NOVEL PROCESS FOR IMPROVING AND MODIFYING THE PROPERTIES OF HAIR

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U.S. Cl.

Int. Cl.

Field of Search

References Cited
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Primary Examiner—G. E. McNeill
Attorney, Agent, or Firm—Cushman, Darby & Cushman

ABSTRACT
Process for improving and modifying the properties of living human hair which comprises subjecting the hair to stretching by mechanical deformation, and converting from 10 to 50% of the cystine in the hair to lanthionine. The conversion is accomplished in an aqueous medium with an alkaline composition.

22 Claims, No Drawings
NOVEL PROCESS FOR IMPROVING AND MODIFYING THE PROPERTIES OF HAIR

The present invention has for its object a novel process for improving and modifying the properties of hair, in particular living human hair.

It is already known how to treat textile keratinous fibers to transform at least a part of the cystine into lanthionine.

Such a treatment is performed in a known way on wool but it cannot be used directly to treat living human hair.

Applicants have now discovered, in a manner that completely surprising, that when a considerable part of the cystine of the hair is transformed into lanthionine, the qualities of the hair are considerably improved and its cosmetic properties modified.

Hair having undergone this transformation called lanthionization has a different composition and structure from that of normal hair, which gives it interesting new properties.

Thus, lanthionized hair shows a great elasticity when it is in the wet state.

This property is manifested more particularly when lanthionized hair is subjected to combing in the wet state, for example after shampooing. Then it has been found that lanthionized hair is much more resistant to breaking and that a number of hairs broken during such an operation is clearly less than that of natural hairs, i.e., unlanthionized.

Thus, when, for example, about 50% of the cystine was transformed into lanthionine by the process according to the invention, the number of hairs broken in the wet state is less than half the number of hairs broken in the case of natural hairs.

Further, it has been found that hair subjected to a lanthionization presents a holding after setting which is clearly improved.

Thus, if previously lanthionized hair is set and this setting is compared with that on hair not treated according to the invention, it is found that the holding of the setting is clearly higher in the case of lanthionized hair, in an atmosphere of normal relative humidity, i.e., between about 50 and 70%.

This property is the more marked the greater the percentage of cystine transformed into lanthionine.

This characteristic of lanthionized hair means that, after setting, this hair, in an atmosphere of normal relative humidity, resumes its initial form less rapidly than untreated hair.

It is proper to note that the treatment of hair according to the invention, when it is accompanied by a smoothing with the aid of a comb, constitutes an excellent means of decurling or deglossing.

It has also been found that hair subjected to lanthionization according to the process of the invention presents a greater permeability to hair treating agents than untreated hair. This improved permeability generally facilitates all capillary treatments, in particular dyeing operations, whether direct dyeing or oxidation dyeing is involved, and bleaching operations. Thus dyeing and bleaching are realized more easily and rapidly than in the case of untreated hair and, in addition, the intensity of the coloring is improved.

Further, in treating lanthionized hair with standard capillary products intended to give the hair more suppleness or brilliance, better results are obtained than in the case where the same treatment is applied to unlanthionized hair.

Moreover, it has also been found that hair, of which a considerable part of the cystine has been transformed into lanthionine, presents an alkaline solubility less than that of natural hair not treated according to the invention. By alkaline solubility is meant the loss of weight by putting in the presence of an N/4 sodium hydroxide solution at a temperature of 65°C.

It should be noted that lanthionization of hair gives it irreversible properties which it keeps during its entire life. This is particularly the case for better holding of a setting which is retained for all successive settings, without it being necessary to use any additional product, even if these latter settings are simply done with water.

In conformance with the present invention, the process consists of submitting to a lanthionization treatment human hair that is subjected to an extension by mechanical deformation. This mechanical deformation is able to be realized by either a longitudinal stretching (for example a smoothing, by uncurling, with the aid of a comb) or by rolling about curlers or hair setting rollers.

When the hair is subjected during treatment to an extension by mechanical deformation, it is necessary, in order to obtain an interesting improvement of the cosmetic qualities of the hair, to transform about 10 to 50%, and preferably about 15 to 50%, of the cystine into lanthionine.

To achieve this result, according to the invention, one subjects the hair to an extension by mechanical deformation, treating it in an aqueous medium with a composition having a pH of between about 10.5 and 13, for a sufficient time to obtain the desired proportion of lanthionine, keeping the hair in the wet state during the entire treatment.

According to the process of the invention, the treatment is generally effectuated on hair subjected to an extension by a mechanical deformation corresponding to a stretching of the order of 1 to 3%, and preferably from 1 to 2% of wet hair.

This stretching is able to be obtained by either rolling the hair on curlers or on hair setting rollers, or in subjecting the hair to a decurling by combing, that is to say, a mechanical smoothing of the hair with the aid of a comb.

In order to maintain the hair in a wet state during treatment, it is possible, for example, to cover the hair with an impermeable cap in order to avoid all loss of water, or yet to envelop, with the aid of a thin sheet of aluminum, the curlers on which the locks of hair are enrolled.

The compositions utilized in the process defined hereinabove are preferably hydroxide bases of the alkali metals or alkaline earth metals. One is able in particular to utilize Ca(OH)₂, LiOH, NaOH, KOH, or their mixtures, without this listing being limiting.

The molar concentration of these alkali or alkaline earth metal hydroxides is determined by the desired value of the pH, which should be between 10.5 and 13.

In the case where the process of the invention is utilized in order to treat living hair, in subjecting it to an extension by mechanical deformation, the above process should be practiced at a sufficiently high temperature so that the treatment period is not too long, this temperature, however, being bearable by the hair.
The treatment is effectuated at a temperature between about 25° to 30° and 120°C. The period of treatment, which is a function of the proportion of the lanthionine desired, varies according to the treatment conditions, and particularly according to the composition used, and the temperature, as will be explained in detail below.

Therefore, theoretically the period of treatment can vary from a few minutes to a few hours, but, for practical reasons, the characteristics of the process of the present invention have been selected so that the treatment period is not less than five minutes, or preferably, about ten minutes, and is not greater than about 60 minutes.

Of course, it is necessary to rinse carefully the hair after treatment.

The proportion of lanthionization which is obtained by the treatment according to the invention (that is to say the percentage of cystine which is transformed into lanthionine) depends on the different characteristics of the treatment.

Thus, the proportion of lanthionization is higher, the higher the pH of the composition according to the invention.

The increase of temperature also plays a role in the sense of an increase in the degree of lanthionization. The influence of these different variables will be illustrated below with concrete examples. When the process of the invention is applied to dry hair, the degree of lanthionization is generally higher than when applying the process to hair previously wetted. In case it is possible to apply the process to dry hair, the pH or the temperature may thus be lowered.

According to the invention, an effort should not be made to exceed a degree of lanthionization of 50%, which seems to constitute an optimum result for natural hair, that is to say, hair not having previously undergone permanent deformation treatment or bleaching, otherwise the hair is degraded without an increase in its degree of lanthionization.

On the other hand, when hair is to be treated that has been previously degraded by prior capillary treatments, that is to say hair whose relative content of cystine is less than the normal content by at least about 10%, in this case the degree of lanthionization applied according to the process of the invention should be reduced correspondingly.

To do this, the period of temperature of treatment, or the pH of the composition should be reduced, for example, it would be possible to use compositions having a pH of 10.5 to 12, at a temperature between about 25 to 30°C and 50°C for a period between 5 and 20 to 30 minutes.

According to a first embodiment of the invention, the hair is subjected to a mechanical deformation, treating it in an aqueous medium with a composite of a hydroxide base of an alkali or alkaline earth metal having a pH between 12.5 and 13, at a temperature between 30° and 120°C, for a sufficient time to obtain the desired degree of lanthionine, this time being between about 5 and 60 minutes.

It should be noted that when the composition is a simple, aqueous solution of the alkaline base, the treatment time should be longer than in the case of a composition in gel or cream form, if it is desired to obtain a comparable degree of lanthionization. A particular example illustrating this phenomena will be given further on.

In order to put the first embodiment into practice at the selected temperature, one can roll up the hair, subjecting it to an extension by mechanical deformation, as indicated above, on heated rollers in the case where heating is necessary in order to obtain a particular temperature, that is to say, temperatures between 50° and 120°C.

But if one desires to operate between 30° and 50°C, it is sufficient to heat the hair, if necessary, to the temperature selected, by means of warm air, for example, under a heating hood. One is able in this case, in order to subject the hair to the requisite mechanical tension, either to roll it on hair setting rollers, or on ordinary curlers (non-heated), or in the case of uncurling, subjecting it to a mechanical smoothing with the aid of a comb.

The nature of the hydroxide giving the composition its pH between about 12.5 and 13 does not have a critical influence on the treatment according to the invention. For example, it is possible to use the following hydroxides: Ca(OH)₂, LiOH, NaOH, KOH, or their mixtures without this list being limiting.

The molar concentration of the alkali or alkaline earth metal hydroxides or their mixtures in the composition is determined by the desired value of the pH of the composition, which should be between 12.5 and 13.

The particular operating conditions according to the first embodiment of the invention, as a function of the temperature at which it is desired to operate can be made precise as indicated below. When operating between 30° and 50°C (preferably between 40° and 50°C), the treatment period must be of the order of 20 to 60 minutes. However, if the composition is a simple aqueous solution with an alkaline base, the treatment period should be at least 30 to 40 minutes.

When operating between 50° and 80°C, the treatment period must be of the order of 10 to 50 minutes.

When operating between 80° and 120°C, the treatment period must be of the order of 5 to 20 minutes.

To illustrate more concretely the influence of temperatures and the treatment period, there are given below the results obtained in treating hair with a solution of 0.1 N sodium hydroxide solution (pH = 13), the hair being subjected to an extension corresponding to a stretching of about 2% of the wet hair.

The results are summarized in the following table.

<table>
<thead>
<tr>
<th>Temperature in °C</th>
<th>Time in minutes</th>
<th>Degree of lanthionization in %</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>30</td>
<td>13</td>
</tr>
<tr>
<td>60</td>
<td>10</td>
<td>22</td>
</tr>
<tr>
<td>80</td>
<td>10</td>
<td>23.5</td>
</tr>
<tr>
<td>120</td>
<td>10</td>
<td>30</td>
</tr>
</tbody>
</table>

According to a second embodiment of the invention, it is also possible to perform the lanthionization treatment with compositions having an alkali or alkaline earth metal hydroxide base, but, in addition, comprising particular substances which have the effect of making it possible to reduce the time, temperature, and/or
the pH of the treatment. Hereafter these substances will be designated as “lanthionization activator”.

According to the second embodiment, one subjects the hair to a mechanical deformation, treating them in an aqueous medium with the aid of a composition having a pH between about 10.5 and 13, at a temperature between 30° and 120°C, for a sufficient period to obtain the desired degree of lanthionization, this period being about 5 to 60 minutes, said composition having an alkali metal or alkaline earth metal hydroxide base and containing a lanthionization activator selected from the group consisting of electrolytes that are neutral from an oxidation-reduction standpoint, reducing agents having a limited hydrolytic action on the S-S bonds on the cystine, and cationic surfactants.

The alkali or alkaline earth metal hydroxides that can be used in the second embodiment of the process of the invention are particularly Ca(OH)₂, LiOH, NaOH, KOH, or their mixtures. Their concentration is a function of the desired value of the pH which must be between 10.5 and 13.

The neutral electrolytes from an oxidation-reduction standpoint, can be inorganic electrolytes, such as alkali halides, such as, for example, sodium chloride or lithium bromide, the alkaline earth halides such as calcium chloride, or the alkali or alkaline earth sulfates such as sodium, potassium, or calcium sulfate. They are preferably utilized in a concentration of up to 5 moles per liter.

The electrolytes, neutral from an oxidation-reduction standpoint, can also be organic electrolytes such as guanidine carbonate, and are preferably used in a concentration of up to one mole per liter.

The reducing agents having a limited hydrolytic action on the S-S bonds of the cystine, can include, for example, alkali or alkaline earth sulfides, in a concentration up to 3 x 10⁻¹⁸ ₂ moles per liter or alkali or alkaline earth sulfites at a concentration between 10⁻¹⁸ ₃ and 10⁻¹⁸ ₄ moles per liter.

The activators, made up of cationic surface active compounds, can include, for example, cetyltrimethylammonium bromide (known under the trademark Cetavlon) at a concentration of up to 3 x 10⁻¹⁶ ₂ moles per liter, or a quaternary ammonium hydroxide such as that known as Hyamine 10 X, at a concentration of up to 10⁻¹⁶ ₄ moles per liter.

It should be noted that according to the second embodiment of the process of the invention, the treatment of the hair can give rise to different modes of execution, depending upon the temperature of the treatment.

In order to operate between 50° and 120°C, one is able, for example, to roll the hair subjecting it to an extension by mechanical deformation as indicated above, on heated curlers.

In order to operate between 30° and 50°C, one is able to heat the hair if necessary, at the chosen temperature with the aid of warm air, for example, under a heated hood.

One is equally able to operate without heating, that is to say, in practice between 30° to 35° and 40°C.

In these last two cases, in order to subject the hair to the required mechanical tension, one can either roll the hair on hair setting rollers or on curlers, or, in the case of decurling, submit it to a mechanical smoothing with the aid of a comb.

The particular conditions of treatment according to the second embodiment of the invention, can be as pre-

cise, as a function of the temperature at which it is desired to operate, in the following fashion.

When operating between 30° and 50°C, the treatment period must be of the order of 15 to 60 minutes.

When operating between 50° and 80°C, the treatment period must be between 5 and 60 minutes and 40 minutes.

When operating between 80° and 120°C, the treatment period must be between 5 and 20 minutes.

To illustrate more concretely, the influence of temperature and the treatment period, and in order to illustrate equally the influence of the lanthionization activators, there is given below the results obtained in treating the hair with a 0.1 N sodium hydroxide solution, to which has been added lithium bromide, so that the lithium bromide concentration is between 0.1 M and 3.8 M, which leads to a lowering of the pH which varies as a consequence from 11.8 to 10.5, the hair being submitted to a mechanical tension corresponding to a stretching of about 2% of the wet hair.

The results are summarized in the following table:

<table>
<thead>
<tr>
<th>Temperature in °C</th>
<th>Time in minutes</th>
<th>Degree of lanthionization in %</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH 10.5</td>
<td>pH 11</td>
<td>pH 12</td>
</tr>
<tr>
<td>40</td>
<td>20</td>
<td>13</td>
</tr>
<tr>
<td>60</td>
<td>10</td>
<td>24</td>
</tr>
<tr>
<td>80</td>
<td>10</td>
<td>45</td>
</tr>
<tr>
<td>120</td>
<td>10</td>
<td>50</td>
</tr>
</tbody>
</table>

The compositions used according to the invention are advantageous in gel or cream form, with sufficient consistency for the composition to be retained naturally on the hair. In this way there is prevented a considerable evaporation of the aqueous phase, which should be retained in order to assure practice of the process according to the invention. Actually, according to the invention, it is necessary that the hair be kept in the wet state during the entire treatment period.

Further, the cream or gel should be such that the aqueous phase containing the active substances can come into contact and assure impregnation of the hair.

These emulsions constituting the composition are preferably of the oil-in-water type.

The compositions according to the present invention are prepared according to the usual methods.

They comprise adjuvants usually used in creams or gels, particularly, polyoxyethylene glycols; other polyethers such as nonylphenol polyethoxylates; fatty acids such as oleic acid; fatty alcohols such as oleyl alcohol; hydroxyethyl cellulose; etc.

It should be noted that according to the invention the alkaline composition which makes it possible to achieve the transformation of cystine into lanthionine should not contain alcohol or only contain a slight alcohol content (preferably less than 10%) because the presence of alcohol increases the alkaline solubility of the hair.

The treatment according to this invention is clearly distinguished from standard processes of hair treatment such as those which are used for permanent deformations, oxidizing, dyeing, or bleachings, because these
treatments are always carried out under conditions different from those according to the invention, and they practically always take place in a medium that is both alkaline and oxidizing.

At the time of these standard treatments, it seems that a certain amount of Keratocystine (K=S=S-K) is temporarily transformed into lanthionine (K=S=S-K), but since the nascent lanthionine is very sensitive to oxidizing agents, peroxide, persulfate, etc.) it immediately gives rise to the formation of oxides corresponding to the formula K=SO—K and K=SOO—K, K being the residue of the keratinous molecule.

Such a transformation is irreversible, and at the time of hydrochloric hydrolysis of hair treated by extended processes, comprising such oxides, these latter decompose in order to give cysteic acid (K=S=O—).

On the other hand, when hair is treated according to the invention, a considerable formation of lanthionine is obtained which is stable in regard both to alkaline agents and acid agents.

Hair treated according to the invention shows, after having undergone a hydrochloric hydrolysis, a degree of lanthionine which remains unchanged and which is always reproducible under precise dosing conditions.

There is indicated below the way to determine the degree of lanthionization under consideration in the present application.

Definition of degree of lanthionization

The degree is equal to the percentage of initial cystine bonds of the natural hair transformed into lanthionine bonds during the treatment.

Technique of analysis of the hair

Principle

The different amino acids are repeated by chromatography on sulfonic type ion exchange resin after hydrochloric hydrolysis, followed by a ninhydrin colorimetry and a quantitative determination in relation to a standard.

Equipment

Technicon TSM 1 autoanalyzer

Technique: according to the Technicon methodology

Elution buffers: sodium citrate

Buffer 1 pH 3.25
0.2N Na+ 0.1 M citrate 6% methanol

Buffer 2 pH 3.15
0.2N Na+ 0.1 M citrate 6% methanol

Buffer 3 pH 4.25
0.2N Na+ 0.1 M citrate 6% methanol

Buffer 4 pH 6.00
0.37 N 0.1 M citrate 6% methanol

Mode of operation

20 mg of dry hair (dried at 120° for 20 minutes) are carefully weighed.

The hair is hydrolyzed with 5 ml of 5.6 N (azeotrope) hydrochloric acid in a sealed test tube. It is left in an oven at 120°C for 4 hours with agitation.

The tube is opened and the hydrolysate is brought to dryness in a rotary evaporator at 35°C under vacuum. The residue is dissolved with 10 ml of distilled water and again dried.

10 ml are quantitatively transferred with decinormal hydrochloric acid into a graduated flask. 0.1 ml is deposited in 2 shallow dishes.

A control deposit of 0.05 ml is made, in two shallow dishes, of the standard solution containing 2.5 moles per ml of each amino acid and in particular lanthionine.

CALCULATIONS

1. Surfaces S and S standard are noted on the chromatograms obtained respectively with the hydrolysate of hair and with the standard solution for the batches of each amino acid.

2. For each amino acid there is calculated a formula wherein

\[ K = \frac{0.0125 \times S \times MW}{S_a \times S} \]

K represents the amount (in g) of each amino acid present in 100 g of hair

MW is the molecular weight of the amino acid considered

Sa is the sampling in mg of hair

3. Degree of lanthionization

The amount of cystine present in the average undegraded hair is 16%.

Degree of lanthionization: \[ L = K \times \text{lanthionine} \times 7.2 \]

There is indicated below a method of treatment of hair according to the present invention, the compositions utilized being for example, those that are described later in the examples.

TREATMENT ON ROLLERS OR CURLERS

The wet hair is rolled up on rollers or heated curlers, then with the aid of a brush, the rolled hair on each curler is coated separately with the cream or gel according to the invention. The hair is protected, for example, by means of a plastic bonnet in order to avoid evaporation. Contact is permitted for the time necessary for the desired treatment.

One effectuates an abundant rinsing and a gentle shampooing and finishes the treatment with a normal hair setting (water or aqueous solution) on rollers or curlers.

There is indicated below some examples of the treatments which can be realized according to one of the methods of application which has just been defined.

In these examples, there is indicated the constituents of the compositions used, the temperature, the time and the pH of treatment, and the proportion of lanthionization obtained, as well as, in certain cases, the improvement of the holding of the setting of the hair.

The rate of lanthionization was determined as indicated above.

Improvement of the holding of the setting can be determined by the following process:

DETERMINATION OF THE IMPROVEMENT OF THE HOLDING OF THE SETTING

Definition: Improvement of the holding of a lock of treated hair after wetting and drying on rollers, subjected to a release under the action of its own weight in an atmosphere of fixed relative humidity (65%) for 2 hours at 22°C, in relation to a lock of natural hair.

TECHNIQUE

Equipment

Plastic box (35 × 45 × 30 cm) provided with small fan permitting homogenization, with opening in the lid.

The relative humidity set at 65% is obtained with a saturated solution of sodium nitrite.
MODE OF OPERATION

Locks of 800 mg and about 240 mm of useful length are wetted by dipping in a beaker of 250 ml of distilled water, then rolled on rollers 2 cm in diameter.

Drying is for 2 hours in an oven at 60°C.

After cooling at ambient temperature, the locks are removed from the rollers and suspended by small clips on the inside of the measuring enclosure.

The uncurling is followed by watching the end of the locks which uncurl in front of a stiff sheet of paper marked off in millimeters. Each series of measurements is made in comparison with a control lock (untreated natural hair).

Readings are made every 5 minutes for 2 hours and 30 minutes. A final reading is made after 16 hours.

CALCULATIONS

Improvement of the holding of the setting is given by the formula

\[ T = \frac{l_c - l_r}{l - l_r} \times 100 \]

wherein:
- \( l_c \) is the length of the control lock after 2 hours uncurling
- \( l_r \) is the length of the treated lock after 2 hours uncurling
- \( l \) is the length of the lock at rest (\( \approx 240 \) mm).

EXAMPLE 1

**Formula:** Gel

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydroxyethyl cellulose WP 4400</td>
<td>4 g</td>
</tr>
<tr>
<td>Hydrated lithium oxide (LiOH, H₂O)</td>
<td>2 g</td>
</tr>
<tr>
<td>Potassium sulfate (K₂SO₄)</td>
<td>17.4 g</td>
</tr>
<tr>
<td>Water sufficient for 100 g</td>
<td>100 g</td>
</tr>
</tbody>
</table>

**pH gel:** 12.7

**Use:**
- Temperature: 40°C
- Time: 30 minutes

Degree of lanthionization on wet hair: 18%

EXAMPLE 2

**Formula:** Gel

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydroxyethyl cellulose WP 4400</td>
<td>4 g</td>
</tr>
<tr>
<td>Hydrated lithium oxide (LiOH, H₂O)</td>
<td>2 g</td>
</tr>
<tr>
<td>Sodium chloride (NaCl)</td>
<td>17.5 g</td>
</tr>
<tr>
<td>Water sufficient for 100 g</td>
<td>100 g</td>
</tr>
</tbody>
</table>

**pH gel:** 11.7

**Use:**
- Temperature: 40°C
- Time: 30 minutes

Degree of lanthionization on wet hair: 23%

Degree of lanthionization (application to dry hair): 24%

Improvement of the holding of the setting: +28%

EXAMPLE 3

**Formula:** Gel

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydroxyethyl cellulose WP 4400</td>
<td>4 g</td>
</tr>
<tr>
<td>Hydrated lithium oxide (LiOH, H₂O)</td>
<td>1.5 g</td>
</tr>
<tr>
<td>Sodium hydroxide (NaOH)</td>
<td>0.62 g</td>
</tr>
<tr>
<td>Water sufficient for 100 g</td>
<td>100 g</td>
</tr>
</tbody>
</table>

**pH gel:** 12.3

**Use:**
- Temperature: 40°C
- Time: 40 minutes

Degree of lanthionization on wet hair: 20%

EXAMPLE 4

**Formula:** Gel

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydroxyethyl cellulose WP 4400</td>
<td>4 g</td>
</tr>
<tr>
<td>Hydrated lithium oxide (LiOH, H₂O)</td>
<td>2 g</td>
</tr>
<tr>
<td>Lithium iodide (LiI)</td>
<td>26 g</td>
</tr>
<tr>
<td>Water sufficient for 100 g</td>
<td>100 g</td>
</tr>
</tbody>
</table>

**pH gel:** 11

**Use:**
- Temperature: 45°C
- Time: 15 minutes

Degree of lanthionization on wet hair: 35%

Improvement of the holding of the setting: +43%

EXAMPLE 5

**Formula:** Gel

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydroxyethyl cellulose WP 4400</td>
<td>4 g</td>
</tr>
<tr>
<td>Sodium hydroxide (NaOH)</td>
<td>1 g</td>
</tr>
<tr>
<td>Water sufficient for 100 g</td>
<td>12.6 g</td>
</tr>
</tbody>
</table>

**pH gel:**
- Temperature: 50°C
- Time: 30 minutes

Degree of lanthionization on wet hair: 19%

EXAMPLE 6

**Formula:** Cream

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nonylphenol polyethoxyster (n=4)</td>
<td>12 g</td>
</tr>
<tr>
<td>Nonylphenol polyethoxyster (n=8)</td>
<td>10 g</td>
</tr>
<tr>
<td>Oleic Acid</td>
<td>3 g</td>
</tr>
<tr>
<td>Triethanolamine</td>
<td>7 g</td>
</tr>
<tr>
<td>Oleyl alcohol</td>
<td>8 g</td>
</tr>
<tr>
<td>Ethanol</td>
<td>10 g</td>
</tr>
<tr>
<td>Calcium oxide (CaO)</td>
<td>12.5 g</td>
</tr>
<tr>
<td>Water sufficient for 100 g</td>
<td>100 g</td>
</tr>
</tbody>
</table>

**pH of cream:** 12.7

**Use:**
- Temperature: 60°C
- Time: 20 minutes

Degree of lanthionization on dry hair: 44%

Improvement of the holding of the setting: +50%

Degree of lanthionization on wet hair: 23%

Improvement of the holding of the setting: +27%

EXAMPLE 7

**Formula:** Gel

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydroxyethyl cellulose WP 4400</td>
<td>4 g</td>
</tr>
<tr>
<td>Sodium hydroxide (NaOH)</td>
<td>2 g</td>
</tr>
<tr>
<td>Lithium bromide (LiBr)</td>
<td>8.7 g</td>
</tr>
<tr>
<td>Water sufficient for 100 g</td>
<td>100 g</td>
</tr>
</tbody>
</table>

**pH gel:** 12.1

Degree of lanthionization on dry hair: 24%

Improvement of the holding of the setting: +28%
Degree of lanthionization on wet hair: 19%

EXAMPLE 8

Formula: Gel

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydroxyethyl cellulose WP 4400</td>
<td>4 g</td>
</tr>
<tr>
<td>Hydrated lithium oxide (LiOH, H₂O)</td>
<td>2 g</td>
</tr>
<tr>
<td>Cetavlon</td>
<td>10 g</td>
</tr>
<tr>
<td>Water sufficient for</td>
<td>100 g</td>
</tr>
</tbody>
</table>

pH gel: 12.4

Use:

<table>
<thead>
<tr>
<th>Condition</th>
<th>Temperature</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>temperature</td>
<td>60°C</td>
<td>20 minutes</td>
</tr>
</tbody>
</table>

Degree of lanthionization on dry hair: 42%
Degree of lanthionization on wet hair: 28%

EXAMPLE 9

Formula: Gel

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydroxyethyl cellulose WP 4400</td>
<td>4 g</td>
</tr>
<tr>
<td>Sodium hydroxide (NaOH)</td>
<td>1.6 g</td>
</tr>
<tr>
<td>Strontium sulfide at 60%</td>
<td>0.36 g</td>
</tr>
<tr>
<td>Water sufficient for</td>
<td>100 g</td>
</tr>
</tbody>
</table>

pH gel: 12.8

Use:

<table>
<thead>
<tr>
<th>Condition</th>
<th>Temperature</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>temperature</td>
<td>70°C</td>
<td>15 minutes</td>
</tr>
</tbody>
</table>

Degree of lanthionization on wet hair: 22%

EXAMPLE 10

Formula: Gel

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydroxyethyl cellulose WP 4400</td>
<td>4 g</td>
</tr>
<tr>
<td>Hydrated lithium oxide (LiOH, H₂O)</td>
<td>2 g</td>
</tr>
<tr>
<td>Lithium bromide (LiBr)</td>
<td>34.8 g</td>
</tr>
<tr>
<td>Water sufficient for</td>
<td>100 g</td>
</tr>
</tbody>
</table>

pH gel: 10.5

Use:

<table>
<thead>
<tr>
<th>Condition</th>
<th>Temperature</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>temperature</td>
<td>80°C</td>
<td>10 minutes</td>
</tr>
</tbody>
</table>

Degree of lanthionization on wet hair: 18%

EXAMPLE 11

Formula: Gel

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydroxyethyl cellulose WP 4400</td>
<td>4 g</td>
</tr>
<tr>
<td>Hydrated lithium oxide (LiOH, H₂O)</td>
<td>1.25 g</td>
</tr>
<tr>
<td>Guanidine carbonate</td>
<td>18 g</td>
</tr>
<tr>
<td>Water sufficient for</td>
<td>100 g</td>
</tr>
</tbody>
</table>

pH gel: 12.6

Use:

<table>
<thead>
<tr>
<th>Condition</th>
<th>Temperature</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>temperature</td>
<td>80°C</td>
<td>15 minutes</td>
</tr>
</tbody>
</table>

Degree of lanthionization on wet hair: 21.5%

What is claimed is:

1. A process for improving and modifying the properties of living human hair which comprises subjecting the hair to a stretching by mechanical deformation and treating said hair in an aqueous medium with a composition consisting essentially of an alkali or alkaline earth metal hydroxide base and having a pH between about 10.5 and 13 for a time sufficient to convert about 10 to 50% of the cystine of the hair into lanthionine, while maintaining the hair in the wet state during the treatment.
2. The process of claim 1 wherein about 15 to 50% of the cystine is transformed into lanthionine.
3. The process of claim 1 wherein the hair to be treated has been previously degraded and has a relative degree of cystine less than the normal content by at least 10% and the process is applied so as to reduce correspondingly the degree of lanthionization.
4. The process of claim 1 wherein the hair is treated at a temperature between about 25°C and 120°C for sufficient time to obtain the degree of lanthionization desired.
5. The process of claim 4 wherein said composition has a pH of between 12.5 and 13, and the process is carried out at a temperature between about 30°C and 120°C for from about 5 to 60 minutes.
6. The process of claim 5 wherein the temperature is from about 30°C to 50°C and the treatment time is between about 20 and 60 minutes.
7. The process of claim 5 wherein the temperature is between 50°C and 80°C and the treatment time is between 10 and 50 minutes.
8. The process of claim 5 wherein the temperature is between 80°C and 120°C, and the treatment time is between 5 and 20 minutes.
9. The process of claim 4 wherein said composition also contains a lanthionization activator selected from the group consisting of electrolytes that are neutral from an oxidation-reduction standpoint; reducing agents having a limited hydrolytic action on the S–S bonds of cystine; and cationic surfactant compounds; said treatment being carried out for about 5 to 60 minutes at a temperature between 30°C–120°C.
10. The process of claim 9 wherein the temperature is between 30°C and 50°C and the treatment time is between 15 and 60 minutes.
11. The process of claim 9 wherein the temperature is between 50°C and 80°C and the treatment time is between 5 to 10 minutes and 40 minutes.
12. The process of claim 9 wherein the temperature is between 80°C and 120°C, and the treatment time is between 5 and 20 minutes.
13. The process of claim 9 wherein the electrolytes are inorganic electrolytes and are present at a concentration of up to 5 moles per liter.
14. The process of claim 9 wherein the electrolytes are organic electrolytes and are present at a concentration of up to one mole per liter.
15. The process of claim 9 wherein the reducing agents are alkali or alkaline earth metal sulfides and are present at a concentration of up to 3 \times 10^{-4} moles per liter.
16. The process of claim 4 wherein the temperature is between about 50°C to 80°C, and 80 to 120°C and the hair is rolled up on heated hair curlers.
17. The process of claim 4 wherein the temperature is between 30°C and 50°C and the hair is either rolled on hair curlers or on hair setting rollers, or is subjected to a mechanical smoothing with the aid of a comb.
18. The process of claim 4 wherein the hair is subjected to a stretching by mechanical deformation corresponding to a stretching of the order of 1 to 3% of the wet hair.
19. The process of claim 4 wherein the composition contains at least one hydroxide selected from the group consisting of calcium hydroxide, lithium hydroxide, sodium hydroxide, and potassium hydroxide.

20. The process of claim 4 in which the composition is in the form of a gel or a cream containing an oil-in-water emulsion.

21. The process of claim 9 wherein said reducing agent is an alkali or alkaline earth metal sulfite present in amounts between $10^{-2}$ and $10^{-1}$ moles per liter.

22. A process for improving and modifying the properties of living human hair which comprises subjecting the hair to a stretching by mechanical deformation and treating said hair in an aqueous medium with a composition having a pH of between 10.5 and 13, said composition consisting essentially of an alkali or alkaline earth metal hydroxide base and a lanthionization activator selected from the group consisting of cetyl trimethylammonium bromide present in amounts of up to $3 \times 10^{-2}$ moles per liter and a quaternary ammonium hydroxide present in amounts up to $10^{-1}$ moles per liter, said treatment being carried out for about 5 to 60 minutes at a temperature between 30° and 120°C.