an alpha-beta-unsaturated dehydro-alanine moiety and a cysteine moiety. After the hair has been brought into the desired shape, the dehydro-alanine moieties and the cysteine moieties form thioether bonds and combine to lanthionine, stabilizing the straightened state of the hair. Since the disulfide or cystin moieties are converted into lanthionine moieties, this type of hair straightening process using an alkaline agent is also called lanthionization.

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Both the two-stage reduction/oxidation method and the lanthionization method rely on a cleavage of the disulfide bonds and the formation of new bonds among the hair proteins, leading to an irreversible change of the shape of the hair.

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This means that these processes can achieve a permanent straightening, wherein the treated portion of the hair maintains its shape, and the straightening effect only vanishes because of the growth of the hair.

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Recently, it has been found that carboxylic acids having a carbonyl group adjacent to the carboxy group, such as glyoxylic acid, which are known as a buffering agent in cosmetic compositions, may have a semi-permanent

straightening effect when used in combination with mechanical straightening means.

In this respect, WO 2011/104282 describes a process for semi-permanent hair straightening, which involves applying a composition comprising an  $\alpha$ -keto acid onto the hair, leaving the composition in contact with the hair for 15 to 120 minutes, drying the hair and straightening the hair with a straightening iron at a temperature of  $200\pm 50^{\circ}\text{C}$ .

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Furthermore, WO 2012/010351 describes a treatment for semi-permanent straightening of curly, frizzy or wavy hair by applying a solution of glyoxylic acid in combination with mechanical straightening, using a straightening iron at a temperature of  $200\pm 30^{\circ}\text{C}$ . After the treatment, the hair is said to retain its shape for at least six consecutive washings.

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EP 1 382 324 describes a foaming hair conditioner comprising a quaternary ammonium compound having an alkyl residue of 14 carbon atoms or higher ("monoalkyl quat") in combination with a C16-dialkyl quat and a C18-dialkyl quat at a certain ratio. The use of such a conditioner in connection with a straightening agent is not described, though.

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#### Summary of the Invention

The present invention relates to a hair straightening composition having a pH of 4 or less and comprising:

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- at least one carboxylic acid of the formula (I) and/or a hydrate thereof and/or a salt thereof:

## R-CO-COOH            Formula (I)

- wherein R is selected from hydrogen, COOH, CN,  
optionally substituted C<sub>1</sub>-C<sub>10</sub> alkyl, optionally  
5 substituted C<sub>2</sub>-C<sub>10</sub> alkenyl, optionally substituted C<sub>2</sub>-C<sub>10</sub>  
alkynyl, optionally substituted C<sub>3</sub>-C<sub>10</sub> cycloalkyl,  
optionally substituted C<sub>6</sub>-C<sub>10</sub> aryl or a 5-10-membered,  
optionally substituted heteroaryl group, wherein the  
optional substituents of the alkyl group are selected  
10 from halogen, hydroxyl, amino and C<sub>1</sub>-C<sub>4</sub> alkoxy, and the  
optional substituents of the other groups are selected  
from halogen, hydroxyl, amino, C<sub>1</sub>-C<sub>4</sub> alkyl and C<sub>1</sub>-C<sub>4</sub>  
alkoxy; and
- 15 - at least one quaternary ammonium salt having two C<sub>5</sub>-C<sub>24</sub>  
linear or branched, saturated or unsaturated hydrocarbon  
groups in the molecule, which may be the same or  
different and may be optionally substituted with one or  
more substituents selected from halogen, hydroxyl, amino  
20 and C<sub>1</sub>-C<sub>4</sub> alkoxy.

The composition may be formulated as a one-part composition,  
or as a two-part composition comprising the parts A and B,  
which are stored separately and mixed prior to the  
25 application to the hair, wherein part A comprises the  
carboxylic acid of formula (I) and part B comprises at least  
one of a fragrance, a surfactant or a conditioning component.  
The quaternary ammonium salt having two C<sub>5</sub>-C<sub>24</sub> hydrocarbon  
groups is contained in either or both of part A and part B,  
30 and is preferably contained in part B in case it has acid-  
sensitive groups. Improved fragrance stability is observed  
with two-part compositions.

In another aspect, the present invention relates to a process for semi-permanent hair straightening, comprising the following steps performed in this order:

- 5 (a) application of the above-described composition, which may be a one-part composition or a mixture of parts A and B of a two-part composition, as defined above, onto the hair;
- (b) leaving the composition on the hair for 1 to 120  
10 minutes;
- (c) optionally rinsing off the hair;
- (d) drying the hair;
- (e) treating the hair with an iron having a surface temperature of  $180 \pm 50^{\circ}\text{C}$ ; and
- 15 (f) optionally rinsing off and/or shampooing the hair and drying.

In yet another aspect, the present invention relates to the use of the above-described composition for hair  
20 straightening, and to a kit comprising the composition and a straightening iron.

#### Detailed description of the Invention

25 Carboxylic acids of the formula (I), such as glyoxylic acid, have recently been found to provide remarkable semi-permanent straightening effects. However, there is a demand for improving the ease of use of these products and the smoothness of the straightened hair. It has not yet been  
30 described in the prior art that these aspects can be substantially improved by using a specific quaternary ammonium compound in combination with the acids of the formula (I).

The present inventors have found that the problem of improving the ease of use and the smoothness of the straightened hair can be solved by combining the carboxylic acid of formula (I) with a specific quaternary ammonium compound having two long-chain hydrocarbon groups.

Accordingly, the present invention provides a hair straightening composition, which comprises at least one carboxylic acid of the formula (I) in combination with at least one quaternary ammonium compound having two long-chain hydrocarbon groups, and a process for semi-permanent straightening of the hair utilizing said composition.

1. The Carboxylic acid of Formula (I)

The straightening composition comprises at least one carboxylic acid of the following formula (I) as the active component for achieving the straightening effect:



wherein R is selected from hydrogen, COOH, CN, optionally substituted C<sub>1</sub>-C<sub>10</sub> alkyl, optionally substituted C<sub>2</sub>-C<sub>10</sub> alkenyl, optionally substituted C<sub>2</sub>-C<sub>10</sub> alkynyl, optionally substituted C<sub>3</sub>-C<sub>10</sub> cycloalkyl, optionally substituted C<sub>6</sub>-C<sub>10</sub> aryl or a 5-10-membered, optionally substituted heteroaryl group, wherein the optional substituents of the alkyl group are selected from halogen, hydroxyl, amino and C<sub>1</sub>-C<sub>4</sub> alkoxy, and the optional substituents of the other groups are selected from halogen, hydroxyl, amino, C<sub>1</sub>-C<sub>4</sub> alkyl and C<sub>1</sub>-C<sub>4</sub> alkoxy.

As preferred examples, glyoxylic acid, pyruvic acid and 2-ketobutyric acid can be mentioned.

5 The carboxylic acid of Formula (I) may be comprised in the composition in its free acid form. The carbonyl group adjacent to the acid group of the acid may also be present in the hydrate form. Apart from the free acid form and the hydrate thereof, salts of the acid or the hydrate may also be used.

10

The hydrate of the acid of Formula (I) may be formed when providing the composition as an aqueous solution. For instance, glyoxylic acid ( $\text{H-CO-COOH}$ ) in aqueous solution is almost quantitatively present as the hydrate ( $\text{H-C(OH)}_2\text{-COOH}$ ).

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Besides, the hydrate may also condense to dimers.

A salt of the carboxylic acid of Formula (I) may also be used. As examples, alkali metal salts such as the sodium or potassium salt, alkaline earth metal salts such as the magnesium salt or the calcium salt and tertiary or quaternary ammonium salts may be mentioned.

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In the present invention, glyoxylic acid, its salts and its hydrated form are the more preferred carboxylic acids of

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Formula (I).

The concentration of the at least one carboxylic acid of the Formula (I) and/or a hydrate thereof and/or salts thereof is usually in the range of 0.1 to 40%, preferably 0.5 to 40%, more preferably 2.5 to 40%, more preferably 0.5 to 30%, more preferably 1 to 25% and more preferably 2.5 to 20%, and even more preferably 2.5 to 14% by weight, based on the total weight of the straightening composition.

30



As discussed above, conventional permanent hair shaping/straightening techniques are based on the re-organization of the disulfide bridges and involve a cleavage of the disulfide bonds either by using a sulfur-based reducing agent or an alkali agent, followed by the shaping of the hair and the formation of new bonds (i.e., disulfide bonds formed by the action of an oxidizing agent or thioether bonds, respectively). In contrast to these permanent straightening methods, the present invention does not utilize cleavage of the disulfide bonds and fixing the bonds in the new shape. Therefore, the straightening composition of the present invention does not require the presence of sulfur-based reducing agents, and preferably is free of sulfur based reducing agents. However, up to 2% by weight calculated to the total of the composition of sulfur based reducing agents does not disturb the straightening performance of the compositions. Therefore, the treatment composition has less than 2% by weight of sulfur-based reducing agents, and preferably is free of sulfur-based reducing agents.

## 2. The Quaternary Ammonium Salt

The straightening composition of the present invention comprises at least one quaternary ammonium salt ("quat") having two C<sub>5</sub>-C<sub>24</sub> linear or branched, saturated or unsaturated hydrocarbon groups in the molecule.

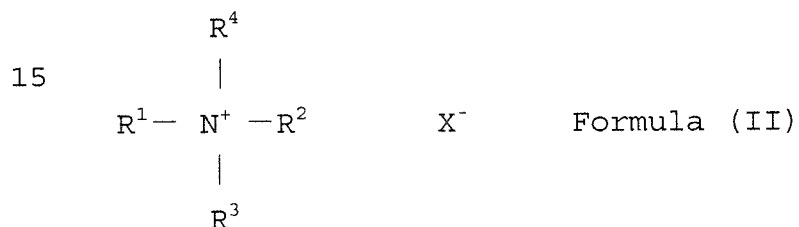
In accordance with the present invention, each of the C<sub>5</sub>-C<sub>24</sub> linear or branched, saturated or unsaturated hydrocarbon groups may be attached to the cationic nitrogen atom of the quaternary ammonium compound either directly or via a spacer

group, or may be attached to the heterocyclic structure in case of a cyclic quaternary ammonium compound.

The two C<sub>5</sub>-C<sub>24</sub> linear or branched, saturated or unsaturated hydrocarbon groups of the quaternary ammonium salt may be the same or different, and may optionally be substituted with at least one substituent selected from halogen, hydroxyl, amino and C<sub>1</sub>-C<sub>4</sub> alkoxy. Preferably, the number of carbon atoms in the hydrocarbon groups is 8 to 22, more preferably 10 to 18.

10

In one embodiment, the quaternary ammonium salt is a non-cyclic quaternary ammonium salt of the following formula (II):



wherein R<sup>1</sup> and R<sup>2</sup> are independently selected from the group consisting of:

- optionally substituted C<sub>5</sub>-C<sub>24</sub> alkyl;
- optionally substituted C<sub>5</sub>-C<sub>24</sub> alkenyl;
- optionally substituted C<sub>5</sub>-C<sub>24</sub> alkynyl;
- groups of the formula R'-CO-NH-(CH<sub>2</sub>)<sub>n</sub>-, wherein R' is an optionally substituted C<sub>5</sub>-C<sub>24</sub> alkyl, C<sub>5</sub>-C<sub>24</sub> alkenyl or C<sub>5</sub>-C<sub>24</sub> alkynyl group and n is an integer of 1 to 4; and
- groups of the formula R'-CO-O-(CH<sub>2</sub>)<sub>n</sub>-, wherein R' and n are the same as defined above;

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the optional substituent(s) being selected from halogen, hydroxyl, amino and C<sub>1</sub>-C<sub>4</sub> alkoxy;

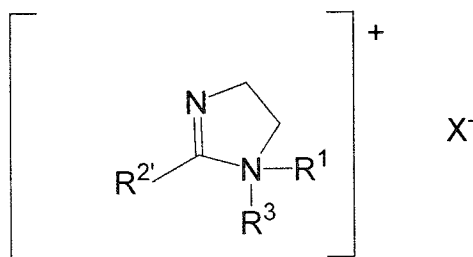
R<sup>3</sup> and R<sup>4</sup>, which may be identical or different, represent an alkyl group with 1 to 4 carbon atoms, which may optionally be substituted with one or more hydroxyl groups or ethylene oxide and/or propylene oxide adducts thereof, the average addition number being in the range of 1 to 4; and

X<sup>-</sup> represents an anion such as chloride, bromide, methosulfate or ethosulfate.

Compounds of formula (II) wherein R<sup>1</sup> and R<sup>2</sup> represent alkyl are also referred to as "di-alkyl quats". As preferable examples for such compounds of formula (II), di-C<sub>12</sub>-C<sub>15</sub>-alkyl dimethylammonium or di-C<sub>12</sub>-C<sub>15</sub>-alkyl hydroxyethylmonium methanesulfonates may be mentioned.

In case one or both of R<sup>1</sup> and R<sup>2</sup> represent a group of the formula R'-CO-NH-(CH<sub>2</sub>)<sub>n</sub>- or R'-CO-O-(CH<sub>2</sub>)<sub>n</sub>-, n is preferably 2 and the R'-CO-moiety is preferably derived from a saturated or unsaturated C<sub>8</sub>-C<sub>22</sub>-fatty acid or a mixture of such fatty acids. As a preferable example for such a compound, dioleylethyl hydroxyethylmonium methanesulfate (TETRANYL™ CO-40, commercially available from KAO CORPORATION) may be mentioned.

In another preferred embodiment, the quaternary ammonium salt is a cyclic compound of the imidazoline type, represented by the following formula (III):



Formula (III)

wherein  $R^1$  and  $R^3$  are the same as for the formula (II) defined above, and  $R^{2'}$  represents a linear or branched  $C_5$ - $C_{24}$  alkyl,  $C_5$ - $C_{24}$  alkenyl or  $C_5$ - $C_{24}$  alkynyl group which may be optionally substituted with at least one substituent selected  
5 from halogen, hydroxyl, amino and  $C_1$ - $C_4$  alkoxy.

As apparent from formula (III), these imidazoline type quats may be considered as the quaternized cyclization product of an acyl amide compound of the formula  $R^{2'}-CO-NR^1-CH_2-CH_2-NH_2$ ,  
10 wherein the  $NH_2$  group undergoes a cyclization with the carbonyl group, and the resulting imidazoline ring is quaternized with  $R^3$ .

Preferably,  $R^1$  in formula (III) represents a group of the  
15 formula  $R^{1'}-CO-NH-CH_2CH_2-$ , wherein the definition of  $R^{1'}$  is the same as  $R^{2'}$ . In this case, the compound of the formula (III) may be considered to be the quaternized cyclization product of diacylated diethylene triamine. The acyl groups  $R^{1'}-CO-$  and  $R^{2'}-CO-$  are preferably selected from saturated or  
20 unsaturated fatty acids and mixtures thereof.

As a preferable example thereof, Quaternium-91 (di-behenyl imidazoline quat, methosulfate salt) may be mentioned. The commercially available product Crodazosoft™ DBP-Q  
25 (manufactured by Croda Inc.) is a mixture of Quaternium-91, cetrimonium methosulfate and cetearyl alcohol, and may be preferably used for the present invention.

In the composition of the present invention, it is possible  
30 to use only a single type of the quaternary ammonium salt having two  $C_5$ - $C_{24}$  linear or branched, saturated or unsaturated hydrocarbon groups in the molecule, or a combination of two or more types.

The content of the at least one quaternary ammonium salt, such as the quaternary ammonium salt of the formula (II) and/or (III), in the composition is usually 0.01 to 15 wt%,  
 5 more preferably 0.05 to 10 wt.%, and even more preferably 0.1 to 5 wt.%, based on the total weight of the straightening composition.

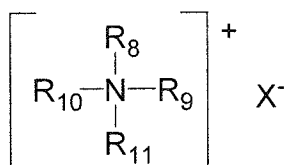
### 3. Surfactant

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The straightening composition may comprise a surfactant. As the surfactant, any of a further cationic surfactant (in addition to the quaternary ammonium compound defined above), a nonionic surfactant, an amphoteric surfactant and an  
 15 anionic surfactant can be used. It is also possible to use two or more types of surfactants in combination.

The further cationic surfactant is preferably a mono-long chain alkyl quaternary ammonium salt, having a C<sub>8</sub>-C<sub>24</sub> alkyl  
 20 residue and three C<sub>1</sub>-C<sub>4</sub> alkyl residues.

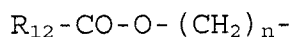
In view of gliding of the iron on the hair, it is preferable to include at least one mono alkyl quaternary ammonium surfactant ("monoalkyl quat"), which is selected from the  
 25 compounds with the general formula



wherein R<sub>8</sub> is a saturated or unsaturated, branched or  
 30 straight alkyl chain with 8-22 C atoms or



wherein  $R_{12}$  is a saturated or unsaturated, branched or  
5 straight alkyl chain with 7-21 C atoms and  $n$  is an integer of  
1 - 4, or



10 wherein  $R_{12}$  is a saturated or unsaturated, branched or  
straight alkyl chain with 7-21 C atoms and  $n$  is an integer of  
1 - 4, and

$R_9$ ,  $R_{10}$  and  $R_{11}$  are independent from each other an alkyl group  
15 with 1 to 4 carbon atoms, hydroxyl alkyl chain with 1 to 4  
carbon atoms, or ethoxy or propoxy group with a number of  
ethoxy or propoxy groups varying in the range of 1 to 4, and  
 $X$  is chloride, bromide, methosulfate or ethosulfate.

20 Suitable cationic surfactants are, for example, long-chain  
quaternary ammonium compounds which can be used alone or in  
admixture with one another, such as cetyl trimethyl ammonium  
chloride, myristyl trimethyl ammonium chloride,  
behentrimonium chloride, trimethyl cetyl ammonium bromide,  
25 stearyl trimethyl ammonium chloride, stearyl trimonium  
chloride and stearamidopropyltrimonium chloride.

Examples of the nonionic surfactant include polyoxy- $C_{1-4}$ -  
alkylene  $C_{8-24}$ -alkyl ether, polyoxy- $C_{1-4}$ -alkylene  $C_{8-24}$ -alkylene  
30 alkenyl ether, higher ( $C_{12}$ - $C_{24}$ ) fatty acid sucrose ester,  
polyglycerin  $C_{8-24}$ -fatty acid ester, higher ( $C_{12}$ - $C_{24}$ ) fatty  
acid mono- or diethanolamide, polyoxyethylene hardened castor  
oil, polyoxyethylene sorbitan  $C_{8-24}$ -fatty acid ester,

polyoxyethylene sorbit C<sub>8-24</sub>-fatty acid ester, C<sub>8-24</sub>-alkyl saccharide surfactant, C<sub>8-24</sub>-alkylamine oxide, and C<sub>8-24</sub>-alkylamidoamine oxide.

5 Examples of the amphoteric surfactant include an imidazoline-based surfactant, a carbobetaine-based surfactant, an amidobetaine-based surfactant, a sulfobetaine-based surfactant, a hydroxysulfobetaine-based surfactant and an amidosulfobetaine-based surfactant.

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Examples of the anionic surfactant include alkylbenzenesulfonate, alkyl or alkenyl ether sulfate, alkyl or alkenyl sulfate, olefin sulfonate, alkanesulfonate, saturated or unsaturated fatty acid salts, alkyl or alkenyl ether carboxylate,  $\alpha$ -sulfo fatty acid salts, N-acylamino acid type surfactants, phosphoric acid mono- or diester type surfactants, and sulfosuccinate. Examples of the alkyl ether sulfate include polyoxyethylene alkyl ether sulfate. Examples of the counterion for the anionic residues of these

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20 surfactants include an alkalimetal ion such as sodium ion or potassium ion; an alkaline earth metal ion such as calcium ion or magnesium ion; an ammonium ion; and an alkanolamine having 1 to 3 alkanol groups each having 2 or 3 carbon atoms (for example, monoethanolamine, diethanolamine,

25 triethanolamine, or triisopropanolamine).

The surfactant can be used singly or in combination of two or more kinds. When adding a surfactant to the straightening composition, the content thereof usually is 0.05 to 10% wt.%, more preferably 0.1 to 5 wt.%, based on the total weight of

30 the straightening composition.

#### 4. Conditioning Component

The straightening composition may optionally comprise a conditioning component suitable for application to the hair. The conditioning component is an oil or polymer which adheres to the hair and improves the feel and the manageability.

When using the conditioning component, the total content thereof is preferably 0.01 to 30 wt.%, more preferably 0.05 to 20 wt.%, and even more preferably 0.1% to 10 wt.%, based on the total weight of the straightening composition.

Examples of the conditioning component generally include cationic polymers, silicones, higher alcohols, and organic conditioning oils (for example, hydrocarbon oil, polyolefin and fatty acid ester). The composition may comprise a single type of conditioning component, or two or more in combination.

#### Cationic Polymers

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A cationic polymer is a polymer having a cationic group or a group capable of being ionized into a cationic group, and in general, an amphoteric polymer acquiring net cationic charge is also included in the terminology. That is, the cationic polymer is a polymer containing an amino group or an ammonium group in a side chain of the polymer chain, or a polymer including a diallyl quaternary ammonium salt as a constituent unit, and examples thereof include cationized cellulose, cationic starch, cationic guar gum, a polymer or copolymer of a diallyl quaternary ammonium salt, and quaternized polyvinylpyrrolidone. Among these, from the viewpoint of softness, smoothness and easy finger-combing during shampooing, and easy manageability and moisture retention



during drying, and from the viewpoint of stability of the agent, a polymer including a diallyl quaternary ammonium salt as a constituent unit, quaternized polyvinylpyrrolidone, and cationized cellulose are preferred, and a polymer or  
5 copolymer of a diallyl quaternary ammonium salt, and cationized cellulose are more preferred.

Specific examples of the polymer or copolymer of a diallyl quaternary ammonium salt include dimethyldiallylammonium  
10 chloride polymer (polyquaternium-6, for example, MERQUAT 100; Nalco Company), dimethyldiallylammonium chloride/acrylic acid copolymer (polyquaternium-22, for example, MERQUAT 280, MERQUAT 295; Nalco Company), and dimethyldiallylammonium chloride/acrylic acid amide copolymer (polyquaternium-7, for  
15 example, MERQUAT 550; Nalco Company).

Specific examples of the quaternized polyvinylpyrrolidone include quaternary ammonium salts synthesized from a copolymer of vinylpyrrolidone (VP) and dimethylaminoethyl  
20 methacrylate, and diethyl sulfate (polyquaternium 11, for example, GAFQUAT 734, GAFQUAT 755 and GAFQUAT 755N (all by ISP Japan, Ltd.)).

Specific examples of the cationized cellulose include a  
25 polymer of a quaternary ammonium salt obtained by adding glycidyltrimethylammonium chloride to hydroxyethylcellulose (polyquaternium-10, for example, RHEOGUARD G and RHEOGUARD GP (all by Lion Corp.), POLYMER JR-125, POLYMER JR-400, POLYMER JR-30M, POLYMER LR-400 and POLYMER LR-30M (all by Amerchol  
30 Corp.)), and a hydroxyethylcellulose/dimethyldiallylammonium chloride copolymer (polyquaternium-4, for example, CELQUAT H-100, CELQUAT L-200 (all by National Starch and Chemical Company)).

The cationic polymer may be used in combination of two or more kinds. Furthermore, the cationic polymer gives better effects when the content is increased, but an excessively  
5 high content of the cationic polymer may cause stability failure and a decrease in the viscosity of the agent alone or during mixing. From this viewpoint, and from the viewpoint of enhancing the feel to the touch, the content of the cationic polymer is preferably 0.001 to 20 wt%, more preferably 0.01  
10 to 10 wt.%, and even more preferably 0.05 to 5 wt.%, based on the total weight of the straightening composition.

#### Silicones

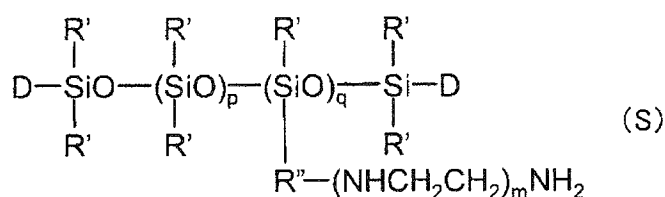
15 In order to improve the feel of use, the straightening composition preferably contains a silicone. Examples of the silicone include dimethylpolysiloxane, and modified silicone (for example, amino-modified silicone, fluorine-modified  
silicone, alcohol-modified silicone, polyether-modified  
20 silicone, epoxy-modified silicone, polyoxazoline silicone (as described in JP Hei 2-276824), or alkyl-modified silicone), but dimethylpolysiloxane, polyether-modified silicone and amino-modified silicone are preferred.

25 The dimethylpolysiloxane may be any cyclic or non-cyclic dimethylsiloxane polymer, and examples thereof include SH200 series, BY22-019, BY22-020, BY11-026, B22-029, BY22-034, BY22-050A, BY22-055, BY22-060, BY22-083, FZ-4188 (all by Dow Corning Toray Co., Ltd.), KF-9008, KM-900 series, MK-15H, and  
30 MK-88 (all by Shin-Etsu Chemical Co., Ltd.).

The polyether-modified silicone may be any silicone having a polyoxyalkylene group, and the group constituting the

polyoxyalkylene group may be an oxyethylene group or an oxypropylene group. More specific examples include KF-6015, KF-945A, KF-6005, KF-6009, KF-6013, KF-6019, KF-6029, KF-6017, KF-6043, KF-353A, KF-354A, KF-355A (all by Shin-Etsu  
 5 Chemical Co., Ltd.), FZ-2404, SS-2805, FZ-2411, FZ-2412, SH3771M, SH3772M, SH3773M, SH3775M, SH3749, SS-280X series, BY22-008 M, BY11-030, and BY25-337 (all by Dow Corning Toray Co., Ltd.).

10 The amino-modified silicone may be any silicone having an amino group or an ammonium group, and examples thereof include an amino-modified silicone oil having all or a part of the terminal hydroxyl groups capped with a methyl group or the like, and an amodimethicone which does not have the  
 15 terminals capped. A preferred example of the amino-modified silicone may be a compound represented by the following formula:



20 wherein R' represents a hydroxyl group, a hydrogen atom or R<sup>x</sup>; R<sup>x</sup> represents a substituted or unsubstituted monovalent hydrocarbon group having 1 to 20 carbon atoms; D represents R<sup>x</sup>, R''-(NHCH<sub>2</sub>CH<sub>2</sub>)<sub>m</sub>NH<sub>2</sub>, OR<sup>x</sup>, or a hydroxyl group; R'' represents a divalent hydrocarbon group having 1 to 8 carbon atoms; m  
 25 represents a number from 0 to 3; p and q represent numbers, the sum of which is, as a number average, equal to or greater than 10 and less than 20,000, preferably equal to or greater than 20 and less than 3000, more preferably equal to or

greater than 30 and less than 1000, and even more preferably equal to or greater than 40 and less than 800.

Specific examples of suitable commercially available products  
5 of the amino-modified silicone include amino-modified  
silicone oils such as SF8452C, SS-3551 (all by Dow Corning  
Toray Co., Ltd.), KF-8004, KF-867S, and KF-8015 (all by Shin-  
Etsu Chemical Co., Ltd.); and amodimethicone emulsions such  
as SM8704C, SM8904, BY22-079, FZ-4671, and FZ-4672 (all by  
10 Dow Corning Toray Co., Ltd.).

The total content of these silicones in the straightening  
composition of the present invention is usually 0.1 to 20  
wt.%, preferably 0.2% to 10 wt.% and more preferably 0.5 to 5  
15 wt.%, based on the total weight of the straightening  
composition.

#### Oil component

20 For improving the feel upon use, the straightening  
composition may also include an organic conditioning oil.  
The organic conditioning oil that is suitably used as a  
conditioning component is preferably a low-viscosity and  
water-insoluble liquid, and is selected from a hydrocarbon  
25 oil having at least 10 carbon atoms, a polyolefin, a fatty  
acid ester, a fatty acid amide, a polyalkylene glycol, and  
mixtures thereof. The viscosity of such an organic  
conditioning oil as measured at 40°C is preferably 1 to 200  
mPa·s, more preferably 1 to 100 mPa·s, and even more  
30 preferably 2 to 50 mPa·s. For the determination of the  
viscosity, a capillary viscometer may be used.

Examples of the hydrocarbon oil include a cyclic hydrocarbon, a linear aliphatic hydrocarbon (saturated or unsaturated), and a branched aliphatic hydrocarbon (saturated or unsaturated), and polymers or mixtures thereof are also included. The linear hydrocarbon oil preferably has 12 to 19 carbon atoms. The branched hydrocarbon oil includes hydrocarbon polymers, and preferably has more than 19 carbon atoms.

The polyolefin is a liquid polyolefin, more preferably a liquid poly- $\alpha$ -olefin, and even more preferably a hydrogenated liquid poly- $\alpha$ -olefin. The polyolefin used herein is prepared by polymerizing an olefin monomer having 4 to 14 carbon atoms, and preferably 6 to 12 carbon atoms.

15

The fatty acid ester may be, for example, a fatty acid ester having at least 10 carbon atoms. Examples of such a fatty acid ester include esters having a hydrocarbon chain derived from a fatty acid and an alcohol (for example, monoesters, polyhydric alcohol esters, or di- and tricarboxylic acid esters). The hydrocarbon group of these fatty acid esters may have another compatible functional group such as an amide group or an alkoxy group as a substituent, or the hydrocarbon group may be covalently bonded to those functional groups.

20

More specifically, an alkyl and alkenyl ester of a fatty acid having a fatty acid chain having 10 to 22 carbon atoms, a carboxylic acid ester of an aliphatic alcohol having an aliphatic chain derived from an alkyl and/or alkenyl alcohol having 10 to 22 carbon atoms, and a mixture thereof are suitably used. Specific examples of these preferred fatty acid esters include isopropyl isostearate, hexyl laurate, isoheptyl laurate, isoheptyl palmitate, isopropyl palmitate, isopropyl myristate, decyl oleate, isodecyl oleate, hexadecyl

30

stearate, decyl stearate, dihexadecyl adipate, lauryl lactate, myristyl lactate, cetyl lactate, oleyl stearate, oleyl oleate, oleyl myristate, lauryl acetate, cetyl propionate and dioleyl adipate.

5

Further suitable oil components are natural oils such as paraffin oil and natural triglycerides.

Suitable natural triglycerides are argan oil, shea butter  
10 oil, karite oil, olive oil, almond oil, avocado oil, ricinus oil, coconut oil, palm oil, sesame oil, peanut oil, sunflower oil, peach kernel oil, wheat germ oil, macadamia nut oil, macadamia oil, night primrose oil, jojoba oil, castor oil, soya oil, lanolin, passiflora oil, black cumin oil, borage  
15 oils, grapeseed oil, hempseed oil, kukui nut oil, and rosehip oil.

The organic conditioning oil may be used in combination of two or more kinds, and the total concentration is typically  
20 in the range of 0.1 to 20 wt.%, preferably 0.2 to 10 wt.%, more preferably 0.5 to 5 wt.%, based on the total weight of the straightening composition.

### Alcohols

25

From the viewpoint of improving the sense of touch and stability, the straightening composition may also contain a higher alcohol having 8 carbon atoms or more. Usually, the higher alcohol has 8 to 22 carbon atoms, and preferably 16 to  
30 22 carbon atoms. Specific examples thereof include cetyl alcohol, stearyl alcohol, behenyl alcohol, and mixtures thereof.

The higher alcohol may be used in combination of two or more kinds, and the content thereof is typically 0.1 to 20 wt.%, preferably 0.2 to 10 wt.%, more preferably 0.5 to 5 wt.%, based on the total weight of the straightening composition.

5

Additionally polyols may suitably be comprised in the compositions. Examples of the polyalkylene glycol include polyethylene glycol and polypropylene glycol, and a mixture of the two may be used, or a copolymer of ethylene oxide and propylene oxide may also be used.

10

#### 5. The Formulation of the Straightening Composition

The straightening composition may suitably be in the form of a solution, emulsion, cream, gel, paste and mousse.

15

In order to provide a sufficient straightening effect, the pH of the straightening composition is 4.0 or less, preferably in the range of 1 to 3.5, more preferably 1 to 3 and more preferably 1.5 to 3, as measured directly and at ambient temperature (25°C). The pH of the composition may be adjusted using known alkaline solutions, preferably with sodium hydroxide solution.

20

#### 25 Emulsion Formulations

The straightening composition is preferably formulated as an emulsion, preferably including a fatty alcohol such as cetearyl alcohol. In view of emulsion stability, a non-ionic or an additional cationic surfactant may optionally be added.

30

It is especially preferable to include a quaternary ammonium compound having one C<sub>5</sub>-C<sub>24</sub> hydrocarbon group as the additional

cationic surfactant. In this case, the ratio of the quaternary ammonium compound having two C<sub>5</sub>-C<sub>24</sub> hydrocarbon groups and the quaternary ammonium compound having one C<sub>5</sub>-C<sub>24</sub> hydrocarbon group is preferably within the range of 10:1 to 1:10, more preferably 5:1 to 1:5, more preferably 2:1 to 1:2. In order to improve the ease of use, one or more further conditioning components such as a silicone, preferably an amodimethicone may be added to the emulsion. Preferable emulsion formulations are described in the following.

10

## Emulsion Formulation 1

2-20 wt.%	Glyoxylic acid
0.1-2 wt.%	Di-C <sub>12</sub> -C <sub>15</sub> alkyldimethyl ammonium salt (e.g., chloride or methosulfate)
0.2-5 wt.%	Mono-C <sub>14</sub> -C <sub>18</sub> alkyltrimethyl ammonium salt, preferably cetrimonium methosulfate
1-5 wt.%	C <sub>14</sub> -C <sub>20</sub> fatty alcohol, preferably cetearyl alcohol

20

## Emulsion Formulation 2

The emulsion composition may comprise a diacyloxyalkyl quat such as dioleylethyl hydroxyethylmonium methosulfate (TETRANYL™ CO-40) as an alternative to the dialkyl quat:

2-20 wt.%	Glyoxylic acid
0.1-2 wt.%	Diacyloxyalkyl quat, preferably TETRANYL™ CO-40
0.2-5 wt.%	Mono-C <sub>14</sub> -C <sub>18</sub> alkyltrimethyl ammonium salt, preferably Cetrimonium methosulfate
1-5 wt.%	C <sub>14</sub> -C <sub>20</sub> fatty alcohol, preferably cetearyl alcohol

30



## Emulsion Formulation 3

Another preferable type of formulation utilizes an imidazoline type quat of the formula (III), such as  
5 quaternium-91:

2-20 wt.%	Glyoxylic acid
0.1-2 wt.%	imidazoline type quat preferably quaternium-91
10 0.2-5 wt.%	Mono-C <sub>14</sub> -C <sub>18</sub> alkyltrimethyl ammonium salt, preferably cetrimonium methosulfate
1-5 wt.%	C <sub>14</sub> -C <sub>20</sub> fatty alcohol, preferably cetearyl alcohol

15 The emulsion formulations 1-3 may optionally comprise further ingredients such as additional surfactants and/or conditioning components. Cosmetically acceptable additives such as preservatives, dyes, and fragrances may be added if desired. The balance is water. The pH of the emulsion  
20 formulations 1-3 is adjusted to 1.5 to 2.5 using a base such as sodium hydroxide.

Gel Emulsions

25 Gel emulsions may be formulated by further adding a polymeric thickening agent to an emulsion formulation such as the Formulation Examples 1-3 described above.

30 Preferable polymeric thickening agents include anionic polysaccharides such as alginate, pectinate, xanthan, hydroxypropyl xanthan or dehydroxanthan, non-ionic polysaccharides such as cellulose ethers (e.g., methylcellulose, hydroxyethylcellulose (HEC), methyl

hydroxyethylcellulose (MHEC), ethyl hydroxyethylcellulose (EHEC), methyl ethyl hydroxyethylcellulose (MEHEC)), starch or dextrans, and cationic or amphoteric polymers such polyquaternium-37 or the ones described above as conditioning  
 5 agents. Among these polymers, xanthan, hydroxypropyl xanthan and dehydroxanthan are especially preferable.

The viscosity of such gel emulsions is typically within the range of 1,000 to 25,000, preferably 2500 to 15,000 mPa\*s, as  
 10 measured at 20°C with a Brookfield viscometer (e.g., at 10 rpm with an appropriated spindle). The concentration of the polymeric thickening agent depends on the type of the agent and the desired viscosity, and is typically within the range of 0.01 to 15 wt.%, preferably 0.05 to 10 wt.%, more  
 15 preferably 0.1 to 5 wt.%, and even more preferably 0.5 to 2 wt.% based on the weight of the straightening composition.

Preferable gel emulsion formulations are described in the following.

20

#### Gel Emulsion Formulation 1

5-20 wt.%	Glyoxylic acid
0.1-2 wt.%	Di-C <sub>12</sub> -C <sub>15</sub> alkyldimethyl ammonium salt 25 (e.g., chloride or methosulfate)
0.2-5 wt.%	Mono-C <sub>14</sub> -C <sub>18</sub> alkyltrimethyl ammonium salt, preferably cetrimonium methosulfate
1-5 wt.%	C <sub>14</sub> -C <sub>20</sub> fatty alcohol, preferably cetearyl alcohol
30 0.1-1 wt.%	thickening agent, preferably Xanthan gum, hydroxypropyl xanthan gum or dehydroxanthan gum

The gel emulsion formulations 1 may optionally comprise further ingredients such as additional surfactants and/or conditioning components. Cosmetically acceptable additives such as preservatives, dyes, and fragrances may be added if  
5 desired. The balance is water. The pH of the gel emulsion formulations 1-3 is adjusted to 1.5 to 2.5 using a base such as sodium hydroxide.

#### Two-component Formulations

10

In case it is desired to include compounds such as fragrances or surfactants and/or conditioning components which comprise acid-sensitive groups, it is possible that the storage stability at the above-described pH values is diminished.

15

Besides, it is also possible that fragrance compounds undergo undesired reactions with the carbonyl group of the carboxylic acid of formula (I), which may lower the storage stability.

20

In order to avoid such problems, it may be preferable in these cases to formulate the straightening composition as a two-part system, comprising the parts A and B, which are stored separately and mixed prior to the application to the hair.

25

Part A comprises the carboxylic acid of the formula (I), while part B comprises at least one of a fragrance, a surfactant and a conditioning agent. The quaternary ammonium compound having two C<sub>5</sub>-C<sub>24</sub> hydrocarbon groups and, optionally, thickeners, acid insensitive surfactants and conditioning  
30 agents may be added to part A, to part B or to both parts. An ester group containing quaternary ammonium compound such as a diacyloxyalkyl quat (e.g., TETRANYL™ CO-40) is preferable included in part B.

The pH of part B is adjusted such that the ingredients have sufficient storage stability, typically above 4 and usually within the range of 4 to 8, while the pH of part A is less than 4, usually within the range of 1 to 3.5. The final pH after mixing of parts A and B is 4 or lower, preferably 1 to 3.5. The parts A and B are mixed at a predefined ratio, e.g., 1:1, prior to use.

## 10 6. Hair Treatment Process

The hair treatment process of the present invention achieves a semi-permanent straightening of the hair, utilizing the acid of formula (I) such as glyoxylic acid as the active agent. The straightening effect of this process is not achieved by cleaving the disulfide bonds by reduction or the action of strong alkali. Accordingly, the usage of a reducing composition or an alkaline relaxer (lanthionization agent) is not required.

20

In step (a) of the process of the present invention, the straightening composition is applied to the hair. The application weight ratio of hair to composition is 0.5:2 to 2:0.5, preferably 0.5:1 to 1:0.5, more preferably about 1:1.

25

Subsequent to the application, the straightening composition is left on the hair for 1 to 120 minutes, preferably 5 to 90 minutes, more preferably 10 to 60 minutes and more preferably 15 to 45 minutes at a temperature of 45°C or below, preferably at ambient temperature (step (b)). Then, the straightening composition is optionally rinsed off from hair (step (c)).

30

In subsequent step (d), the hair is dried in order to avoid an excessive steam generation in the subsequent step of treating the hair with the iron. Typically, a hair dryer is used for this purpose. It is preferable to dry the hair under  
5 continuous combing in order to prevent entanglement of the hair.

Subsequent to the drying, the hair is treated with an iron having a surface temperature of  $180\pm 50^{\circ}\text{C}$ , preferably 170 to  
10  $200^{\circ}\text{C}$ . A usual straightening iron may be used for this purpose (step (e)). Finally, the hair may optionally be rinsed off with water and/or shampooed and dried again (step (f)).

#### 15 Examples

The present invention is now illustrated by the following non-limiting examples.

#### 20 Example 1

A straightening composition in gel/emulsion form was prepared by mixing the following ingredients:

25	Glyoxylic Acid	10 wt.%
	Cetearyl Alcohol	2.18 wt.%
	Dehydroxanthan Gum	0.4 wt.%
	Cetrimonium Methosulfate	0.85 wt.%
	Quaternium-91	0.27 wt.%
30	Water	ad. 100 wt.%

The pH was adjusted to 2.0 using sodium hydroxide.

Example 2

A straightening composition in gel/emulsion form was prepared by mixing the following ingredients:

5

Glyoxylic Acid	10 wt.%
Cetearyl Alcohol	2.18 wt.%
Dehydroxanthan Gum	0.4 wt.%
Cetrimonium Methosulfate	0.85 wt.%
10 Di-C <sub>12</sub> -C <sub>15</sub> Dialkyl-	
dimethylammonium Chloride	0.27 wt.%
Water	ad. 100 wt.%

The pH was adjusted to 2.0 using sodium hydroxide.

15

Test Example

The feel of use of the composition of Examples 1 and 2 of the present invention as well as the resulting smoothness and the properties of the straightened hair were evaluated as follows.

20

A hairstreak weighing approximately 2 g was shampooed with a commercially available shampoo and blow dried. Subsequently, it was treated with approximately 1 g of a straightening composition and left at room temperature for about 15 min and dried with a hair drier. Afterwards, hair was treated with a flat iron having a surface temperature of 220°C for 6 times. This was followed by washing the streaks with a commercially available shampoo and air-drying. The streaks were then visually and/or subjectively evaluated for the properties in Table 1 below by a hair stylist. The results of the evaluation are shown in the following table 1.

30

Table 1:

Criterion	Example 1	Example 2
Good Iron Gliding (during step e)	3	3
Natural Hair Feeling (uncoated after step e)	4	4
Less Volume in Hair (after step f)	4	4
Smoother hair structure (after step f)	5	5
Better combability (after step f)	5	5
(1 = very poor result; 2= poor; 3 = satisfactory; 4 = good 5 = very good result)		

As apparent from the results, the compositions comprising the  
 5 quaternary ammonium compound provide superior ease of use  
 during the ironing, feel of use and smoothness and volume  
 reduction of the straightened hair.

Example 3: Straightening solution

10

	% by weight
Glyoxylic acid	10
Tetranyl CO 40	4
Sodium hydroxide	q.s. to pH 2.5
15 Water	q.s. to 100

Example 4: Straightening Gel

	% by weight
20 Glyoxylic acid	5
Tetranyl CO 40	3
Xanthan gum	1
Sodium hydroxide	q.s. to pH 2.5

31

Water q.s. to 100

Example 5

% by weight

5	Glyoxylic acid	5
	Polyquaternium-37	0.7
	Dibehenylidmonium chloride	1.5
	Cetearyl alcohol	4.0
	Behentrimonium chloride	1.8
10	Dimethicone	0.3
	Water	to 100

The pH is adjusted to 1.8 with sodium hydroxide.

Example 6

15		% by weight
	Glyoxylic acid	10
	Hydroxyethylcellulose	1.1
	Sodium hydroxide	q.s. to pH 1.9
	Distearyldimonium chloride	1.5
20	Cetrimonium chloride	0.5
	Ceteareth-30	1.5
	Cetearyl alcohol	3.0
	Fragrance	0.8
	Water	to 100

25

Example 7

% by weight

	Glyoxylic acid	10
	Sodium hydroxide	q.s. to pH 2.0
30	Ceteareth-30	2.5
	Cetearyl alcohol	1.0
	Dicetyldimonium chloride	0.8
	Dimethicone	1.0



32

PEG-40 hydrogenated castor oil	0.5
Fragrance	0.8
Water	to 100

5 Example 8

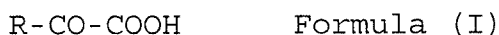
% by weight

Glyoxylic acid	10
Polyquaternium-22	0.7
Sodium hydroxide	q.s. to pH 2.0
10 Quaternium-91	1.5
Behenamidopropyltrimonium chloride	0.9
PEG-40 hydrogenated castor oil	0.5
Fragrance	0.8
Water	to 100

## CLAIMS

1. A hair straightening composition having a pH of 4 or less and comprising:

- at least one carboxylic acid of the formula (I) and/or a hydrate thereof and/or a salt thereof:



wherein R is selected from hydrogen, COOH, CN, optionally substituted C<sub>1</sub>-C<sub>10</sub> alkyl, optionally substituted C<sub>2</sub>-C<sub>10</sub> alkenyl, optionally substituted C<sub>2</sub>-C<sub>10</sub> alkynyl, optionally substituted C<sub>3</sub>-C<sub>10</sub> cycloalkyl, optionally substituted C<sub>6</sub>-C<sub>10</sub> aryl or a 5-10-membered, optionally substituted heteroaryl group, wherein the optional substituents of the alkyl group are selected from halogen, hydroxyl, amino and C<sub>1</sub>-C<sub>4</sub> alkoxy, and the optional substituents of the other groups are selected from halogen, hydroxyl, amino, C<sub>1</sub>-C<sub>4</sub> alkyl and C<sub>1</sub>-C<sub>4</sub> alkoxy; and

- at least one quaternary ammonium salt having two C<sub>5-24</sub> linear or branched, saturated or unsaturated hydrocarbon groups in the molecule, which may be the same or different and may be optionally substituted with one or more substituents selected from halogen, hydroxyl, amino and C<sub>1</sub>-C<sub>4</sub> alkoxy.

2. The hair straightening composition according to claim 1, which is a two-part composition comprising the parts A and B, which are provided for separate storage and for mixing prior to the application to the hair,

wherein part A comprises the carboxylic acid of formula (I) and part B comprises at least one of a fragrance, a surfactant or a conditioning component, and

wherein the quaternary ammonium salt having two C<sub>5-24</sub> linear or branched, saturated or unsaturated hydrocarbon groups is contained in either or both of part A and part B.

3. The hair straightening composition according to claim 1 or 2, wherein the carboxylic acid of Formula (I) is glyoxylic acid and/or a hydrate thereof and/or a salt thereof.

4. The hair straightening composition according to any of the claims 1 to 3, which comprises the at least one carboxylic acid of Formula (I) and/or a hydrate thereof and/or a salt thereof at a concentration in the range of 0.1 to 40% by weight, based on the weight of the total composition.

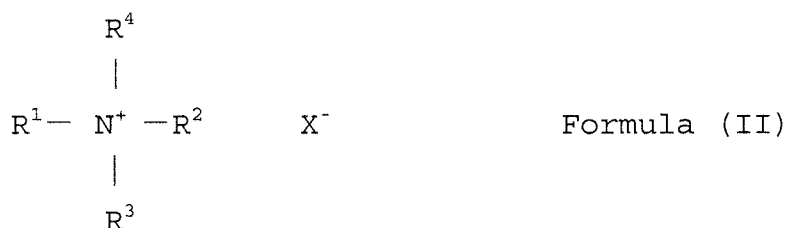
5. The hair straightening composition according to claim 4, which comprises the at least one carboxylic acid of Formula (I) and/or a hydrate thereof and/or a salt thereof at a total concentration in the range of 0.5 to 40 % by weight, based on the weight of the total composition.

6. The hair straightening composition according to claim 5, which comprises the at least one carboxylic acid of Formula (I) and/or a hydrate thereof and/or a salt thereof at a total concentration in the range of 2.5 to 40 % by weight, based on the weight of the total composition.

7. The hair straightening composition according to any of the claims 1 to 6, wherein the straightening composition has a pH of 1 to 3.5.

8. The hair straightening composition according to any of the claims 1 to 7, which is free of any sulfur-based reducing agents.

9. The hair straightening composition according to any of the claims 1 to 8, wherein the quaternary ammonium salt is a compound of the formula (II):



wherein R<sup>1</sup> and R<sup>2</sup> are independently selected from the group consisting of:

- optionally substituted C<sub>5</sub>-C<sub>24</sub> alkyl;
- optionally substituted C<sub>5</sub>-C<sub>24</sub> alkenyl;
- optionally substituted C<sub>5</sub>-C<sub>24</sub> alkynyl;
- groups of the formula R'-CO-NH-(CH<sub>2</sub>)<sub>n</sub>-, wherein R' is an optionally substituted C<sub>5</sub>-C<sub>24</sub> alkyl, C<sub>5</sub>-C<sub>24</sub> alkenyl or C<sub>5</sub>-C<sub>24</sub> alkynyl group and n is an integer of 1 to 4; and
- groups of the formula R'-CO-O-(CH<sub>2</sub>)<sub>n</sub>-, wherein R' and n are the same as defined above;

the optional substituent(s) being selected from halogen, hydroxyl, amino and C<sub>1</sub>-C<sub>4</sub> alkoxy;

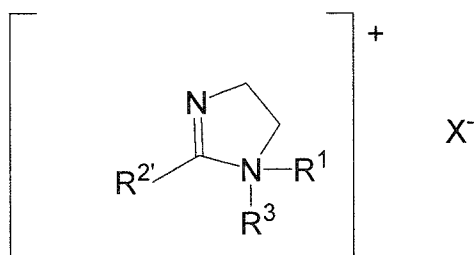
R<sup>3</sup> and R<sup>4</sup>, which may be identical or different, represent an alkyl group with 1 to 4 carbon atoms, which may optionally be substituted with one or more hydroxyl groups or ethylene oxide and/or propylene oxide adducts thereof, the average addition number being in the range of 1 to 4; and

X<sup>-</sup> represents an anion.

10. The hair straightening composition according to claim 9, wherein  $R^1$  and  $R^2$  both are  $C_5$ - $C_{24}$  alkyl.

11. The hair straightening composition according to claim 9, wherein  $R^1$  and  $R^2$  both are  $R'-CO-O-(CH_2)_n-$ .

12. The hair straightening composition according to any of the claims 1 to 8, wherein the quaternary ammonium salt is a compound of the formula (III):



Formula (III)

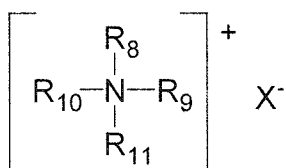
wherein  $R^1$ ,  $R^3$  and  $X^-$  are the same as defined in claim 6, and  $R^{2'}$  represents a linear or branched  $C_5$ - $C_{24}$  alkyl,  $C_5$ - $C_{24}$  alkenyl or  $C_5$ - $C_{24}$  alkynyl group which may be optionally substituted with one or more substituents selected from halogen, hydroxyl, amino and  $C_1$ - $C_4$  alkoxy.

13. The hair straightening composition according to any of the claims 1 to 12, wherein the total content of the quaternary ammonium salt(s) is 0.01 to 15 % by weight, based on the total of the composition.

14. The hair straightening composition according to any of the claims 1 to 13, wherein the hair straightening composition further comprises a silicone oil and/or a cationic polymer.

15. The hair straightening composition according to any of the claims 1 to 14, wherein the hair straightening composition further comprises one or more surfactants selected from cationic, nonionic, anionic and amphoteric ones.

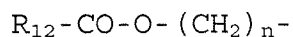
16. The hair straightening composition according to claim 15, wherein the cationic surfactant is a mono alkyl quaternary ammonium surfactant of the general formula



wherein  $R_8$  is a saturated or unsaturated, branched or straight alkyl chain with 8-22 C atoms or



wherein  $R_{12}$  is a saturated or unsaturated, branched or straight alkyl chain with 7-21 C atoms and  $n$  is an integer of 1 - 4, or



wherein  $R_{12}$  is a saturated or unsaturated, branched or straight alkyl chain with 7-21 C atoms and  $n$  is an integer of 1 - 4, and

$R_9$ ,  $R_{10}$  and  $R_{11}$  are independent from each other an alkyl group with 1 to 4 carbon atoms, hydroxyl alkyl chain with 1 to 4 carbon atoms, or ethoxy or propoxy group with a number of

ethoxy or propoxy groups varying in the range of 1 to 4, and X is chloride, bromide, methosulfate or ethosulfate.

17. The hair straightening composition according to any of the claims 1 to 16, which is an emulsion.

18. The hair straightening composition according to claim 17, which comprises at least one higher alcohol having 8 to 22 carbon atoms.

19. Use of the hair straightening composition as defined in any of the claims 1 to 18 for straightening the hair.

20. The use according to claim 19, wherein the composition is not used in combination with a reducing composition or an alkaline relaxer.

21. Process for semi-permanent hair straightening, comprising the following steps performed in this order:

- (a) application of the hair straightening composition as defined in any of the claims 1 to 18 onto the hair, preferably in a weight ratio of hair to composition of 0.5:2 to 2:0.5;
- (b) leaving the composition on the hair for 1 to 120 minutes;
- (c) optionally rinsing off the hair;
- (d) drying the hair; and
- (e) treating the hair with an iron having a surface temperature of  $180 \pm 50^{\circ}\text{C}$ , preferably 170 to  $200^{\circ}\text{C}$
- (f) optionally rinsing off and/or shampooed the hair and drying.

22. The process according to claim 21, wherein the combination with the application of a reducing composition or an alkaline relaxer is excluded.

23. The process according to claim 21 or 22, wherein in step (b), the composition is left on the hair for 10 to 60 minutes.

24. Kit for hair straightening, comprising the hair straightening composition as defined in any of the claims 1 to 18 and a straightening iron.



INTERNATIONAL SEARCH REPORT

International application No  
PCT/EP2013/069126

A. CLASSIFICATION OF SUBJECT MATTER  
INV. A61K8/365 A61K8/41 A61Q5/06  
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)  
A61K A61Q

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, WPI 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 2012/010351 A2 (ALDERAN S A S DI D OTTAVI ADELE & C [IT]; MANNOZZI ALDERANO [IT]) 26 January 2012 (2012-01-26) cited in the application	1,3-10, 19,20,24
Y	page 3, line 10 - line 30 page 4, line 4 - line 9 ----- -/--	1-24

Further documents are listed in the continuation of Box C.

See patent family annex.

\* Special categories of cited documents :

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier application or patent but published on or after the international filing date
- "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)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

- "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
- "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
- "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
- "&" document member of the same patent family

Date of the actual completion of the international search  19 November 2013	Date of mailing of the international search report  06/12/2013
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  Lenzen, Achim

## INTERNATIONAL SEARCH REPORT

International application No  
PCT/EP2013/069126

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	<p>Anonymous: "COMMISSION DECISION of 8 May 1996 establishing an inventory and a common nomenclature of ingredients employed in cosmetic products", EUR-Lex OFFICIAL JOURNAL OF THE EUROPEAN COMMUNITIES, L132/1, 1 June 1996 (1996-06-01), pages 1, 139, 141, 169, 222, 279, 384-385, 421, 520, XP002715458, Retrieved from the Internet: URL:<a href="http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:1996:132:0001:0684:EN:PDF">http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:1996:132:0001:0684:EN:PDF</a> [retrieved on 2013-11-04] pages 139, 141, 169 and 421</p> <p style="text-align: center;">-----</p>	1-24
X	<p>DATABASE GNPD [Online] MINTEL; January 2012 (2012-01), "Moroccan Relaxing Treatment with Argan Oil", XP002703715, Database accession no. 1692744</p>	1-8, 13-19
Y	<p>paragraph "Product Description"; page 1 composition "thermal-activated concentrate"; page 2</p> <p style="text-align: center;">-----</p>	1-24
A	<p>"International Cosmetic Ingredient Dictionary and Handbook", 2012, Personal Care Products Council, XP002715459, vol. 2, pages 2814-2815, entries "Quaternium-80" and "Quaternium-82"; page 2814 - page 2815</p> <p style="text-align: center;">-----</p>	1-24
X	<p>EP 2 258 337 A1 (KPSS KAO GMBH [DE]) 8 December 2010 (2010-12-08)</p> <p>examples 9,11</p> <p style="text-align: center;">-----</p>	1,3-5, 7-9,11, 13-15, 17,18
Y	<p>WO 2011/104282 A2 (ALDERAN S A S DI D OTTAVI ADELE &amp; C [IT]; MANNOZZI ALDERANO [IT]) 1 September 2011 (2011-09-01) cited in the application examples on pages 8-11 claims 1,5</p> <p style="text-align: center;">-----</p> <p style="text-align: center;">-/--</p>	1-24

## INTERNATIONAL SEARCH REPORT

International application No  
PCT/EP2013/069126

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2010/300471 A1 (MALLE GERARD [FR] ET AL) 2 December 2010 (2010-12-02) paragraph [0064] claims 15,20,21,26-28 -----	1-24
Y	WO 2012/105985 A1 (SYED ALI N [US]) 9 August 2012 (2012-08-09) cited in the application claim 1 -----	1-24
Y	GAO T ET AL: "QUATERNIUM-91: A NEW MULTIFUNCTIONAL HAIR CONDITIONING INGREDIENT", COSMETICS & TOILETRIES, WHEATON, IL, US, vol. 118, no. 5, 1 May 2003 (2003-05-01), pages 47-56, XP009049226, ISSN: 0361-4387 the whole document -----	1-24
Y	WO 00/00171 A1 (PROCTER & GAMBLE [US]; GIRET MICHAEL JOSEPH [GB]; LANGSCH DIETER HANS) 6 January 2000 (2000-01-06) claim 1 -----	1-24

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Information on patent family members

International application No PCT/EP2013/069126
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