



(51) International Patent Classification:

H05H 1/24 (2006.01) A61L 2/14 (2006.01)

(21) International Application Number:

PCT/EP2018/085921

(22) International Filing Date:

19 December 2018 (19.12.2018)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

1762661 20 December 2017 (20.12.2017) FR

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(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— with international search report (Art. 21(3))

(54) Title: COSMETIC TREATMENT PROCESS USING COLD PLASMA AND DEVICE FOR CARRYING OUT THE PROCESS

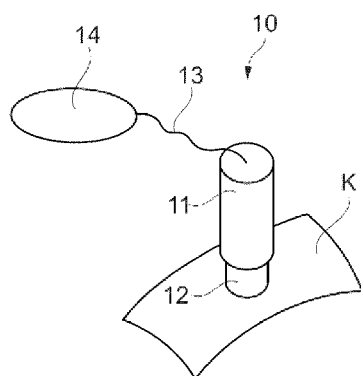


Fig. 1

(57) Abstract: A non-therapeutic cosmetic process for treating human keratin materials (K), comprising the step consisting in exposing said materials (K) to a polarized cold atmospheric plasma and comprising also a topical application of a cosmetic composition before and/or during and/or after the exposure to the polarized cold atmospheric plasma.



COSMETIC TREATMENT PROCESS USING COLD PLASMA AND DEVICE FOR CARRYING OUT THE PROCESS

The present invention relates to non-therapeutic, especially cosmetic, processes for treating human keratin materials and devices for carrying out these processes.

Prior art

5 It is known that certain bacteria are involved in certain skin disorders such as acne, skin imperfections, atopy, and scalp dandruff conditions. These bacteria are present at the surface of the skin but may also be located deeper within the skin. This is for example the case for the bacterium *Propionibacterium Acnes* (*P. acnes*), found in hair follicles. Inflammatory acne corresponds to the proliferation of this bacterium in the hair
10 follicle.

The use of a cold atmospheric plasma for its antimicrobial properties is known. Application WO 2011/144344 A2 discloses a device for at least partially sterilizing a surface contaminated especially by pathogenic germs, using a cold atmospheric plasma; various electrode arrangements for producing the plasma are described and a large number
15 of applications are mentioned, for instance deodorizing.

In the medical field, the antimicrobial properties of cold atmospheric plasmas have been demonstrated under controlled laboratory conditions. The publication New Journal of Physics 11 (2009) 115012 teaches that cold atmospheric plasmas are highly effective against Gram-positive bacteria, Gram-negative bacteria, spores, bacteria that form
20 biofilms, viruses and fungi. Moreover, cold atmospheric plasmas are considered to be safe in the medical field. The antimicrobial properties of cold atmospheric plasmas are utilized in the medical field for various applications such as the treatment of different types of skin diseases, dental care or else wound healing.

Thus, application US 2008/0237484 A1 describes the use of a cold atmospheric
25 plasma for wound disinfection.

It is known from the document Clinical Plasma Medicine 2 (2014) 38–49 that a cold atmospheric plasma generated in air or an aqueous solution adjacent to the plasma produces reactive species derived from oxygen and nitrogen, referred to as RONS (reactive oxygen and nitrogen species). These reactive species, RONS, are produced by the
30 discharge that gives rise to the plasma. The main reactive species, RONS, generated, are

hydrogen peroxide H_2O_2 , excited molecular species such as singlet oxygen $^1\text{O}_2$, radical species such as atomic oxygen $\text{O}^\cdot$, atomic nitrogen $\text{N}^\cdot$, $\text{OH}^\cdot$, $\text{NO}_2^\cdot$, $\text{NO}^\cdot$, positive ions such as O_2^+ , N_2^+ , N^+ , negative ions such as O^- , O_2^- , ONOO^- , NO_2^- and NO_3^- . The antimicrobial effect of cold atmospheric plasmas is mainly explained by the generation of these reactive species.

The transdermal or transcutaneous administration of molecules requires the molecules to pass through the skin and in particular through the *stratum corneum*, which corresponds to the outer layer of the skin, composed of dead, flattened and keratin-rich cells referred to as corneocytes. These dense cells are surrounded by a complex mixture of intercellular lipids. The *stratum corneum* has a protective barrier function by preventing the penetration of molecules through the skin. This barrier property of the *stratum corneum* is especially associated with its lipophilic nature and with its thickness. The transport of medicaments and other molecules through the skin is therefore a very slow phenomenon. There is therefore a need to improve transdermal permeation.

Cold atmospheric plasmas are also used for their properties of electroporation, especially of the skin. This electroporation effect of cold atmospheric plasmas, also referred to as “plasmaporation”, makes it possible to improve the transdermal or transcutaneous administration of molecules by applying an electric field to the skin. This electric field has a dual function: firstly, it makes it possible to improve the permeability of the skin to molecules by creating pores, and secondly it acts as a driving force on the charged/polarized molecules, making it possible to carry them through the newly created pores. This driving force is due to a phenomenon of electrorepulsion, which corresponds to the migration of a charged/polarized molecule, such as an ionic molecule, by repulsion between charges of the same sign.

The publication Biointerphases 10, 029517 (2015) describes the electroporation properties of cold atmospheric plasma by demonstrating the formation of small pores in skin samples subjected to irradiation by a plasma beam, which has the consequence of making it possible to improve the penetration of molecules through the *stratum corneum*.

Application US 2015/0094647 A1 discloses a process for opening pores and for displacing molecules in the skin, comprising the steps consisting in applying a plasma

to the surface of the skin and applying an excipient containing at least one molecule to the surface of the tissue; since it is generated by the application of an alternating pulsed voltage to an electrode, the plasma is alternating.

US 2014/0188071 A1 describes a process for applying a substance, especially a therapeutic substance, to an area of the skin, and applying a plasma to this same area; the substance may be placed in a material having an open foam structure, and the plasma is then applied to this material; however, the application of a plasma through such a material may adversely affect the structure of the material and cause side effects and/or make the substance ineffective.

Application WO 2017/087600 A1 discloses a process for recovering analytes by inverse plasmaporation, in which a subject's skin is subjected to a cold atmospheric plasma which enables the analytes present in the interstitial fluid of the subject's body to migrate to the surface of their skin; since it is generated by the application of an alternating pulsed voltage to an electrode, the plasma is alternating.

US 2017/0246440 A1 relates to a device for administering bioactive or cosmetic substances, comprising an applicator of cold atmospheric plasma and a plurality of microneedles. However, the use of said microneedles, creating 100-200 μm -deep holes in the *stratum corneum*, is liable to cause physical damage to the skin.

There remains a need for novel solutions capable of exerting a beneficial action on disorders of human keratin materials, and especially an action against microorganisms such as bacteria, viruses, fungi or parasites which are located deep in human keratin materials such as the skin.

Summary of the invention

The present invention aims to further perfect the processes and devices used to treat human keratin materials, and especially to overcome all or some of the above drawbacks. It achieves this aim by virtue of a non-therapeutic cosmetic process for treating human keratin materials, comprising the step consisting in exposing said materials to a polarized cold atmospheric plasma.

The invention provides a non-invasive, effective, quick and easy-to-use solution in order to treat and/or prevent disorders or dysfunction, especially those that are aesthetic, of human keratin materials.

5 This process may be carried out on healthy keratin materials, especially on healthy skin or a healthy scalp, in order to further improve the appearance thereof, for example by preventing the appearance of small aesthetic defects such as benign spots or the appearance of odors, for example by being used to treat the skin of the underarms.

10 In addition, the invention is advantageous if it is desired to cause certain species, and especially certain reactive species, RONS, to penetrate deeper into human keratin materials. The bacteria located deep in human keratin materials may therefore be reached by the antibacterial effect of the polarized cold atmospheric plasma.

Another advantage of the invention is that of not causing damage to the human keratin materials treated, especially by localized heating, nor of a sensation of pain.

15 The topical application of a cosmetic composition before and/or during and/or after exposure to the cold atmospheric plasma makes it possible to combine the effects of the topical application and the plasma. This makes it possible to increase the effectiveness of the treatment and/or to maintain a durable effect and/or to supplement the treatment.

20 Moreover, the treatment process according to the invention affords the advantage of increasing the maximum size of the molecules that may be administered within human keratin materials.

For the purposes of the present invention, the term "preventing" means reducing the risk of manifestation of the phenomenon under consideration.

25 "Cold atmospheric plasma" denotes a plasma at atmospheric pressure that does not lead to any excessive heating of the substrate exposed to the plasma, that is to say a plasma with a mean temperature which remains close to the initial temperature of the gas (temperature before initiating the plasma) and/or close to room temperature. "Cold atmospheric plasma" is also referred to as "nonthermal plasma" or "non-equilibrium plasma".

"Polarized plasma" denotes a plasma generated from a polarized electric field.

“Alternating voltage” denotes a voltage with a polarity that continually varies (inverts) periodically.

“Unidirectional voltage” should be understood to mean that the direction of polarization (the polarity) of the voltage is constant over time, either positive ($V(t) \geq 0 \text{ V}$) or negative ($V(t) \leq 0 \text{ V}$).

“Pulsed voltage” denotes a voltage corresponding to a signal with a non-sinusoidal waveform, for example a pulsed signal, the pulses of which have a slot shape.

“Human keratin materials” is intended to mean any human keratin material in general and especially the scalp and skin, keratin fibers such as the hair, eyelashes, eyebrows, moustache, body hair and nails, and/or mucous membranes such as the lips, and more particularly the scalp and skin.

“Topical application” denotes external application to human keratin materials.

Preferably, the process according to the invention comprises the step consisting in selecting the polarity of the polarized cold atmospheric plasma.

The cold atmospheric plasma may be negatively polarized. The human keratin materials exposed to the negatively polarized cold atmospheric plasma thus receive a negative electric field which makes it possible to selectively accelerate the negatively polarized/charged species towards the exposed human keratin materials by an effect of electrorepulsion. This makes it possible to cause the negatively polarized/charged species to more quickly and deeply penetrate within the exposed human keratin materials.

As a variant, the cold atmospheric plasma is positively polarized. The human keratin materials exposed to the positively polarized cold atmospheric plasma thus receive a positive electric field which makes it possible to selectively accelerate the positively polarized/charged species towards the exposed human keratin materials by an effect of electrorepulsion. This makes it possible to cause the positively polarized/charged species to more quickly and deeply penetrate within the exposed human keratin materials.

Preferably, the process according to the invention also comprises a topical application of a cosmetic composition before and/or during and/or after the exposure to the polarized cold atmospheric plasma.

The topical application may be performed on the exposed or intended to be exposed human keratin materials.

The cosmetic composition may comprise a compound chosen from: prebiotics, probiotics, postbiotics, plant extracts, antibacterial active agents, antifungal active agents, vitamins, fatty substances and mixtures thereof.

5 The cosmetic composition may comprise charged species to penetrate within the human keratin materials.

The cold atmospheric plasma may be polarized with the same polarity than the polarity of the charged species to penetrate within the human keratin materials.

For example, in the case of the topical application of a cosmetic composition before, during or after exposure to the polarized cold atmospheric plasma, if the cosmetic
10 composition comprises negatively charged species to penetrate within the human keratin materials, the polarity of the polarized cold atmospheric plasma is selected negative, and if the cosmetic composition comprises positively charged species to penetrate within the human keratin materials, the polarity of the polarized cold atmospheric plasma is selected positive.

15 Preferably, the duration of exposure to the plasma per cm^2 is between 0.1 s/cm^2 and 20 s/cm^2 .

Preferably, the power density of the plasma is between 0.1 W/cm^2 and 1 W/cm^2 .

Preferably, the temperature of the plasma at the point of application is less than or equal to 60°C , better still less than or equal to 40°C .

20 Advantageously, one or more electrodes for generating the polarized cold atmospheric plasma, comprising an electrical conductor covered with an insulating dielectric material, are brought close to the keratin materials.

The distance between the material covering the conductor of the or each electrode and said materials is preferably between 0.05 mm and 3 mm .

25 According to another aspect thereof, another subject of the invention is a device for treating human keratin materials, preferably for carrying out the process according to the invention as defined above.

In particular, the device comprises a generator of polarized cold atmospheric plasma comprising at least one electrode for generating polarized cold atmospheric plasma,
30 suitable for the treatment of said materials, and at least one selector for selecting the polarity of the polarized cold atmospheric plasma. Such a device advantageously makes it

possible to select the polarity of the polarized cold atmospheric plasma generated by the plasma generator.

The gas used for producing the plasma may be air, preferably ambient air.

Preferably, the or each electrode is supplied by a high unidirectional voltage
5 with an amplitude of between 0.5 and 50 kV, better still between 0.8 and 15 kV, better still between 0.8 and 5 kV.

The or each electrode may be supplied by a high unidirectional voltage with a pulse period of between 1 ns and 1 ms.

Preferably, the or each electrode is supplied by a high unidirectional voltage
10 with a frequency of pulse repetition or of pulse cycles of between 50 Hz and 100 kHz.

The plasma generator may be a direct-type generator, preferably of DBD type.

Preferably, the plasma generator comprises an insulating dielectric material between the or each electrode and the human keratin materials to be treated.

Preferably, the or each electrode comprises an electrical conductor and an
15 insulating dielectric material covering it externally.

Preferably, the or each electrode is supplied by a high unidirectional pulsed voltage, preferably assuming a value equal to or close to zero between the emission of the pulses.

The plasma generator may comprise means for setting characteristics of the
20 voltage supplying the or each electrode, especially the waveform thereof, the peak-to-peak amplitude thereof, the frequency thereof, the duty cycle thereof, in particular in the case in which the signal is square-wave or rectangular-wave, the polarity thereof, the duration of emission thereof and/or the number, the period, or the frequency of repetition of the pulses in the case in which the signal is pulsed.

25 The plasma generator may comprise a signal generator and a high voltage generator generating a high voltage.

The selector may comprise an H-bridge.

The selector may be connected to the output of the signal generator and to the input of the high voltage generator.

30 In one variant, the selector is connected to the output of the high voltage generator and to the or each plasma generation electrode.

Preferably, the plasma generator comprises a rectifier configured to enable the rectification of an alternating voltage. The rectifier thus makes it possible to obtain a unidirectional voltage from an alternating voltage.

The rectifier may be located within the signal generator, the high voltage generator or the selector.

The rectifier may be controlled or uncontrolled.

The rectifier may comprise one or more diodes.

As a variant, the rectifier comprises one or more diodes and one or more capacitors.

Preferably, the or each electrode may be borne by a hand-held piece.

According to another aspect thereof, another subject of the invention is a non-therapeutic cosmetic use of a polarized cold atmospheric plasma generated by a device according to the invention as defined above, for preventing and/or treating a disorder, preferably an aesthetic disorder, of human keratin materials.

In particular, the polarized cold atmospheric plasma generated by the device according to the invention as defined above is used for preventing and/or treating an acneic skin condition, preferably an acneic human skin condition.

As a variant, it is used for preventing and/or treating a scalp dandruff condition, preferably a human scalp dandruff condition.

In another variant, it is used for deodorization, preferably for preventing and/or treating human underarm odors.

Moreover, the present invention relates also to a non-therapeutic cosmetic process for the prevention and/or treatment of a disorder, preferably an aesthetic disorder, of human keratin materials, comprising the step consisting in exposing human keratin materials with a disorder or prone to a disorder, preferably an aesthetic disorder, to a polarized cold atmospheric plasma, and preferably comprising also a topical application of a cosmetic composition before and/or during and/or after the exposure to the polarized cold atmospheric plasma.

Moreover, the present invention relates also to a non-therapeutic cosmetic process for the prevention and/or treatment of an acneic skin condition, preferably an acneic human skin condition, comprising the step consisting in exposing a skin with acne

or prone to acne to a polarized cold atmospheric plasma, and preferably comprising also a topical application of a cosmetic composition before and/or during and/or after the exposure to the polarized cold atmospheric plasma.

Moreover, the present invention relates also to a non-therapeutic cosmetic process for the prevention and/or treatment of a scalp dandruff condition, preferably a human scalp dandruff condition, comprising the step consisting in exposing a scalp with dandruff or prone to dandruff to a polarized cold atmospheric plasma, and preferably comprising also a topical application of a cosmetic composition before and/or during and/or after the exposure to the polarized cold atmospheric plasma.

Moreover, the present invention relates also to a non-therapeutic cosmetic process for the prevention and/or treatment of human underarm odors, comprising the step consisting in exposing a skin of the underarms with odors or prone to odors to a polarized cold atmospheric plasma, and preferably comprising also a topical application of a cosmetic composition before and/or during and/or after the exposure to the polarized cold atmospheric plasma.

Plasma

For the purposes of the invention, a plasma is an artificially generated ionized gas in which interactions take place between electrons, ions and neutral species. A plasma is produced by the creation of an intense electric field in a gas. This intense electric field, which may be obtained by subjecting two electrically conductive areas, respectively referred to as electrode and counter electrode, to a large electrical potential difference, enables a transfer of kinetic energy to the gas. A plasma may also generate reactive species, produced by the electric field resulting in the plasma.

The cold atmospheric plasma according to the invention may be a direct or indirect plasma.

In direct plasmas, it is the substrate which acts as the counter electrode required for producing the plasma; the plasma is therefore generated between the electrode and the substrate. One of the main direct plasma technologies is the plasma known as DBD (Dielectric Barrier Discharge).

The DBD plasma production device is therefore characterized by the presence of an insulating dielectric material between the electrically conductive material of the electrode and the substrate. The presence of this insulating dielectric material prevents the formation of an electric arc during the production of the electric field resulting in the plasma since otherwise all the energy is dissipated into the electric arc and therefore only affects a small portion of the gas occupying the space between the electrode and the substrate.

Due to its position between the electrically conductive material of the electrode and the substrate, the insulating dielectric material will have, from the moment of application of the potential difference between the electrically conductive material of the electrode and the substrate, a surface electric charge which is:

- negative, resulting from the deposition of electrons if the dielectric material is associated with the positively charged electrode, or

- positive, resulting from the deposition of positive ions if the dielectric material is associated with the negatively charged electrode.

Due to this surface electric charge, the dielectric material will reduce the intensity of the electric field initially created, down to a value that causes the extinction of the plasma. The plasma can arise again when a new discharge is able to occur, that is to say after elimination of these charges adsorbed onto the dielectric material, which is usually carried out by inverting the polarity between the electrodes. The DBD-type plasma is therefore not generated continuously but in the form of point discharges, the frequency of which will depend on the frequency of an alternating voltage applied to the electrode.

In indirect plasmas, the plasma is generated between two electrodes and is then directed towards the substrate using a gas stream. One of the main technologies is known as "plasma-torch".

In the context of a direct plasma, the area to be treated, for example the skin and/or the scalp, acts as the counter electrode and the area located under the electrode is treated.

The cold atmospheric plasma according to the invention may be generated from different gases (air, helium, oxygen, etc.). When the plasma is a direct plasma, the preferential gas is air.

Preference is given to using a direct plasma and even more preferentially a DBD-type plasma.

Treatment device

The polarized cold atmospheric plasma according to the invention is generated using any suitable device that makes it possible to expose human keratin materials to a plasma.

The plasma is emitted from a generator of polarized cold atmospheric plasma comprising, in accordance with the invention, at least one electrode for generating polarized cold atmospheric plasma, suitable for the treatment of human keratin materials, and at least one selector for selecting the polarity of the polarized cold atmospheric plasma, configured in order to make it possible to advantageously select the polarity of the plasma generated.

Unlike alternating cold atmospheric plasmas generated from a high alternating voltage applied to the electrode, the polarized cold atmospheric plasma according to the invention is generated by applying a high unidirectional voltage to the electrode. A polarized electric field is thus obtained, which makes it possible to generate a polarized cold atmospheric plasma.

“High voltage” denotes a voltage with an amplitude greater than or equal to 0.5 kV, better still to 0.8 kV, even better between 0.8 and 5 kV.

In the case in which the plasma generator is of DBD type, the polarized cold atmospheric plasma according to the invention is generated from a high unidirectional pulsed voltage. Preferably, the high unidirectional pulsed voltage assumes a value equal to or close to zero between the emission of the pulses. This enables the natural continual periodical elimination of the electric charges at the surface of the insulating dielectric material covering the electrically conductive material of the electrode, by returning the potential difference between the electrically conductive material of the electrode and the substrate to zero.

The application of a negative high unidirectional voltage to the electrode makes it possible to obtain an intense negatively polarized electric field in the gas occupying the space between the electrode and the substrate, which leads to a negatively polarized cold atmospheric plasma in this same space.

5 Conversely, the application of a positive high unidirectional voltage to the electrode makes it possible to obtain an intense positively polarized electric field in the gas occupying the space between the electrode and the substrate, which leads to a positively polarized cold atmospheric plasma in this same space.

10 In the case in which the electrode(s) are supplied by a high negative voltage, the human keratin materials exposed to the plasma receive a negative electric field. Among the reactive species, RONS, produced by the discharge leading to the plasma generated in air, anions (for example O^- , O_2^- , $ONOO^-$, NO_2^- and NO_3^-) are, by an effect of electrorepulsion, pushed into the pores that have been newly created in the human keratin materials by plasmaporation. These anionic reactive species may exert an antimicrobial
15 effect more deeply in the human keratin materials. For example, these anionic reactive species may react with bacteria located deep in the skin, such as *P. Acnes* which is found in the hair follicle.

 Conversely, in the case in which the electrode(s) are supplied by a high positive voltage, the human keratin materials exposed to the plasma receive a positive
20 electric field. The effect on the keratin materials may then be different. The field created may especially be utilized to push other chemical species into the pores.

 In the case of the topical application of a cosmetic composition before, during or after exposure to the polarized cold atmospheric plasma, the possibility of being able to select the polarity of the plasma is beneficial since it makes it possible to improve the
25 diffusion of some active agents as a function of their polarity/charge, as is described in detail below.

 The emission of plasma is preferably carried out from an electrode for generating plasma, borne by a hand-held piece which has an ergonomic design compatible with the application to human keratin materials. Use is for example made of a
30 hand-held piece of pen format, or else a hand-held piece comprising a comb suitable for facilitating exposure of the scalp to the plasma.

Preferably, the device makes it possible to control the intensity of the plasma produced, which facilitates obtaining homogeneous exposure of the materials treated to the plasma.

5 The device may be arranged to keep a predefined distance between the plasma generation electrode and the keratin materials, for example by virtue of a guide which bears on the keratin materials when the electrode moves relative to said keratin materials. This guide may have a curved surface which substantially matches the curvature of the area exposed, such as a part of the face, the underarms or the scalp.

10 The position of the device relative to the human keratin materials when said device is moved may be detected, for example by means of accelerometers and/or of a camera, and the plasma production may be automatically controlled as a function of the position of the device so as to ensure the most complete and homogeneous precise treatment; for example, if it is detected that the device is again passing over a site on the scalp that has already been treated, the plasma production may be momentarily
15 interrupted or reduced.

The device may be arranged so as to detect, for example by means of a camera, a movement of the device which is too fast to allow satisfactory treatment, and to make the user aware of this.

20 The device may be mains-operated, rechargeable battery-operated and/or battery-operated.

The device according to the invention is preferably compact and/or portable.

The device may comprise a member for massaging the human keratin materials, the action of which may or may not be concomitant with the plasma treatment.

Non-therapeutic cosmetic treatment process

25 The process according to the invention comprises exposing the human keratin materials to a polarized cold atmospheric plasma.

The keratin materials may be exposed to this plasma by keeping a plasma generation electrode at a controlled distance, ensuring the local production of the plasma.

In order to carry out the treatment, it may be necessary to move the plasma generation electrode relative to the keratin materials, which makes it possible to treat a larger body surface.

The treatment time is adjusted to the desired result.

5 The treatment time is preferentially between 1" and 10', and more preferentially between 1" and 5'.

The keratin materials may be exposed to the plasma by keeping the plasma generation electrode at a controlled distance from the surface of the human keratin materials while it is moved.

10 This movement may be carried out manually or in an automated manner. In the case of manual movement, the latter can be assisted, where appropriate, by a guidance structure placed on or around the area to be treated.

 The plasma production may be automatically interrupted over time, the generator stopping, for example, after a predefined operating period or when it is detected
15 that the whole of the targeted area has been treated.

 The treatment may be repeated periodically, at intervals of 2 days to 1 month, for example.

Active agents

 The cosmetic compositions for topical application used according to the
20 invention contain a medium compatible with their application to the human keratin materials that they aim to treat, in particular chosen from the scalp, skin, hair, lips, eyelashes, eyebrows and nails.

 When the cosmetic treatment process comprises the topical application of a cosmetic composition before, during or after exposure to the plasma, the penetration of the
25 active treatment agent(s) may be facilitated. In the case of a skin disorder, exposing the skin to the plasma may reduce the lipid barrier function, enable the formation of pores, and promote the passage of charged/polarized molecules into the skin through the newly created pores, by virtue of the electric field from which the plasma is generated and which acts as a driving force on the charged/polarized molecules.

30 The cosmetic compositions for topical application suitable for the invention comprise compounds, especially chosen from:

- spring waters, especially those sold by Vichy, La Roche-Posay, St Gervais and competitors,

- sources of carbon, such as:

- simple or complex sugars and also the homopolymers or heteropolymers of the following compounds: adonitol; amygdalin; arabinose; cellobiose; dulcitol; erythritol; esculin; fructose; galactose; glucose; glycerol; glycogen; inositol; inulin; lactose; maltose; mannitol; mannose; melezitose; melibiose; raffinose; rhamnose; ribose; salicin; sorbitol; sorbose; starch; sucrose; trehalose; xylose, and also the phosphate-based or sulfate-based or substituted derivatives thereof such as proxylane with xylose
- di-, tri- and polysaccharides
- glycogen, polymer of glucose and all the polymers thereof
- heterosaccharides
- O- and C-glycosides
- honey, maple syrup and other natural complex sugars
- polyhydroxybutyrate
- formic, acetic or propionic acid and especially lactic acid and acids of glycolysis and of the Krebs cycle and all saturated or unsaturated fatty acids up to C18; the glycerol-containing derivatives and cellulosic derivatives thereof
- the traditional genera *Bifidobacterium spp.* and *Lactobacillus spp.* and also the hydrolysates thereof
- all the bacteria constituting the natural skin flora such as for example the family of the *Xanthomonadaceae*
- plant extracts rich in carbohydrates and polymers thereof

- fine particles from atmospheric pollution
- nitrogen-containing sources such as:
 - all derivatives of ammonium and nitrates/nitrites
 - hydrogenated compounds such as: ammonium ions NH_4^+ , amide ions NH_2^- , primary amines RNH_2 and secondary amines R_2NH , hydrazoic acid HN_3 , hydrazine N_2H_4
 - oxygen-containing compounds: nitrosylazide N_4O ; nitrous oxide N_2O , nitrogen monoxide NO , N_2O_3 , nitrogen dioxide NO_2 , the dimer thereof, dinitrogen tetroxide N_2O_4 , dinitrogen pentoxide N_2O_5 and nitrogen trioxide NO_3
 - nitrogen oxoanions: nitrate ions NO_3^- and nitrite ions NO_2^-
 - all amino acids, including taurine, and the peptide heteropolymers or homopolymers thereof
 - bacteria contained in spring water, mineral water, drinking water or sea water, of oligotrophic or eutrophic biotopes
 - yeasts, peptones regardless of the origin and treatment thereof
 - plant and (macro- and micro-)algae extracts
 - urea, indole and derivatives thereof
- trace elements and macroelements such as:
 - calcium, phosphorus, potassium, sulfur, sodium, chlorine and magnesium
 - all inorganic (salts) and organic derivatives of oxygen, carbon and nitrogen, such as CaCl_2 , MgSO_4 , MnSO_4 , NaCl , phosphates, etc. and the hydrates thereof

- trace elements: Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, As, Se, Br, Mo, Ag, Au, Cd, Sn, I, Li, Cl, Hg, Pb, yttrium, and lanthanide salts; in the form of sulfate, nitrate, phosphate or chloride salts

- vitamins and derivatives such as:

- vitamin K, B8 and B12, thiamine, riboflavin,
nicotinamide, pantothenic acid, pyridoxine and derivatives thereof,
biotin, folic acid, cyanocobalamin and ascorbic acid

- carotenoids and derivatives thereof, retinol and derivatives thereof, calcitriol, tocopherols, tocotrienols, phyloquinone and menaquinone

- carnitine, orotic acid, para-aminobenzoic acid and derivatives thereof, pangamic acid, dimethylglycine and laetrile (amygdalin)

- probiotics, bacterial immunoregulators and lysates of the latter, such as:

- 15 • lipopolysaccharides (LPS) of *Vitreoscilla filiformis*
(Vf)

- lactic acid bacteria (CNCM I-1225 or CNCM 1-2116)

- Gram-positive skin bacteria

- yeasts of the genus *Saccharomyces*, *Yarrowia*,
Kluyveromyces, *Torulaspora*, *Schizosaccharomyces pombe*,
Debaromyces, *Candida*, *Pichia*, *Aspergillus* and *Penicillium*, and also
bacteria of the genus *Bifidobacterium*, *Bacteroides*, *Fusobacterium*,
Melissococcus, *Propionibacterium*, *Enterococcus*, *Lactococcus*,
Staphylococcus, *Peptostreptococcus*, *Bacillus*, *Pediococcus*,
Micrococcus, *Leuconostoc*, *Weissella*, *Aerococcus*, *Oenococcus* and
Lactobacillus and mixtures thereof

- more particularly the following species of these genera: *Saccharomyces cerevisiae*, *Yarrowia lipolitica*, *Kluyveromyces lactis*, *Torulaspora*, *Schizosaccharomyces pombe*, *Candida*, *Pichia*,

Bifidobacterium bifidum, *Bifidobacterium breve*, *Bifidobacterium longum*, *Bifidobacterium animalis*, *Bifidobacterium lactis*, *Bifidobacterium infantis*, *Bifidobacterium adolescentis*, *Bifidobacterium pseudocatenulatum*, *Lactobacillus acidophilus*, *Lactobacillus alimentarius*, *Lactobacillus casei* subsp. *Casei*, *Lactobacillus casei* Shirota, *Lactobacillus paracasei*, *Lactobacillus curvatus*, *Lactobacillus delbruckii* subsp. *Lactis*, *Lactobacillus gasseri*, *Lactobacillus johnsonii*, *Lactobacillus reuteri*, *Lactobacillus rhamnosus*, *Lactobacillus sake*, *Lactococcus lactis*, *Streptococcus thermophilus*, *Staphylococcus carnosus* and *Staphylococcus xylosus* and mixtures thereof

- more specifically, *Lactobacillus johnsonii* (CNCM I-1225), *Lactobacillus paracasei* (CNCM I-2116), *Bifidobacterium adolescentis* (CNCM I-2168), *Bifidobacterium longum* (CNCM I-2170), *Bifidobacterium lactis* (CNCM I-3446), *Bifidobacterium longum* (BB536), and mixtures thereof

- bacteria of the family of the Neisseriaceae
- bacteria cultured on spring water (La Roche-Posay (cf 79203), Saint Gervais or Vichy).

The treatment may be adapted as a function of certain physical factors of the treated human keratin materials, such as, in the case of the skin, its pH, its temperature, its salinity, its a_w (water activity (free water), affected by salinity, sugars, moisture absorbers, urea, glycerol) or else its oxygenation. It is known that *S. aureus* is able to grow if the a_w value is greater than 0.83, and that *S. epidermis* is able to grow if the a_w value is greater than 0.87.

The cosmetic treatment according to the invention may be carried out so as to keep a_w at a value of between 0.83 and 0.87, for example between 0.84 and 0.86, especially 0.85, so that only *S. aureus* is able to grow. This makes it possible to prevent the growth of *S. epidermis* from competing with that of *S. aureus*, which would be the case if the treatment were carried out while keeping a_w at a value above 0.87. Following the same reasoning, since it is known that the growth of the anaerobic bacterium *P. acnes* is promoted in a gaseous environment devoid of oxygen, the treatment according to the

invention may be carried out in an oxygenated gaseous environment, especially one enriched in oxidative species.

Active agents for treating and/or preventing scalp dandruff states

When the present invention is intended to treat and/or prevent scalp dandruff disorders, the composition for topical application may especially comprise one or more anti-dandruff active agents.

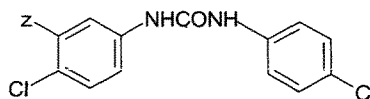
The term "antidandruff active agent" is intended to mean a compound capable of preventing the appearance of dandruff, reducing the amount of dandruff and/or making said dandruff disappear entirely.

An antidandruff active agent that is suitable for use in the invention may especially be chosen from:

- 1-hydroxy-2-pyridone derivatives, such as 1-hydroxy-4-methyl-2-pyridone, 1-hydroxy-6-methylpyridone, 1-hydroxy-4,6-dimethyl-2-pyridone, 1-hydroxy-4-methyl-6-(2,4,4-trimethylpentyl)-2-pyridone, 1-hydroxy-4-methyl-6-cyclohexyl-2-pyridone, 1-hydroxy-4-methyl-6-(methylcyclohexyl)-2-pyridone, 1-hydroxy-4-methyl-6-(2-bicyclo[2,2,1]heptyl)-2-pyridone, 1-hydroxy-4-methyl-6-(4-methylphenyl)-2-pyridone, 1-hydroxy-4-methyl-6-[1-[4-nitrophenoxy]butyl]-2-pyridone, 1-hydroxy-4-methyl-6-(4-cyanophenoxymethyl)-2-pyridone, 1-hydroxy-4-methyl-6-(phenylsulfonylmethyl)-2-pyridone, 1-hydroxy-4-methyl-6-(4-bromobenzyl)-2-pyridone and salts thereof; by way of preferred 1-hydroxy-2-pyridone derivative, mention may be made of the product sold by Hoechst under the name octopyrox (1-hydroxy-4-methyl-6-(2,4,4-trimethylpentyl)-2-pyridone, monoethanolamine salt;

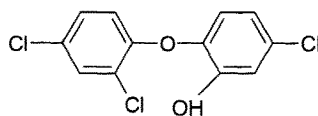
- pyridinethione salts, in particular the calcium, magnesium, barium, strontium, zinc, cadmium, tin and zirconium salts. The zinc salt of pyridinethione is particularly preferred. The zinc salt of pyridinethione is sold in particular under the name zinc omadine by Olin;

- trihalocarbamides of formula:



in which Z represents a halogen atom such as chlorine or a C₁-C₄ trihaloalkyl group such as CF₃;

- triclosan, represented by the formula:



- 5 - azole compounds such as climbazole, ketoconazole, clotrimazole, econazole, isoconazole and miconazole;
- antifungal polymers such as amphotericin B or nystatin;
- selenium sulfides, in particular those of formula S_xSe_{8-x}, x ranging from 1 to 7;
- 10 - sulfur in its various forms, cadmium sulfide, allantoin, coal or wood tars and derivatives thereof, in particular cade oil, salicylic acid, undecylenic acid, fumaric acid, and allylamines such as terbinafine;
- ellagic acid;
- selenium disulfide;
- 15 - technical grade N-oleyl dihydrosphingosine; sodium hydroxide (reference concentration 100% pure sodium hydroxide); citric acid, 1 H₂O; zinc pyrithione in aqueous dispersion; 1-hydroxy-4-methyl 6-trimethylpentyl 2-pyridone, monoethanolamine salt; L-menthol; a mixture of natural tocopherols in soybean oil (50/50); 98% pure L-rhamnose HPLC; L-carnosine (beta-alanyl-L-histidine); DL-bisabolol; sodium chloride; micronized
- 20 powdered selenium disulfide; n-octanoyl-5-salicylic acid; N-octanoyl glycine; zinc pyrrolidone carboxylate (or zinc pidolate); L-arginine,
- fatty substances such as esters of C16-C18 fatty acids and ethylene glycol; cetylstearyl alcohol (50/50 C16/C18); candelilla wax; isopropyl myristate;
- vitamins such as vitamin F glycerides (linoleic/oleic/linolenic acids); DL-
- 25 alpha-tocopherol acetate (vitamin E acetate); vitamin B3 or PP: niacinamide.

Active agents for treating and/or preventing dry and/or hyposeborrheic skin and/or atopy-prone skin

When the present invention is intended to treat and/or prevent dryness of human keratin materials, in particular skin dryness and especially to treat disorders associated with dry and/or hyposeborrheic skin and/or atopy-prone skin, the composition for topical application may especially comprise one or more active agents especially chosen from:

- ethylenediaminetetraacetic acid, tetrasodium salt; natural bisabolol; N-octanoyl glycine; citric acid, 1 H₂O; triethanolamine; n-octanoyl-5-salicylic acid; ethylenediaminetetraacetic acid, disodium salt, 2 H₂O; the sterile biomass of dead *vitreoscilla filiformis* cells in aqueous suspension; pentaerythrityl dibutyl tetrahydroxycinnamate; 99% pure D-mannose; sodium hydroxide (reference concentration 100% pure sodium hydroxide);

- fatty substances such as 2-octyldodecan-1-ol; white mineral oil; stabilized deodorized refined shea butter; cetyl alcohol; glycol distearate; stearyl alcohol; refined rapeseed oil; caprylic/capric triglycerides; stabilized shea olein; the mixture of mineral oil, microcrystalline wax and paraffin; cetylstearyl alcohol (50/50 C16/C18); white beeswax; cetyl palmitate;

- plant extracts such as the purified isomers of centella asiatica, madecassoside/terminoloxide mixture, of 95% purity;

- vitamins such as vitamin B3 or PP: niacinamide.

Active agents for treating and/or preventing skin with imperfections and/or acne-prone skin

When the present invention is intended to treat and/or prevent disorders associated with skin with imperfections and/or acne-prone skin, the composition for topical application may especially comprise one or more active agents especially chosen from:

- nylon-12 particles (6 micrometer size) loaded with linoleic acid; technical grade N-oleyl dihydrosphingosine; ethylenediaminetetraacetic acid, disodium salt, 2 H₂O; sodium hydroxide (reference concentration 100% pure sodium hydroxide); n-octanoyl-5-salicylic acid; 1-hydroxy-4-methyl 6-trimethylpentyl 2-pyridone, monoethanolamine salt; zinc pyrrolidone carboxylate (or zinc pidolate); citric acid, 1 H₂O; glycolic acid; the aqueous extract of ophiopogon japonicus root in preserved water; N-octanoyl glycine; L-

menthol; ethylenediaminetetraacetic acid, tetrasodium salt; zinc gluconate; sodium chloride; pentaerithrityl dibutyl tetrahydroxycinnamate; triethanolamine; 4-(2-hydroxyethyl)-piperazin-1-ethanesulfonic acid; trisodium citrate, 2 H₂O; powdered salicylic acid; LRP spring water;

5 - fatty substances such as myristyl myristate; isopropyl N-lauroyl sarcosinate; isocetyl stearate; caprylic/capric triglycerides mixture, soy lecithin, pentaerithrityl tetraoctanoate, isononyl isononanoate; cetyl alcohol;

 - plant extracts such as the non-stabilized hydroglycolic extract of skullcap roots; tremella fuciformis polysaccharide; eperua falcata bark extract on dextrin support;

10 - vitamins such as vitamin B3 or PP: niacinamide; provitamin B5: dexpanthenol; vitamin E: DL-alpha-tocopherol, DL-alpha-tocopherol acetate (vitamin E acetate).

Detailed description

15 The invention may be understood better from reading the following detailed description of nonlimiting exemplary embodiments thereof and from studying the appended drawing, in which:

 - figure 1 represents an example of a device for treating human keratin materials according to the invention,

20 - figures 2 and 3 illustrate details of the arrangement of the electronics of the treatment device according to the invention,

 - figures 4A to 4F represent examples of alternating voltages and unidirectional voltages produced from said alternating voltages,

25 - figures 5A to 5J illustrate examples of implementation of the non-therapeutic cosmetic process for treating human keratin materials according to the invention,

 - figures 6 to 11 represent examples of electronic circuits making it possible to produce a unidirectional voltage, and

 - figures 12A and 12B illustrate examples of unidirectional voltages at the input and at the output of the selector according to the invention.

Figure 1 represents an example of a treatment device 10 according to the invention.

This device 10 generates a polarized cold atmospheric plasma and it is configured to expose the human keratin materials K to be treated to this plasma.

5 The device 10 comprises an electrode 12 for generating the polarized cold atmospheric plasma, which is borne by a hand-held piece 11.

The electrode 12 is supplied by a high unidirectional voltage.

The hand-held piece 11 is connected to a base station 14 by a cable 13.

10 The hand-held piece 11 may be connected to the cable 13 by a connector, or connected in a non-disconnectable manner.

Likewise, the base station 14 may be connected to the cable 13 by a connector, or connected in a non-disconnectable manner.

The cable 13 may measure between 1 and 5 m in length.

15 The hand-held piece 11 makes it possible to apply the electrode 12 to the surface of the human keratin materials K at a fixed application point, or at a larger body surface. In the latter case, the hand-held piece 11 is moved manually or in an automated manner along the surface to be treated.

20 The base station 14 may comprise a high-voltage stage and the remainder of the electronics required for the operation of the plasma generator. The cable 13 therefore has the requisite electrical insulation.

In one variant, the hand-held piece 11 comprises the high-voltage stage and the base station 14 comprises the remainder of the electronics required for the operation of the plasma generator.

25 In another variant, the device 10 does not have a base station 14. The hand-held piece 11 then contains all the electronics required for the operation of the plasma generator.

The hand-held piece 11 may have an extension.

The electrode 12 may protrude from the body of the hand-held piece 11 at one end.

The electrode 12 may be specifically intended for a particular application. For example, the outer diameter of the electrode 12 and the radius of curvature of its surface for contact with the keratin materials are chosen as a function of the type of keratin materials being treated. The radius of curvature may be chosen so as to substantially match the curvature of the exposed area. This makes it possible to facilitate the application of the electrode 12 to certain body surfaces. For example, in order to treat the skin of the underarms, the surface for contact of the electrode 12 with the skin may have an outwardly convex, especially spherical, especially hemispherical, shape.

The electrode 12 may be removably attached to the hand-held piece 11. Several electrodes 12 having different shapes may be proposed to the user to be mounted on the body of the hand-held piece 11. This makes it possible to treat different types of human keratin materials by choosing the electrode 12 having the most suitable shape.

The electrode 12 may be automatically recognized by the hand-held piece 11. Similarly, the hand-held piece 11 may be automatically recognized by the base station 14 in order to adapt the treatment parameters, and especially the polarity of the plasma, as a function of the type of human keratin materials being treated.

The hand-held piece 11 may contain a tank containing a cosmetic composition that is applied topically to the keratin materials before and/or during and/or after exposure to the plasma. The cosmetic composition may be contained in a cartridge accommodated in the hand-held piece 11. This cartridge may be automatically recognized by the hand-held piece 11, where appropriate.

In one variant, the operation and/or set-up of the device 10 is remotely controlled, for example with a smartphone, a computer, or a remote server. The device 10 therefore comprises a communication interface which may be of Wi-Fi or Bluetooth type, for example housed in the base station 14 or in the hand-held piece 11.

The electrode 12 comprises an electrical conductor and an insulating dielectric that covers it externally, in the case in which the plasma generator is of DBD type.

In this case, the keratin materials K are used as counter electrode.

Figures 2 and 3 show schematic depictions of examples of the arrangement of the electronics of the device 10.

In these examples, the base station 14 comprises a supply 26, a signal generator 25, a polarity selector 24, a high-voltage generator 23 and a control and command interface 27.

Supply

5 The role of the supply 26 is to provide electrical energy to the base station 14 in order for the latter to function. The supply 26 may be a fuel cell or battery, which are especially rechargeable, a mains supply, or any other source of electrical supply.

Signal generator

10 The signal generator 25 is able to generate, at the output, a voltage signal having a defined waveform. This voltage signal may be in sinusoidal wave or non-sinusoidal wave form, for example in triangular wave form, sawtooth wave form, square wave form or rectangular wave form.

The signal generator 25 may be configured to make it possible to deliver an output signal which is alternating or unidirectional low voltage, either positive or negative.

15 The generator 25 may generate the low unidirectional voltage by rectifying an alternating voltage, for example using one or more diodes as illustrated in figures 6 to 10, this rectifier also being able, where appropriate, to multiply the voltage by virtue of the presence of capacitors as illustrated in figures 9 and 10.

The generator 25 may comprise a controlled rectifier.

20 Preferably, the low unidirectional voltage at the output of the generator 25 is in pulsed form.

High voltage generator

The role of the high voltage generator 23 is to amplify the voltage signal at the output of the signal generator 25 by a determined factor.

25 The high voltage generator 23 may receive a low alternating voltage at the input and generate a high alternating voltage or, as a variant, a high unidirectional voltage, for example using a circuit as illustrated in figures 6 to 10.

In another variant, the high voltage generator 23 receives a low unidirectional voltage at the input and delivers a high unidirectional voltage of the same polarity,

Control and command interface

This control and command interface 27 makes it possible to adjust characteristics of the voltage signal generated by the signal generator 25, especially the peak-to-peak amplitude thereof, the frequency thereof, the duty cycle thereof, the waveform thereof, the polarity thereof, the duration of emission thereof and, where appropriate, the number, the period, or the frequency of repetition of the pulses.

Polarity selector

The polarity selector 24 is configured to make it possible to select the polarity of the cold atmospheric plasma, and therefore makes it possible to change the polarity of the plasma during treatment.

The polarity selector 24 may be located upstream, as represented in figure 2, or downstream, as illustrated in figure 3, of the high voltage generator 23.

The selector 24 may be controlled manually or automatically.

The polarity selector 24 may comprise an H-bridge, as illustrated in figure 11. This bridge comprises electronic or electromechanical switches, for example MOSFET transistors. The signal at the input may be alternating, as illustrated in figure 11, or unidirectional.

The polarity selector 24 may only have a polarity inverting function when the voltage at the input is already unidirectional. The selector 24 may receive, at the input, a positive unidirectional voltage as illustrated in figure 12A, and deliver, at the output, a negative unidirectional voltage as represented in figure 12B, or vice-versa.

As a variant, the selector 24 also has a rectifying function when the voltage at the input is alternating, for example using a circuit as illustrated in figures 6 to 10.

Examples of waveforms

Figures 4B, 4D and 4F show examples of unidirectional voltages produced by rectifying alternating voltages, as illustrated in figures 4A, 4C and 4E, respectively.

In the case in which the selector 24 has a rectifying function, figures 4A, 4C and 4E show examples of alternating voltages at the input of the polarity selector 24, and

figures 4B, 4D and 4F show examples of unidirectional voltages at the output of the polarity selector 24.

In the case in which the polarity selector 24 is placed upstream of the high voltage generator 23 (figure 2), the signals represented in figures 4A to 4F are low-voltage.

5 In the case in which the polarity selector 24 is placed downstream of the high voltage generator 23 (figure 3), the signals represented in figures 4A to 4F are high-voltage.

Figure 4A shows an example of a sinusoidal-wave alternating voltage at the input of the polarity selector 24. The voltage produced at the output of the selector 24 by
10 rectifying this sinusoidal-wave alternating voltage may have one of the forms given in figure 4B.

Figure 4C shows an example of a triangular-wave alternating voltage at the input of the selector 24. The voltage produced at the output of the selector 24 by rectifying this triangular-wave alternating voltage may have one of the forms given in figure 4D.

15 Figure 4E shows an example of a rectangular-wave alternating voltage at the input of the selector 24. The voltage produced at the output of the selector 24 by rectifying this rectangular-wave alternating voltage may have one of the forms given in figure 4F.

As a variant, in the case in which the signal generator 25 has a rectifying function, the latter delivers, at the output, a low unidirectional voltage as shown in figures
20 4B, 4D and 4F, by rectifying a low alternating voltage as illustrated in figures 4A, 4C and 4E, respectively.

In another variant, in the case in which the high voltage generator 23 has a rectifying function, the latter delivers, at the output, a high unidirectional voltage as shown in figures 4B, 4D and 4F, by rectifying a low alternating voltage as illustrated in figures
25 4A, 4C and 4E, respectively.

Examples of treatment processes

An example of a treatment process will now be described with reference to figure 5A. In a first step, the keratin materials to be treated are thoroughly cleansed. Then, a cosmetic composition comprising one or more positively charged/polarized active agents,
30 such as vitamin A or tocopheryl acetate, is topically applied to the cleansed area. Finally,

the area is exposed to a positively polarized cold atmospheric plasma. Exposure to the plasma makes it possible to improve the penetration, by electrorepulsion, of the positively charged/polarized active agent(s) into the human keratin materials.

In a process variant in figure 5B, the keratin materials to be treated are
5 cleansed, then a cosmetic composition comprising one or more negatively charged/polarized active agents, such as retinyl palmitate, tocopherol, mandelic acid or ascorbic acid, is topically applied to the same area. Finally, said area is exposed to a negatively polarized cold atmospheric plasma. Exposure to the plasma makes it possible to improve the penetration, by electrorepulsion, of the negatively charged/polarized active
10 agent(s) into the human keratin materials.

In variants, the topical application is carried out without prior cleansing.

In implementation variants illustrated in figures 5C and 5D, the human keratin materials to be treated are firstly thoroughly cleansed, then a cosmetic composition is topically applied to the same area. The keratin materials treated in this way by the cosmetic
15 composition may be cleansed. Then, said area is exposed to a positively polarized cold atmospheric plasma (figure 5C) or, as a variant, negatively polarized cold atmospheric plasma (figure 5D). The topical application of a cosmetic composition before exposure to the polarized cold atmospheric plasma makes it possible to make the surface of the skin more hydrophilic and/or to improve the formation of pores by plasmaporation, and
20 therefore to improve permeation of molecules, such as some reactive species, RONS, having antimicrobial effects, through the keratin materials.

In variants illustrated in figures 5E and 5F, the human keratin materials to be treated are thoroughly cleansed, then exposed to a positively polarized cold atmospheric plasma (figure 5E) or, as a variant, negatively polarized cold atmospheric plasma (figure
25 5F). Then, a cosmetic composition is topically applied to the same area. The step of exposure to the plasma makes it possible to obtain an antimicrobial effect and to improve the permeability of the human keratin materials, so as, in the next step, to facilitate the penetration of the active agent(s) present in the cosmetic composition topically applied to these materials.

30 Another example of a treatment process according to the invention will now be described with reference to figure 5G. In a first optional step, the human keratin materials

to be treated are thoroughly cleansed. Then, the same area is exposed to an alternating cold atmospheric plasma, before a cosmetic composition comprising one or more positively charged/polarized active agents, such as vitamin A or tocopheryl acetate, is topically applied to the same area. Finally, the area is exposed once again to a cold atmospheric plasma, this time positively polarized. Exposure of the human keratin materials to the alternating plasma makes it possible, firstly, to promote the formation of pores in said keratin materials and thereby to improve their permeability by plasmaporation. Exposure of the human keratin materials to the positively polarized plasma then secondly makes it possible to improve the penetration, by electrorepulsion, of the positively charged/polarized active agents into the human keratin materials.

The variant illustrated in figure 5H differs from that described with reference to figure 5G by the polarity of the polarized plasma, and that of the active agents, which is negative. Exposure of the human keratin materials to the negatively polarized plasma makes it possible to improve the penetration, by electrorepulsion, of the negatively charged/polarized active agents into the human keratin materials.

Another example of a treatment process according to the invention is shown in figure 5I. In a first step, the keratin materials to be treated are thoroughly cleansed. Then, a second step consists in exposing the same area to an alternating cold atmospheric plasma. Finally, in a third step, said area is exposed to a positively polarized cold atmospheric plasma. Exposure of the keratin materials to the alternating plasma makes it possible, firstly, to promote the formation of pores in said keratin materials and thereby to improve their permeability by plasmaporation. Exposure of the keratin materials to the positively polarized plasma secondly makes it possible to improve the penetration, by electrorepulsion, of the positively charged/polarized reactive species, RONS, into the human keratin materials.

In the variant illustrated in figure 5J, the plasma is negatively polarized rather than positively polarized. Exposure of the human keratin materials to the negatively polarized plasma makes it possible to improve the penetration, by electrorepulsion, of the negatively charged/polarized reactive species, RONS, into the human keratin materials.

The invention is not limited to the examples that have just been described.

In particular, the step of cleansing the keratin materials in all the examples above may be removed.

The treatment may further be implemented differently, for example by being combined with taking a dietary supplement before, during or after the treatment by plasma.

- 5 The treatment may be implemented on healthy keratin materials in order to prevent, or even treat, disorders of the keratin materials such as dry and/or atopic and/or atopy-prone and/or greasy and/or grease-prone skin and/or skin with imperfections and/or acneic and/or acne-prone skin and/or scalp dandruff disorders. It may also be implemented to treat such disorders, and also other disorders such as eczema, rosacea, or psoriasis.

CLAIMS

1. A non-therapeutic cosmetic process for treating human keratin materials (K), comprising the step consisting in exposing said materials (K) to a polarized cold atmospheric plasma and comprising also a topical application of a cosmetic composition before and/or during and/or after the exposure to the polarized cold atmospheric plasma.

2. The process as claimed in claim 1, comprising the step consisting in selecting the polarity of the polarized cold atmospheric plasma.

3. The process as claimed in claim 1 or 2, wherein the cold atmospheric plasma is negatively polarized.

4. The process as claimed in claim 1 or 2, wherein the cold atmospheric plasma is positively polarized.

5. The process as claimed in any one of the preceding claims, wherein the cosmetic composition comprises a compound chosen from: prebiotics, probiotics, postbiotics, plant extracts, antibacterial active agents, antifungal active agents, vitamins, fatty substances and mixtures thereof.

6. The process as claimed in any one of the preceding claims, the duration of exposure to the plasma per cm^2 being between 0.1 s/cm^2 and 20 s/cm^2 .

7. The process as claimed in any one of the preceding claims, the power density of the plasma being between 0.1 W/cm^2 and 1 W/cm^2 .

8. The process as claimed in any one of the preceding claims, the temperature of the plasma at the point of application being less than or equal to 60°C , better still less than or equal to 40°C .

9. The process as claimed in any one of the preceding claims, wherein one or more electrodes (12) for generating the polarized cold atmospheric plasma, comprising an electrical conductor covered with an insulating dielectric material (22), are brought close to the human keratin materials (K), the distance between the material (22) covering the conductor of the or each electrode (12) and said materials (K) being between 0.05 mm and 3 mm.

10. A device for treating human keratin materials (K), especially for carrying out the process as claimed in any one of the preceding claims, comprising a generator of polarized cold atmospheric plasma comprising at least one electrode (12) for generating

polarized cold atmospheric plasma, suitable for the treatment of said materials (K), and at least one selector (24) for selecting the polarity of the polarized cold atmospheric plasma.

11. The device as claimed in claim 10, the gas used for producing the plasma being air, especially ambient air.

5 12. The device as claimed in claim 10 or 11, the or each electrode (12) being supplied by a high unidirectional voltage with an amplitude of between 0.5 and 50 kV, better still between 0.8 and 15 kV, better still between 0.8 and 5 kV.

13. The device as claimed in any one of claims 10 to 12, the or each electrode (12) being supplied by a high unidirectional voltage with a pulse period of between 1 ns
10 and 1 ms.

14. The device as claimed in any one of claims 10 to 13, the or each electrode (12) being supplied by a high unidirectional voltage with a frequency of pulse repetition or of pulse cycles of between 50 Hz and 100 kHz.

15. The device as claimed in any one of claims 10 to 14, the plasma generator
15 being a direct-type generator, preferably of DBD type.

16. The device as claimed in claim 15, the or each electrode (12) being supplied by a high unidirectional pulsed voltage, especially assuming a value equal to or close to zero between the emission of the pulses.

17. The device as claimed in any one of claims 10 to 16, the plasma generator
20 comprising means (27) for setting characteristics of the voltage supplying the or each electrode (12), especially the waveform thereof, the peak-to-peak amplitude thereof, the frequency thereof, the duty cycle thereof, in particular in the case in which the signal is square-wave or rectangular-wave, the polarity thereof, the duration of emission thereof and/or the number, the period, or the frequency of repetition of the pulses in the case in
25 which the signal is pulsed.

18. The device as claimed in any one of claims 10 to 17, the plasma generator comprising a signal generator (25) and a high voltage generator (23) generating a high voltage.

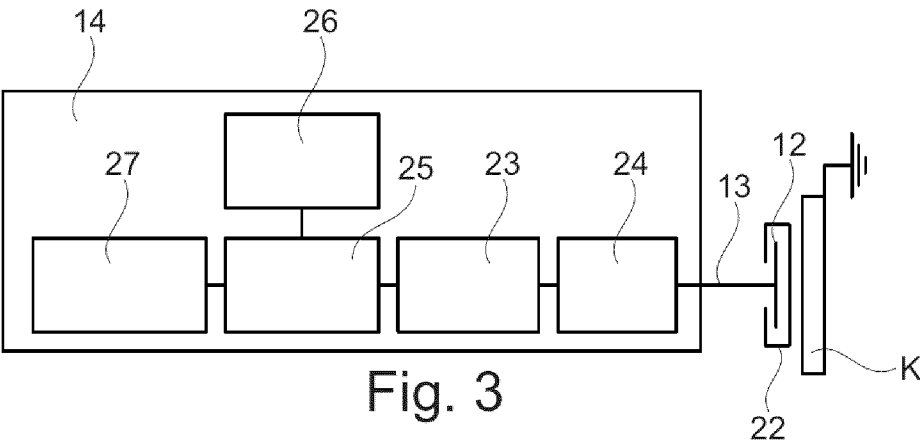
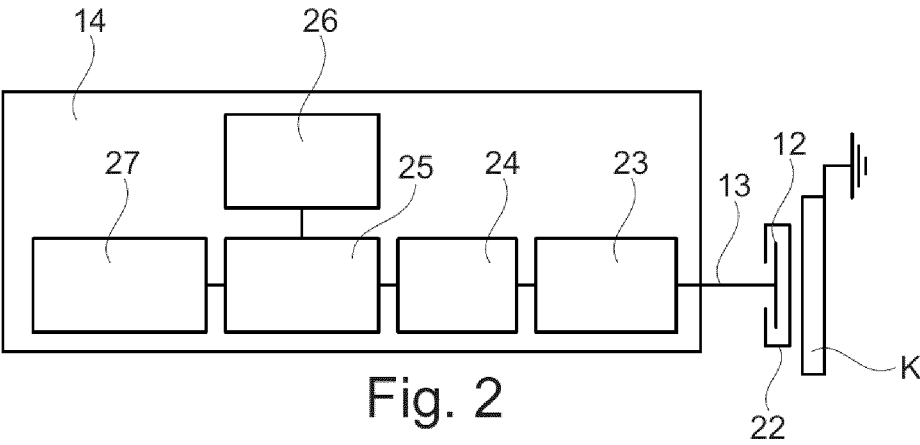
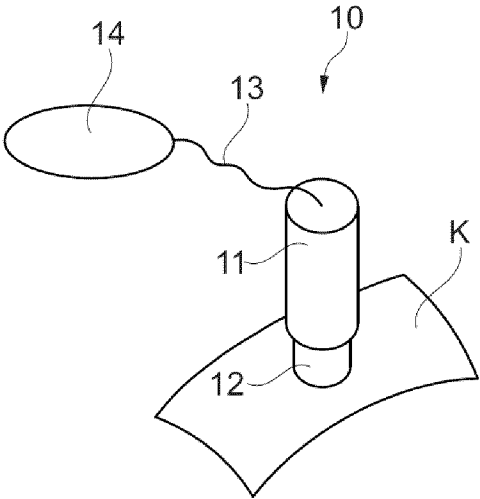
19. The device as claimed in any one of claims 10 to 18, the or each electrode
30 (12) being borne by a hand-held piece (11).

20. The non-therapeutic cosmetic use of a polarized cold atmospheric plasma generated by a device as claimed in any one of claims 10 to 19 for preventing and/or treating a disorder, especially an aesthetic disorder, of human keratin materials (K).

5 21. The use as claimed in claim 20, for preventing and/or treating an acneic skin condition.

22. The use as claimed in claim 20, for preventing and/or treating a scalp dandruff condition.

23. The use as claimed in claim 20, for deodorization, especially for preventing and/or treating human underarm odors.



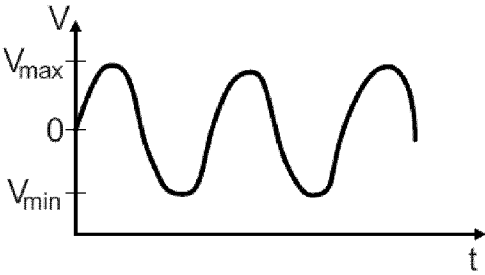


Fig. 4A

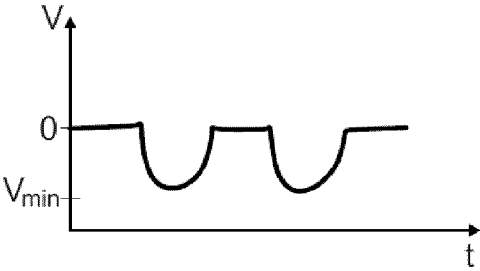
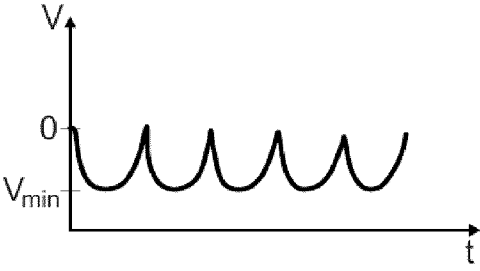
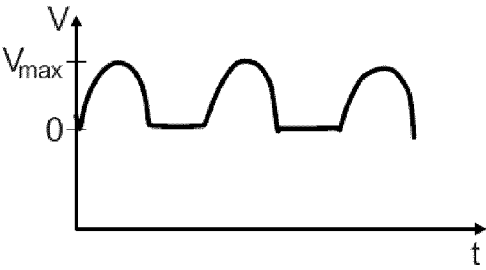
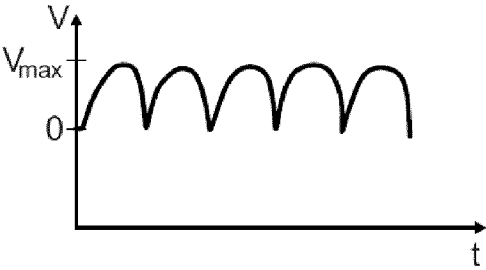


Fig. 4B

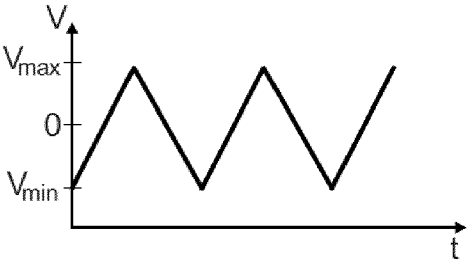


Fig. 4C

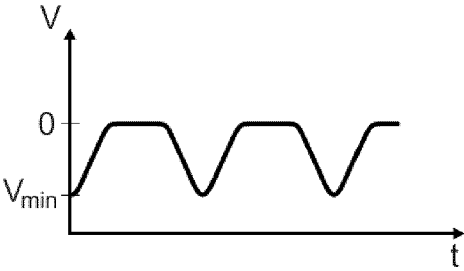
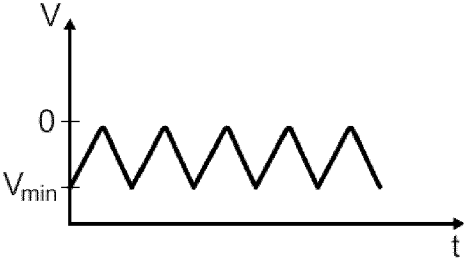
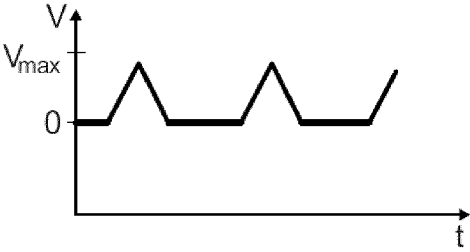
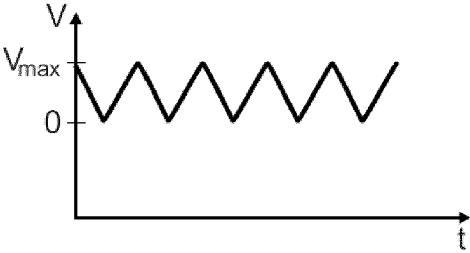


Fig. 4D

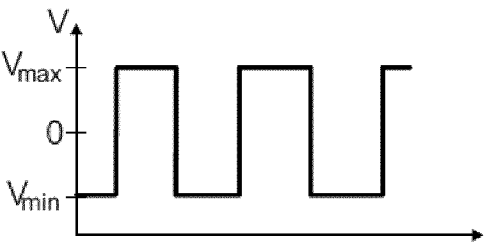
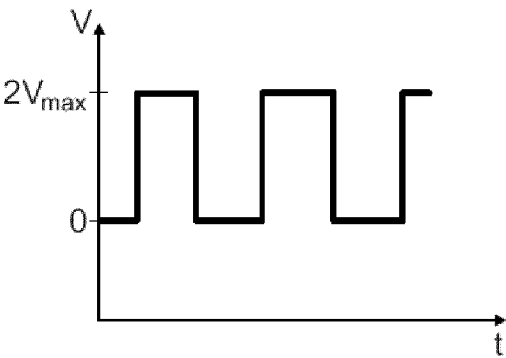


Fig. 4E

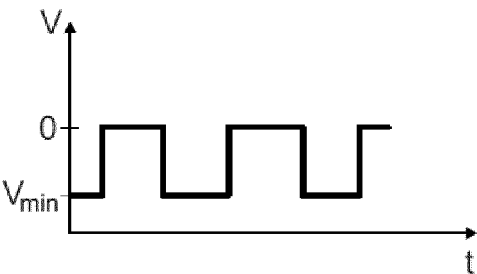
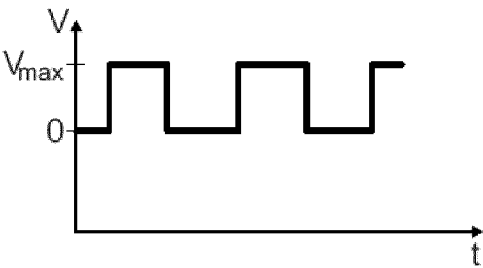
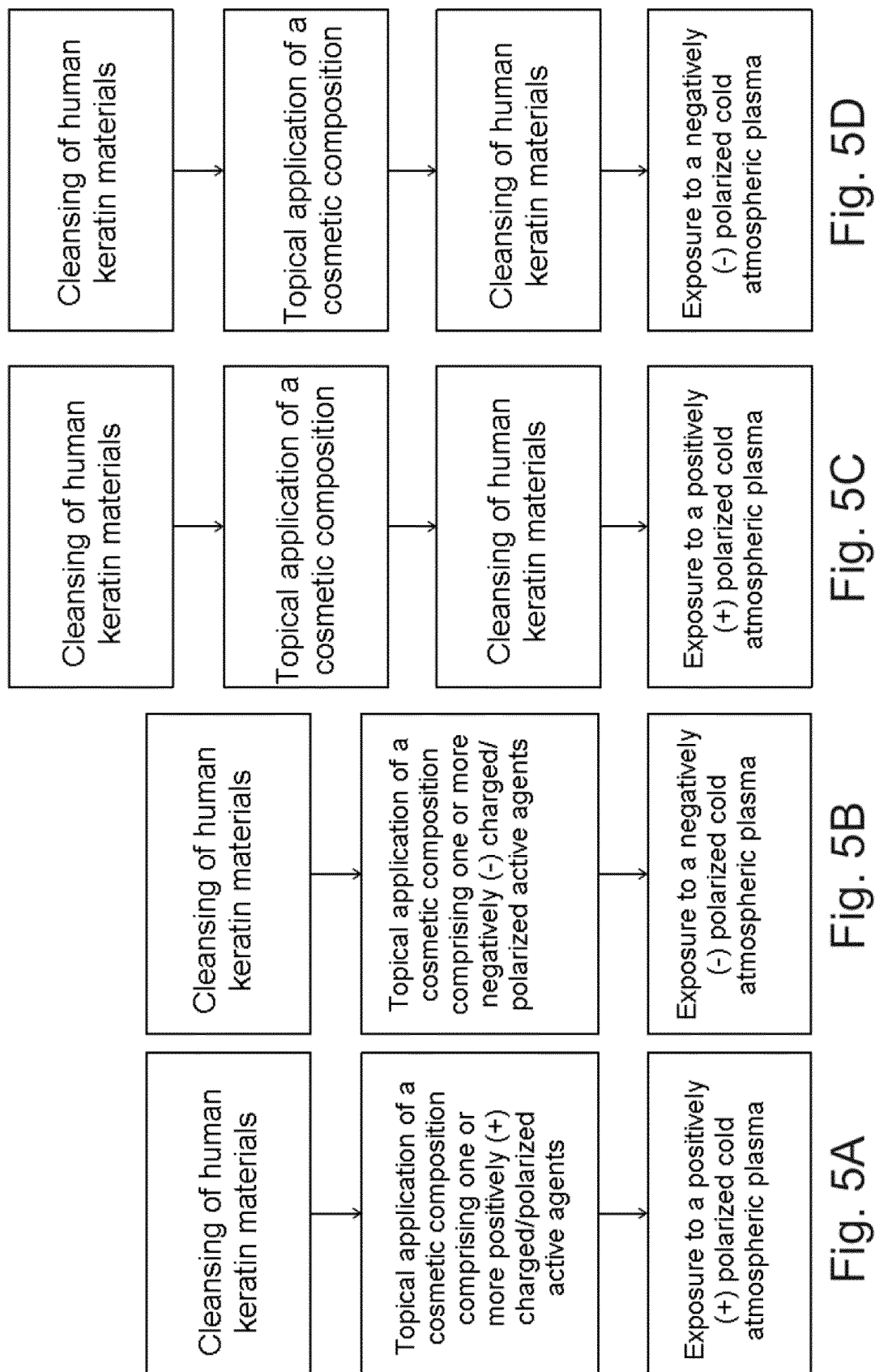


Fig. 4F



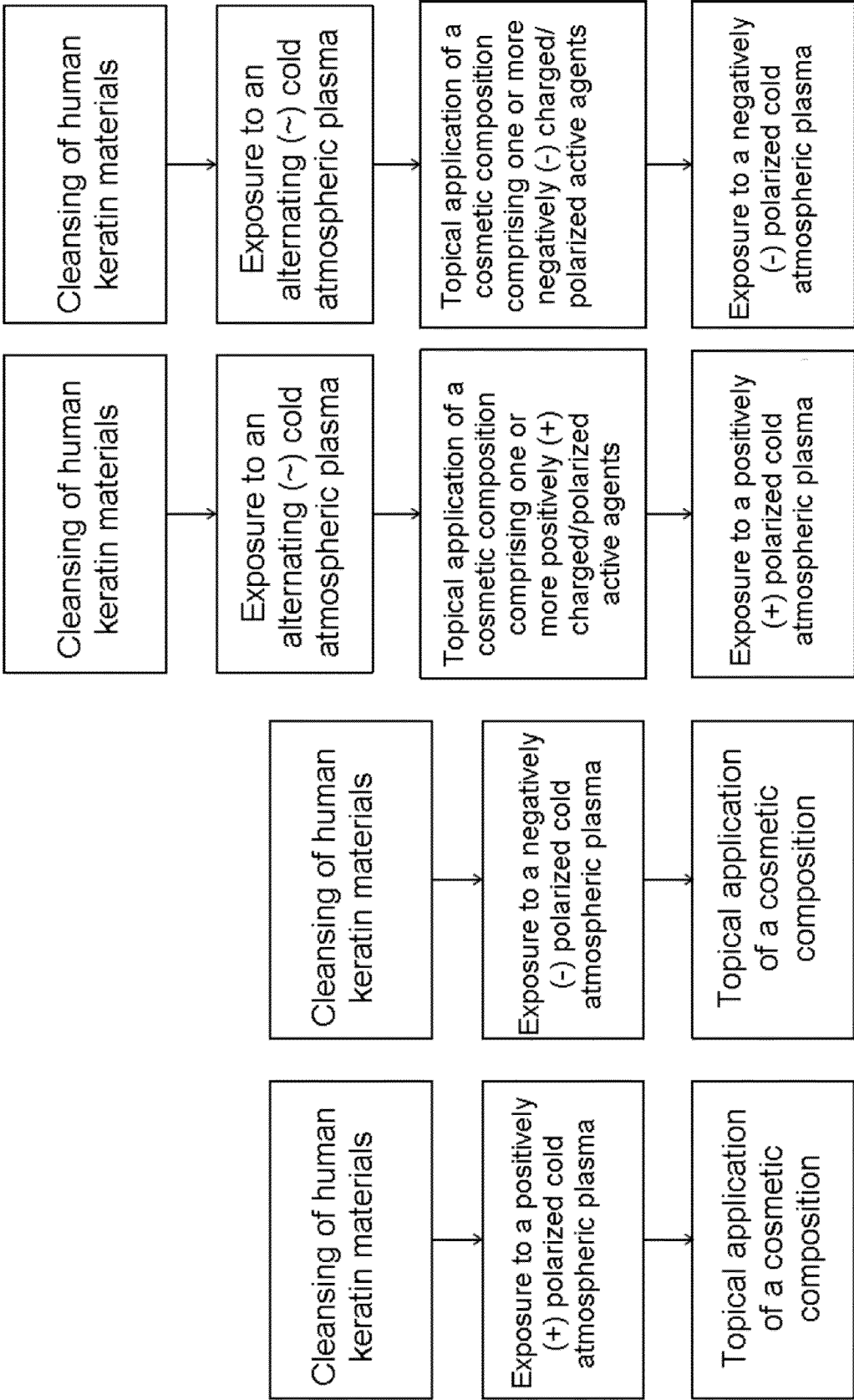


Fig. 5E

Fig. 5F

Fig. 5G

Fig. 5H

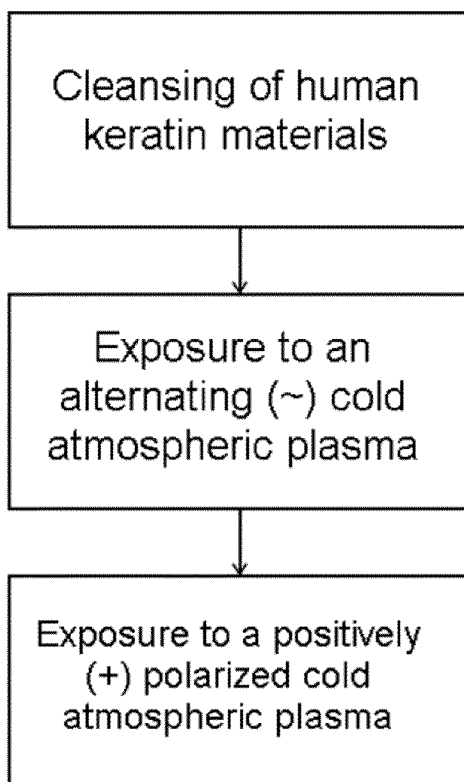


Fig. 5I

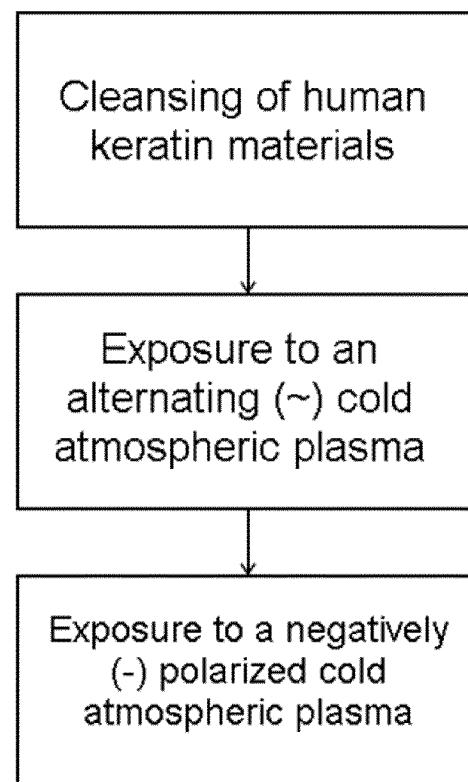


Fig. 5J

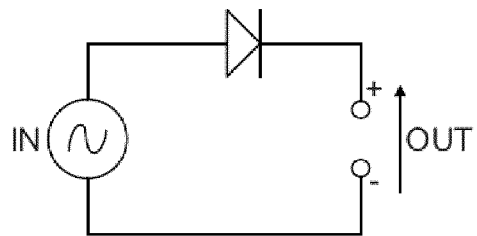


Fig. 6

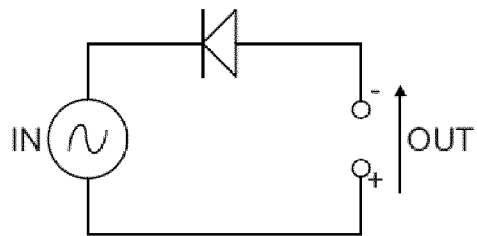


Fig. 7

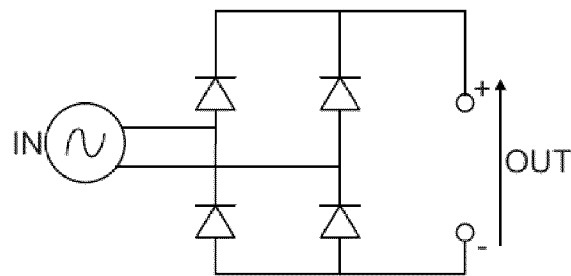


Fig. 8

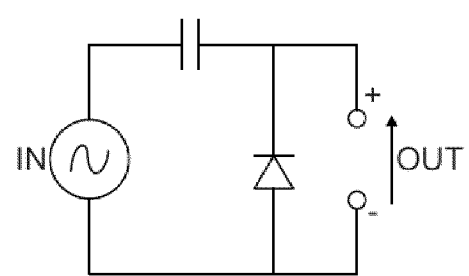


Fig. 9

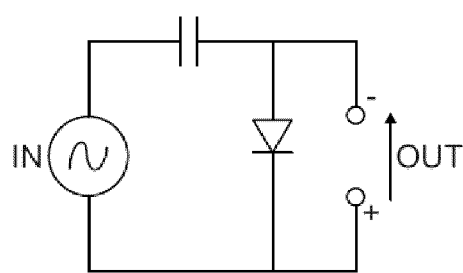


Fig. 10

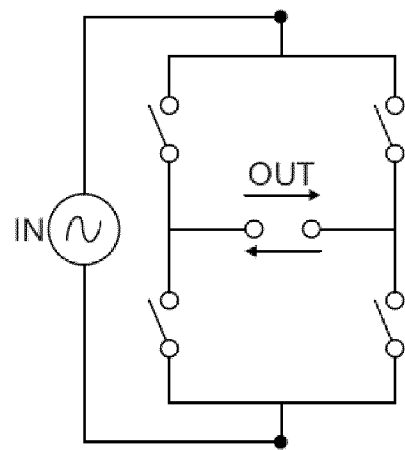


Fig. 11

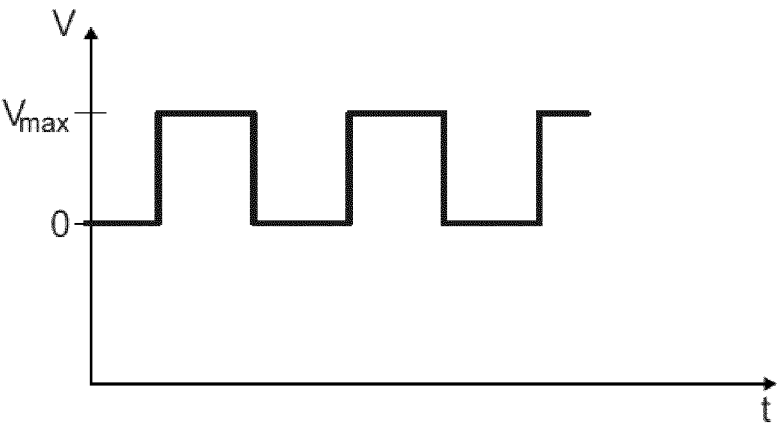


Fig. 12A

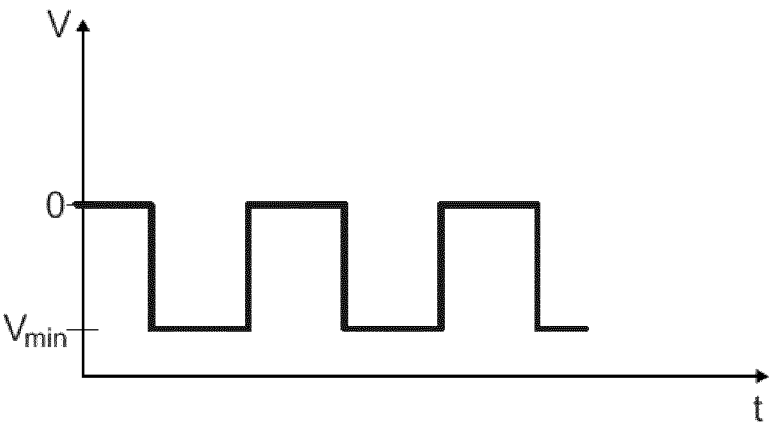


Fig. 12B

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2018/085921

A. CLASSIFICATION OF SUBJECT MATTER
INV. H05H1/24 A61L2/14
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)
H05H A61L

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	US 2014/188037 A1 (JACOFISKY MARC C [US] ET AL) 3 July 2014 (2014-07-03)	10-23
Y	abstract; figures 1-9 paragraphs [0008], [0026], [0029] - [0031], [0033]	1-9
Y	US 2012/288934 A1 (WELTMANN KLAUS-DIETER [DE] ET AL) 15 November 2012 (2012-11-15) abstract paragraphs [0008], [0014], [0015]	1-9
A	WO 2017/102454 A1 (OREAL [FR]; SEB SA [FR]) 22 June 2017 (2017-06-22) page 8, lines 18-20	9
A	WO 2016/016015 A1 (OREAL [FR]) 4 February 2016 (2016-02-04) page 15, lines 21-30	5



Further documents are listed in the continuation of Box C.



See patent family annex.

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"P" document published prior to the international filing date but later than the priority date claimed

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"&" document member of the same patent family

Date of the actual completion of the international search

14 March 2019

Date of mailing of the international search report

22/03/2019

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Crescenti, Massimo

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2018/085921

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