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(54) **DEVICE, METHOD, AND APPARATUS FOR BIOLOGICAL TESTING WITH A MOBILE DEVICE**

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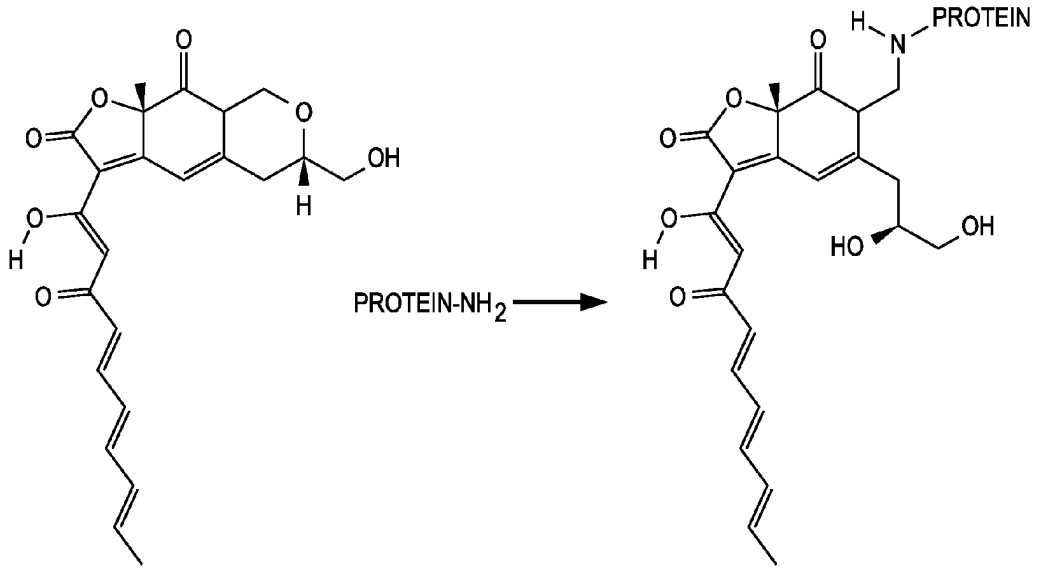
***G06K 9/00*** (2006.01)
***H04N 7/18*** (2006.01)

(52) **U.S. Cl.** ..... **382/128**; 348/77; 348/E07.085

(57) **ABSTRACT**

Compositions, methods, and systems for the imaging and analysis of skin, hair and associated health conditions are described herein. The system includes a method and apparatus for analyzing skin and hair samples by taking a sample, identifying desired components of the sample, obtaining an image electronically using a mobile consumer device, storing and transmitting the image, analyzing the image using an analysis software on a remote server, and optionally sending the results of the analysis back to the consumer device.



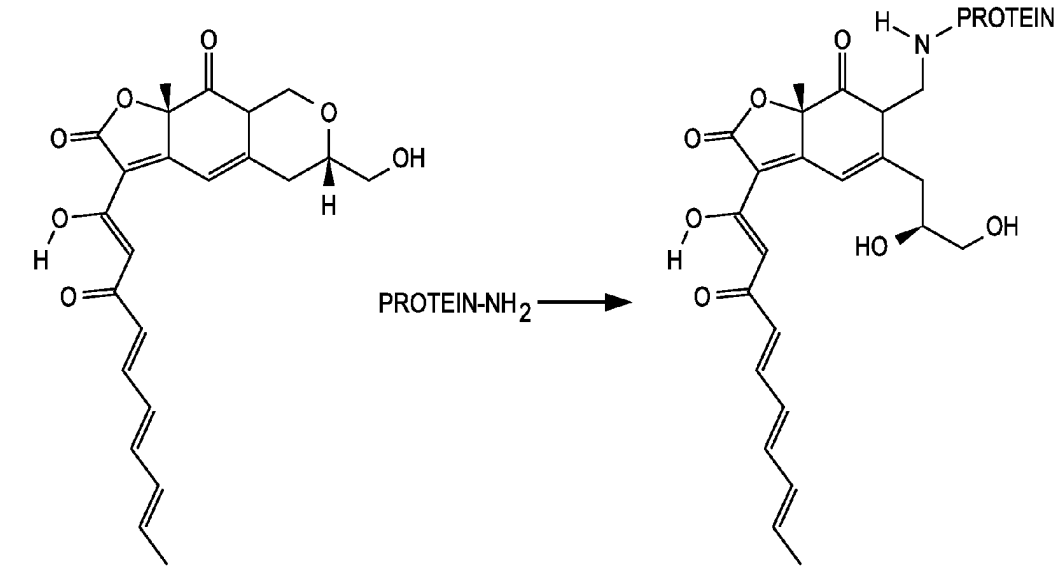

O
O
O
O
OH
H
O
H
O
PROTEIN-NH2
H
N
PROTEIN
O
O
O
O
H
HO
OH

FIG. 1

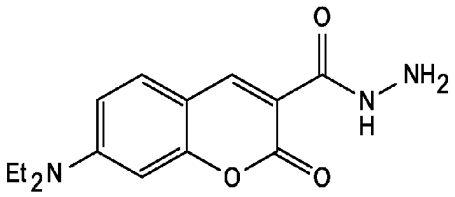

O
NH2
N
H
Et2N
O
O

FIG. 2

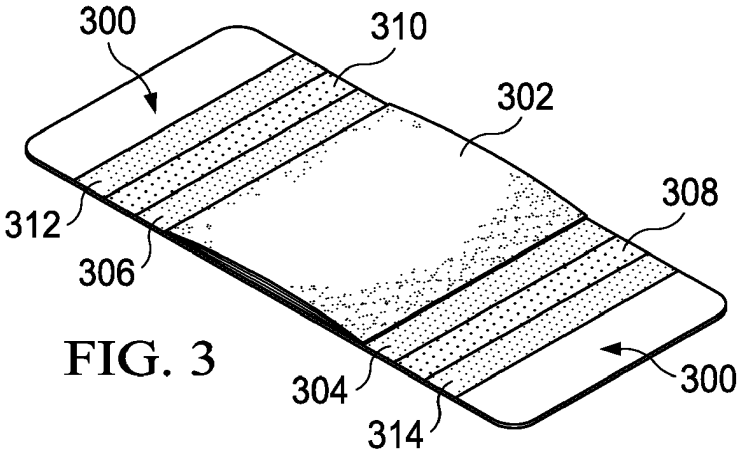



FIG. 3

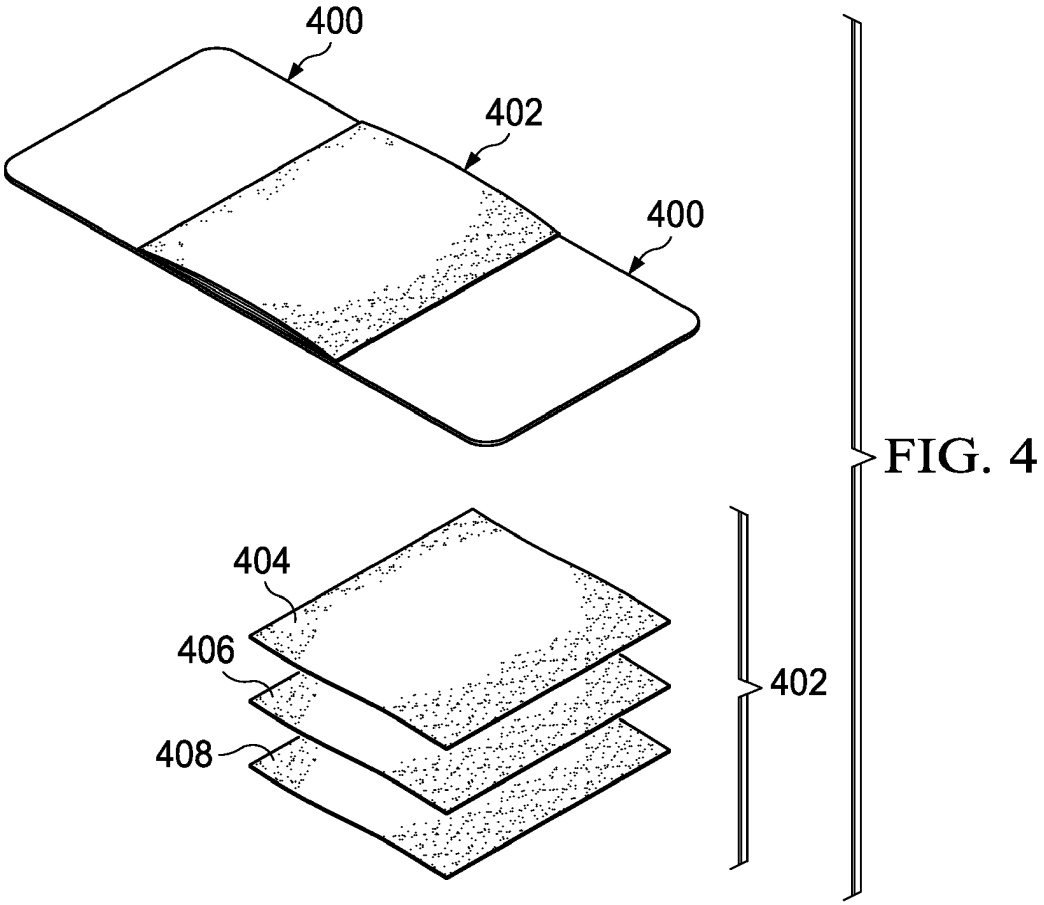



FIG. 4

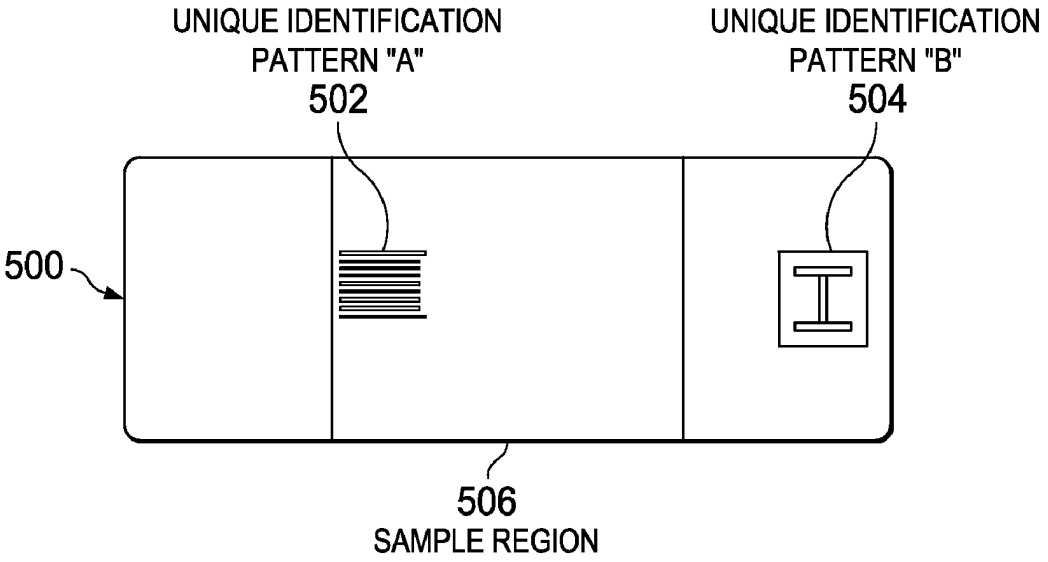

UNIQUE IDENTIFICATION
PATTERN "A"
502
UNIQUE IDENTIFICATION
PATTERN "B"
504
500
506
SAMPLE REGION

FIG. 5

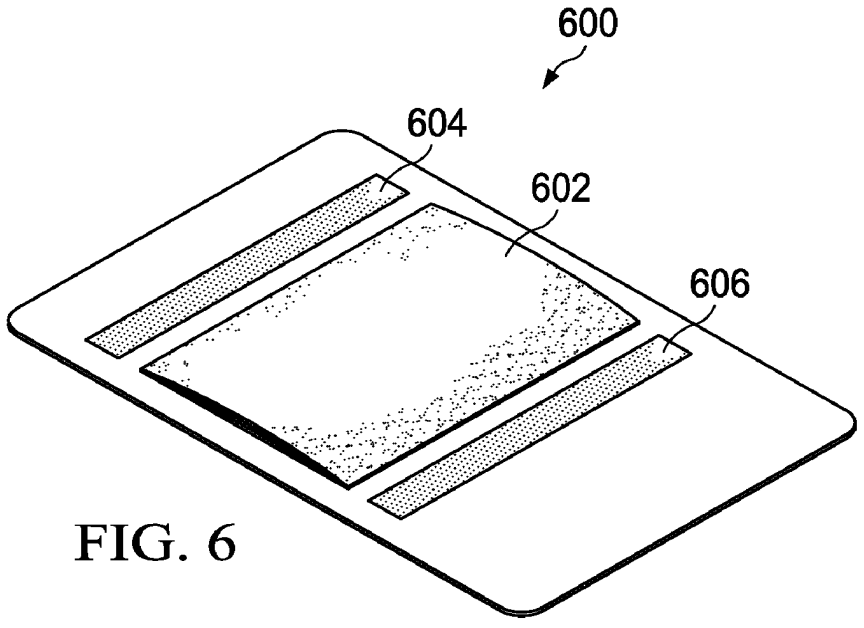

600
604
602
606

FIG. 6

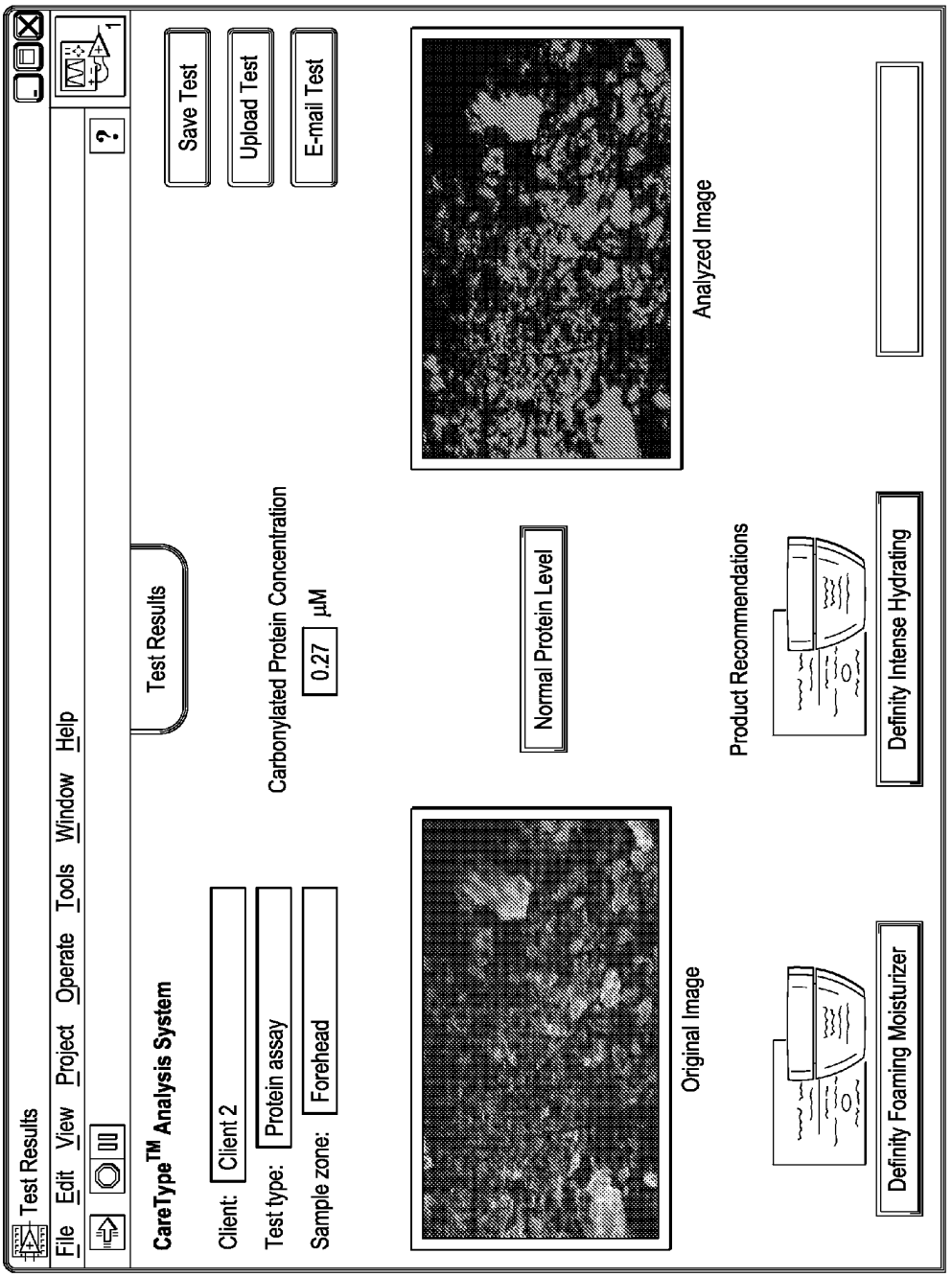

Test Results
File Edit View Project Operate Tools Window Help
CareType™ Analysis System
Test Results
Save Test
Upload Test
E-mail Test
Client: Client 2
Test type: Protein assay
Sample zone: Forehead
Carbonylated Protein Concentration
0.27 µM
Normal Protein Level
Analyzed Image
Original Image
Product Recommendations
Definity Foaming Moisturizer
Definity Intense Hydrating

FIG. 7

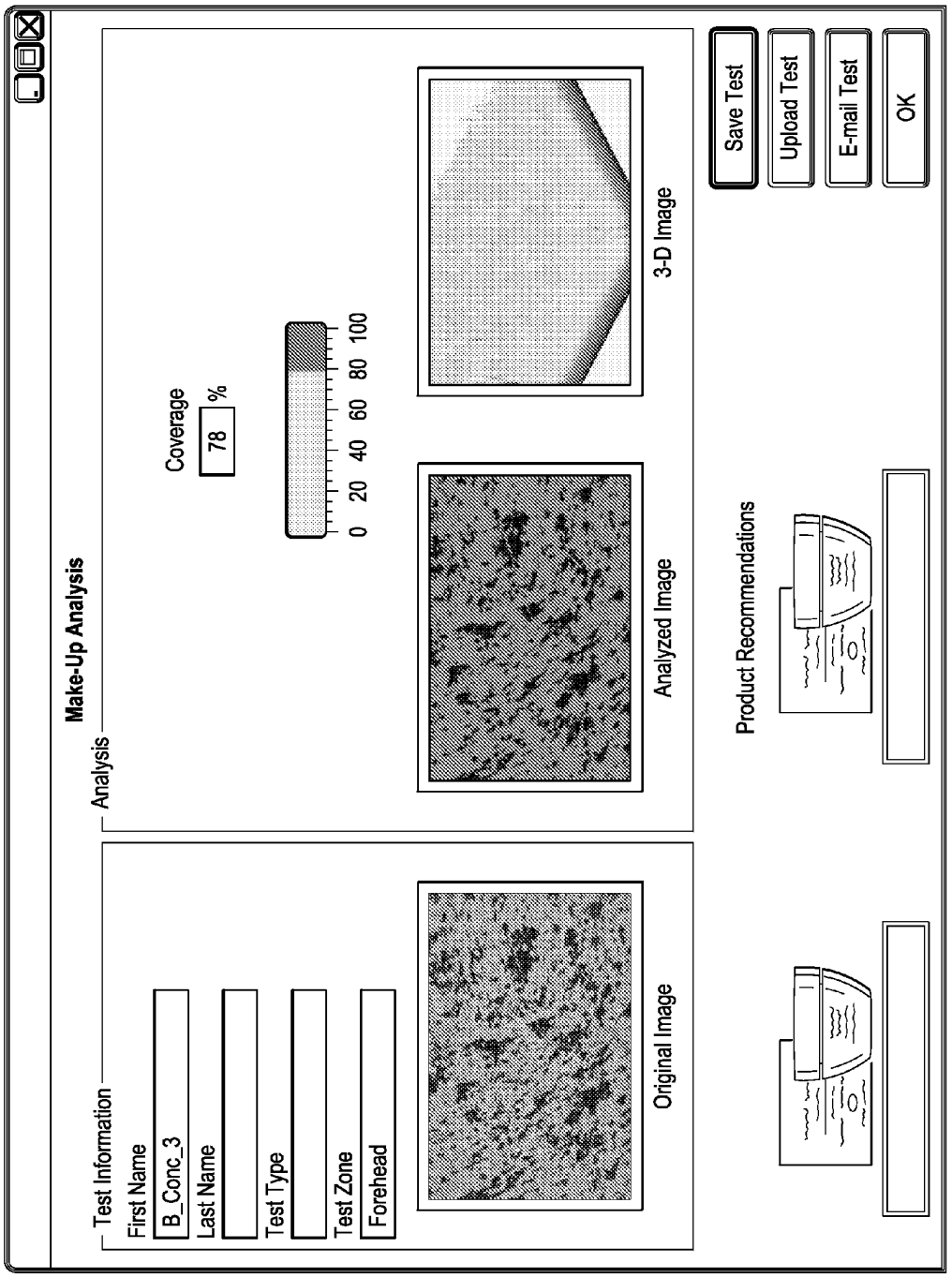

Make-Up Analysis
Test Information
First Name
B_Conc_3
Last Name
Test Type
Test Zone
Forehead
Analysis
Coverage
78
%
0 20 40 60 80 100
Original Image
Analyzed Image
3-D Image
Product Recommendations
Save Test
Upload Test
E-mail Test
OK

FIG. 8

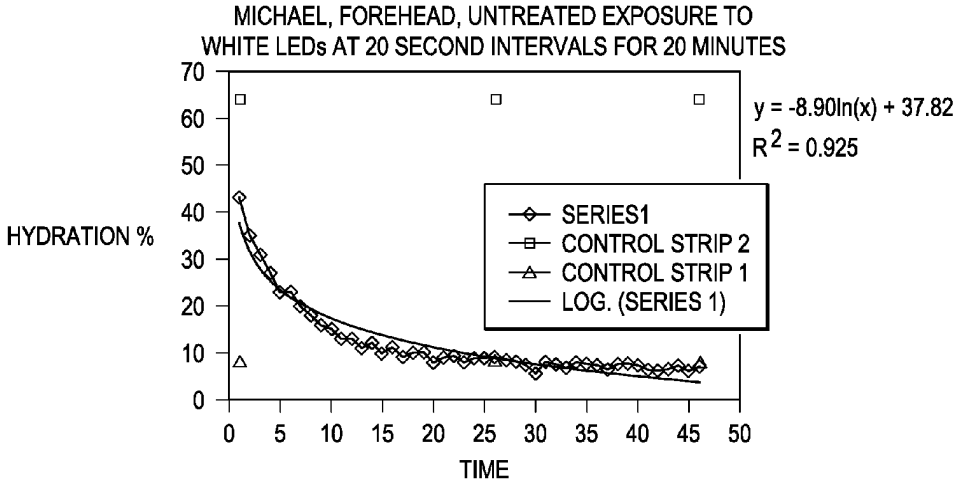
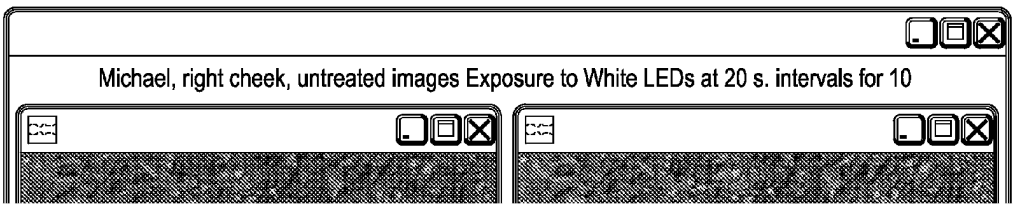

MICHAEL, FOREHEAD, UNTREATED EXPOSURE TO
WHITE LEDs AT 20 SECOND INTERVALS FOR 20 MINUTES
HYDRATION %
TIME
y = -8.90ln(x) + 37.82
R2 = 0.925
SERIES1
CONTROL STRIP 2
CONTROL STRIP 1
LOG. (SERIES 1)
0
10
20
30
40
50
60
70
0 5 10 15 20 25 30 35 40 45 50

FIG. 9


Michael, right cheek, untreated images Exposure to White LEDs at 20 s. intervals for 10

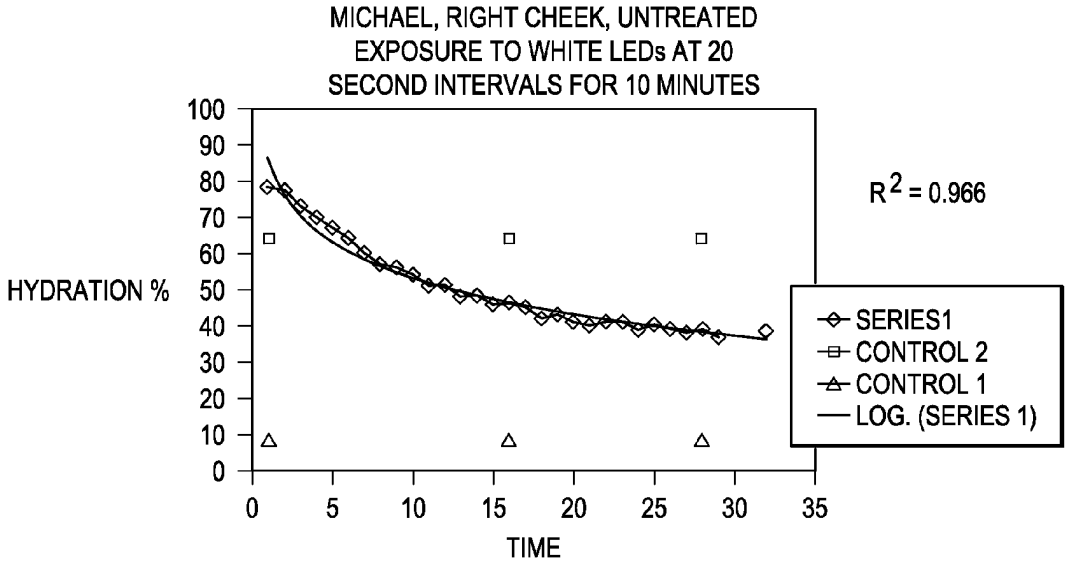
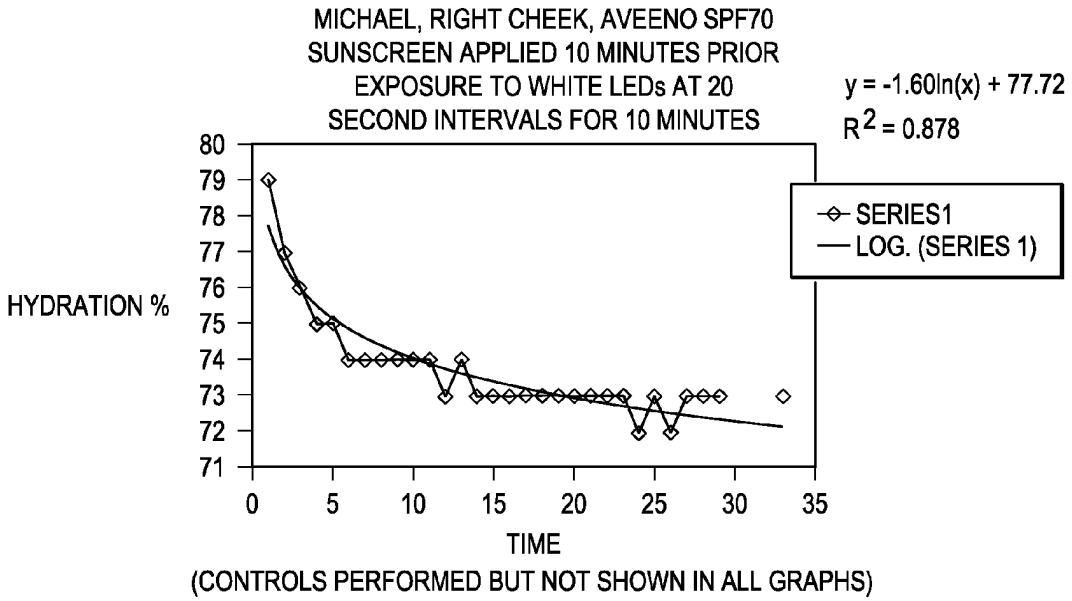



FIG. 11A




(CONTROLS PERFORMED BUT NOT SHOWN IN ALL GRAPHS)

FIG. 11B

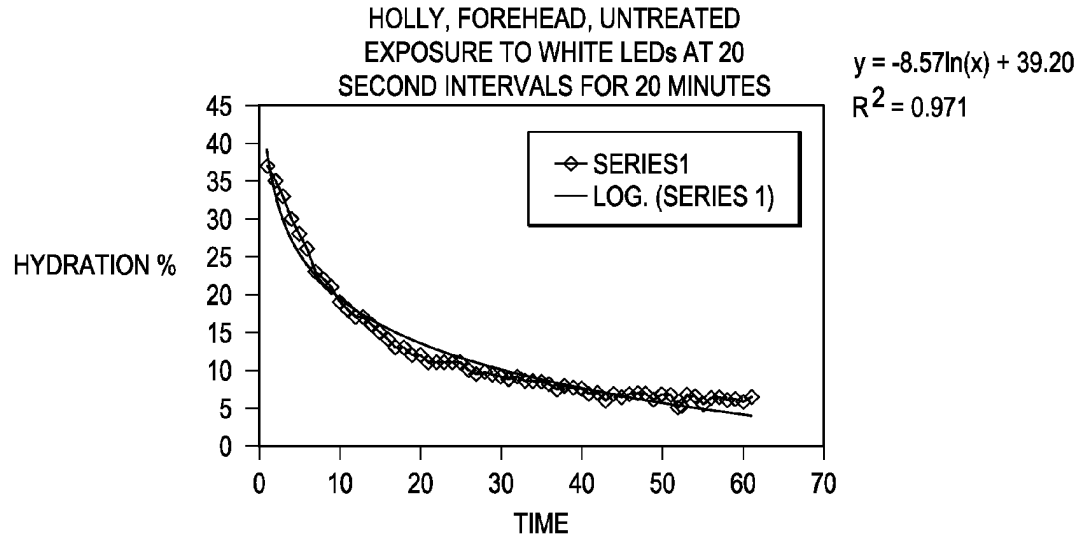



FIG. 12A

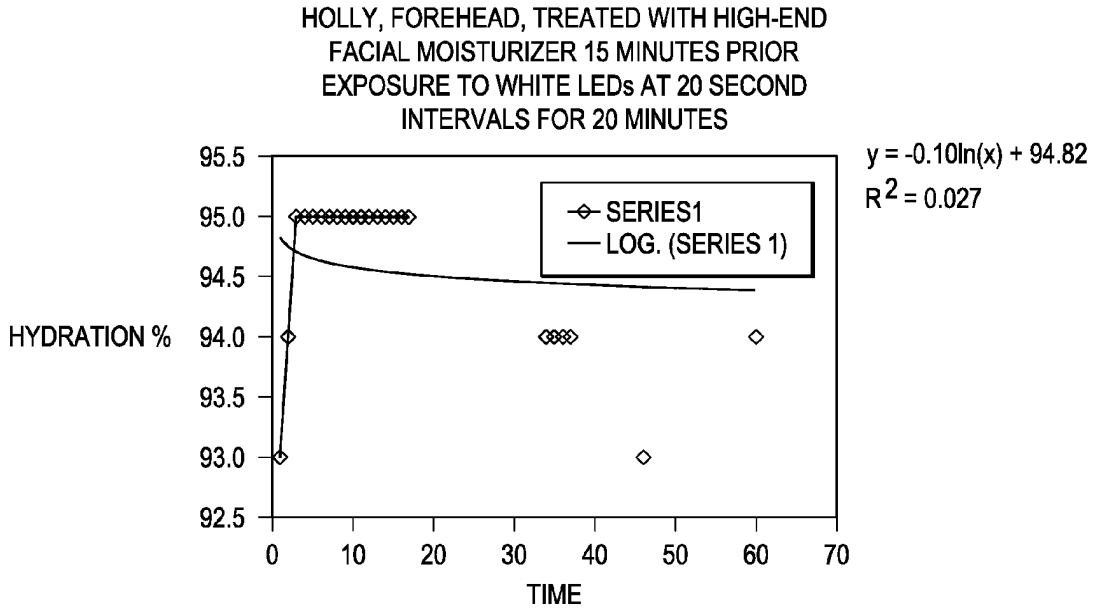



FIG. 12B

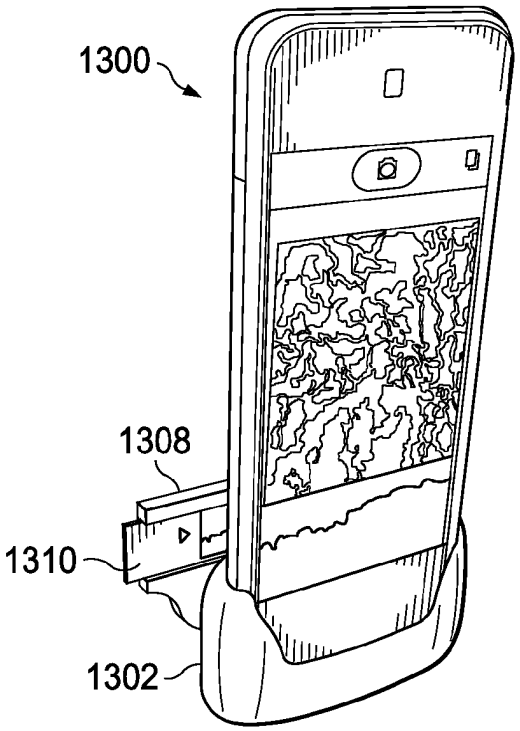



FIG. 13A

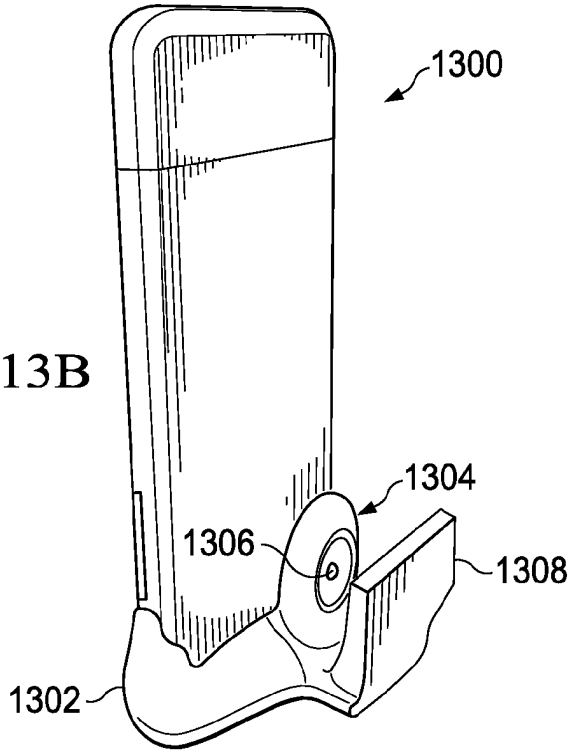



FIG. 13B

FIG. 13C

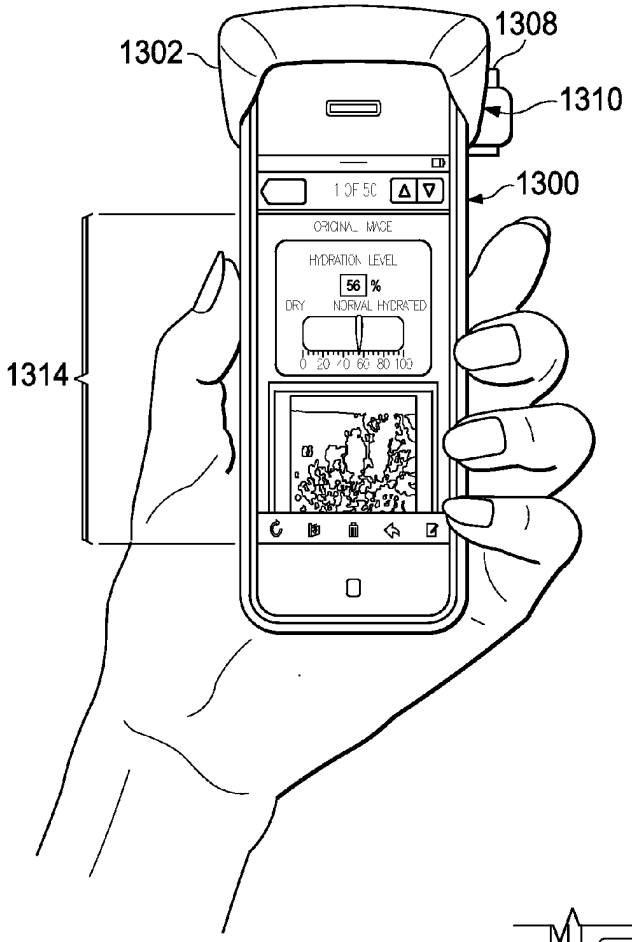
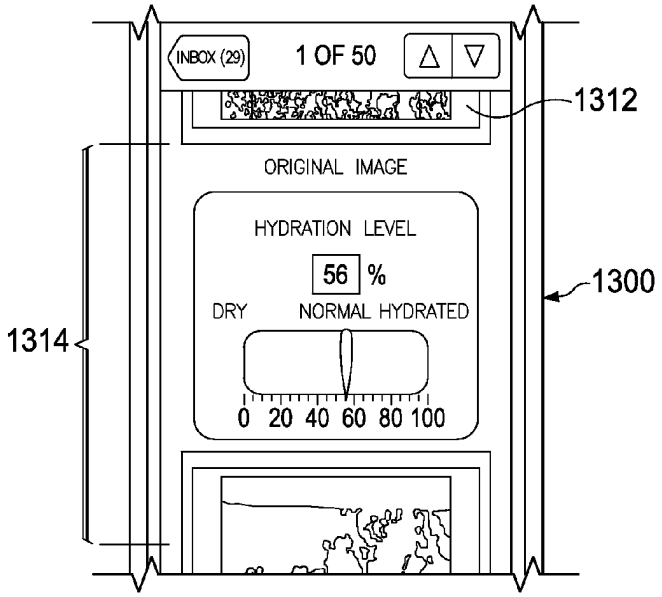



FIG. 13D



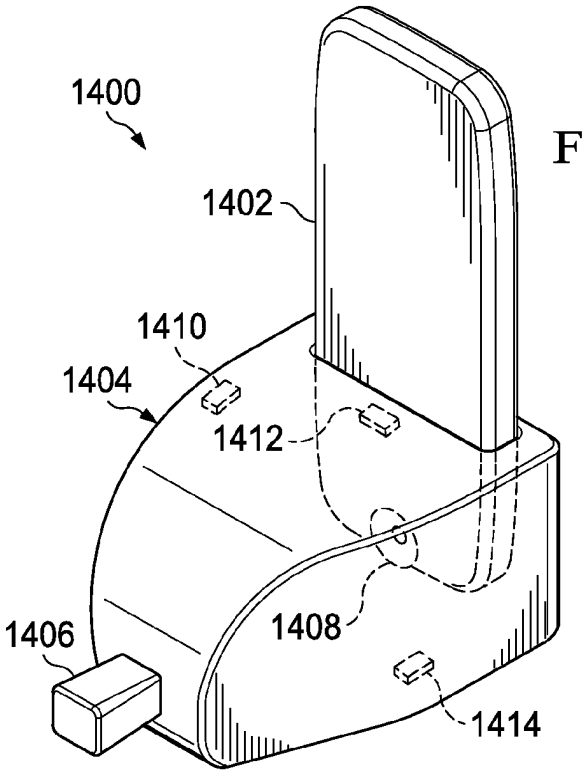



FIG. 14

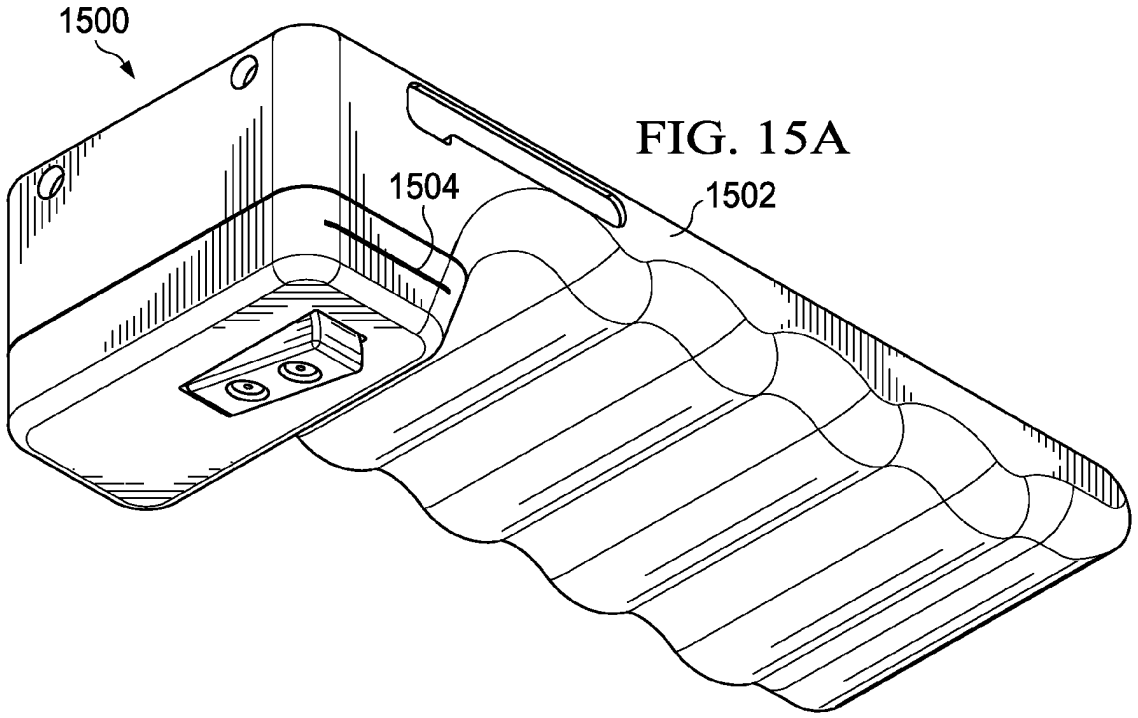



FIG. 15A

FIG. 15B

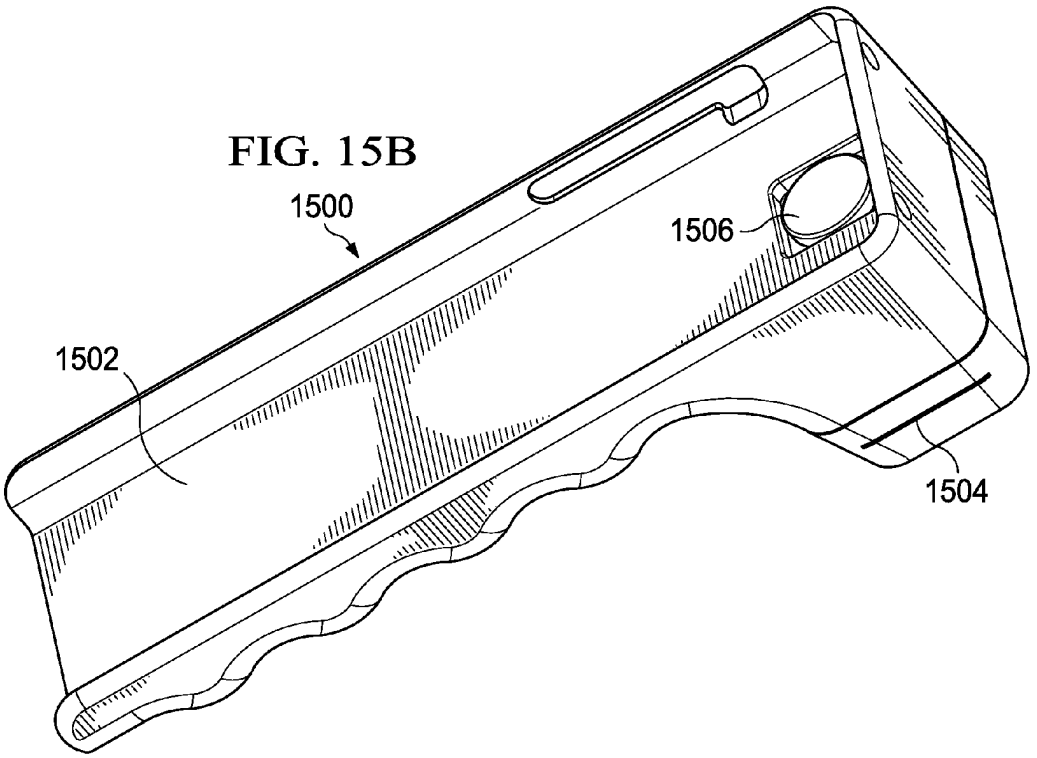
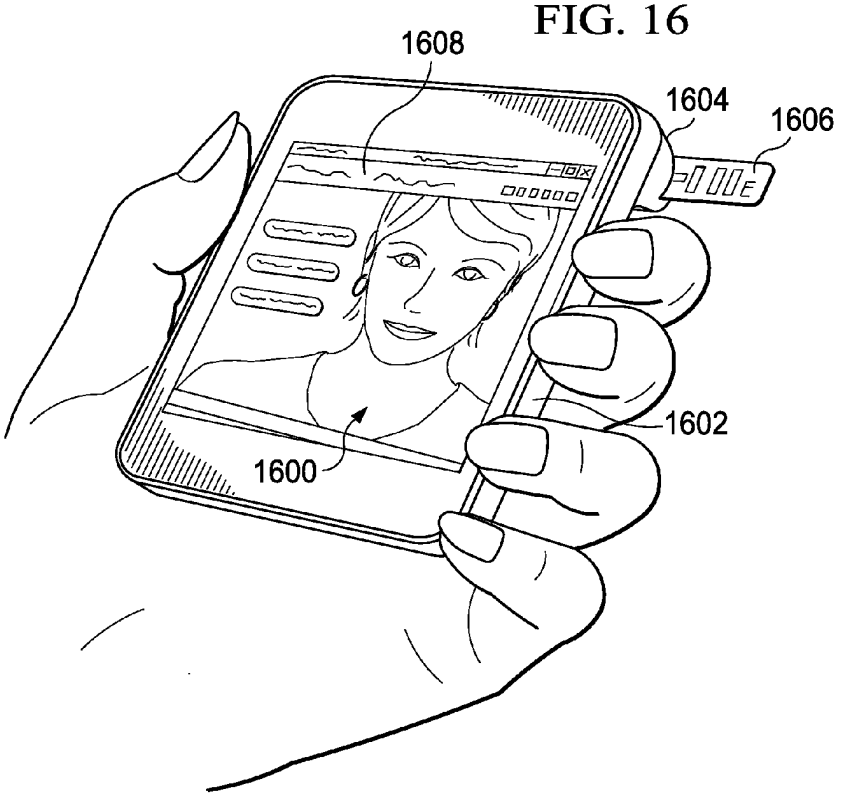



FIG. 16



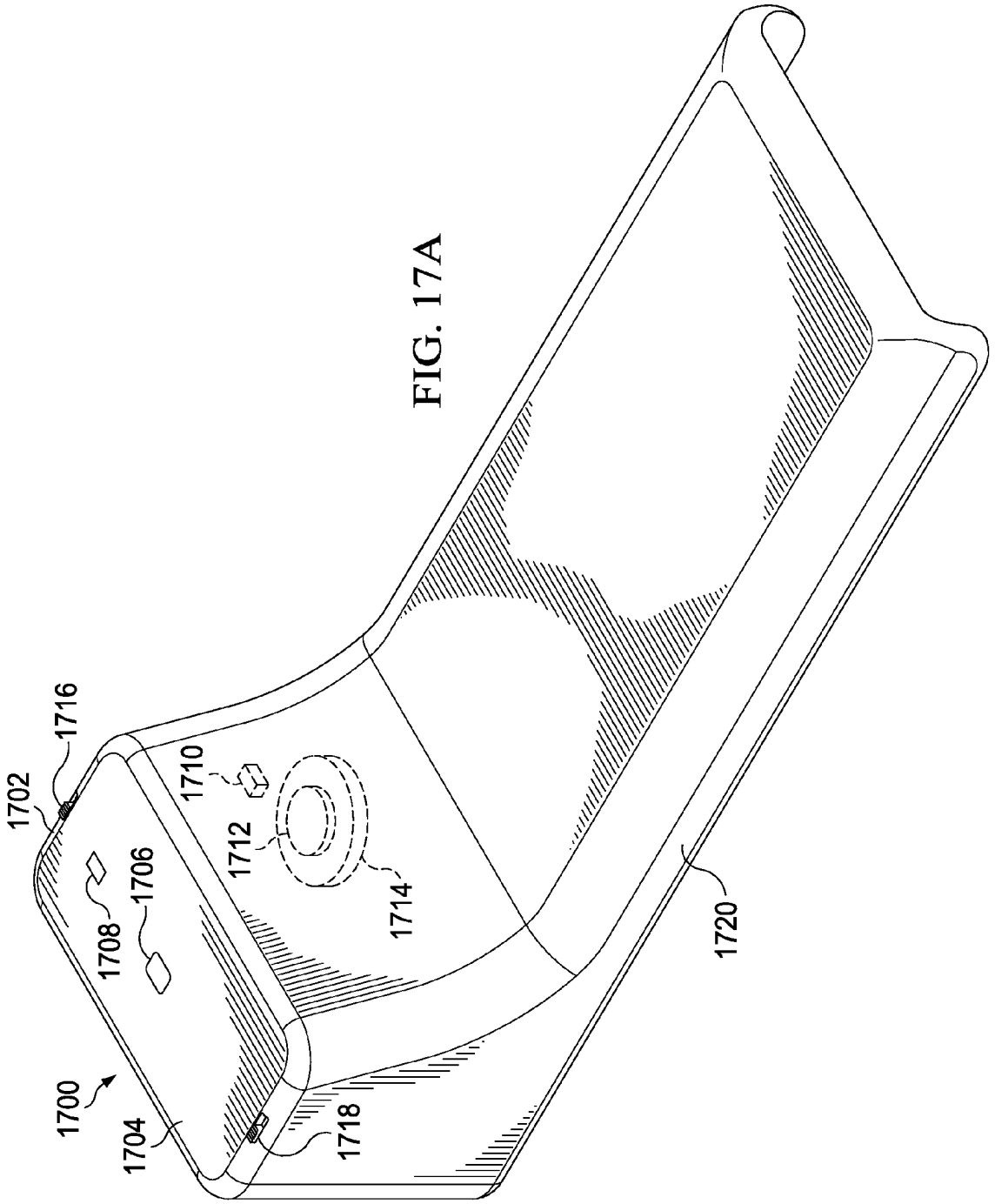



FIG. 17A

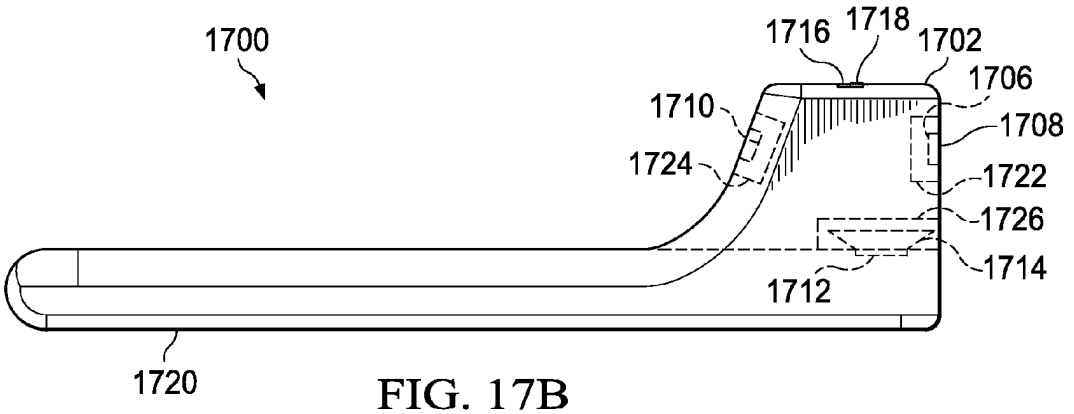



FIG. 17B

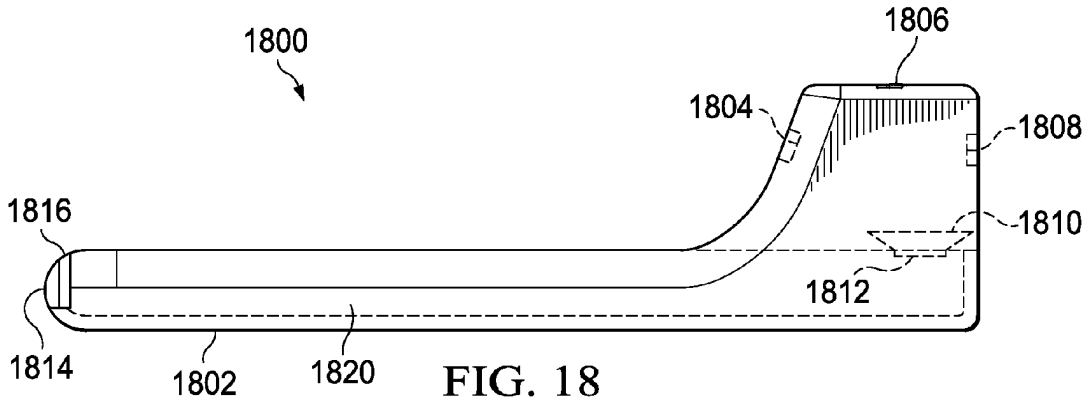



FIG. 18

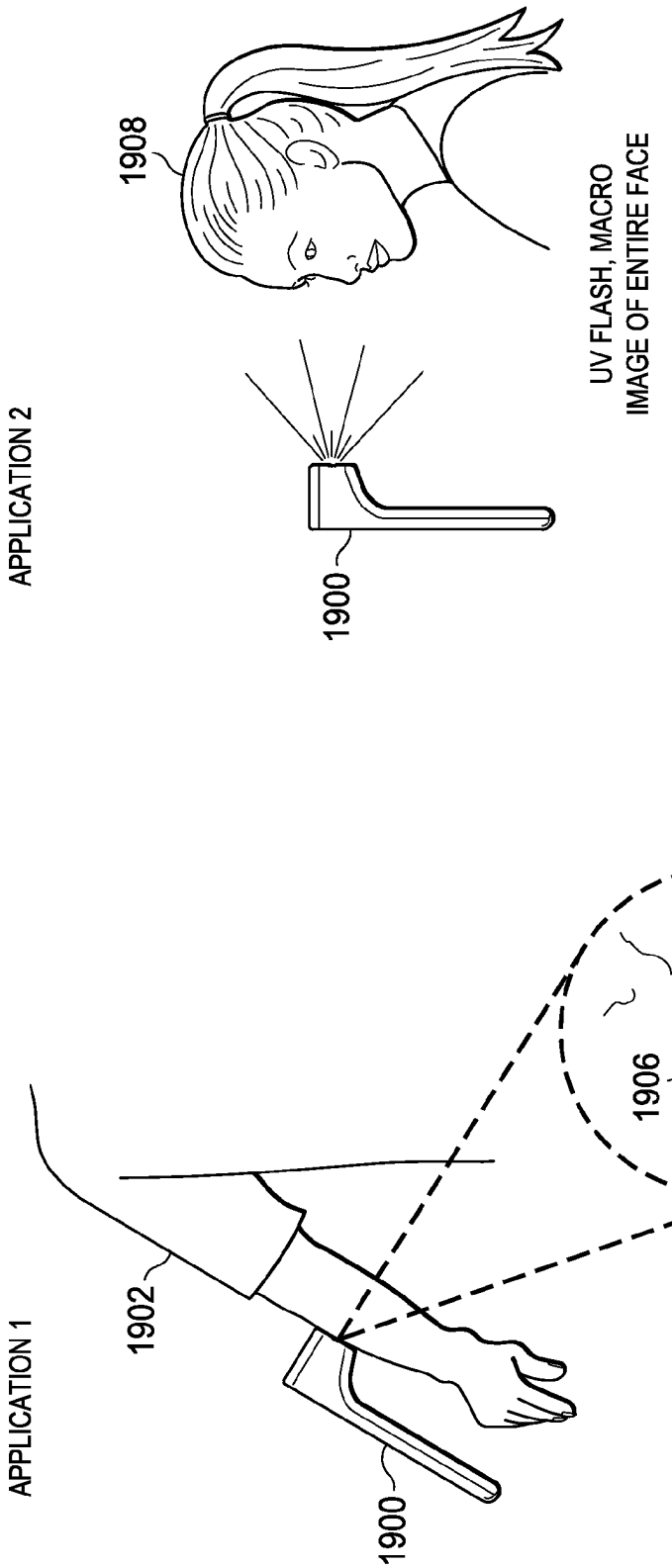

APPLICATION 2
1908
UV FLASH, MACRO
IMAGE OF ENTIRE FACE
1900
APPLICATION 1
1902
MAGNIFIED IMAGE
OF SKIN, MOLE
1906
1904
1900

FIG. 19

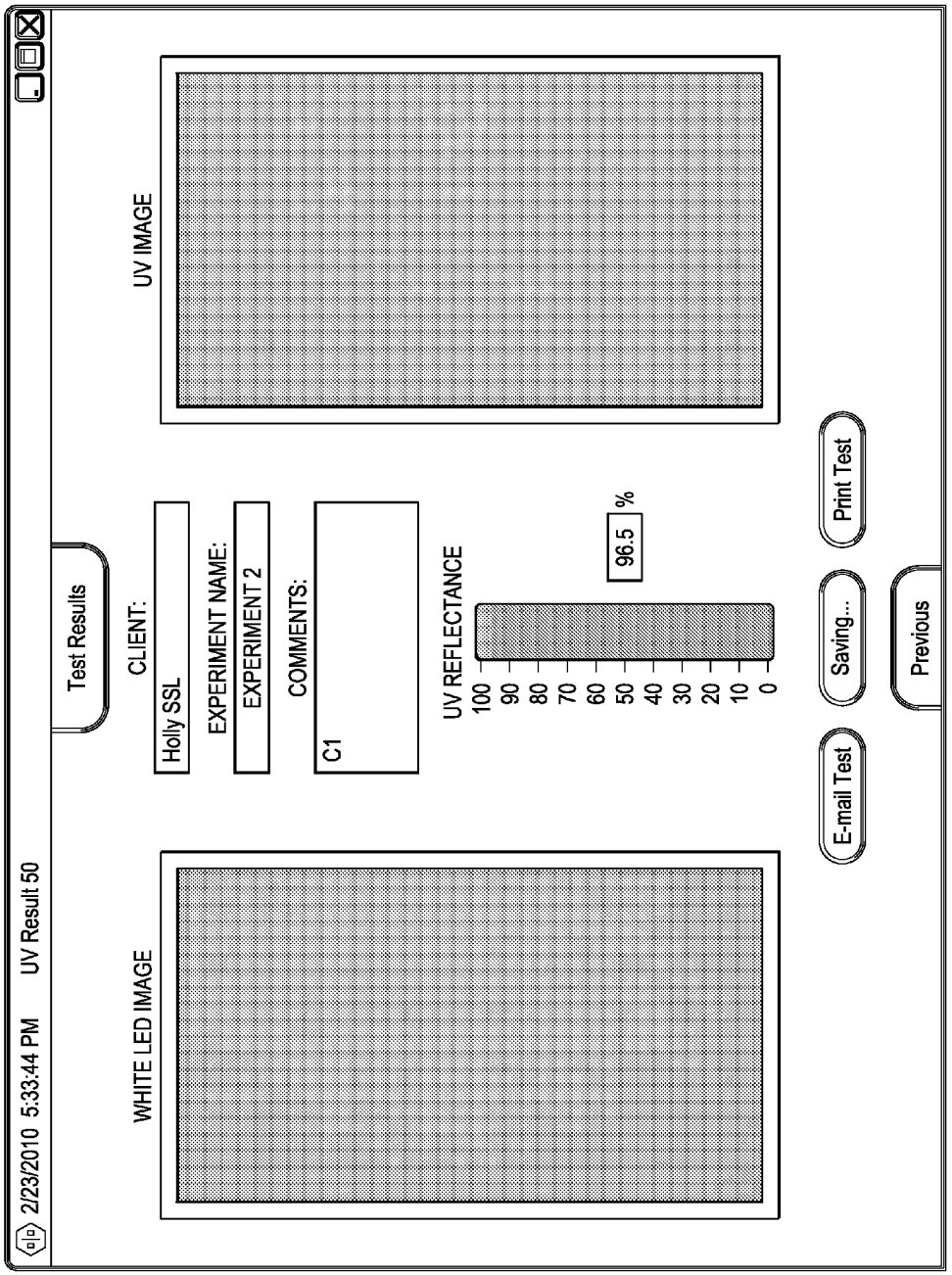

2/23/2010 5:33:44 PM UV Result 50
Test Results
WHITE LED IMAGE
UV IMAGE
CLIENT:
Holly SSL
EXPERIMENT NAME:
EXPERIMENT 2
COMMENTS:
C1
UV REFLECTANCE
100
90
80
70
60
50
40
30
20
10
0
96.5
%
E-mail Test
Saving...
Print Test
Previous

FIG. 20A

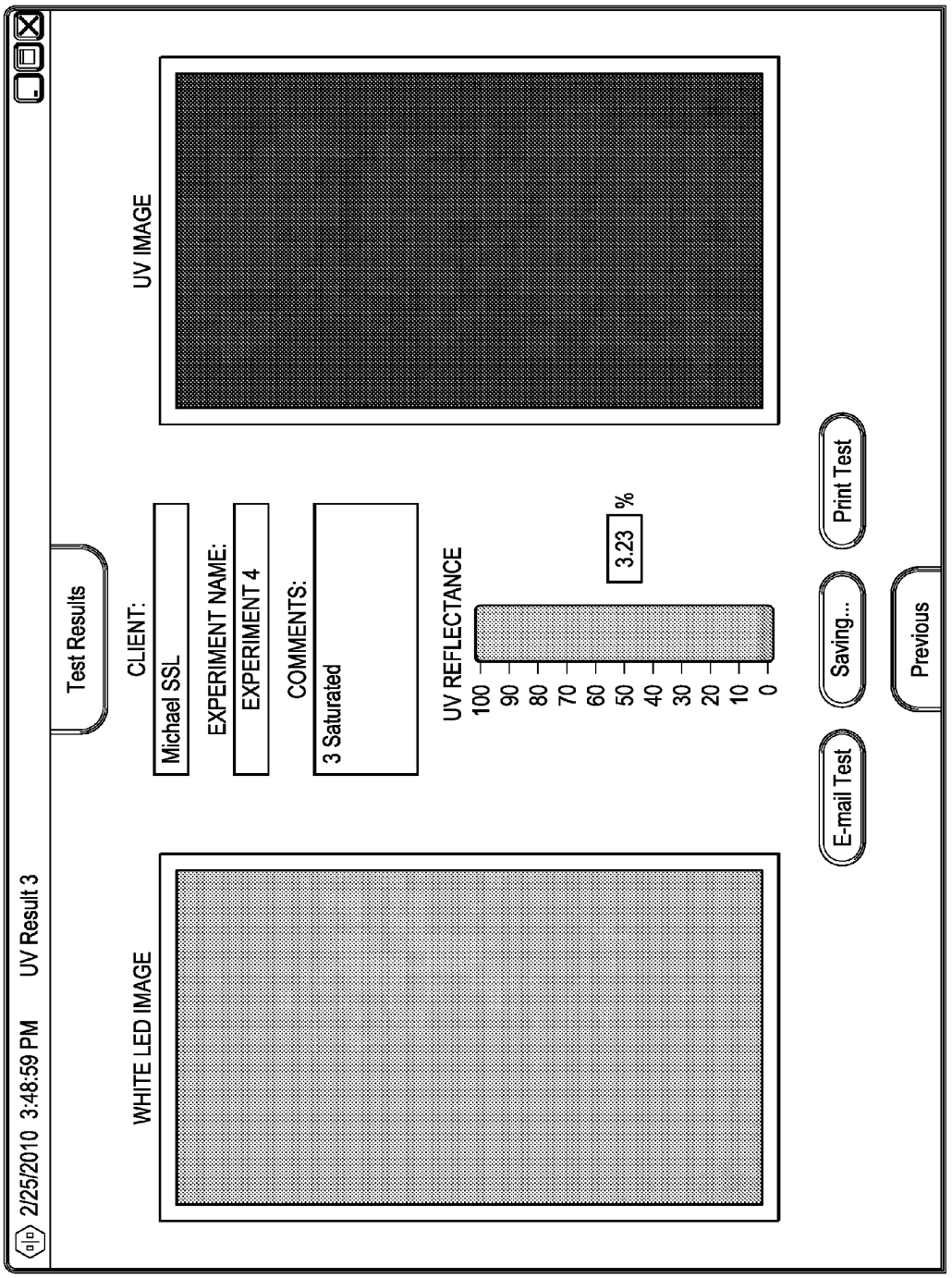

2/25/2010 3:48:59 PM
UV Result 3
Test Results
WHITE LED IMAGE
CLIENT:
Michael SSL
EXPERIMENT NAME:
EXPERIMENT 4
COMMENTS:
3 Saturated
UV IMAGE
UV REFLECTANCE
100
90
80
70
60
50
40
30
20
10
0
3.23
%
E-mail Test
Saving...
Print Test
Previous

FIG. 20B

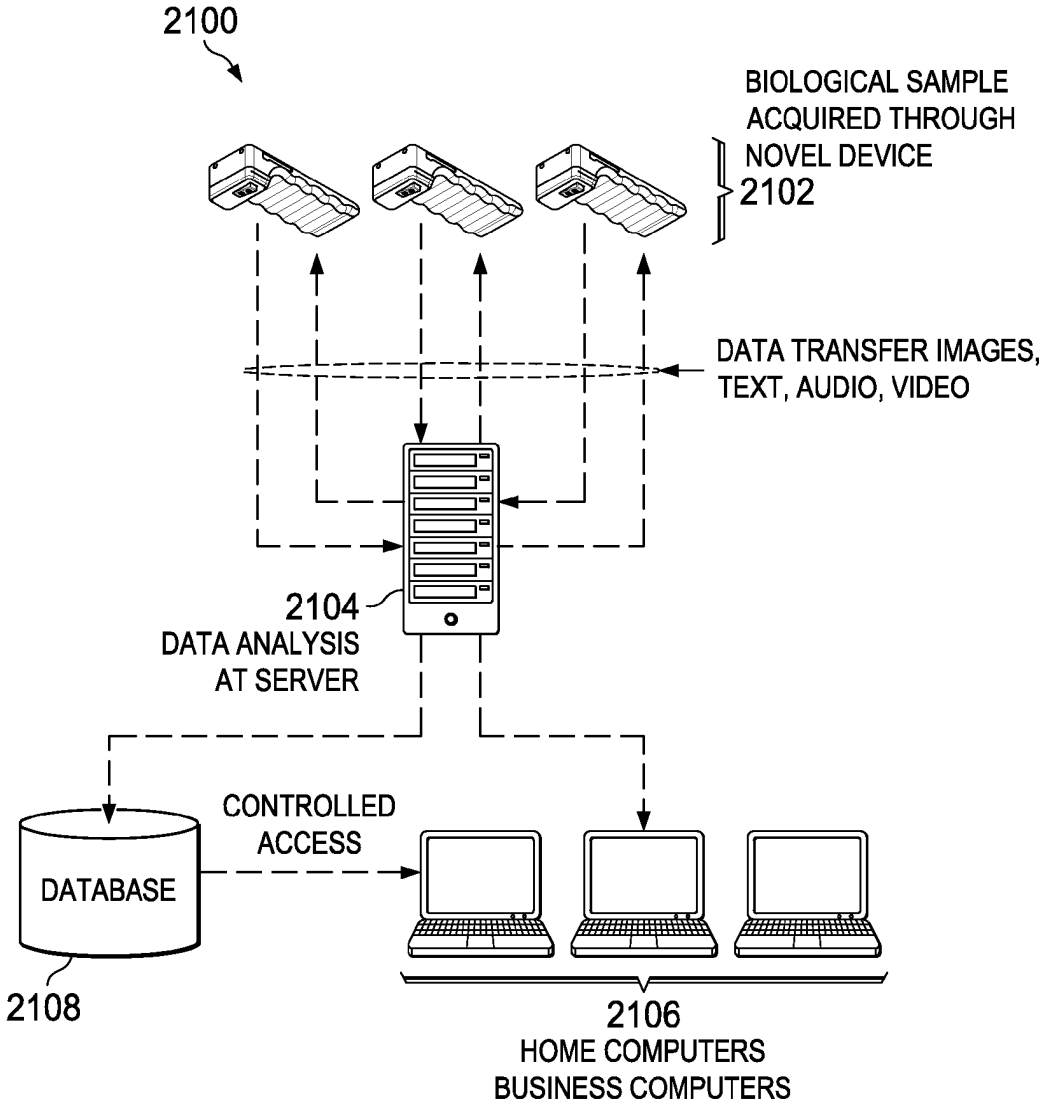

2100
BIOLOGICAL SAMPLE
ACQUIRED THROUGH
NOVEL DEVICE
2102
DATA TRANSFER IMAGES,
TEXT, AUDIO, VIDEO
2104
DATA ANALYSIS
AT SERVER
CONTROLLED
ACCESS
DATABASE
2108
2106
HOME COMPUTERS
BUSINESS COMPUTERS

FIG. 21

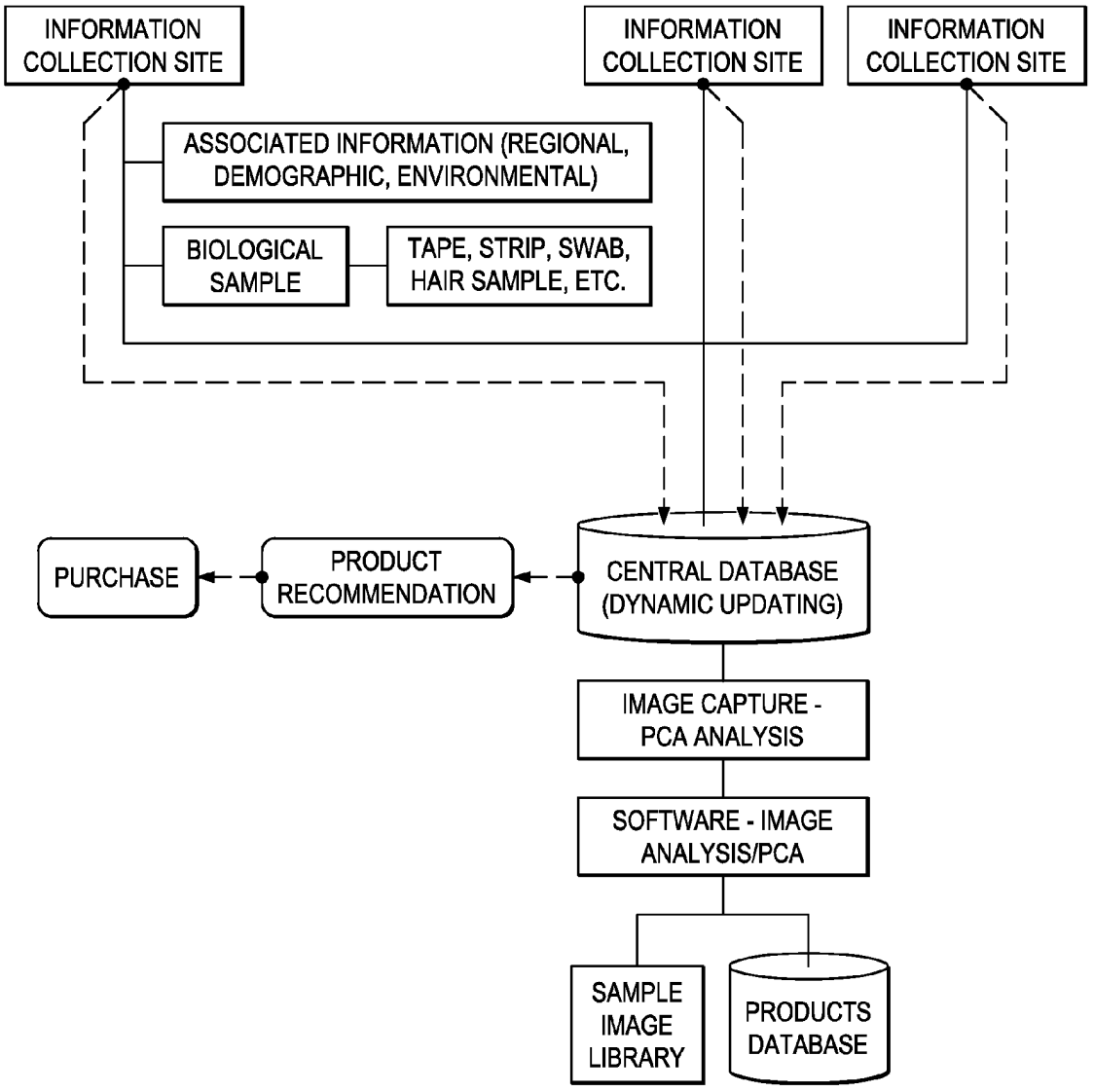

INFORMATION COLLECTION SITE
INFORMATION COLLECTION SITE
INFORMATION COLLECTION SITE
ASSOCIATED INFORMATION (REGIONAL, DEMOGRAPHIC, ENVIRONMENTAL)
BIOLOGICAL SAMPLE
TAPE, STRIP, SWAB, HAIR SAMPLE, ETC.
PURCHASE
PRODUCT RECOMMENDATION
CENTRAL DATABASE (DYNAMIC UPDATING)
IMAGE CAPTURE - PCA ANALYSIS
SOFTWARE - IMAGE ANALYSIS/PCA
SAMPLE IMAGE LIBRARY
PRODUCTS DATABASE

FIG. 22

# DEVICE, METHOD, AND APPARATUS FOR BIOLOGICAL TESTING WITH A MOBILE DEVICE

## CROSS-REFERENCE TO RELATED APPLICATIONS

**[0001]** This application claims priority to U.S. Provisional Application Ser. No. 61/167,493, filed Apr. 7, 2009, the entire contents of which are incorporated herein by reference.

## TECHNICAL FIELD OF THE INVENTION

**[0002]** The present invention relates in general to the sample analysis for assessing associated health conditions, and more particularly, to a novel system, method and apparatus for taking a biological sample to assess an associated health condition using a consumer device, including but not limited to mobile devices

## STATEMENT OF FEDERALLY FUNDED RESEARCH

**[0003]** None.

## BACKGROUND OF THE INVENTION

**[0004]** Without limiting the scope of the invention, this invention relates generally to the field of biological sample analysis using mobile devices in order to assess associated health conditions.

**[0005]** United States Patent Application No. 20090075250 (Cumberland et al., 2009) discloses a sampling and testing device for the detection of specific molds, allergens, viruses, bacteria, fungi, and other protein containing substances. Embodiments of the device include a sampling member slideably engaged with a base that contains a lateral flow strip adapted to detect specific analytes of interest. The sampling member defines a solvent reservoir that stores an elution solvent in a fluid-tight manner before the device is used to sample and test environmental surfaces. During slideable withdrawal of the sampling member from the base, the elution solvent stored in the reservoir is automatically released to associated with the test. The marketing information is sent electronically directly to the consumer, through e-mail or in an SMS text message. The location-determining capabilities of the device, such as GPS, may be utilized to distribute localized marketing information.

**[0007]** The instant invention in one embodiment provides a method of testing a surface sample comprising the steps of: collecting the surface sample with a sampling device, capturing at least one digital image with a digital camera of a consumer device of the sample selected from at least one of before, during or after the sample interacts with the one or more agents, transmitting the at least one digital image of the sample over a network to be analyzed by a remote server and analyzing the transmitted the at least one digital image using an image processing software on the remote server. The method as described herein further comprises the steps of inserting the sampling device into the consumer device or an adaptor linked to the consumer device, wherein the consumer device comprises a digital camera, and optionally provides a GPS location, a vibration capability, an image storage memory, and wherein the adaptor comprises a modifier lens to adjust a focal length of the consumer device camera lens, and one or more LEDs positioned to illuminate the sample. Further the method also comprises the optional steps of: retransmitting the analyzed images back to the consumer device to report a test result and providing electronic media marketing materials comprising health and beauty care product, salon, and service recommendations to the consumer device.

**[0008]** In one aspect of the method the sampling device comprises one or more agents disposed to interact with the surface sample. In another aspect the sample comprises at least one of skin, nail, hair, biological fluid, one or more chemical species or any combinations thereof. In a specific aspect the sampling device further comprises one or more membranes selected from nitrocellulose, UVPE, PVDF, hydrophobic membranes known to those skilled in the art of immunosorbent assays. In yet another aspect the sampling device comprises an optional optical barcode, a radio frequency (RF) ID tag or combinations and modifications

obtaining a sample comprising hair, skin cells, proteins or enzymes from a stratum corneum of the subject with a sampling device, wherein one or more agents are disposed thereon and interact with the skin. The sample or the backing is placed into a consumer device comprising a digital camera or an adaptor linked to or integrating to a consumer device comprising:

**[0011]** (i) a stationary or mobile housing, a docking station or a combination thereof to enclose or integrate the consumer device temporarily or permanently,

**[0012]** (ii) an area to interface, insert, accept, and process the sample or the sampling device or a sampling area for

selected from the group consisting of digital cameras, digital camcorders, mobile phones, camera phones, PDA devices, Blackberry devices, and laptop computers to detect a sample captured on a test strip, the apparatus comprising: (i) a stationary or mobile housing, a docking station or a combination thereof to enclose or integrate with the consumer device temporarily or permanently, therein the housing comprises a sample receiving port, (ii) one or more modifier lenses, wherein the modifier lenses adjust the focal length of a digital camera of the consumer device to focus the sample, and (iii) one or more lights to illuminate the sample, wherein the digital camera is capable of capturing one or more images the

back to the consumer device to report the results of the skin and the associated health condition to the subject or a health care professional. The consumer device of the present invention is selected from the group consisting of digital cameras, digital camcorders, mobile phones, camera phones, PDA devices, Blackberry devices, and laptop computers and provides a GPS location and vibration capability. In a specific aspect the consumer device is a mobile phone.

**[0021]** In one aspect of the system disclosed in the present invention the sampling device comprises an optional optical barcode, a radio frequency (RF) ID tag or combinations and modifications thereof. In another aspect the sampling device comprises a disposable card comprised from cardboard or vinyl sized for a cartridge. In yet another aspect the sampling device comprises a background with a random colored pattern for security, calibration, and test validation interpretable by an algorithm processing digital signal from the digital camera. The sampling device of the system is adapted to remove skin cells, proteins, and oils, capture enzymes from a stratum corneum for chemical testing and is selected to maximize the imaging capabilities of an imaging device through minimizing, maximizing or mixing reflective, absorbance, and transmittance properties. In one aspect the sampling device optionally comprises one of a preloaded region with an analyte specific reagent, such as a synthetic receptor, releases a dye upon experiencing a change in pressure, comprises a chemical composition for indicating health conditions or allows flow to a subsequent surface.

**[0022]** Another embodiment of the instant invention discloses an adhesive composition for removing proteins, hair, skin cells, and oils or capturing enzymes comprising an adhesive for removing the stratum corneum in different thicknesses for chemical testing. The composition comprises one or more membranes selected from nitrocellulose, UVPE, PVDF, hydrophobic membranes known to those skilled in the art of immunosorbent assays. In one aspect the adhesive is selected to maximize the imaging capabilities of an imaging

more reagents selected from: a buffer, a dye, an activator a synthetic receptor or linker. In one aspect the composition is placed in one or more regions of a backing or a test strip for imaging skin and assessing skin and associated health conditions. In another aspect the test strip or the backing is placed in an apparatus or an adaptor integrated with one or more consumer devices. In yet another aspect the consumer device is capable of capturing a digital image, providing a GPS location, and an anti-vibration capability selected from the group consisting of digital cameras, digital camcorders, mobile phones, camera phones, PDA devices, Blackberry devices, and laptop computers.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0025]** For a more complete understanding of the features and advantages of the present invention, reference is now made to the detailed description of the invention along with the accompanying figures and in which:

**[0026]** FIG. **1** shows the reaction of mildly green fluorescent epicocconone with nucleophilic amines in proteins to produce a strongly red fluorescent complex;

**[0027]** FIG. **2** shows a carbonylated protein reactive dye would be one that emits in the blue region when excited at 365 nm: 7-diethylaminocoumarin-3-carboxylic acid hydrazide;

**[0028]** FIG. **3** shows a tape strip of firm but flexible composition would include several separate and diverse regions isolated by thin films;

**[0029]** FIG. **4** shows a tape strip of firm but flexible composition would include several separate and diverse regions isolated by thin films;

**[0030]** FIG. **5** shows an example of a unique identification pattern for use with the present invention;

**[0031]** FIG. **6** shows a test strip designed to sample a surface with two or more adhesive regions

**[0032]** FIG. **7** shows that carbonylated proteins can then be imaged and analyzed the reader system and software pro-

tion level quantification based upon image analysis of the dry skin on the adhesive test strip placed in the holder;

**[0043]** FIG. **13**D is an expanded view (close up) of the image shown in FIG. **13**C;

**[0044]** FIG. **14** is a prototype of an enclosed consumer adaptive apparatus as described in the present invention;

**[0045]** FIGS. **15**A and **15**B are Smart phone modifier for imaging test strips. CAD drawings of apparatus which modifies the iPhone to be capable of taking images of tape strips. The lens in the apparatus modifies the focal length of the iPhone camera to be able to clearly focus on the sample. A

**[0057]** Consumer devices can be hand-held and compact so that they can fit into a consumer's wallet and/or pocket (e.g., pocket-sized). For example, the portable consumer devices may include smartcards, ordinary credit or debit cards (with a magnetic strip and without a microprocessor), a keychain device (such as the Speedpass commercially available from Exxon-Mobil Corp.), etc. Other examples of consumer devices include cellular phones, personal digital assistants (PDAs), pagers, payment cards, laptop computers, Blackberry devices, digital cameras, digital camcorders, Blackberry devices, security cards, access cards, smart media, tran-

molecule comprising one or more polypeptide chains. A protein may also comprise non-peptidic components, such as carbohydrate groups. Carbohydrates and other non-peptidic substituents may be added to a protein by the cell in which the protein is produced, and will vary with the type of cell. Proteins are defined herein in terms of their amino acid backbone structures; substituents such as carbohydrate groups are generally not specified, but may be present nonetheless.

**[0063]** A variety of unique methods have been discovered and invented to collect and sample biological materials for diagnostic and analytical purposes. This invention is directly

example, both a sample of an apple's exterior as well as a sample of an apple's interior when cut open would be considered surface samples as applied to this invention.

**[0068]** The present invention includes pigments, dyes, or chelators that can be used on surface samples in order to accentuate certain parameters, label analytes, or bind analytes. As required for these applications, buffers, reagents, heating or cooling, and mixing would also be incorporated.

**[0069]** There are many potential areas of use for such a skin and hair analysis system: a) medical spa industry, which offers aesthetic services such as laser-therapy, Botox, chemi-

invasive methods. Currently available methods for determining skin condition do not provide adequate information to determine the cause of skin conditions. This approach is very subjective and relies on the customer's answers. Preconceived notions and inaccurate information will vary the answers and are not very helpful in assessing actual conditions. Most of the skin conditions or biomarker are non-visible and cannot be determined readily by visual assessment or answering a few subjective questions. The present invention reveals the underlying biomarkers and the causes of skin conditions or problems, which provides for specific personal care.

**[0073]** Tape-stripping is a non-invasive approach that permits a direct quantitative and qualitative assessment of biomarkers from the skin surface and stratum corneum (SC). Examples of tape-stripping products commercially available are D-Squame (CuDerm), Sebutape (CuDerm), various adhesive and mailing tapes (3M), and cyanoacrylate resin. Samples are taken by applying the adhesive tape to a target area of skin in a manner sufficient to isolate an epidermal sample adhering to the adhesive tape. Layers of the SC can be sequentially removed by repeated application of pieces of adhesive tape. The epidermal sample contains biomarkers that correlate to skin conditions. Currently, tape-stripping is used in research or for marketing. These methods give varying degrees of qualitative information, but do not offer any way of detecting specific biomarkers or skin analytes linked to various skin conditions. For instance, an apparatus can determine that skin is dry or less elastic. However, the apparatus does not give the consumer a reason for the dryness or loss of elasticity. The present invention correlates biological markers to skin or hair conditions.

**[0074]** Abundance of biomarkers correlating to skin conditions exemplify why it is currently difficult to coordinate products to consumer skin conditions. Stratum corneum is the

**[0076]** Vitamins, derivatives, forms and complexes. UV exposure and oxidation cause a decrease in the human SC's natural anti-oxidants such as vitamins A, C, and E (in various derivative, forms and complexes). Enzymes found in the stratum corneum include, but are not limited to beta-glucocerebrosidase, phospholipases, acid phosphatase, serine proteases: trypsin (chymotrypsin), cholesterol sulfatase, sphingomyelin deacylase, prosaposin, transglutaminase, peptide methionine sulfoxide reductases, and acid ceramidase. Cholesterol esters and cholesterol sulfate are part of the stratum corneum barrier function. Many analytes or biomarkers interact with each other in various synthesis and degradation pathways. For example, Ceramide EOS (Cer(OS)) main ceramide component of stratum corneum. It contains an omega-hydroxy fatty acid ester-linked to linoleic acid and amide-linked to sphingosine. Free linoleic acid is necessary to maintain skin barrier function, and as such altered levels correlate to dry skin, scaling and inflammation.

**[0077]** The presence of unusual species is an indicator of skin conditions. Presence of ω-hydroxy acid, stimulates ceramide production in the epidermis, and can be correlated to scaling and inflammation. Ceramide(AS) is an unusual species and is correlated to dry, itchy, scaling, roughness, bumps and inflammation. Triglycerides, short-chain saturated fatty acids and unsaturated fatty acids are sebaceous contaminants whose presence may serve to disrupt barrier organization at skin surface correlated to dry skin. Phospholipids should not be present in healthy stratum corneum. Cytokines are known to cause wrinkles, redness, and inflammation. Several interleukins have been detected on the skin surface. For example: IL-8, IL-6, IFN-γ, IL-4, IL-13 cause inflammation. Surfactants are known to bind to stratum corneum proteins and cause dry, itchy skin, scaling, roughness, loss of elasticity, bumps, and inflammation. Metals such as nickel are irritants that can cause bumps, redness and irritation. (Nyren,

processing and display. In one embodiment, the present invention comprises a reader device, disposable test trips or cartridges, and a computer-implemented system to provide a product feedback method.

**[0080]** Skin samples are taken by tape-stripping method and incorporated into a carrier such as a cartridge or test strip. Cartridges or test strips will detect various analytes or biomarkers that correlate with various skin conditions, including but not limited to:

**[0081]** i. Aldehydes, carbonyl proteins, and decreases in

A fluorescence assay fulfills these requirements, along with giving nanogram sensitivity necessary to such a small amount of sample.

**[0090]** Carbonylated Protein Assays. Since the carbonyls in carbonylated proteins are frequently aldehydes and ketones, an amine linked to a fluorophore as a Schiff reagent becomes the obvious choice for a carbonylated protein assay. The linkage typically involves a hydrazide, semicarbazide, carbohydrazide, and thiosemicarbazides, although sometimes aniline-based fluorophores suffice. Some examples of these

**[0095]** The adhesives physical properties are optimized for optical imaging, illuminated from LED's in the IR, visible and UV wavelengths.

**[0096]** In one embodiment, a tape strip of firm but flexible composition would include several separate and diverse regions isolated by thin films (FIGS. **3** and **4**). FIG. **3** shows a backing **300** that may include one or more regions, e.g., an adhesive region **302**, a region that includes as an active agent a receptor **304**, an activator **306**, a filter **308**, a dye **310**, a buffer **312**, an a functionalized material **314** (e.g., an agent that binds to one or more components suspected of being in

and two more separate dye containing regions **604** and **606**, laid out as shown FIG. **6**. A first composition on the test strip in **604** for example, is a thin film comprising 7-diethylaminocoumarin-3-carboxylic acid hydrazide. This thin film can be designed to be soluble in aqueous buffer. Other release paradigms involve a thermo-sensitive film such that an onboard exothermic reaction zone or external heating source dissolves and releases the dye in the film. Upon release 7-diethylaminocoumarin-3-carboxylic acid hydrazide binds to the total protein content contained in the adhesive sample zone **606**. After a rinse buffer such as phosphate buffered

absorb, and react with skin cells and compounds present on the tape strip. These reagents would either provide direct coloration of the tape strip in the form of colorimetric, fluorescent, chemiluminescent, or otherwise optically interrogatable evidence that a reaction has occurred, or they would provide said colorimetric changes to the accompanying fluid, gel or reagent matrix.

**[0106]** The sample module is designed in such a manner as to be transparent in at least one region such that upon insertion of the entire cartridge into the instrument, the sample module may be continually or intermittently optically interrogated or monitored.

**[0107]** A secondary detection module designed in such a fashion as to allow reacted fluids and flowable products from the sample module to collect and aggregate in a region separate and distinct from the actual sample surface. This may be used for secondary sample analysis and detection and purification, amplification, separation. This detection module may be a singular well or group of wells that contain functionalized materials such as region bends, coated walls, selectively absorption matrices or optically reflective absorption properties to enhance, verify and or calibrate the optical interrogation process.

**[0108]** This detection module may also be fitted with optical fitters in between the detection device and the detection regions, in a manner so as to block, concentrate, control specific wavelengths of light transmitted to a reflected out of the detection region.

**[0109]** Additionally, this detection region may include, as part of the cartridge design, an integrated light source ranging from 200-900 that provides illumination to the individual detection regions (wells) and allows the user to directly view the associated color-changes with or without an automated reader device. This internal illumination may also be utilized as a reference calibration or control for determining sample volume, turbidity, particle size/content or may simply save as a particle count, a LUT (look up table) filter, a particle filter, a pattern recognition, a morphological determination, a histogram, a line profile, a topographical representation, a binary conversion, or a color matching profile. The results from analysis are interpreted as product purchase recommendation, health state of the biological sample, cosmetological diagnosis, aesthetic analysis, or any plan of action based from the subsequent data analysis. The data and results from the analysis are organized and stored into the database by grouping and matching of data classified as statistically similar. The interpreted results may be viewed in one or more of the following ways: a display panel on the collection node, an e-mail message, an SMS text message, or through searching/browsing of the database in a web browser. In another aspect, the method includes a micro-analysis of applied cosmetics is performed.

**[0113]** In other embodiments, the invention includes a method for capturing chemical substances of the skin including but not limited to living cells, dead cells, and adsorbed chemical substances on the surface. A method releasing a compound from an adhesive surface for detection in the presence of a skin marker. A method of preparing disposable adhesive sample collection devices. A method of activating a chemical composition resulting from folding the surface onto itself combing the collection zone with the chemical zone. Method of making a backing material unresponsive to light. A method of using a secondary test trip to combine a sample with a reactive chemical composition. An optical identifier for the purposes of quality control and calibration and anti-counterfeiting. A method of preventing counterfeiting by embedding a substance that emits a signature wavelength detectable by an optical reader, interrogated, then processed with a calibration algorithm. A method of embedding wicking fibers into an adhesive sample collection device for allowing flow into a lateral flow membrane. A method of activating an adhesive surface resulting from the mechanical shear of

and the skin samples dries, and becomes lighter in appearance. The logarithmic curve that results from plotting the data points is show below in FIG. **9**. FIG. **10** shows the images captured that are the basis for the curve in FIG. **9**. The images show a clear trend of increasing whiteness in the skin flakes showing dehydration over time.

**[0116]** Different areas of the body, having different levels of skin hydration, will produce unique curves. FIG. **11**A below shows the resultant curve from the skin sample from the cheek as compared to the forehead sample in FIG. **9**.

**[0117]** The above testing can also be used to measure the performance of a consumer product, such as a moisturizer. The same protocol above is carried out with a sample of skin

method with imaging device, comprising a sample receiving area, a processing chamber, and a results chamber being either the sample receiving chamber or a separate collection area.

**[0125]** In one embodiment of the present invention the interface is universal to fit and integrate any consumer device. In other embodiment the interface is specific for the given device.

**[0126]** The apparatus has 3 basic functions and related sub-components:

**[0127]** I. Area to integrate to the consumer device. The primary purpose of this component is for merging together the apparatus which attaches itself either temporarily or per-

(FIGS. **13**A-**13**D). FIG. **13**A is an image of phone **1300**, apparatus **1302** with an adhesive strip **1310** inserted. FIG. **13**B is a back view of phone **1300** placed in the apparatus **1302**. The adaptor **1302** fits and attaches to the phone **1300** to hold all components in static orientation. The adaptor contains a magnifying lens **1304** that is in line with camera lens **1306** on the phone **1300** when the adaptor **1302** is placed onto the phone **1300**. The camera lens **1306** on the phone **1300** and the magnifying lens **1304** on the adaptor **1302** are in line with a piece **1308** of the adaptor that contains a sample collection area, in this embodiment that accepts and holds and adhesive light sources (**1708** and **1710**), two switches (**1716** and **1718**), a sensor **1706** and a modifier lens **1714**. FIG. **17**B is another angle of apparatus **1700** embodiment shown in FIG. **17**A. This apparatus **1700** would allow for analysis of various skin conditions and features, such as moles, acne, skin diseases, pigmentation, and sun damage. In addition to skin, the device could analyze other features such as teeth, gums and hair. FIG. **18** is a Smart phone modifier **1800** with communication port interface **1814**.

**[0135]** FIG. **19** shows two applications apparatus shown in FIGS. **17** and **18**. Application 2 uses a UV LED light source

"recommender") and the recommendation is made for the purpose of the selling the appropriate product to the consumer. Over time and with subsequent consumer visits, the same process is used to track actual product performance and provide tangible validation or recommend another product.

**[0140]** A further embodiment, the central database is uploaded to a handheld instrument that is at the sampling location. The sample is taken and test medium is placed into the reader. The reader then performs the image and PCA analysis and database comparison on the local hard drive. The instrument then gives at an instant product recommendation.

**[0141]** The present invention also includes a method of doing business comprising, a system of data collection nodes, comprising: a computational device capable of optically interrogating biological samples and obtaining user survey data; a software implemented user interface which facilitates interaction between user and computational device and serves as means for data collection, transmission, and analysis; a communication protocol to transmit data between collection node and a main server, including uploading of data to main server from collection node and downloading of data from main server to collection node; a data collection method in which data from the collection nodes is compiled, processed, and stored into a dynamically updated database on the main server, which can be searched and browsed through a web browser or software program interface. In one example, the biological samples involve living or dead tissue, such as dead skin cells or open wounds. In one example, the biological samples are test devices used to obtain a sample of tissue, such as swabs or tape strips. In another example, the biological samples are processed prior to being optically interrogated through photonic, electromagnetically radiating, chemical, biochemical, or electrical. In another example, the data collected includes images of the biological samples and survey information obtained through a questionnaire.

**[0142]** In another example, data is transmitted via broadband wireless or landline connection to an FTP, TCP, or

invention can be employed in various embodiments without departing from the scope of the invention. Those skilled in the art will recognize, or be able to ascertain using no more than routine experimentation, numerous equivalents to the specific procedures described herein. Such equivalents are considered to be within the scope of this invention and are covered by the claims.

**[0145]** All publications and patent applications mentioned in the specification are indicative of the level of skill of those skilled in the art to which this invention pertains. All publications and patent applications are herein incorporated by reference to the same extent as if each individual publication or patent application was specifically and individually indicated to be incorporated by reference.

**[0146]** The use of the word "a" or "an" when used in conjunction with the term "comprising" in the claims and/or the specification may mean "one," but it is also consistent with the meaning of "one or more," "at least one," and "one or more than one." The use of the term "or" in the claims is used to mean "and/or" unless explicitly indicated to refer to alternatives only or the alternatives are mutually exclusive, although the disclosure supports a definition that refers to only alternatives and "and/or." Throughout this application, the term "about" is used to indicate that a value includes the inherent variation of error for the device, the method being employed to determine the value, or the variation that exists among the study subjects.

**[0147]** As used in this specification and claim(s), the words "comprising" (and any form of comprising, such as "comprise" and "comprises"), "having" (and any form of having, such as "have" and "has"), "including" (and any form of including, such as "includes" and "include") or "containing" (and any form of containing, such as "contains" and "contain") are inclusive or open-ended and do not exclude additional, unrecited elements or method steps

REFERENCES

[0150] United States Patent Application No. 20090075250: Environmental Sampling and Testing Method.

What is claimed is:

1. A method of testing a surface sample comprising the steps of:
- collecting the surface sample with a sampling device;
- capturing at least one digital image with a digital camera of a consumer device of the sample selected from at least one of before, during or after the sample interacts with the one or more agents;
- transmitting the at least one digital image of the sample over a network to be analyzed by a remote server; and
- analyzing the transmitted the at least one digital image using an image processing software on the remote server.

2. The method of claim 1, further comprising the steps of inserting the sampling device into the consumer device or an adaptor linked to the consumer device, wherein the consumer device comprises a digital camera, and optionally provides a GPS location, a vibration capability, an image storage memory, and wherein the adaptor comprises a modifier lens to adjust a focal length of the consumer device camera lens, and one or more LEDs positioned to illuminate the sample.

3. The method of claim 1, further comprising the optional steps of:
- retransmitting the analyzed images back to the consumer device to report a test result; and
- providing electronic media marketing materials comprising health and beauty care product, salon, and service recommendations to the consumer device.

4. The method of claim 1, wherein the sampling device comprises one or more agents disposed to interact with the surface sample.

5. The method of claim 1, wherein the sample comprises at least one of skin, nail, hair, biological fluid, one or more chemical species or any combinations thereof.

6. The method of claim 1, wherein the consumer device further comprises one or more membranes selected from nitrocellulose, UVPE, PVDF, hydrophobic membranes known to those skilled in the art of immunosorbent assays.

7. The method of claim 1, wherein the sampling device comprises an optional optical barcode, a radio frequency (RF) ID tag or combinations and modifications thereof.

8. The method of claim 1, wherein the sampling device comprises a disposable card comprised from cardboard or vinyl sized for a cartridge.

9. The method of claim 1, wherein the sampling device comprises a background with a random colored pattern for security, calibration, and test validation interpretable by an algorithm processing digital signal from the digital camera.

10. The method of claim 1, wherein the sampling device is adapted to remove skin cells, proteins, and oils, capture enzymes from a stratum corneum for chemical testing.

11. The method of claim 1, wherein the sampling device is selected to maximize the imaging capabilities of an imaging device through minimizing, maximizing or mixing reflective, absorbance, and transmittance properties.

12. The method of claim 1, wherein the sampling device optionally comprises one of a preloaded region with an analyte specific reagent, such as a synthetic receptor, releases a dye upon experiencing a change in pressure, comprises a chemical composition for indicating health conditions or allows flow to a subsequent surface.

13. The method of claim 1, wherein the consumer device is selected from the group consisting of digital cameras, digital camcorders, mobile phones, camera phones, PDA devices, Blackberry devices, and laptop computers.

14. The method of claim 1, wherein the consumer device is a mobile phone.

15. The method of claim 1, wherein the LEDs comprise UV, Infrared, white or any other wavelength on the visible light spectrum.

16. The method of claim 1, wherein the LEDs are programmed to function optimally from one or more properties of the digital camera of the consumer device comprising speed, color filters or combinations thereof.

17. An apparatus for integration with one or more consumer devices selected from the group consisting of digital cameras, digital camcorders, mobile phones, camera phones, PDA devices, Blackberry devices, and laptop computers to detect a sample captured on a test strip, the apparatus comprising:
- a stationary or mobile housing, a docking station or a combination thereof to enclose or integrate with the consumer device temporarily or permanently, therein the housing comprises a sample receiving port;
- one or more modifier lenses, wherein the modifier lenses adjust the focal length of a digital camera of the consumer device to focus the sample; and
- one or more lights to illuminate the sample, wherein the digital camera is capable of capturing one or more images the sample.

18. The apparatus of claim 17, wherein the lenses comprise a single macro, a micro, a telephoto lens or a combination thereof.

19. The apparatus of claim 17, wherein the lights are defined further as comprising one or more LEDs that emit UV, Infrared, white or any other wavelength on the visible light spectrum.

20. The apparatus of claim 17, wherein the lights are defined further as comprising one or more LEDs that are programmed to function optimally from one or more properties of the digital camera of the consumer device comprising speed, color filters or combinations thereof.

21. A system for assessing a skin and associated health care conditions comprising:
- a consumer device capable of capturing a digital image;
- an apparatus for integrating with the one or more consumer devices comprising:
  - a stationary or mobile housing, docking station or a combination thereof to enclose or integrate the consumer device temporarily or permanently;
  - a sampling area for directly imaging one or more regions of the skin or directly imaging a sampling device, wherein the sampling area comprises one or more sensor, light sources, and switches;
  - a modifier lens to adjust a focal length of the consumer device camera lens, and one or more LEDs for illuminating the sample;
- a port or an interface for transmitting one or more digital images to a remote server; and
- a remote server for analyzing and optionally retransmitting the analyzed image to the consumer device, wherein the server comprises an image processing and analysis software to analyze the transmitted digital image.

22. The system of claim 21, wherein the system optionally provides electronic media marketing materials comprising

health and beauty care products, salon, and service recommendations to the consumer device

**23**. The system of claim **21**, wherein the consumer device is selected from the group consisting of digital cameras, digital camcorders, mobile phones, camera phones, PDA devices, Blackberry devices, and laptop computers.

**24**. The system of claim **21**, wherein the consumer device provides a GPS location and vibration capability.

**25**. The system of claim **21**, wherein the consumer device is a mobile phone.

**26**. The system of claim **21**, wherein the sampling device comprises an optional optical barcode, a radio frequency (RF) ID tag or combinations and modifications thereof.

**27**. The system of claim **21**, wherein the sampling device comprises a disposable card comprised from cardboard or vinyl sized for a cartridge.

**28**. The system of claim **21**, wherein the sampling device comprises a background with a random colored pattern for security, calibration, and test validation interpretable by an algorithm processing digital signal from the digital camera.

**29**. The system of claim **21**, wherein the sampling device is adapted to remove skin cells, proteins, and oils, capture enzymes from a stratum corneum for chemical testing.

**30**. The system of claim **21**, wherein the sampling device is selected to maximize the imaging capabilities of an imaging device through minimizing, maximizing or mixing reflective, absorbance, and transmittance properties.

**31**. The system of claim **21**, wherein the sampling device optionally comprises one of a preloaded region with an analyte specific reagent, such as a synthetic receptor, releases a dye upon experiencing a change in pressure, comprises a chemical composition for indicating health conditions or allows flow to a subsequent surface.

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