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(54) **METHOD AND APPARATUS FOR MEASURING PROPERTIES OF A TARGET SURFACE**

VERFAHREN UND VORRICHTUNG ZUR MESSUNG DER EIGENSCHAFTEN EINER ZIELOBERFLÄCHE

PROCEDE ET APPAREIL POUR MESURER DES PROPRIETES D'UNS SURFACE VISEE

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Description

FIELD OF THE INVENTION

[0001] The invention relates to an apparatus and method using electrical current to measure certain properties of a target surface having a substrate with an insulative coating thereon, and is particularly useful for measuring properties of naturally occurring tissue, and more particularly for measuring properties of the stratum corneum.

BACKGROUND OF THE INVENTION

[0002] For years those of ordinary skill in the art have attempted to make measurements of various properties of target surfaces. As used herein, a target surface comprises a substrate having one or more aesthetically, electrically or otherwise functionally distinguishable layers superimposed thereon. The substrate may be disposed between other components of system under consideration or may be the inner component of the system under consideration. At least one superimposed layer is disposed on the substrate and may provide a protective function or other functionality. The protective layer under consideration is the outwardly facing protective layer, which is exposed when the target surface is in use. To be distinguishable and measurable according to the present invention, it is only necessary that the superimposed layer of the target surface have a greater electrical resistance than the substrate and is relatively thin, as discussed below.

[0003] The measurements of the present invention are applicable to target surfaces comprising natural tissue. As used herein, natural tissue comprises tissue originating from the animal, plant and mineral kingdoms.

[0004] A target surface of particular interest is the human skin. The measurement of various properties of the human skin is important, as the stratum corneum, i.e. the outermost layer of the human skin, provides several functions. For example, the stratum corneum provides a barrier between the inside of the body and the outside world. Maintaining this barrier is important to preventing the intrusion of chemicals, bacteria and viruses into the body. The stratum corneum also regulates the evacuation of moisture from the body. However, measurement of the barrier properties of the human skin must be sanitary, noninvasive and usable with people of differing ages and health conditions.

[0005] The barrier properties of the skin are typically measured by transepidermal water loss. However, this measurement relies upon complex equipment and can be influenced by unrelated health and environmental factors, such as humidity, alcohol intake, Parkinson's disease and certain headaches. Transepidermal water loss is discussed in more detail in Chap. 9 of the Handbook of Non-invasive Methods and the Skin, editors Serup and Jemec, published by CRC Press, © 1995.

[0006] Likewise, other target surfaces of interest include the skin of pets, such as dogs and cats. The condition of the pet's skin can indicate the general overall health and nutrition of the pet. This feature is particularly important, as the pet cannot directly communicate its health concerns or needs.

[0007] U.S. Pat. No. 5,738,107 iss. Apr. 14, 1998 to Martinsen et al., discloses a technique for measuring the moisture content of the skin by placing three electrodes in contact with the skin. A voltage having a frequency less than 50 kHz is applied to the electrodes. The susceptance is then measured under the electrodes. Yet other attempts in the art directly measure phase angle. Illustrative are U.S. 3,665,302 iss. May 23, 1972 to Lees et al.; U.S. 4,758,778 iss. July 19,1988 to Kristinsson; and GB 2298923 pub. Sept. 18, 1996 (Central Research Laboratory Ltd.). However, each of these attempts relies upon AC and complex measurements of phase angle.

[0008] U. S. Pat. No. 6,085,115 iss. July 4, 2000 to Weaver et al, discloses a biopotential measurement that decreases the resistance of the skin to electrical fields. The topical application of a resistance-decreasing agent is also taught in order to diminish unwanted voltages, which compete with the biopotential measurements. The biopotential measurement is made at a skin surface site, which is electroporated through strong electric field pulses. In this method, electroporation is used as an auxiliary means to improve quality of the biopotential measurements and does not indicate properties of the skin.

[0009] WO 0001301 A1, published 13 January 2000, to Szopinski teaches measurement of skin resistance/impedance. Both alternating and direct current may be used to yield AC impedance or DC resistance, respectively. However, each of these teachings relies upon a resistance/impedance measurement to determine skin properties. Resistance measurements are dependent on the value of applied voltage and a number of other factors and, hence, may have low accuracy. Impedance measurement methods have better accuracy but they require complex equipment due to high frequencies involved.

[0010] U.S. 5,239,258 iss. Aug. 24 1993 to Kauffman teaches a method of measuring the freshness of fuels, oils, and food products-by, inter alia, dissolving a sample of the material to be tested in a solvent. The solvent is selected to dissolve both the material and its oxidation products. This procedure is infeasible when one wishes to preserve the integrity of the sample.

[0011] None of the attempts in the prior art known to the inventor teach a method of measuring properties of the skin utilizing relatively high voltages and which rely upon or cause ion transfer through the stratum corneum

[0012] Furthermore, the method and apparatus of the present invention may be broadly applied to measurements of the barrier properties of many natural coatings disposed on many natural substrates, particularly those that are electrically conductive. For example, the present invention may be used to measure certain properties of any thin insulating layer deposited on the surface of a conductive natural substrate, e.g. the permeability of the waxy layer of a plant leaf, barrier properties of a plant root, the effectiveness of chemical coatings on plants, the grade of leather, waterproof resistance of cloth, residual dust/dirt on conductive surfaces, bacteriological, viral, mold or other contamination on conductive surfaces. For example, the invention may be used to test food products, e.g. as the outer layers of vegetables such as potatoes, carrots, apples and oranges.

SUMMARY OF THE INVENTION

[0013] The invention is defined in the appended set of claims.

[0014] In one embodiment the invention comprises a method for measuring the barrier properties of a target surface comprising natural tissue. The method comprises the steps of providing a probe. The probe has a pair of spaced apart electrodes in electrical communication with each other, providing a voltage generator, capable of supplying an increasing voltage between said electrodes, and providing a voltage meter capable of indicating the voltage between said electrodes. The electrodes are placed in contact with the skin of a test subject. An increasing voltage is supplied from the voltage generator to the electrodes until current between said electrodes reaches a predetermined value. The voltage, which occurs when said current reaches the predetermined value, is noted.

[0015] In another embodiment the invention comprises a device for measuring the barrier properties of a target surface comprising natural tissue. The device comprises a probe. The probe has a pair of spaced apart electrodes in electrical communication with each other. The electrodes are contactable with the skin of a subject. The device also comprises a voltage generator, capable of supplying an increasing voltage between the electrodes, and a voltage meter capable of indicating the voltage between the electrodes. The voltage meter indicates the voltage between said electrodes when current therebetween reaches a predetermined value.

[0016] One of skill will recognize the aforementioned method and device have applicability to measurements of the target surface moisture content, barrier properties and other properties as well. For example, measurements of other barriers, coatings, and laminae on various substrates may be made according to the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017]

Fig. 1 is a schematic electrical diagram of a device according to the present invention.

Fig. 2 is a perspective view of an exemplary probe according to the present invention.

Fig. 3 is a perspective view of an alternative embodiment of a probe according to the present invention and having a first electrode with a plurality of discrete contact surfaces circumferentially disposed around a second electrode.

Figs. 4A, 4B, and 4C are graphical representations of tests according to the present invention, measuring the barrier properties of the stratum corneum of human skin on a 42 year old Caucasian male wherein Fig. 4A was measured on the right cheek, Fig. 4B was measured on the left cheekbone and Fig. 4C was measured on the left side of the forehead.

DETAILED DESCRIPTION OF THE INVENTION

[0018] Referring to Fig. 1, in one embodiment the invention comprises a device for measuring barrier properties of the skin or other protective layers of a target surface. The device comprises a probe 10 having two electrodes 12 for contacting the surface to be measured, a voltage generator for supplying a an electric potential to the probe 10, a voltage meter indicating the voltage supplied to the probe 10, and a current meter indicating the current between the electrodes 12.

[0019] The apparatus and method of the present invention are noninvasive. By noninvasive it is meant that the device does not penetrate or cause damage to the target surface. The apparatus and method also do not measure the electrical resistance of the target surface as occurs with many teachings of the prior art. Likewise, a phase shift, as may occur with alternating current is not measured according to the present invention. Instead, the present invention measures a nonlinear response to an applied voltage.

[0020] The apparatus according to the present invention may be placed in fixed location. In one embodiment the apparatus is portable and can be used in a variety of positions and orientations.

[0021] Referring to Fig. 2 and examining the device in more detail, the probe 10 has first and second electrodes 12. Each electrode 12 is contactable with the target surface. Each electrode 12 has a proximal end proximate the voltage generator, and a distal end for contacting the target surface. Preferably the distal end of the electrode 12 has a contact area large enough to prevent damage to the target surface and discomfort to the subject if the device testing a human or animal.

[0022] The amount of contact area is dependent upon the pressure to be applied by the electrode 12. For the embodiments described herein, the electrodes 12 may apply a contact pressure of 10 to 100 grams per square meter. To ensure precision in the measurement, a contact pressure of 50 grams per square meter may be utilized. If desired, the electrodes 12 or the entire probe 10 may be spring loaded to provide the desired contact pressure. For the embodiments described herein, the distal ends of the electrodes 12 may have a contact area of 0.5 to 10 square millimeters. To ensure precision in the measurement a contact area of 2 square millimeters may be utilized.

[0023] Preferably the distal end of the electrode 12 is round in cross section. The distal end of the electrode 12 may be ground to a highly polished surface finish to ensure proper electrical contact with the target surface. The electrodes 12 may have a convex shape at the distal end. If a convex shape is chosen for the electrodes 12, they may be spherical, having a radius of curvature of 0.05 to 5 millimeters and more particularly 2 millimeters.

[0024] The electrodes 12 may be thought of as two points separated by a variable or predetermined distance. The spacing between the electrodes 12 should be greater than the thickness of the layer of the target surface, in order to ensure the desired electrical path occurs. The desired electrical path according to the present invention is from one electrode 12, through the layer, into the substrate, back through the layer and into the other electrode 12. If the electrodes 12 are spaced too close together, the electrical path may be shunted therebetween, without reaching the substrate. For the embodiments described and claimed herein, when the electrodes 12 contact the target surface they may be spaced apart a distance less than that needed to achieve a significant voltage drop in the target substrate. The electrodes 12 are spaced apart on a pitch of 3 to 8 millimeters and 5 millimeters in a preferred embodiment.

[0025] Referring to Fig. 3, the first electrode 12 may comprise a plurality of discrete contact surfaces. The plural contact surfaces of the first electrode 12 may be equally or unequally spaced from the second electrode 12. In one suitable embodiment, the contact surfaces of the first electrode 12 are disposed around the second electrode 12 in a circular geometry. In this geometry, the contact surfaces may be equally radially spaced from the second electrode 12 and equally circumferentially spaced from each other. Alternatively, the contact surfaces may be equally radially spaced from the second electrode 12 and unequally circumferentially spaced from each other, if there is concern that the target surface is not axi-resistant to electric current flow therethrough. Either the first electrode 12 or second electrode 12 may be the anode/cathode.

[0026] In yet another alternative embodiment, the second electrode 12 may completely circumscribe the first, separated by an equal or unequal annular clearance. In yet another embodiment, the second electrode 12 may be interposed between two contact surfaces of the first electrode 12, one contact surface circumbscribing the second electrode 12, which, in turn, circumscribes the other contact surface of the first electrode 12. The embodiments having electrodes 12, or contact surfaces thereof, circumscribing other electrodes 12, may utilize either concentric or eccentric geometries.

[0027] Referring back to Fig. 1, the device also comprises a voltage generator. The voltage generator may provide direct current, although alternating current is also contemplated. Direct current provides the advantage that no capacitance effects will be encountered, as is known to one of skill.

[0028] Referring to Figs. 4A, 4B and 4C the voltage generator may provide a voltage increasable from a baseline value to a threshold value. The baseline value is the initial value of the voltage at the time the electrodes 12 contact the target surface. The threshold value is the value of the voltage at the time during the test that the current between the electrodes 12 reaches a predetermined value. Typically the value of the threshold voltage will be greater than the value of the baseline voltage. The voltage may be increasable from 0 to 200 volts in a first embodiment, and from 0 to 30 volts in a second embodiment. The voltage may be monotonically increased from 0 volts to the maximum voltage applied during a particular test.

[0029] The measurements of Figs. 4A -4C were carried out with a monotonically increasing voltage rate of 1.5 volts per second, using probes 10 contact pressure of 50 grams per square meter, spherically shaped distal ends having a diameter of 5 millimeters, and electrodes 12 spaced apart on a pitch of 8 millimeters. For illustrative purposes, the measurements of Figs. 4A-4C were not terminated when the threshold current was reached. The threshold current and associated voltage for the measurements illustrated in each of Figs 4A- 4C are shown in Table 1 below:

Table 1

Figure	Threshold current (microamperes)	Applied voltage at Threshold Current (volts)
4A	1	10.2
4B	1	4.7

(continued)

Figure	Threshold current (microamperes)	Applied voltage at Threshold Current (volts)
4C	1	6.6

[0030] The predetermined current may be from 0.1 to 5 microamperes, and specifically 1 microampere. If the predetermined current is too high, it may damage or cause pain to the target surface. If the predetermined current is too low, background noise may interfere with the accuracy of the measurement, unless special instrumentation is used.

[0031] If the voltage is monotonically increased, it may be increased at a rate of 0.1 to 10 volts per second. In one suitable embodiment, the voltage may monotonically increase at a rate of 1.5 volts per second. The voltage may be increased at a rate, which is less than the rate of the electrical response of the surface being tested. The rate of the electrical response of the subject is the rate of change of electric current through the subject upon application of a certain voltage applied as a step function. If desired, the voltage may be increased in a nonlinear fashion. For example, the applied voltage may increase very rapidly at the beginning of the test, then increase more slowly as the threshold value is approached. This procedure provides the advantage that total test time may be reduced, while allowing for accuracy around the threshold voltage.

[0032] Alternatively, the voltage may be increased from a baseline value to an upper value. The upper value may be greater than the threshold value of the voltage. When the upper voltage is reached, the voltage is reduced to a lower value, which is equal to or greater than the baseline voltage. The voltage is then in creased to a new upper voltage, which may be greater than the previous upper voltage. The voltage is then reduced until a new lower voltage, greater than the previous lower intermediate voltage is reached. This process is carried out for one or more cycles, until the threshold value is reached at least once. This procedure of nonmonotonically increasing the voltage may cause hysteresis in the current between the two electrodes 12. The hysteresis may provide further information about the target surface. For example, hysteresis may indicate the incipience, duration or relaxation time of aqueous pathways in the stratum corneum, as discussed below.

[0033] Referring back to Figs. 1-2, a suitable voltage generator is commercially available from the Agilent Technologies, Inc of Palo Alto, Ca under model number 33120A. Also, the invention comprises a current meter and voltage meter, each of suitable resolution and response time. A suitable combination meter is commercially available from Agilent Technologies, Inc. under model number 34401A.

[0034] If desired, the device may further comprise a reference signal generator and a signal comparator. The signal comparator compares the value of the current between the probes 10 to the value of the current of the reference signal. When the current between the electrodes 12 reaches a predetermined value, a stop signal is sent to the voltage generator. The voltage applied to the electrodes 12 does not further increase. This stop signal thus provides a safety feature for the device. When the stop signal is high, further increases in voltage and/or current to the electrodes 12 do not occur, preventing injury to the target surface. The stop signal may be activated when the current applied to the electrodes 12 reaches the value of the current of the reference signal. The current applied to the electrodes 12 may be indicated by the current meter.

[0035] The voltage, which occurs when the predetermined current is reached, is noted. If desired, this voltage may be recorded for future reference.

[0036] Without being bound by theory, it is believed that as the voltage is applied to human and other animal skin, the electric field creates aqueous pathways through the stratum corneum when the voltage reaches a certain level. The aqueous pathways allow ions from the epidermis to penetrate the stratum corneum. Ions travel through the aqueous pathways between the electrodes 12 and the epidermis. The ions create an electric current. This current increases with the applied voltage. The threshold voltage at which the predetermined current is reached is noted upon the predetermined current being reached. This voltage is directly proportional to the stratum corneum barrier capability, and inversely proportional to the moisture level in the SC. This process does not damage the skin or other target surface. Prophetically, the present invention can be utilized to measure the thickness and strength of paint/wax/stain or varnish on a metal substrate (for instance, a car body panel), the caliper of thin synthetic films, e.g. polyolefinics, and synthetic nonwovens, placed on a conductive substrate, etc.

Claims

1. A method for measuring barrier properties of a target surface comprising natural tissue, said method comprising the steps of providing a probe (10), said probe having a pair of spaced apart electrodes (12) in electrical communication with each other, providing a voltage generator, said voltage generator being capable of supplying an increasing voltage between said electrodes, providing a voltage meter, said voltage meter being capable of indicating the

voltage between said electrodes, placing said electrodes in contact with the target surface, said method **characterized by** the step of supplying an increasing voltage from said voltage generator to said electrodes until current between said electrodes reaches a predetermined value, and noting said voltage which occurs when said current reaches said predetermined value.

2. The method according to claim 1, further **characterized by** the step of monitoring the current between said electrodes (12) in real time.

3. The method according to claims 1 or claim 2, **characterized in that** said predetermined current is from 0.1 to 3 microamperes.

4. The method according to any one of claims 1 to 3, **characterized in that** said voltage is monotonically increased at a rate of 0.1 to 10 volts per second.

5. The method according to any one of claims 1 to 3, **characterized in that** said voltage is nonlinearly increased from a baseline value to said predetermined value.

6. The method according to any one of claims 1 to 5, **characterized in that** said target surface comprises human tissue.

7. A device for measuring the barrier properties of a target surface comprising natural tissue, said device comprising:

a probe (10), said probe having a pair of spaced apart electrodes (12) in electrical communication with each other, said electrodes being spaced apart a distance of 3 to 10 mm and said electrodes being contactable with the skin of a subject;
a voltage generator, said voltage generator being capable of supplying an increasing voltage between said electrodes;
a current meter indicating the current between the electrodes (12); and
a voltage meter indicating the voltage between said electrodes (12), whereby said voltage meter is adopted to indicate the voltage between said electrodes when the current therebetween reaches a predetermined value.

8. A device according to claim 7, wherein each said electrode (12) has a contact area of between 0.5 to 10 mm^2.

9. A device according to claims 7 or claim 8, having a first electrode and a second electrode, wherein said first electrode comprises a plurality of discrete contact surfaces disposed about said second electrode in a radial pattern.

10. A device according to any one claims 7 to 9, wherein said voltage is monotonically increasable at a rate of 0.1 to 10 volts per second.

Patentansprüche

1. Verfahren zum Messen von Sperreigenschaften einer Zieloberfläche, die natürliches Gewebe umfasst, wobei das Verfahren- die folgenden Schritte umfasst; Bereitstellen einer Sonde (10), wobei die Sonde ein Paar beabstandeter Elektroden (12) in elektrischer Verbindung miteinander umfasst, Bereitstellen einer Spannungsquelle, wobei die Spannungsquelle eine zunehmende Spannung zwischen den Elektroden liefern kann, Bereitstellen eines Voltmeters, wobei das Voltmeter die Spannung zwischen den Elektroden anzeigen kann, Platzieren der Elektroden in Kontakt mit der Zieloberfläche, wobei das Verfahren durch den Schritt des Lieferns einer zunehmenden Spannung aus der Spannungsquelle an die Elektroden, bis die Stromstärke zwischen den Elektroden einen vorbestimmten Wert erreicht, und des Notierens der Spannung, die auftritt, wenn die Stromstärke den vorbestimmten Wert erreicht, **gekennzeichnet** ist,

2. Verfahren gemäß Anspruch 1, das weiterhin durch den Schritt des Überwachens der Stromstärke zwischen den Elektroden (12) in Echtzeit **gekennzeichnet** ist.

3. Verfahren gemäß Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** die vorbestimmte Stromstärke 0,1 bis 3 Mikroampère beträgt.

4. Verfahren gemäß einem der Ansprüche 1 bis 3, **dadurch gekennzeichnet, dass** die Spannung mit einer Geschwin-

digkeit von 0,1 bis 10 Volt pro Sekunde monoton erhöht wird,

5. Verfahren gemäß einem der Ansprüche 1 bis 3, **dadurch gekennzeichnet, dass** die Spannung nichtlinear von einem Grundlinienwert auf den vorbestimmten Wert erhöht wird.

6. Verfahren gemäß einem der Ansprüche 1 bis 5, **dadurch gekennzeichnet, dass** die Zieloberfläche menschliches Gewebe umfasst.

7. Vorrichtung zum Messen der Sperreigenschaften einer Zieloberfläche, die natürliches Gewebe umfasst, wobei die Vorrichtung Folgendes umfasst:

eine Sonde (10), wobei die Sonde ein Paar beabstandeter Elektroden (12) in elektrischer Verbindung miteinander umfasst, wobei die Elektroden in einem Abstand von 3 bis 10 mm voneinander beabstandet sind und die Elektroden mit der Haut eines Probanden in Kontakt gebracht werden können;
eine Spannungsquelle, wobei die Spannungsquelle eine zunehmende Spannung zwischen den Elektroden liefern kann;
ein Amperemeter, das die Stromstärke zwischen den Elektroden (12) anzeigt; und
ein Voltmeter, das die Spannung zwischen den Elektroden (12) anzeigt, wobei das Voltmeter geeignet ist, die Spannung zwischen den Elektroden anzuzeigen, wenn die Stromstärke dazwischen einen vorbestimmten Wert erreicht.

8. Vorrichtung gemäß Anspruch 7, wobei die Elektrode (12) eine Kontaktfläche zwischen 0,5 und 10 mm^2 hat.

9. Vorrichtung gemäß Anspruch 7 oder 8, die eine erste Elektrode und eine zweite Elektrode aufweist, wobei die erste Elektrode eine Menge von diskreten Kontaktflächen umfasst, die in einem radialen Muster um die zweite Elektrode herum angeordnet sind.

10. Vorrichtung gemäß einem der Ansprüche 7 bis 9, wobei die Spannung mit einer Geschwindigkeit von 0,1 bis 10 Volt pro Sekunde monoton erhöht werden kann.

Revendications

1. Procédé de mesure des propriétés de barrière d'une surface cible comprenant un tissu naturel, ledit procédé comprenant les étapes consistant à : prévoir une sonde (10), ladite sonde ayant une paire d'électrodes espacées (12) en communication électrique l'une avec l'autre, prévoir un générateur de tension, ledit générateur de tension étant capable de fournir une tension croissante entre lesdites électrodes, prévoir un voltmètre, ledit voltmètre étant capable d'indiquer la tension entre lesdites électrodes, et placer lesdites électrodes en contact avec la surface cible, ledit procédé étant **caractérisé par** les étapes consistant à fournir une tension croissante par ledit générateur de tension auxdites électrodes jusqu'à ce que le courant entre lesdites électrodes atteigne une valeur prédéterminée, et à noter ladite tension qui se produit lorsque ledit courant atteint ladite valeur prédéterminée.

2. Procédé selon la revendication 1, **caractérisé en outre par** l'étape de surveillance du courant entre lesdites électrodes (12) en temps réel.

3. Procédé selon la revendication 1 ou la revendication 2, **caractérisé en ce que** ledit courant prédéterminé est de 0,1 à 3 micro-ampères.

4. Procédé selon l'une quelconque des revendications 1 à 3, **caractérisé en ce que** ladite tension est augmentée de manière monotone à une vitesse de 0,1 à 10 volts par seconde.

5. Procédé selon l'une quelconque des revendications 1 à 3, **caractérisé en ce que** ladite tension est augmentée de manière non linéaire d'une valeur de base à ladite valeur prédéterminée.

6. Procédé selon l'une quelconque des revendications 1 à 5, **caractérisé en ce que** ladite surface cible comprend un tissu humain.

7. Dispositif de mesure des propriétés de barrière d'une surface cible comprenant un tissu naturel, ledit dispositif

comprenant :

une sonde (10), ladite sonde ayant une paire d'électrodes espacées (12) en communication électrique l'une avec l'autre, lesdites électrodes étant espacées selon une distance de 3 à 10 mm et lesdites électrodes pouvant toucher la peau d'un sujet ;
un générateur de tension, ledit générateur de tension étant capable de fournir une tension croissante entre lesdites électrodes ;
un dispositif de mesure du courant indiquant le courant entre les électrodes (12) ; et
un voltmètre indiquant la tension entre lesdites électrodes (12), de sorte que ledit voltmètre est adapté pour indiquer la tension entre lesdites électrodes lorsque le courant entre elles atteint une valeur prédéterminée.

8. Dispositif selon la revendication 7, dans lequel chaque électrode (12) possède une zone de contact située entre 0,5 et 10 mm^2.

9. Dispositif selon la revendication 7 ou la revendication 8, ayant une première électrode et une seconde électrode, dans lequel ladite première électrode comprend une pluralité de surfaces de contact discrètes disposées autour de ladite seconde électrode selon un modèle radial.

10. Dispositif selon l'une quelconque des revendications 7 à 9, dans lequel ladite tension peut augmenter de manière monotone à une vitesse de 0,1 à 10 volts par seconde.

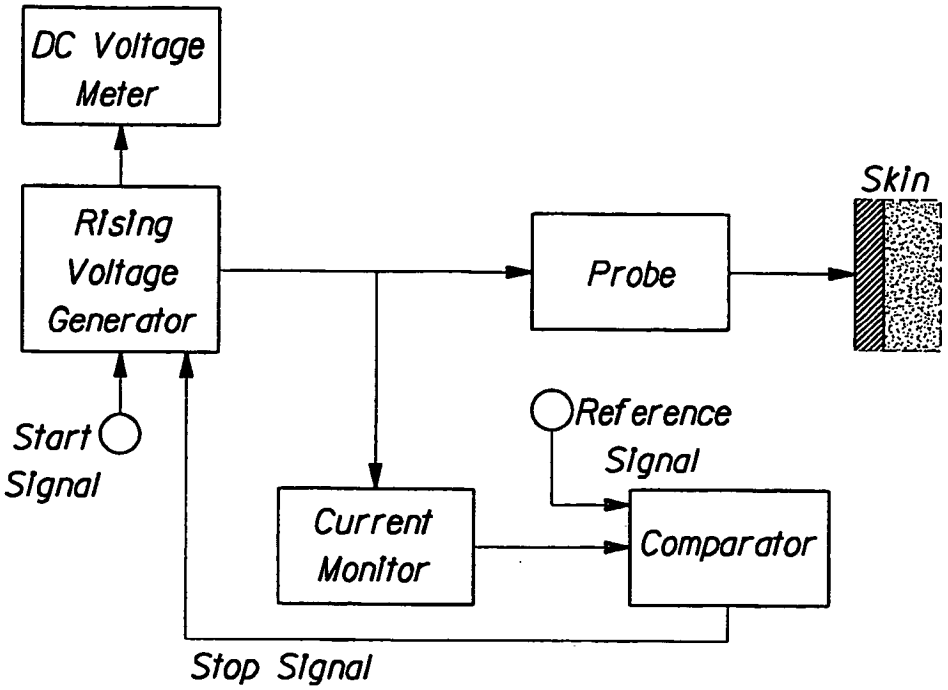
DC Voltage Meter
Rising Voltage Generator
Start Signal
Probe
Skin
Reference Signal
Current Monitor
Comparator
Stop Signal

Fig. 1

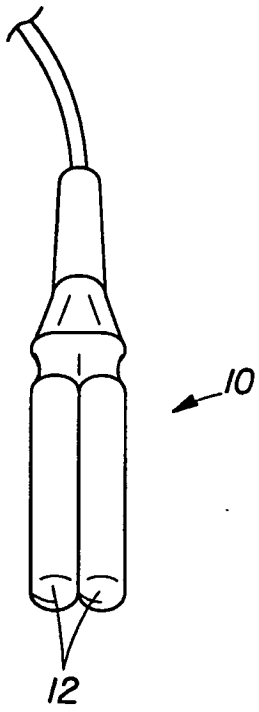
10
12

Fig. 2

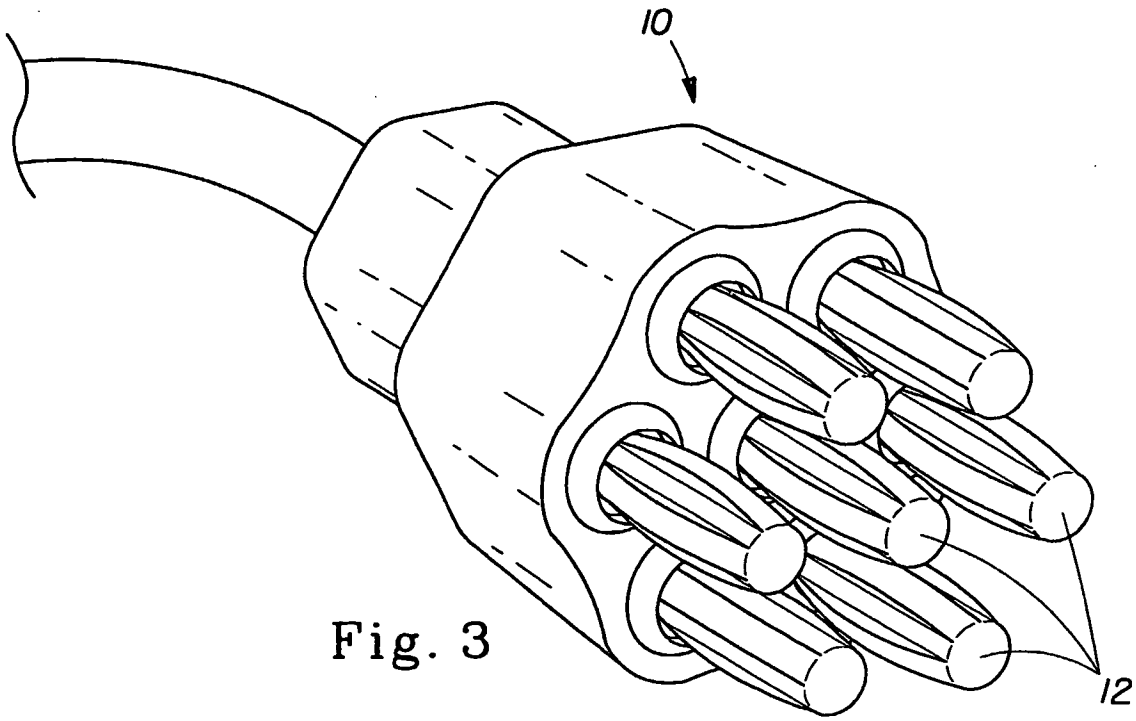

Fig. 3

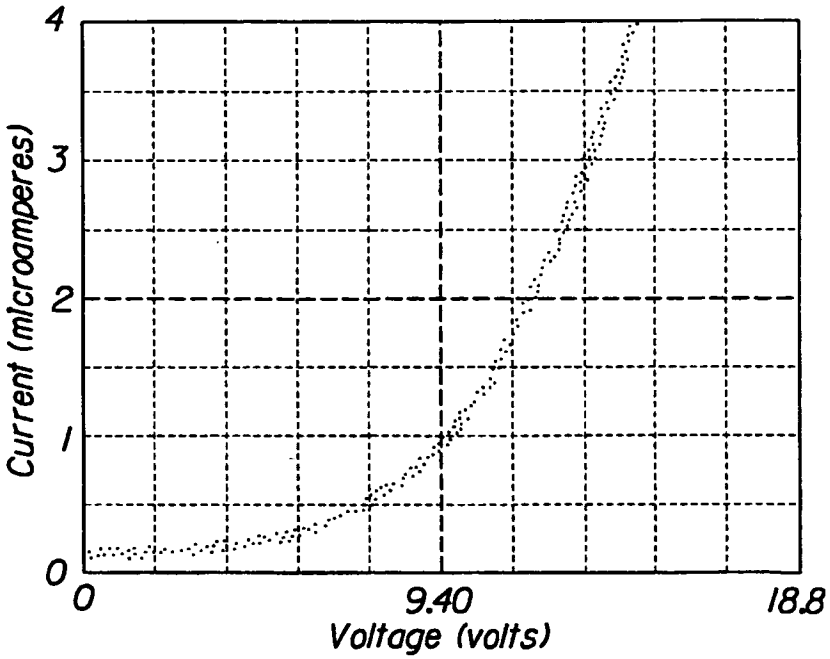

Fig. 4A

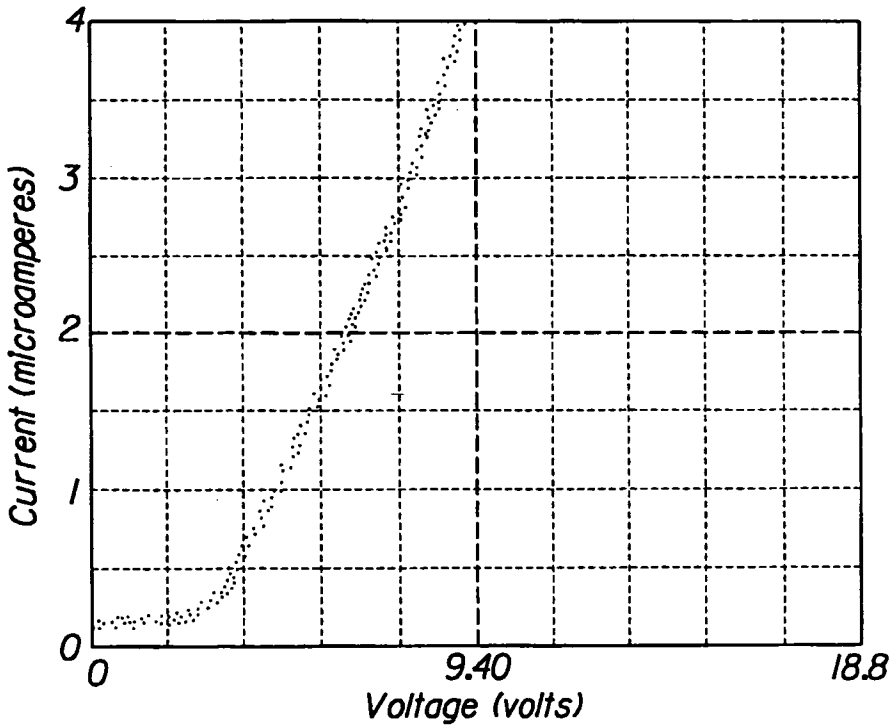
Current (microamperes)
4
3
2
1
0
0
9.40
18.8
Voltage (volts)

Fig. 4B

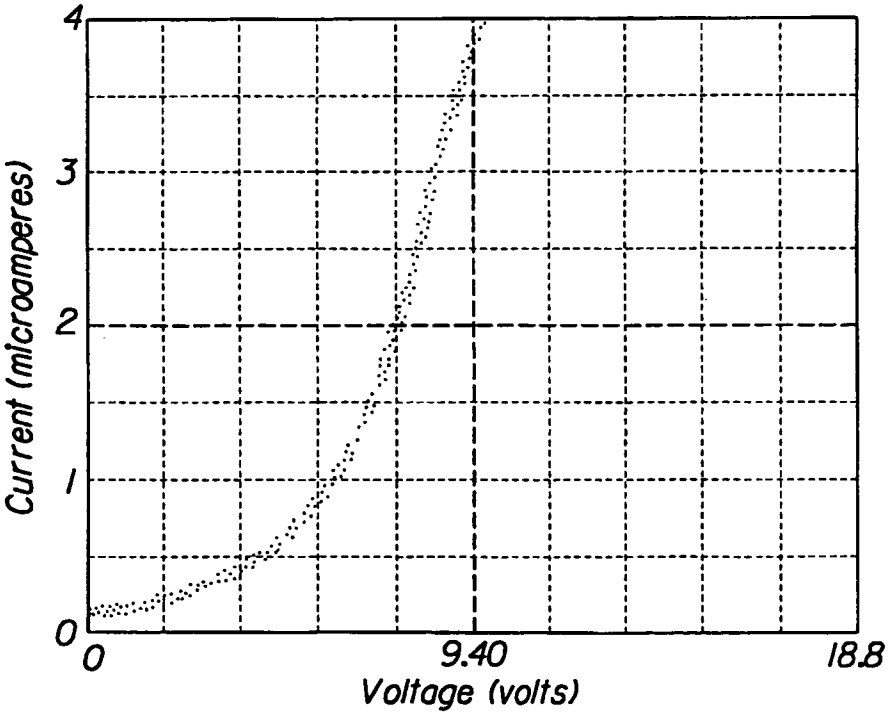
Current (microamperes)
4
3
2
1
0
0
9.40
18.8
Voltage (volts)

Fig. 4C

REFERENCES CITED IN THE DESCRIPTION

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专利名称(译)	用于测量目标表面的性质的方法和设备		
公开(公告)号	EP1399061B1	公开(公告)日	2007-09-05
申请号	EP2002732056	申请日	2002-06-10
[标]申请(专利权)人(译)	宝洁公司		
申请(专利权)人(译)	宝洁公司		
当前申请(专利权)人(译)	宝洁公司		
[标]发明人	PINYAYEV ALEKSEY MIKHAILOVICH		
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IPC分类号	A61B5/05 A61B5/103 G01N27/02 G01B7/06 A61B5/00 A61B5/0408 A61B5/0492 A61B5/053 G01N27/00 G01N33/483		
CPC分类号	A61B5/442 A61B5/0531		
优先权	09/879706 2001-06-13 US		
其他公开文献	EP1399061A1		
外部链接	Espacenet		

摘要(译)

一种测量天然存在的组织（例如皮肤）的屏障特性的方法。该方法包括以下步骤：提供具有彼此电连通的一对间隔开的电极的探针，能够在所述电极之间提供增加的电压的电压发生器，以及能够指示所述电极之间的电压的电压计。将电极放置成与目标表面接触。从电压发生器向电极提供增加的电压，直到所述电极之间的电流达到预定值。记录当电流达到预定值时发生的电压。在另一个实施方案中，本发明包括用于测量皮肤屏障性质的装置。该装置包括探针。探针具有一对彼此电连通的间隔开的电极。电极可与受试者的皮肤或其他目标表面非侵入性地接触。该装置还包括能够在电极之间提供增加的电压的电压发生器，以及能够指示电极之间的电压的电压计。当电极之间的电流达到预定值时，电压表指示电极之间的电压。

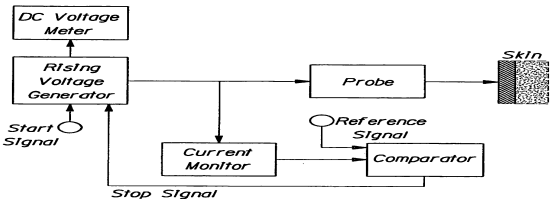

Fig. 1

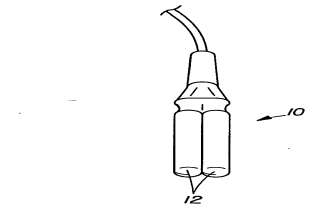

Fig. 2