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- **HYUNG JIN AHN ET AL: "An ultrastuctural study of hair fiber damage and restoration following treatment with permanent hair dye", INTERNATIONAL JOURNAL OF DERMATOLOGY, vol. 41, no. 2, 1 February 2002 (2002-02-01), pages 88-92, XP055270760, UK ISSN: 0011-9059, DOI: 10.1046/j.1365-4362.2002.01375.x**
- **VALÉRIA FERNANDES MONTEIRO ET AL: "Morphological analysis of polymers on hair fibers by SEM and AFM", MATERIALS RESEARCH, vol. 6, no. 4, 1 December 2003 (2003-12-01), pages 501-506, XP055270758, BR ISSN: 1516-1439, DOI: 10.1590/S1516-14392003000400013**
- **JACALYN G GOULD ET AL: "Electron microscopy-image analysis: Quantification of ultrastructural changes in hair fiber cross sections as a result of cosmetic treatment Presented at the Society of Cosmetic Chemists Annual Meeting", J. SOC. COSMET. CHEM, vol. 36, 1 January 1985 (1985-01-01), pages 53-59, XP055270759,**
- **GIERAD LAPUT ET AL: "3D Printed Hair: Fused Deposition Modeling of Soft Strands, Fibers and Bristles", USER INTERFACE SOFTWARE AND TECHNOLOGY, 1 January 2015 (2015-01-01), pages 593-597, XP055270761, 2 Penn Plaza, Suite 701 New York NY 10121-0701 USA ISBN: 978-1-4503-3069-5**

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Description

Field of the Invention

[0001] The present invention relates to a method of analysing the effect of assaults, such as environmental conditions, mechanical assaults, chemical treatments, and every day hair care regimes on hair, and to a method of determining and applying a suitable treatment to the hair, using 3D images.

Background and Prior Art

[0002] HYUNG JIN AHN ET AL: "An ultrastuctural study of hair fiber damage and restoration following treatment with permanent hair dye",INTERNATIONAL JOURNAL OF DERMATOLOGY, vol. 41, no. 2, 1 February 2002 (2002-02-01), pages 88-92, XP055270760, UK; discloses an ultra-structural study of hair fibre damage and restoration using electron microscopy.

[0003] VALERIA FERNANDES MONTEIRO ET AL: "Morphological analysis of polymers on hair fibers by SEM and AFM", MATERIALS RESEARCH, vol. 6, no. 4, 1 December 2003 (2003-12-01), pages 501-506, XP055270758, BR; and JACALYN G GOULD ET AL: "Electron microscopy-image analysis: Quantification of ultrastructural changes in hair fiber cross sections as a result of cosmetic treatment; Presented at the Society of Cosmetic Chemists Annual Meeting", J. SOC. COSMET. CHEM, vol. 36, 1 January 1985 (1985-01-01), pages 53-59, XP055270759 disclose imaging and microscope-based approaches for analysing the effect of treatments on hair fibres.

[0004] GIERAD LAPUT ET AL: "3D Printed Hair: Fused Deposition Modelling of Soft Strands, Fibers and Bristles", USER INTERFACE SOFTWARE AND TECHNOLOGY, 1 January 2015, (2015-01-01), pages 593-597, XP055270761, discloses the production of hair fibres by 3D printing.

[0005] WO14041186A1 describes a system or component such as software for 3D modelling of bodies.

[0006] Consumers are aware of the damage that certain assaults such as treatments, protocols and hair care regimes can cause to the surface and structure of their hair. Although remedial treatments are available to mitigate these detrimental effects, the concept can be difficult for the consumer to grasp and the full effects of the remedial treatments difficult to fully comprehend.

[0007] Despite the prior art, there remains a need for new and improved methods of determining effects of treatments and assaults on hair.

[0008] The method of the invention can be used to assess properties of hair fibres, which have been exposed to various treatments and assaults.

Definition of the Invention

[0009] In a first aspect, the present invention provides a method of analysing the effect of an assault on hair, comprising the steps of:

(i) collecting imaging data for at least one hair surface,
(ii) applying at least one assault to the at least one hair surface,
(iii) collecting imaging data for the at least one hair surface arising from step (ii),
(iv) converting the imaging data collected at steps (i) and (iii) into a format suitable to create magnified images from a 3D printer,
(v) producing magnified 3D models of the at least one hair surface from a 3D printer using the data from step iv,
(vi) comparing the 3D model arising from step (iii) to the 3D model of step (i) and
(vii) assessing the degree of damage to the hair.

[0010] Preferably, steps (ii) to (vii) are repeated. Steps (ii) to (vii) may be repeated multiple times in order to assess the impact of repeated or long term exposure to the assault. For example, from 2 to 20 times, preferably from 2 to 8 times.

[0011] This method allows the properties shown in the magnified image/3D model at step (v) of the method of the invention to be compared to the initial image/3D model from step (i).

[0012] Properties that may be seen in the magnified image are external topographical aspects of the hair fibre, for example, cuticle lift, cuticle damage (for example, chipping, splitting, change in shape and breaking), cuticle erosion, split ends, kinks, blobs, cracks, holes and knots. These may be present at the initial imaging stage (i) depending on the age and condition of the hair at the beginning of the method. Thus, it is possible to illustrate to the consumer the impact of their usual hair regime and of other everyday assaults suffered by their hair.

[0013] The image may be used to assess the degree of damage to the hair, preferably by comparison to a scale. Preferably, the scale comprises indicators, for example numbers or letters, where the indicators correspond to incremental

levels of damage. In another preferred embodiment, the scale of damage comprises illustrations, such as photographs or CAD images that illustrate the degree of damage in increments. Both indicators and illustrations may be used together.

[0014] A preferred method comprises the steps of:-

(i) collecting imaging data for at least one hair surface,
(ii) applying at least one assault to the at least one hair surface,
(iii) collecting imaging data for the at least one hair surface arising from step (ii),
(iv) converting the imaging data collected at steps (i) and (iii) into a format suitable to create magnified images from a 3D printer,
(v) producing magnified 3D models of the at least one hair surface from a 3D printer using the data from step iv,
(vi) comparing the 3D model arising from step (iii) to the 3D model arising from step (i),
(vii) assessing the degree of damage to the hair, and
(viii) repeating steps (ii) to (vii).

[0015] The method of the invention can be used to define the hair need of an individual.

[0016] The method of the invention may be used in an educational tool, in communication with press, media or trade, at point of sale, in professional environments such as salons, and in commercial material, advertisement material and promotional material.

[0017] In a second aspect of the invention, there is provided a method of determining the effect of a beneficial treatment or regime on hair. The method comprises a step of applying a suitable beneficial treatment or regime to the hair, where the treatment is determined according to the analysis of the 3D images. Implementation of a beneficial treatment, or beneficial changes to the treatment that the individual is using are envisaged within the method of the invention. For example, treatments that are suitable for the properties revealed in the magnified 3D image, such as treatments for lifted cuticles, or for erroded cuticles (as is apparent in bleached hair), or for split ends and so on. The treatment may also be determined according to the assessment of the degree of damage to the hair; or by a combination of both the analysis of the 3D images and the assessment of the degree of damage. Beneficial regimes include making changes to a current regime such as switching from blow drying to natural drying, switching to hair colourant treatments that have a lower peroxide content than current, reducing combing to reduce further damage to damaged cuticles, washing hair less frequently, and so on. The implementation of a new beneficial regime, such as a regular use of a repair treatment, is also envisaged.

[0018] The method of the second aspect of the invention comprises the steps of:-

(i) collecting imaging data for at least one hair surface,
(ii) converting the imaging data from step (i) and optional step (ii) into a format suitable to create magnified images from a 3D printer,
(iii) producing magnified 3D model(s) of the at least one hair surface using the data from step (iii),
(iv) analyzing the properties of the hair surface apparent from the 3D model(s),
(v) assessing the degree of damage to the hair,
(vi) applying a suitable beneficial treatment or regime to the hair, taking into account the findings of steps (v) and/or (vi),
(vii) collecting imaging data for the at least one hair surface arising from step (vii) and producing a magnified 3D model of the treated hair surface using the imaging data,
(viii) comparing the 3D model arising from step (viii) to the 3D model arising from step (i) or step (ii), and
(ix) assessing the beneficial effect to the hair.

[0019] In this way it is possible to demonstrate any surface improvement, such as "smoothing", arising from the application of the treatment or regimes to the hair.

[0020] Steps (vi) to (ix) may be repeated.

[0021] In this method, at least one assault may be applied to the at least one hair surface and collecting imaging data for the resulting hair surface, after step (i).

General Description of the Invention

The Assault

[0022] Many assaults occur during everyday life or as part of a normal hair care regime or consumer habit.

[0023] Assaults are preferably selected from mechanical assaults, chemical assaults, environmental assaults and mixtures thereof.

[0024] Preferred mechanical assaults are combing, brushing, the application of hot irons for curling, straightening or

setting and blow drying.

[0025] Preferred chemical assaults are treatments that contain chemicals that modify the hair, for example colouring treatments, bleaching, straightening treatments, relaxing treatments and use of surfactants, for example use of shampoo.

[0026] Preferred environmental assaults include, for example, humidity, pollution, hard water, salt water, ultra violet light, wind and temperature extremes.

The Image

[0027] Preferably, the image is a topographic surface image; more preferably, the topographic surface image is produced using a 3D optical profiler, such as a Sensofar S neox, or laser profilometer.

[0028] The topographic surface is converted into a format suitable for a 3D printer, preferably it is exported in a digital file as spatial coordinates (X, Y, Z) of each point which describes the topographic (3D) surface. Preferably, this is completed using a profilometer. An example of a suitable profilometer is the Sensofar S neox profilometer that can produce a 3d image of the surface to be studied. The profilometer software, for example sensoSCAN v5, can export a file ".dat" that is a list of all the X, Y, Z coordinates of each point.

[0029] Preferably, the magnified 3D image has a magnification of from 100 to 50,000, preferably 30,000 times.

[0030] If desired the conversion of the imaging data iv) comprises a magnification process. The magnification is preferably achieved by change of resolution, units and/or rescale of coordinate axis, producing a new digital file with the new spatial coordinates. A preferred way of magnifying the data points is using Matlab. In this preferred method the ".dat" file is imported in Matlab as a matrix and a set of Matlab scripts are used to manipulate the matrix and change the resolution/scale. It is highly preferred if the matrix is exported into a new ASCII file ".XYZ" as a list of all the X, Y, Z coordinates of each point.

[0031] The imaging data is converted into an image suitable for a 3D printer. Preferably, the file is imported in a 3D-CAD software and the 3D surface is applied onto a face of a parallelogram to obtain a 3D object. The resulting 3D image is exported to a digital file compatible with the 3D-printer device software. The XYZ file is preferably imported into a software conversion package, for example the "Rhino" software package, which can convert it into a 3d file and export as a .STL file.

[0032] The 3D image is printed to form a 3D object. This can be achieved by using any of the modern 3D printers available, an example is EOS (Electro Optical Systems) EOSINT P380 Selective Laser Sintering printer and a 3D replica of the magnified surface produced.

[0033] Preferably, a colour rinse is applied to the 3D model to highlight the areas of interest. The colours can be varied according to the surface height. This is useful in showing up extent of cuticle lift and depth of holes, etc.

The Hair

[0034] The method of the invention can be carried out on a single hair fibre, or a bundle of hair fibres.

[0035] The hair is preferably human hair.

Beneficial Treatments and Regimes

[0036] Preferred treatments and regimes are those that reduce or alleviate the effects of damage to the hair.

[0037] Preferred treatments for hair (step vi) are rinse off and leave on products. Preferred hair treatment compositions are selected from a shampoo, a rinse-off hair conditioner, a hair mask, a leave-on conditioner composition, and a pre-treatment composition, more preferably selected from a rinse-off hair conditioner, a hair mask, a leave-on conditioner composition, and a pre-treatment composition, for example an oil treatment, and most preferably selected from a rinse-off hair conditioner, a hair mask and a leave-on conditioner composition.

[0038] Rinse off conditioners for use in the invention are conditioners that are typically left on wet hair for 1 to 2 minutes before being rinsed off.

[0039] Hair masks for use in the present invention are treatments that are typically left on the hair for 3 to 10 minutes, preferably from 3 to 5 minutes, more preferably 4 to 5 minutes, before being rinsed off.

[0040] Leave-on conditioners for use in the invention are typically applied to the hair and left on the hair for more than 10 minutes, and preferably are applied to the hair after washing and not rinsed out until the next wash.

[0041] Treatments compositions for use in the method of the current invention preferably comprise conditioning agents. Conditioning agents are preferably selected from cationic surfactants, used singly or in admixture.

[0042] Cationic surfactants useful in compositions for use in the method of the invention contain amino or quaternary ammonium hydrophilic moieties which are positively charged when dissolved in aqueous composition.

[0043] Examples of suitable cationic surfactants are those corresponding to the formula

$$[N(R_1)(R_2)(R_3)(R_4)]^+ (X)^-$$

in which R_1, R_2, R_3 and R_4 are independently selected from (a) an aliphatic group of from 1 to 22 carbon atoms, or (b) an aromatic, alkoxy, polyoxyalkylene, alkylamido, hydroxyalkyl, aryl or alklaryl group having up to 22 carbon atoms; and X is a salt-forming anion such as those selected from halogen, (e.g. chloride, bromide), acetate, citrate, lactate, glycolate, phosphate nitrate, sulphate, and alkylsulphate radicals.

[0044] The aliphatic groups can contain, in addition to carbon and hydrogen atoms, ether linkages, and other groups such as amino groups. The longer chain aliphatic groups, e.g., those of about 12 carbons, or higher, can be saturated or unsaturated.

[0045] The most preferred cationic surfactants for compositions for use in the method of the present invention are monoalkyl quarternary ammonium compounds in which the akyl chain lengthy is C_8 to C_{14}.

[0046] Suitable examples of such materials correspond to the formula

$$[N(R_5)(R_6)(R_7)(P_8)]^+ (X)^-$$

in which R_5 is a hydrocarbon chain having 8 to 14 carbon atoms or a functionalised hydrocarbyl chain with 8 to 14 carbon atoms and containing ether, ester, amido or amino moieties present as substituents or as linkages in the radical chain, and R_6, R_7 and R_8 are independently selected from (a) hydrocarbyl cahins of from 1 to about 4 carbon atoms, or (b) functionalised hydrocarbyl chains having from 1 to about 4 carbon atoms and containing one or more aromatic, ether, ester, amido or amino moieties present as substituents or as linkages in the radical chain, and X is a salt-forming anion such as those selected from halogen, (e.g. chloride, bromide), acetate, citrate, lactate, glycolate, phosphate nitrate, sulphate and alkylsulphate radicals.

[0047] The functionalised hydrocarbyl cahins (b) may suitably contain one or more hydrophilic moieties selected from alkoxy (preferably C_1-C_3 alkoxy), polyoxyalkylene, alkylester, and combinations thereof.

[0048] Preferably the hydrocarbon chains R_1 have 12 to 14 carbon atoms, most preferably 12 carbon atoms. They may be derived from source oils which contain substantial amounts of fatty acids having the desired hydrocarbyl chain length. For example, the fatty acids from palm kernel oil or coconut oil can be used as a source of C_8 to C_{12} hydrocarbyl chains.

[0049] Typical monoalkyl quarternary ammonium compounds of the above general formula for use in compositions for use in the method of the invention include:

(i) Lauryl trimethylammonium chloride (available commercially as Arquad C35 ex Akzo); cocodimethyl benzyl ammonium chloride (available commercially as Arquad DMCB-80 ex-Akzo)

(ii) Compounds of the formula:

$$[N(R_1)(R_2)((CH_2CH_2O)_xH)((CH_2CH_2O)_yH]^+ (X)^-$$

wherein:

x + y is an integer from 2 to 20;
R_1 is a hydrocarbyl chain having 8 to 14, preferably 12 to 14, most preferably 12 carbon atoms and containing ether, ester, amido or amino moieties present as substituent's or as linkages in the radical chain;
R_2 is a C_1-C_3 alkyl group or benzyl group, preferably methyl, and
X is a salt-forming anion such as those selected from halogen, (e.g. chloride, bromide), acetate, citrate, lactate, glycolate, phosphate nitrate, sulphate, methosulphate and alkylsulphate radicals.

[0050] Suitable examples are PEG-n lauryl ammonium chlorides (where n is the PEG chain length), such as PEG-2 cocomonium chloride (available commercially as Ethoquad C12 ex-Akzo Nobel); PEG-2 cocobenzyl ammonium chloride (available commercially as Ethoquad CB12 ex-Akzo Nobel); PEG-5 cocomonium methosulphate (available commercially as Rewoquat CPEM ex Rewo); PEG-15 cocomonium chloride (available commercially as Ethoquad C/25 ex-Akzo).

(iii) Compounds of the formula:

$$[N(R_1)(R_2)(R_3)((CH_2)_nOH)]^+ (X)^-$$

wherein:

n is an integer from 1 to 4, preferably 2;

R_1 is a hydrocarbyl chain having 8 to 14, preferably 12 to 14, most preferably 12 carbon atoms;
R_2 and R_3 are independently selected from C_1 - C_3 alkyl groups, and are preferably methyl, and
X- is a salt-forming anion such as those selected from halogen, (e.g. chloride, bromide), acetate, citrate, lactate, glycolate, phosphate nitrate, sulphate, alkylsulphate radicals. Suitable examples are lauryldimethylhydroxyethylammonium chloride (available commercially as Prapagen HY ex-Clariant).

[0051] Mixtures of any of the foregoing cationic surfactants compounds may also be suitable.

[0052] Examples of suitable cationic surfactants for use in hair compositions for use in the method of the invention include cetyltrimethylammonium chloride, behenyltrimethylammonium chloride, cetylpyridinium chloride, tetramethylammonium chloride, tetraethylammonium chloride, octyltrimethylammonium chloride, dodecyltrimethylammonium chloride, hexadecyltrimethylammonium chloride, octyldimethylbenzylammonium chloride, decyldimethylbenzylammonium chloride, stearyldimethylbenzylammonium chloride, didodecyldimethylammonium chloride, dioctadecyldimethylammonium chloride, tallowtrimethylammonium chloride, cocotrimethylammonium chloride, and the corresponding hydroxides thereof. Further suitable cationic surfactants include those materials having the CTFA designations Quaternium-5, Quaternium-31 and Quaternium-18. Mixtures of any of the foregoing materials may also be suitable. A particularly useful cationic surfactant is cetyltrimethylammonium chloride, available commercially, for example as DEHYQUART, ex Henkel.

[0053] The level of cationic surfactant is preferably from 0.01 to 10, more preferably 0.05 to 5, most preferably 0.1 to 2 w.t. % of the total composition.

[0054] A preferred conditioner comprises a conditioning gel phase. Such conditioners and methods for making them are described in WO2014/016354, WO2014/016353, WO2012/016352 and WO2014/016351.

[0055] The conditioning compositions may also comprise other optional ingredients. Such ingredients include, but are not limited to; fatty material, deposition polymers and further conditioning agents.

[0056] Conditioner compositions preferably additionally comprise fatty materials. The combined use of fatty materials and cationic surfactants in conditioning compositions is believed to be especially advantageous, because this leads to the formation of a structured lamellar or liquid crystal phase, in which the cationic surfactant is dispersed.

[0057] By "fatty material" is meant a fatty alcohol, an alkoxylated fatty alcohol, a fatty acid or a mixture thereof.

[0058] Preferably, the alkyl chain of the fatty material is fully saturated.

[0059] Representative fatty materials comprise from 8 to 22 carbon atoms, more preferably 16 to 22. Examples of suitable fatty alcohols include cetyl alcohol, stearyl alcohol and mixtures thereof. The use of these materials is also advantageous in that they contribute to the overall conditioning properties of compositions.

[0060] Alkoxylated, (e.g. ethoxylated or propoxylated) fatty alcohols having from about 12 to about 18 carbon atoms in the alkyl chain can be used in place of, or in addition to, the fatty alcohols themselves. Suitable examples include ethylene glycol cetyl ether, polyoxyethylene (2) stearyl ether, polyoxyethylene (4) cetyl ether, and mixtures thereof. The level of fatty material in conditioners is suitably from 0.01 to 15, preferably from 0.1 to 10, and more preferably from 0.1 to 5 percent by weight of the total composition. The weight ratio of cationic surfactant to fatty alcohol is suitably from 10:1 to 1:10, preferably from 4:1 to 1:8, optimally from 1:1 to 1:7, for example 1:3.

[0061] Further conditioning ingredients include esters of fatty alcohol and fatty acids, such as cetyl palmitate.

[0062] A conditioning composition for use in the present invention may preferably comprise a miscellar structured liquid.

[0063] The pH of a conditioner comprising the present composition is preferably 3-5. More preferably the pH of the composition is 4.5-5.5.

[0064] Where the composition has a pH of less than 3.10 it is preferred that it is in the form of a conditioning mask for intense treatment.

[0065] Further conditioning ingredients include conditioning oils, preferably selected from coconut oil and olive oil.

[0066] The invention will now be illustrated by the following non-limiting Examples:

EXAMPLES

[0067] Specimen hair fibres were sampled from a human head and the untreated specimens were imaged according to the method below. The fibres were then treated with bleach and imaged as before.

[0068] The method of treating with bleach was as follows:
Commercially available in-homes bleach products, L'Oreal Platine Precision Powder Bleach and Excel Creme Peroxide (9% Vol) were used.

[0069] The hair was dark brown European hair, in 7g/10" Flat Metal switches.

[0070] Bleach powder (60 g) and creme peroxide (120 g) were placed in a tinting bowl and mixed to a smooth, creamy consistency.

[0071] A switch of hair was spread (in a fan shape) on a sheet of aluminium foil.

[0072] The freshly prepared bleach mixture was applied to the hair with a tinting brush, ensuring even coverage on each side.

[0073] The switch was then wrapped in the aluminium foil and left to develop at ambient temperature for 30 minutes. The switch was then removed from the foil and rinsed for 2 minutes under the tap, running the fingers down the switch to ensure complete removal of the bleach.

[0074] Switches were subjected to the bleaching treatment 4 or 8 times in order to show the effect of repeated bleaching assaults.

Imaging Method

[0075] The topographic surface of the hair fibres was converted into a format suitable for a 3D printer, by exporting in a digital file as spatial coordinates (X, Y, Z) of each point which describes the topographic (3D) surface using a sensoSCAN v5 with a Sensofar S neox profilometer.

[0076] The resulting digital file data was magnified by importing to Matlab as a matrix and using Matlab scripts to manipulate the matrix and change the resolution/scale. The matrix was then exported into a new ASCII file ".XYZ" as a list of all the X,Y,Z coordinates of each point. The magnification was 30,000 times.

[0077] The imaging data was converted into an image suitable for a 3D printer using 3D-CAD software and the 3D surface was applied onto a face of a parallelogram to obtain a 3D object. The resulting 3D image was exported to a digital file compatible with the 3D-printer device software by use of the "Rhino" software package, which converted it into a 3D file and exported it as a .STL file.

[0078] The 3D image was then printed to form a 3D object. This was achieved by using an EOS (Electro Optical Systems) EOSINT P380 Selective Laser Sintering printer and a 3D replica of the magnified surface produced.

[0079] Comparing and analysing the resulting 3D images demonstrated the effect of the bleach assault on the hair.

[0080] The results are shown in Figures 1, 2 and 3, where:-

Fig 1 is a 3D printed object of an untreated hair fibre.
Fig 2 is a 3D printed object of a hair fibre that has been treated 4 times with bleach.
Fig 3 is a 3D printed object that has been treated 8 times with bleach.

[0081] It is possible to see positive and negative depth of surface features of the hair fibres, and to handle the objects such that all aspects may be closely examined in detail, both visually and tactilely. The effect of the bleaching assault is clear, where cuticle erosion and aspects of damage to the outer structure of the hair surfaces is apparent.

Claims

1. A method of analysing the effect of an assault on hair, comprising the steps of:

(i) collecting imaging data for at least one hair surface,
(ii) applying at least one assault to the at least one hair surface,
(iii) collecting imaging data for the at least one hair surface arising from step (ii),
(iv) converting the imaging data collected at steps (i) and (iii) into a format to create magnified images from a 3D printer,
(v) producing magnified 3D models of the at least one hair surface from a 3D printer using the data from step iv,
(vi) comparing the 3D model arising from step (iii) to the 3D model of step (i) and
(vii) assessing the degree of damage to the hair.

2. A method as claimed in claim 1, which further comprises a step of repeating steps (ii) to (vii).

3. A method of determining the effect of a beneficial treatment or regime on hair comprising the steps of:

(i) collecting imaging data for at least one hair surface,
(ii) converting the imaging data from step (i) into a format to create magnified images from a 3D printer,
(iii) producing magnified 3D model(s) of the at least one hair surface from a 3D printer using the data from step (ii),
(iv) analyzing the properties of the hair surface apparent from the 3D model(s),
(v) assessing the degree of damage to the hair,
(vi) applying a suitable beneficial treatment or regime to the hair, taking into account the findings of steps (iv) and/or (v),
(vii) collecting imaging data for the at least one hair surface arising from step (vi) and producing a magnified 3D model of the treated hair surface using the imaging data,

(viii) comparing the 3D model arising from step (vii) to the 3D model arising from step (iii), and
(ix) assessing the beneficial effect to the hair.

4. A method as claimed in claim 3, which further comprises the step of applying at least one assault to the at least one hair surface and collecting imaging data for the resulting hair surface, after step (i).

5. A method as claimed in claim 3 or claim 4, which further comprises a step of repeating steps (vi) to (ix).

6. A method as claimed in any one of claims 3 to 5, where the degree of damage is carried out by comparison to a scale.

7. A method as claimed in any of claims 3 to 6, wherein the beneficial treatment or regime comprises application of a hair treatment composition to the hair.

8. A method as claimed in claim 7 wherein the hair composition is selected from a rinse-off hair conditioner, a hair mask, a leave-on conditioner composition, and a pre-treatment composition.

9. A method as claimed in any preceding claim, which further comprises a step of applying a colour rinse to the 3D model to highlight the areas of interest.

10. A method as claimed in any preceding claim, wherein the magnified 3D has a magnification of from 100 to 50,000, preferably 30,000 times.

Patentansprüche

1. Verfahren zur Analyse des Effekts eines Angriffs auf das Haar, umfassend die Schritte:

(i) Sammeln von Bildgebungsdaten für mindestens eine Haaroberfläche,
(ii) Anwenden von mindestens einem Angriff auf die mindestens eine Haaroberfläche,
(iii) Sammeln von Bildgebungsdaten für die mindestens eine Haaroberfläche, die sich aus dem Schritt (ii) ergibt,
(iv) Umwandeln der in den Schritten (i) und (iii) gesammelten Bildgebungsdaten in ein Format, um vergrößerte Bilder von einem 3D-Drucker zu erzeugen,
(v) Erzeugen vergrößerter 3D-Modelle der mindestens einen Haaroberfläche von einem 3D-Drucker unter Verwendung der Daten aus Schritt iv,
(vi) Vergleichen des sich aus Schritt (iii) ergebenden 3D-Modells mit dem 3D-Modell von Schritt (i) und
(vii) Bewerten des Grades der Schädigung an dem Haar.

2. Verfahren, wie in Anspruch 1 beansprucht, das ferner einen Schritt des Wiederholens der Schritte (ii) bis (vii) umfasst.

3. Verfahren zur Bestimmung des Effekts einer vorteilhaften Behandlung oder eines vorteilhaften Behandlungsschemas für das Haar, umfassend die Schritte:

(i) Sammeln von Bildgebungsdaten für mindestens eine Haaroberfläche,
(ii) Umwandeln der Bildgebungsdaten von Schritt (i) in ein Format, um vergrößerte Bilder von einem 3D-Drucker zu erzeugen,
(iii) Erzeugen eines oder mehrerer vergrößerter 3D-Modelle der mindestens einen Haaroberfläche von einem 3D-Drucker unter Verwendung der Daten von Schritt (ii),
(iv) Analysieren der Eigenschaften der Haaroberfläche, die aus dem oder den 3D-Modellen ersichtlich sind,
(v) Bewerten des Grades der Schädigung an dem Haar,
(vi) Anwenden einer geeigneten vorteilhaften Behandlung oder eines geeigneten vorteilhaften Behandlungsschemas auf das Haar unter Berücksichtigung der Befunde der Schritte (iv) und / oder (v),
(vii) Sammeln von Bildgebungsdaten für die mindestens eine Haaroberfläche, die sich aus Schritt (vi) ergibt, und Erzeugen eines vergrößerten 3D-Modells der behandelten Haaroberfläche unter Verwendung der Bildgebungsdaten,
(viii) Vergleichen des sich aus Schritt (vii) ergebenden 3D-Modells mit dem sich aus Schritt (iii) ergebenden 3D-Modell und
(ix) Bewerten des vorteilhaften Effekts auf das Haar.

4. Verfahren, wie in Anspruch 3 beansprucht, das ferner den Schritt des Anwendens mindestens eines Angriffs auf die mindestens eine Haaroberfläche und des Sammelns von Bildgebungsdaten für die sich ergebende Haaroberfläche nach Schritt (i) umfasst.

5. Verfahren, wie in Anspruch 3 oder Anspruch 4 beansprucht, das ferner einen Schritt der Wiederholung der Schritte (vi) bis (ix) umfasst.

6. Verfahren, wie in irgendeinem der Ansprüche 3 bis 5 beansprucht, wobei der Schadensgrad durch Vergleich mit einer Skala bestimmt wird.

7. Verfahren, wie in irgendeinem der Ansprüche 3 bis 6 beansprucht, wobei die vorteilhafte Behandlung oder das vorteilhafte Behandlungsschema das Aufbringen einer Haarbehandlungszusammensetzung auf das Haar umfasst.

8. Verfahren, wie in Anspruch 7 beansprucht, wobei die Haarzusammensetzung ausgewählt ist aus einem abspülbaren Haarkonditionierungsmittel, einer Haarmaske, einer Leave-on-Konditionierungszusammensetzung und einer Vorbehandlungszusammensetzung.

9. Verfahren, wie in irgendeinem vorhergehenden Anspruch beansprucht, welches ferner einen Schritt des Anwendens einer Farbspülung auf das 3D-Modell umfasst, um die interessierenden Bereiche hervorzuheben.

10. Verfahren, wie in irgendeinem vorhergehenden Anspruch beansprucht, wobei das vergrößerte 3D eine Vergrößerung von 100- bis 50.000-, bevorzugt 30.000-fach aufweist.

Revendications

1. Procédé d'analyse de l'effet d'une attaque sur des cheveux, comprenant les étapes de :

   (i) recueil de données d'images pour au moins une surface des cheveux,
   (ii) application d'au moins une attaque sur la au moins une surface des cheveux,
   (iii) recueil de données d'images pour la au moins une surface des cheveux provenant de l'étape (ii),
   (iv) conversion des données d'images recueillies dans les étapes (i) et (iii) dans un format pour créer des images agrandies à partir d'une imprimante 3D,
   (v) production de modèles 3D agrandis de la au moins une surface des cheveux à partir d'une imprimante 3D en utilisant les données de l'étape iv,
   (vi) comparaison du modèle 3D provenant de l'étape (iii) par rapport au modèle 3D de l'étape (i) et
   (vii) détermination du degré de détérioration des cheveux.

2. Procédé selon la revendication 1, qui comprend de plus une étape de répétition des étapes (ii) à (vii).

3. Procédé de détermination de l'effet d'un traitement ou d'un régime bénéfique sur des cheveux comprenant les étapes de :

   (i) recueil de données d'images pour au moins une surface de cheveux,
   (ii) conversion des données d'images de l'étape (i) dans un format pour créer des images agrandies à partir d'une imprimante 3D,
   (iii) production d'un(de) modèle(s) 3D agrandi(s) de la au moins une surface des cheveux à partir d'une imprimante 3D en utilisant les données de l'étape (ii),
   (iv) analyse des propriétés de la surface des cheveux visibles à partir du(des) modèle(s) 3D,
   (v) détermination du degré de détérioration des cheveux,
   (vi) application d'un traitement ou régime bénéfique approprié aux cheveux, prise en compte des résultats des étapes (iv) et/ou (v),
   (vii) recueil de données d'images pour la au moins une surface des cheveux provenant de l'étape (vi) et production d'un modèle 3D agrandi de la surface des cheveux traités en utilisant les données d'images,
   (viii) comparaison du modèle 3D provenant de l'étape (vii) au modèle 3D provenant de l'étape (iii), et
   (ix) détermination de l'effet bénéfique sur les cheveux.

4. Procédé selon la revendication 3, qui comprend de plus l'étape d'application d'au moins une attaque à la au moins

une surface des cheveux et recueil de données d'images pour la surface des cheveux résultante, après l'étape (i).

5. Procédé selon la revendication 3 ou la revendication 4, qui comprend de plus une étape de répétition des étapes (vi) à (ix).

6. Procédé selon l'une quelconque des revendications 3 à 5, dans lequel le degré de détérioration est réalisé par comparaison à une échelle.

7. Procédé selon l'une quelconque des revendications 3 à 6, dans lequel le traitement ou régime bénéfique comprend l'application d'une composition de traitement des cheveux aux cheveux.

8. Procédé selon la revendication 7, dans lequel la composition des cheveux est choisie parmi un après-shampoing sans rinçage, un masque capillaire, une composition d'après-shampoing sans rinçage, et une composition de pré-traitement.

9. Procédé selon l'une quelconque des revendications précédentes, qui comprend de plus une étape d'application d'un rinçage de couleur au modèle 3D pour accentuer les zones d'intérêt.

10. Procédé selon l'une quelconque des revendications précédentes, dans lequel la 3D agrandie présente un agrandissement de 100 à 50 000, de préférence 30 000 fois.

Fig. 1

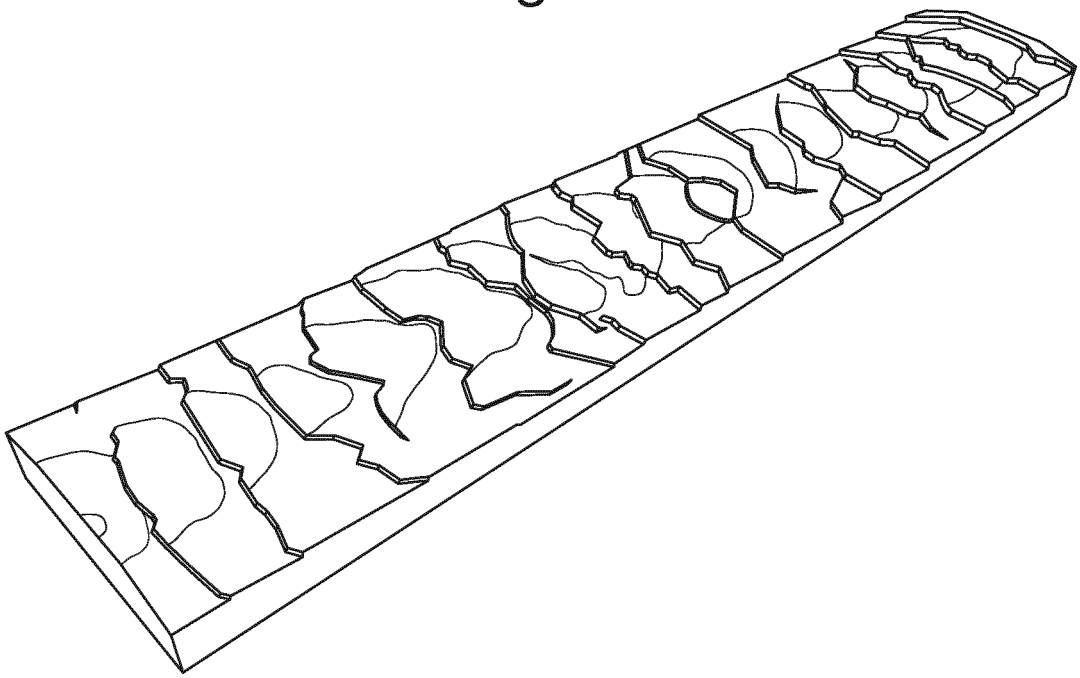


Fig. 2

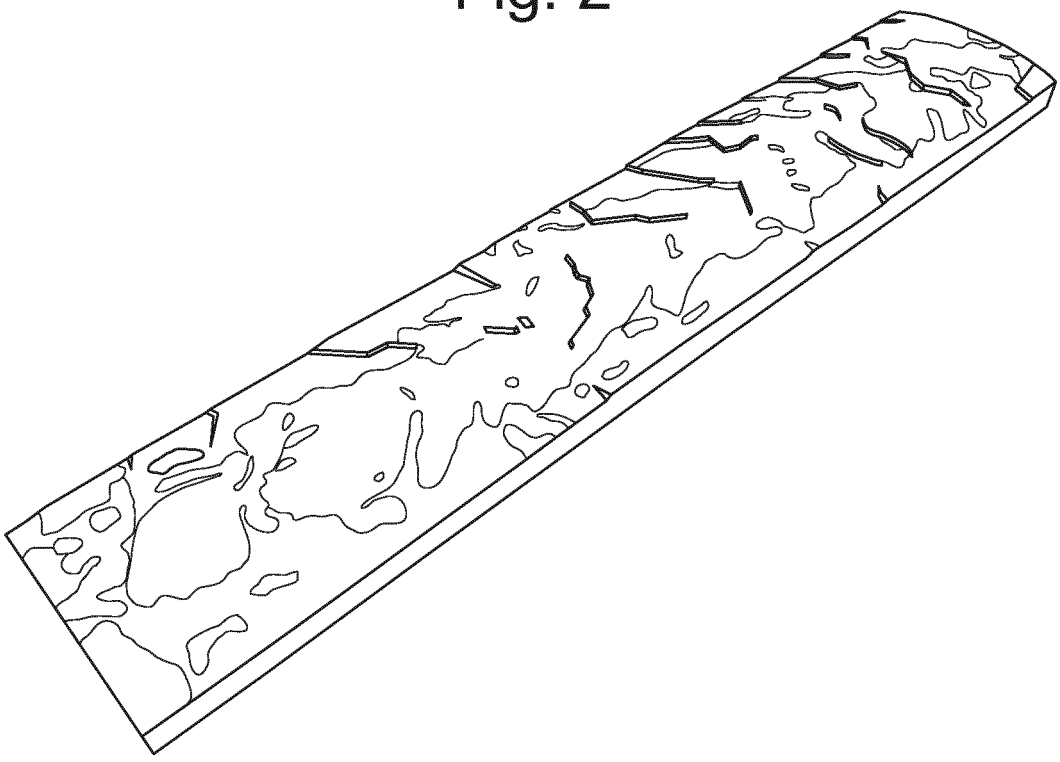
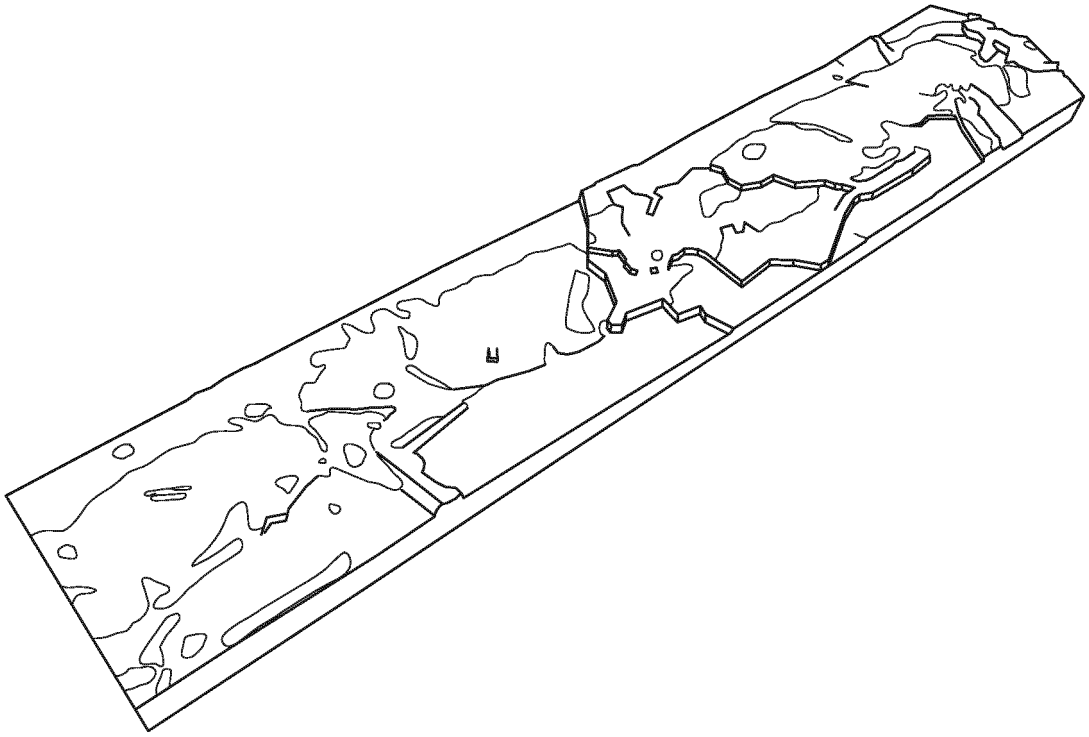


Fig. 3



REFERENCES CITED IN THE DESCRIPTION

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专利名称(译)	建模系统		
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IPC分类号	G01N33/68 A61Q5/00 A61B5/00		
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摘要(译)

一种使用3D打印机分析至少一个头发表面的方法，包括收集至少一个头发表面的第一成像数据。 对至少一个头发表面进行至少一次攻击； 在施加至少一次攻击之后，收集至少一个头发表面的第二成像数据； 将第一成像数据转换为第一格式化数据，该第一格式化数据与3D打印机相关联； 将第二成像数据转换为第二格式化数据，该第二格式化数据与3D打印机相关联； 使用第一格式化数据从3D打印机产生至少一个头发表面的第一3D模型； 并使用第二格式化数据从3D打印机生成至少一个头发表面的第二3D模型。