

Composition and Process for semi-permanent straightening of
the 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
10 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-alanin moieties and the cysteine moieties form thioether bonds and combine to lanthionine,
15 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.
- 20 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. This means that these processes can achieve a permanent
25 straightening, wherein the treated portion of the hair maintains its shape, and the straightening effect only vanishes because of the growth of the hair.

Recently, it has been found that carboxylic acids having a
30 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 α -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 $200\pm 50^{\circ}\text{C}$.

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.

EP 0685 219 describes a composition useful as a pre-treatment agent before subjecting the hair to a perm wave treatment, the composition comprising a film-forming cationic, anionic and/or amphoteric polymer, an amphoteric surfactant, an organic acid and a C2 to C4 alcohol, and being free of cationic surfactants.

Summary of the Invention

The present invention provides 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, at a total

concentration in the range of 0.1 to 40 % by weight,
based on the weight of the total composition:



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wherein R is selected from hydrogen, COOH, CN,
optionally substituted C₁-C₁₀ alkyl, optionally
substituted C₂-C₁₀ alkenyl, optionally substituted C₂-C₁₀
alkynyl, optionally substituted C₃-C₁₀ cycloalkyl,
10 optionally substituted C₆-C₁₀ 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 C₁-C₄ alkoxy, and the
optional substituents of the other groups are selected
15 from halogen, hydroxyl, amino, C₁-C₄ alkyl and C₁-C₄
alkoxy; and

- at least one polymeric thickening agent selected from
non-ionic, anionic, cationic and amphoteric polymers
20 having a viscosity of at least 500 mPa·s, preferably
1,000 mPa·s, more preferably 1,500 mPa·s and more
preferably 2,000 mPa·s (measured at a polymer
concentration of 1% by weight in water at 20°C with a
Brookfield viscometer at 10 rpm for 1 minute with an
25 appropriate spindle).

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
30 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 polymeric thickening agent is contained in

either or both of part A and part B. Improved fragrance stability is observed with two-part compositions.

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

- (a) application of the hair straightening composition, which
10 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 minutes;
- (c) optionally rinsing off the hair;
- 15 (d) drying the hair;
- (e) treating the hair with an iron having a surface temperature of $180 \pm 50^{\circ}\text{C}$; and
- (f) optionally rinsing off and/or shampooing the hair and drying.

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Further aspects of the present invention relate to the use of the composition for straightening hair and to a kit for hair straightening, comprising the straightening composition and a straightening iron.

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The hair straightening composition according the present invention may meet one of the following requirements (1), (2) or (1)+(2):

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- (1) the hair straightening composition does not contain a quaternary ammonium salt having two $\text{C}_5\text{-C}_{24}$ 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 C₁-C₄ alkoxy;

- (2) the hair straightening composition is not an aqueous solution of 13.0 wt.% of glyoxylic acid monohydrate (corresponding to 10.4 wt.% glyoxylic acid) and 1.6 wt.% of dehydroxanthan gum and having a pH of 1.5 (adjusted with NaOH);

Detailed description of the Invention

Carboxylic acids of the formula (I), such as glyoxylic acid, have recently been found to provide remarkable semi-permanent straightening effects. When the hair is treated with a straightening iron at high temperature after the application of the acid, however, there is the problem that excessive smoke development may occur. This problem has not yet been addressed in the prior art.

The present inventors have found that this problem can be solved by combining the carboxylic acid of formula (I) with a specific polymeric thickening agent, which also provides an improved hair feel during application.

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 C₁-C₁₀ alkyl, optionally substituted C₂-C₁₀ alkenyl, optionally substituted C₂-C₁₀ alkynyl, optionally substituted C₃-C₁₀ cycloalkyl, optionally substituted C₆-C₁₀ 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 C₁-C₄ alkoxy, and the optional substituents of the other groups are selected from halogen, hydroxyl, amino, C₁-C₄ alkyl and C₁-C₄ alkoxy.

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

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.

The hydrate of the acid of Formula (I) may be formed when providing the composition in an aqueous medium. For instance, glyoxylic acid (H-CO-COOH) in aqueous solution is almost quantitatively present as the hydrate (H-C(OH)₂-COOH). 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 and quaternary ammonium salts may be mentioned.

In the present invention, glyoxylic acid, its salts and its hydrated form are the more preferred carboxylic acids of Formula (I).

5 The concentration of the at least one carboxylic acid of the Formula (I) and/or a hydrate thereof and/or salts thereof is 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
10 more preferably 2.5 to 14% by weight, based on the total weight of the straightening composition.

As discussed above, conventional permanent hair shaping/straightening techniques are based on the re-
15 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
20 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-
25 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 composition. Therefore, the composition usually has less than
30 2% by weight of sulfur-based reducing agents, and preferably is free of sulfur-based reducing agents.

2. The Thickening Polymer

The straightening composition comprises at least one polymeric thickening agent selected from non-ionic, anionic, cationic and amphoteric polymers having a viscosity of at least 500 mPa·s measured at a polymer concentration of 1% by weight in water and at 20°C with a Brookfield viscometer, e.g., at 10 rpm for 1 minute with an appropriate spindle.

The total concentration of the one or more thickening agent is typically within the range of 0.01 to 15 wt.%, preferably 0.05 to 10 wt.%, more preferable 0.1 to 5 wt.%, and more preferably 0.5 to 2 wt.% based on the weight of the straightening composition.

15 Non-ionic Polymers

Any cosmetically acceptable non-ionic thickening polymers, which are usually employed in the field of hair cosmetic compositions, may be used as the polymeric thickening agent in the composition of the present invention. The composition may include a single kind or multiple kinds of non-ionic polymer, and may further include one or more anionic, cationic and/or amphoteric polymers in combination with the non-ionic polymer.

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Examples for the non-ionic polymers include neutral polysaccharides and derivatives such as ethers or esters thereof. In this respect, neutral gums such as guar gum, hydroxypropyl guar, cellulose ethers such as hydroxyethylcellulose (HEC), methyl hydroxyethylcellulose (MHEC), ethyl hydroxyethylcellulose (EHEC), methyl ethyl hydroxyethylcellulose (MEHEC), hydroxypropylcellulose (HPC), hydroxypropylmethylcellulose (HPMC), hydrophobically modified

derivatives thereof such as HM-EHEC, starch and dextrans may be mentioned.

Cellulose ethers such as MHEC or MEHEC are preferable. As
5 commercially available example, STRUCTURE® CEL 12000 M
(MEHEC) may be mentioned (available from AkzoNobel, the
number indicating the viscosity in cps).

Anionic polymers

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Any cosmetically acceptable anionic thickening polymers,
which are usually employed in the field of hair cosmetic
compositions, may be used as the polymeric thickening agent
in the composition of the present invention. The composition
15 may include a single kind or multiple kinds of anionic
polymer, and may further include one or more non-ionic,
cationic and/or amphoteric polymers in combination with the
anionic polymer.

20 Examples for the anionic polymer include anionic
polysaccharides and derivatives thereof, such as alginate,
pectin, hyaluronate, anionic gums such as xanthan gum,
dehydroxanthan gum, hydroxypropyl xanthan gum, gum arabic,
gum karaya or gum tragacanth, or anionic cellulose
25 derivatives such as carboxymethyl cellulose (CMC).

Further examples include synthetic anionic polymers such as
polyacrylic acid or copolymers containing acrylic acid in
combination with neutral vinylic and/or acrylic monomers, and
30 salts thereof such as sodium polyacrylate.

Xanthan gum, hydroxypropyl xanthan gum and dehydroxanthan gum
are particularly preferable in view of pH stability.

Cationic Polymers

Any cosmetically acceptable cationic thickening polymers, which are usually employed in the field of hair cosmetic compositions, may be used as the polymeric thickening agent in the composition of the present invention. The composition may include a single kind or multiple kinds of cationic polymer, and may further include one or more non-ionic, anionic and/or amphoteric polymers in combination with the cationic polymer.

A cationic polymer is a polymer having a cationic group such as quaternary ammonium or a group capable of being ionized into a cationic group, such as a primary, secondary or tertiary amine group. The cationic polymer typically is a polymer containing an amine 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.

Among the cationic polymers, polymers having tertiary amine groups or quaternary ammonium groups are preferable, and polymers having quaternary ammonium groups are more preferable, since these polymers are not prone to condensation with the carbonyl group of the carboxylic acid of Formula (I). Conversely, polymers having primary amine groups are less preferable, since they might undergo condensation reactions with the carboxylic acid of Formula (I) and thus reduce the effective concentration thereof.

Examples of preferred cationic polymers include cationized cellulose, cationic starch, cationic guar gum, a vinyllic or (meth)acrylic polymer or copolymer having quaternary ammonium side chains, (meth)acrylate/aminoacrylate copolymer, amine

substituted polyacrylate crosspolymers, a polymer or copolymer of a diallyl quaternary ammonium salt, and quaternized polyvinylpyrrolidone.

- 5 As an example of the vinylic or (meth)acrylic polymer or copolymer having quaternary ammonium side chains, poly(2-methacryloxyethyltrimethylammonium chloride) (Polyquaternium-37) may be mentioned.
- 10 Specific examples of the quaternized polyvinylpyrrolidone include quaternary ammonium salts synthesized from a copolymer of vinylpyrrolidone (VP) and dimethylaminoethyl methacrylate, and diethyl sulfate (polyquaternium-11).
- 15 As an example of the (meth)acrylate/aminoacrylate copolymer, Acrylates/Aminoacrylates/C10-30 Alkyl PEG-20 Itaconate Copolymer may be mentioned.

As an example of the amine substituted polyacrylate
20 crosspolymers, Polyacrylates-1 Crosspolymer may be mentioned.

Specific examples of the cationized cellulose include a polymer of a quaternary ammonium salt obtained by adding glycidyltrimethylammonium chloride to hydroxyethylcellulose
25 (polyquaternium-10), and a hydroxyethylcellulose/dimethyldiallylammonium chloride copolymer (polyquaternium-4), and a polymeric quaternary ammonium salt of hydroxyethyl cellulose reacted with a trimethyl ammonium substituted epoxide and a lauryl dimethyl ammonium substituted epoxide
30 (polyquaternium-67).

Among these examples, polyquaternium-37 is particularly preferable.

Amphoteric Polymers

The amphoteric polymer contains both, cationic and anionic groups. From a structural point of view, the amphoteric
5 polymer may be derived from any of the described cationic polymer types by the additional introduction of anionic groups or co-monomers.

Like the cationic polymers, the amphoteric polymers may also
10 provide a hair conditioning effect, specifically in case of a positive net charge.

Any cosmetically acceptable amphoteric thickening polymers, which are usually employed in the field of hair cosmetic
15 compositions, may be used as the polymeric thickening agent in the composition of the present invention. The composition may include a single kind or multiple kinds of amphoteric polymer, and may further include one or more non-ionic, anionic and/or cationic polymers in combination with the
20 amphoteric polymer.

As examples for the amphoteric polymer, carboxyl-modified or sulfonate-modified cationic polysaccharides such as
carboxymethylchitosan may be mentioned.
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Further examples include copolymers of cationic vinylic or (meth)acrylic monomers with (meth)acrylic acid, such as dimethyldiallylammonium chloride/acrylic acid copolymer (polyquaternium-22).
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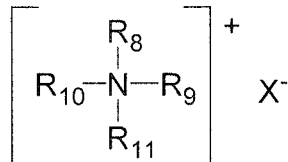
As an amphoteric polymer, polyquaternium-22 is particularly preferable.

3. Surfactant

The straightening composition may comprise a surfactant. As the surfactant, any of a cationic surfactant, a nonionic
 5 surfactant, an amphoteric surfactant and an anionic surfactant can be used. It is also possible to use two or more types of surfactants in combination.

The cationic surfactant is preferably a mono-long chain alkyl
 10 quaternary ammonium salt, having a C₈-C₂₄ alkyl residue and three C₁-C₄ alkyl residues.

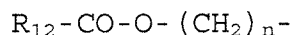
Preferably at least one mono alkyl quaternary ammonium
 surfactant is selected from the compounds with the general
 15 formula



wherein R₈ is a saturated or unsaturated, branched or
 20 straight alkyl chain with 8-22 C atoms or



wherein R₁₂ is a saturated or unsaturated, branched or
 25 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

- 5 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.

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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,
15 behentrimonium chloride, trimethyl cetyl ammonium bromide, stearyl trimethyl ammonium chloride, stearyl trimonium chloride and stearamidopropyltrimonium chloride.

- Examples of the nonionic surfactant include polyoxy- C_{1-4} -
20 alkylene C_{8-24} -alkyl ether, polyoxy- C_{1-4} -alkylene C_{8-24} -alkylene 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,
25 polyoxyethylene sorbit C_{8-24} -fatty acid ester, C_{8-24} -alkyl saccharide surfactant, C_{8-24} -alkylamine oxide, and C_{8-24} -alkylamidoamine oxide.

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

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, α -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 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, 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 the straightening composition.

4. Conditioning Component

The straightening composition may optionally comprise a conditioning component suitable for application to the hair. The conditioning component generally is an oil or an additional 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
5 silicones, higher alcohols, and organic conditioning oils (for example, hydrocarbon oil, polyolefin and fatty acid ester), as well as cationic surfactants and cationic or amphoteric polymers, including the ones described above.

10 The composition may comprise a single type of conditioning component, or two or more in combination.

Silicones

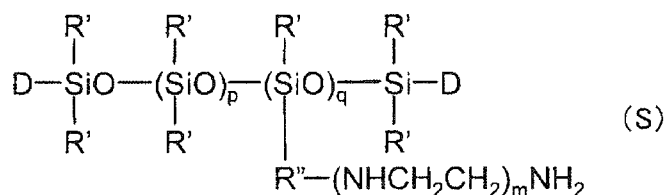
15 In order to improve the feel of use, the straightening composition preferably contains a silicone. Examples of the silicone include dimethylpolysiloxane, and modified silicone (for example, amino-modified silicone, fluorine-modified silicone, alcohol-modified silicone, polyether-modified
20 silicone, epoxy-modified silicone, polyoxazoline silicone (as described in JP A 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 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 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^x; R^x represents a substituted or unsubstituted monovalent hydrocarbon group having 1 to 20 carbon atoms; D represents R^x, R''-(NHCH₂CH₂)_mNH₂, OR^x, or a hydroxyl group; R'' represents a divalent hydrocarbon group having 1 to 8 carbon atoms; m 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 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 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 wt.%, based on the total weight of the straightening composition.

Oil component

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 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 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- α -olefin, and even more preferably a hydrogenated liquid poly- α -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.

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.

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, isohexyl laurate, isohexyl palmitate, isopropyl palmitate, isopropyl myristate, decyl oleate, isodecyl oleate, hexadecyl

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

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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

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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.

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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.

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5. Formulation of the Straightening Composition

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

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The overall viscosity of the composition generally depends on the type and amount of the polymeric thickening agent and usually is at least 1000 mPa*s, as measured at 20°C with a Brookfield viscometer, under conditions such as 10 rpm for 1 minute with an appropriate spindle. If the composition is provided in the form of a thickened solution, gel or emulsion, the viscosity is typically within the range of 1,000 to 25,000, preferably 2,500 to 15,000 mPa*s.

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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.

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Gel Formulations

A preferable straightening composition may be formulated as a gel comprising the following ingredients:

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(Gel Formulation 1)

% by weight

2 to 20 Glyoxylic acid;

0.1 to 2 Anionic thickening polymer,

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preferably xanthan or hydroxypropyl xanthan or dehydroxanthan;

0.1 to 1 surfactant such as cocamidopropylbetaine or cocoyl betaine, decyl glucoside, sodium laureth sulphate

15 Alternative preferable gel formulations are described below.

(Gel Formulation 2)

% by weight

2 to 20 Glyoxylic acid;

20

0.1 to 2 Non-ionic thickening polymer, preferably MHEC or MEHEC;

0.1 to 1 surfactant such as cocamidopropylbetaine or cocoyl betaine, decyl glucoside, sodium laureth sulphate, or cetrimonium chloride

25

(Gel Formulation 3)

% by weight

2 to 20 Glyoxylic acid;

0.1 to 2 cationic thickening polymer,

30

preferably polyquaternium-37;

0.1 to 1 surfactant such as cocamidopropylbetaine or cocoyl betaine, decyl glucoside or cetrimonium chloride

(Gel Formulation 4)

% by weight

2 to 20 Glyoxylic acid;

0.1 to 2 amphoteric thickening polymer,

5 preferably polyquaternium-22;

0.1 to 1 surfactant such as cocamidopropylbetaine or cocoyl
betaine, decyl glucoside, sodium laureth sulphate,
or cetrimonium chloride

10 The gel formulations 1-4 may optionally comprise additional
ingredients such as 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 gel formulations 1-4 may
15 be adjusted to 1.5 to 2.5 using a base such as sodium
hydroxide, if necessary.

The viscosity of the gel formulations 1-4 depends on the type
and amount of the thickening polymer and is typically within
20 the range of 1,000 to 25,000, preferably 2,500 to 15,000
mPa*s, as measured at 20°C with a Brookfield viscometer,
under conditions such as 10 rpm for 1 minute with an
appropriate spindle.

25 Emulsions

For further enhancing the ease of use, it is also possible to
formulate the straightening composition as an emulsion.
Preferable emulsions are gel emulsions which contain the same
30 ingredients in the same amounts as the Gel Formulations 1-4
described above, and additionally include a fatty alcohol,
optionally in combination with a surfactant, preferably a
cationic surfactant and/or an oil component, preferably a

silicone. An especially preferable emulsion formulation is described in the following.

(Emulsion Formulation 1)

- 5 2 to 20 wt.% Glyoxylic acid;
0.1 to 2 wt.% Anionic thickening polymer,
preferably xanthan, hydroxypropyl xanthan or
dehydroxanthan;
1-5 wt.% Fatty Alcohol, preferably cetearyl alcohol
10 1-5 wt.% C₁₂₋₂₄-alkyltrimethylammonium salt,
such as behentrimonium chloride

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

20

Two-component Formulations

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

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.

- 5 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 thickening agent and, optionally, acid insensitive surfactants and conditioning agents may be added to part A, to part B or to
10 both parts.

The fragrance may use fragrance raw materials described in Common Fragrance and Flavor Materials: Preparation, Properties and Uses, by Horst Surburg, Johannes Panten (John
15 Wiley & Sons, 5th edition, 2006), Perfume and Flavor Chemicals, volume 1 and 2, by Steffen Arctander, (published by the author in 1969), Perfume and Flavor Materials of Natural Origin, by Steffen Arctander (published by the author in 1961).

20

In the view of stability, the fragrance is preferably a citrus note, more preferably one or more fragrance raw materials having a citrus note, selected from Limonene, Pinene, Citral, Dihydromyrcenol, Pamplefleure, Lemon oil,
25 Orange oil, Mandarin oil and Lime oil. The content of the fragrance raw materials having a citrus note is preferably 5-100%, more preferably 20-90%, even more preferably 30-80%, of the fragrance.

- 30 In the view of the same reason, the Part A is preferably comprised of a fragrance having a citrus note, more preferably one or more fragrance raw materials having a citrus note, selected from Limonene, Pinene, Citral,

Dihydromyrcenol, Pamplefleurfleur, Lemon oil, Orange oil, Mandarin oil and Lime oil.

The pH of part B is adjusted such that the ingredients have
5 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.

10

Preferable two-component formulations are described in the following.

Two-component formulation 1 (Gel)

15

Part A: Gel component comprising Glyoxylic acid

5-40 wt.% Glyoxylic acid;

0.2 to 4 wt.% Anionic thickening polymer,

20

preferably xanthan, dehydroxanthan or hydroxypropyl xanthan

Acid-insensitive components may be added if desired. The balance is water, and the pH may be adjusted to pH 1-3,
25 preferably 1.5 to 2, with a base such as NaOH, if necessary.

Part B: Conditioning component comprising an ester compound and/or fragrance

30 1-4 wt.% Fatty acid ester, preferably isopropyl palmitate or isopropyl myristate

2-8% PEG-40-hydrogenated castor oil

0-2% Fragrance

Further ingredients such as surfactants or additional conditioning components may be added if desired. The balance is water. The pH is 6-7.

- 5 The parts A and B are stored separately and are mixed at a predefined ratio such as 1:1 prior to use.

Two-component formulation 2 (Gel-Emulsion)

- 10 Part A: Gel component comprising Glyoxylic acid

5-40 wt.% Glyoxylic acid;
 0.2 to 4 wt.% Anionic thickening polymer,
 preferably xanthan or dehydroxanthan or
 15 hydroxypropyl xanthan

Acid-insensitive components may be added if desired. The balance is water, and the pH may be adjusted to pH 1-3, preferably 1.5 to 2, with a base such as NaOH, if necessary.

20

Part B: Conditioning component in emulsion form comprising an ester compound and/or fragrance

- 1-8 wt.% Fatty alcohol, preferably cetearyl alcohol
 25 1-8 wt.% silicone oil
 1-8 wt.% C₁₂₋₂₄-alkyltrimethylammonium salt,
 such as behentrimonium chloride
 0.5-4 wt.% Fatty acid ester ,
 preferably isopropyl palmitate
 30 or isopropyl myristate
 0-2% Fragrance

Further ingredients such as surfactants or additional conditioning components may be added if desired. The balance is water. The pH is 6-7.

- 5 The Parts A and B are stored separately and are mixed at a predefined ratio such as 1:1 prior to use.

6. Hair Treatment Process

- 10 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
15 action of strong alkali. Accordingly, the usage of a reducing composition or an alkaline relaxer (lanthionization agent) is not required.

In step (a) of the process of the present invention, the
20 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.

Subsequent to the application, the straightening composition
25 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
30 (step (c)).

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 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 200°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)).

10

Examples

The present invention is now illustrated by the following non-limiting examples. The amounts of the ingredients are indicated as percent by weight.

15

Reference Example

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

20

Ingredients	wt. %
Glyoxylic Acid 50%	20
Cetearyl Alcohol	2.0
Behentrimonium Chloride	2.0
NaOH	q.s. pH 2
Water	ad. 100

25

Example 1

30

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

31

	Ingredients	wt. %
	Glyoxylic Acid 50%	20
	Dehydroxanthan Gum	1.0
	NaOH	q.s. pH 2
5	Water	ad. 100

Example 2

A straightening composition in gelled emulsion form was
10 prepared by mixing the following ingredients:

	Ingredients	wt. %
	Glyoxylic Acid 50%	20
	Dehydroxanthan Gum	1.0
15	Cetearyl Alcohol	2.0
	Behentrimonium Chloride	2.0
	NaOH	q.s. pH 2
	Water	ad. 100

20 Test Example 1

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
25 composition, left at room temperature for about 15 min and dried with a hair drier. Afterwards, the hairstreak was treated with a flat iron having a surface temperature of 220°C for 6 times. Smoke generation and iron gliding on the hair surface were observed during ironing. The streaks were
30 then evaluated for their coated/uncoated feeling by a hair stylist visually and/or subjectively. The performance of the composition of the Reference Example and of Examples 1 and 2 of the present invention was evaluated with respect to smoke

generation and ease/feel of use. The results are shown in Table 1 below.

Table 1: Results of comparative tests

	Reference Example	Example 1	Example 2
Low Smoke Generation (during step e)	4	2	2
Good Iron Gliding (during step e)	3	4	1
Uncoated Hair Feeling (after step e)	4	2	2
5 = very poor result; 4= poor; 3 = satisfactory; 2 = good; 1 = very good result			

5

As apparent from the results, the compositions of Examples 1 and 2 according to the present invention provide a substantial reduction of the smoke generation during the ironing, and also are advantageous in view of hair feeling during application. The emulsion formulations of the Reference Example and Example 2 facilitate the gliding of the iron, in comparison to the plain gel formulation of Example 1. In Example 2, the gliding is remarkably improved.

10

15 Example 3: Two-component Gel-Emulsion

Part A: Gel component (pH 1.5)

	Ingredients	wt. %
20	Glyoxylic Acid 50%	40
	Dehydroxanthan Gum	1.0
	NaOH 32%	3.0
	Water	ad. 100

Part B: Emulsion component (pH 6.5)

Five variants of Part B differing with respect to the fragrance were prepared (no fragrance, fragrance A-D).

5

Ingredients	wt. %
Cetearyl Alcohol	2.0
Silicone emulsion	2.0
Behentrimonium Chloride	1.5
10 Fragrance*	0 or 1.0
Isopropyl myristate	1.0
Dipropylene glycol	1.0
Water	ad. 100

*Fragrances A-D: see the Table below.

15

The parts A and B were mixed at a ratio of 1:1, yielding a mixed gel-emulsion composition having a pH of 1.6-1.7.

Test Example 2

20

The storage stability of the parts A and B of Example 3 and of the mixed gel emulsion were evaluated by comparing the scent of the fresh mixture, the mixture stored for one month at 50°C and the mixture of the components stored separately
25 for one month at 50°C. Several variants of Part B were examined, differing with respect to the fragrance component. Fragrance evaluation was done by the group of trained technicians. The following results were obtained as in the Table 2.

30

Table 2: Comparative test results of fragrance stability

Fragrance of Part B	Fresh Sample	After one month stored at 50°C	
		Mixture stored	Parts A and B stored separately
None	3	5	3
Fragrance A ^{*1}	1	6	3
Fragrance B ^{*2}	1	5	1
Fragrance C ^{*3}	1	5	2
Fragrance D ^{*4}	1	5	2
Evaluation of Scent: 1 = very good; 2= good; 3 = satisfactory; 4 = acceptable; 5 = unacceptable; 6= bad			

*1 Copacabana™ (Source: Mane; sweet, fruity odor)

*2 Midnight Dream™ (Source: Fragrance Resources; citric, soap-like odor)

*3 Sensational Hair™ (Source: Fragrance Resources; spice odor)

*4 Parati™ (Source: Mane; sweet, fruity odor)

Example 4: Two-component Gel System

Part A: Gel component (pH 1.5)

5

Ingredients	wt. %
Glyoxylic Acid 50%	40
Dehydroxanthan Gum	1.0
NaOH 32%	3.0
10 Water	ad. 100

Part B: Conditioning component containing an ester (pH 5-7)

Two variants of Part B were prepared, comprising isopropyl
 15 palmitate and isopropyl myristate as an ester component, respectively.

Ingredients	wt. %
Ester component	1.0
PEG-40-hydrogenated castor oil	1.0
Water	ad 100

5

The parts A and B were mixed at a ratio of 1:1, yielding a mixed gel composition having a pH of 1.6-1.7.

Test Example 3

10

The impact on storage stability was evaluated by comparing the hair properties and the gliding of the iron with respect to natural hair and bleached hair either for the fresh mixture of Parts A and B of Example 4 or for a mixture aged for three days at 40°C. The hair streaks were treated in the same way as described above for Test Example 1, and subsequently rinsed and dried. The following results were obtained as presented in Table 3.

20 Table 3: Comparative test results on the effect of stability of the composition on straightening process

Effect on hair	Fresh Mixture		Mixture stored for 3 days at 40°C		Parts A and B stored separately for 3 days at 40°C, then mixed	
	Natural hair	Bleached hair	Natural hair	Bleached hair	Natural hair	Bleached hair
Softness*	1	3	2	4	1	3
Smoothness*	1	3	2	4	1	3
Gliding of the iron (step e)	2	3	3	4	2	3

*Touch after treatment (after step f, rinsed out and dried)
 Evaluation scale: 1 = very good; 2= good; 3 = satisfactory; 4 = acceptable; 5 = unacceptable; 6= bad

Example 5

% by weight

	Glyoxylic acid	5
	Polyquaternium-37	0.7
5	Steartrimonium chloride	1.5
	Dimethicone	1.0
	Water	to 100

The pH of the example is 1.8.

10 Example 6

% by weight

	Glyoxylic acid	10
	Hxdroxyethylcellulose	1.1
	Sodium hydroxide	q.s. to pH 1.9
15	Behentrimonium chloride	1.5
	Cocamide MEA	0.5
	Dimethicone	1.0
	Fragrance	0.8
	Water	to 100

20

Example 7

% by weight

	Glyoxylic acid	10
	Xanthan gum	0.7
25	Sodium hydroxide	q.s. to pH 1.8
	Cocamide MEA	1.5
	PEG-40 hydrogenated castor oil	0.5
	Dimethicone	1.0
	Fragrance	0.8
30	Water	to 100

37

Example 8

	% by weight
Glyoxylic acid	10
Polyquaternium-22	0.7
5 Sodium hydroxide	q.s. to pH 2.0
Cetrimonium chloride	1.5
Dimethicone	1.0
PEG-40 hydrogenated castor oil	0.5
Fragrance	0.8
10 Water	to 100

Example 9

	% by weight
Glyoxylic acid	10
15 Polyacrylate-1 cross polymer	1
Sodium hydroxide	q.s. to pH 1.5
Dimethicone	1.0
PEG-40 hydrogenated castor oil	0.5
Fragrance	0.8
20 Water	to 100

Example 10

	% by weight
Glyoxylic acid	10
25 Structure Plus™ (product of Akzo Nobel)	1
Sodium hydroxide	q.s. to pH 1.5
Dimethicone	1.0
PEG-40 hydrogenated castor oil	0.5
30 Fragrance	0.8
Water	to 100

38

Example 11

	% by weight
Glyoxylic acid	10
Polyquaternium-67	1
5 Sodium hydroxide	q.s. to pH 1.5
Dimethicone	1.0
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:

- glyoxylic acid and/or a hydrate thereof and/or a salt thereof at a concentration, at a total concentration in the range of 0.1 to 40 %, based on the weight of the total composition; and

- at least one polymeric thickening agent selected from methyl hydroxyethyl cellulose (MHEC), methyl ethyl hydroxyethyl cellulose (MEHEC), xanthan gum, hydroxypropyl xanthan gum, dehydro xanthan gum, polyquaternium-37 and polyquaternium-22 having a viscosity of at least 500 mPa·s measured at a polymer concentration of 1% by weight, in water and at 20°C with a Brookfield viscometer, at a total concentration in the range of 0.01 to 15 % by weight, based on the total of the composition.

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 glyoxylic acid and part B comprises at least one of a fragrance, a surfactant or a conditioning component, and

wherein the polymeric thickening agent is contained in either or both of part A and part B.

3. The hair straightening composition according to claim 2, wherein the fragrance is one or more fragrance raw materials having citric note, selected from Limonene, Pinene, Citral, Dihydromyrcenol, Pamplefleurfleur, Lemon oil, Orange oil, Mandarin oil and Lime oil.

4. The hair straightening composition according to any one of the claims 1 to 3, which comprises glyoxylic acid 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.

5. The hair straightening composition according to claim 4, which comprises glyoxylic acid 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.

6. The hair straightening composition according to any of the claims 1 to 5, wherein the straightening composition has a pH of 1 to 3.

7. The hair straightening composition according to any of the claims 1 to 6, wherein the hair straightening composition further comprises one or more surfactants selected from nonionic, anionic, cationic and amphoteric ones.

8. The hair straightening composition according to claim 7, wherein the straightening composition comprises cationic surfactant.

9. The hair straightening composition according to any of the claims 1 to 8, which is an emulsion.

10. The hair straightening composition according to claim 9, which comprises at least one higher alcohol having 8 to 22 carbon atoms.

11. The hair straightening composition according to any of the claims 1 to 10, which further comprises a silicone.

12. The hair straightening composition according to any of the claims 1 to 11, which contains less than 2 wt. % of sulfur-based reducing agents.

13. The hair straightening composition according to claim 12, wherein the straightening composition is free of sulfur-based reducing agents .

14. Use of the hair straightening composition as defined in any of the claims 1 to 13 for straightening the hair.

15. The use according to claim 14, wherein the composition is not used in combination with a reducing composition or in combination with an alkaline relaxer.

16. 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 13 onto the hair;

(b) leaving the composition on the hair for 1 to 120 minutes;

(d) drying the hair; and

(e) treating the hair with an iron having a surface temperature of $180 \pm 50^{\circ}\text{C}$.

17. The process according to claim 16, wherein the combination with the application of a reducing composition and combination with the application of an alkaline relaxer are excluded.

18. The process according to claim 16 or 17, wherein in step (b), the composition is left on the hair for 10 to 60 minutes.

19. Kit for hair straightening, comprising the hair straightening composition as defined in any of the claims 1 to 13 and a straightening iron.