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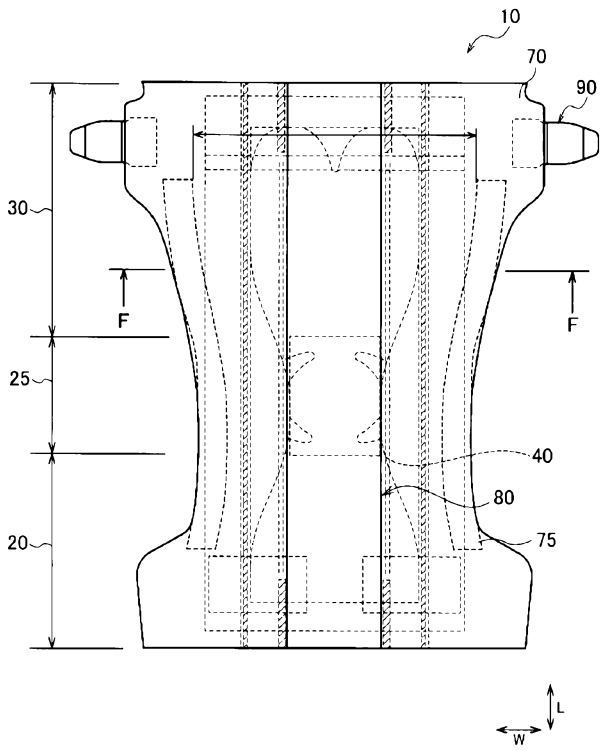
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(54) **Title**: ABSORBENT ARTICLE

(54) 発明の名称 : 吸収性物品



(57) **Abstract**: Provided is an absorbent article which is objectively improved with respect to comfortability when worn on the basis of the correspondence between a measurement value based on near-infrared spectroscopy (NIRS) and physical properties of the absorbent article. In this disposable diaper (10), the sum of a first prescribed number of amplitude peaks of a frequency spectrum obtained by executing a Fourier transform on waveform data of the friction resistance for the surface of a top sheet (50) on a time axis is 0.025gf•s or less, and the ratio of the sum of a second prescribed number of amplitude peaks of the frequency spectrum to the sum of the first prescribed number of amplitude peaks is 20% or more, the friction resistance in the waveform data being friction resistance generated in the opposite direction to the lengthwise direction (L) of the product when the surface of the top sheet (50) is stroked in the lengthwise direction (L) of the product according to a prescribed measurement condition.

(57) 要約: 近赤外線分光法（NIRS）に基づく測定値と、吸収性物品の物性とを対応付けに基づいて着用時の快適性をより客観的に向上させた吸収性物品を提供する。使い捨ておむつ(10)は、所定の測定条件に基づいて、トップシート(50)の表面を製品長手方向(L)に沿って撫でることによって、製品長手方向(L)と正反対の方向に発生する摩擦抵抗力の時間軸における波形データに対してフーリエ変換を実行することによって得られた周波数スペクトルの第１所定数の振幅ピークの和が 0.025gf・s 以下であり、かつ第１所定数の振幅ピークの和に対する周波数スペクトルの第２所定数の振幅ピークの和の割合が 20%以上である。

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[DESCRIPTION]

[Title of Invention]

ABSORBENT ARTICLE

[Technical Field]

[0001]

The present invention relates to an absorbent article, and particularly, to an absorbent article of which comfort at the time of being worn is objectively improved by associating a measurement value based on near-infrared spectroscopy (NIRS) with a physical property of the absorbent article.

[Background Art]

[0002]

A reference herein to a patent document or other matter which is given as prior art is not to be taken as an admission that the document or matter was known or that the information it contains was part of the common general knowledge as at the priority date of any of the claims.

[0002a]

In absorbent articles such as a disposable diaper, the comfort of a wearer greatly depends on texture (tactile sensation). Conventionally, nonwoven fabrics with favorable texture have been used on the basis of knowledge or sensation of a developer.

[0003]

In addition, there have been attempts regarding a method of measuring physical properties of members such as a nonwoven fabric based on an objective indicator. For example, a method of measuring physical properties of members such as a nonwoven fabric has been known (for example, Patent Literature 1) based on flexural rigidity or the like according to KES (see: "The Standardization and Analysis of Hand Evaluation" second edition (The Hand Evaluation and Standardization Committee, the Textile Machinery Society of Japan, Issued on July 10, 1980).

[Citation List]

[Patent Literature]

[0004]

[Patent Literature 1]

Japanese Unexamined Patent Application Publication No. 2008-43674 (claim 1 et al.)

[Summary of Invention]

[0005]

Meanwhile, recently, near-infrared spectroscopy (NIRS) has been known as a new popular method of measuring a brain function. The measurement using the NIRS can

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be simply performed as compared to measurement of a brain wave, and thus, has affinity with an infant or the like for which measurement for long period of time is difficult.

[0006]

It has been found that there is a case where the nonwoven fabric (an absorbent article) with the texture, which has conventionally been considered to have a great comfort, does not necessarily indicates a favorable value, that is, a value representing that the comfort is great, when a state of a brain of an infant wearing the absorbent article (a disposable diaper) is measured according to the NIRS.

[0007]

In other words, it has been found that there is a case where setting of a conventional flexural rigidity value, or physical properties of the absorbent article (nonwoven fabric) according to the knowledge or sensation of a developer does not necessarily contribute to improvement in the comfort at the time of wearing the absorbent article. In particular, it is often difficult for an infant or an elderly person to accurately deliver his feeling to others, and thus, there has been a strong demand for establishment of a method capable of objectively evaluating the comfort at the time of wearing the absorbent article.

[0008]

Thus, the present invention has been made in view of such situations, and it is desirable to provide an absorbent article of which comfort at the time of being worn is objectively further improved based on association between a measurement value according to the near-infrared spectroscopy (NIRS) and a physical property of the absorbent article.

[0009]

In one form of the invention there is provided a method for evaluating comfort of an absorbent article provided with a skin-contact surface sheet that abuts against a skin of a wearer, comprising the following steps of: calculating a sum of amplitude peaks of a first predetermined number selected in order from a largest amplitude peak of frequency spectrum obtained by stroking a top surface of the skin-contact surface sheet along a first direction based on a predetermined measurement condition and performing Fourier transform with respect to waveform data in a time axis of a frictional resistance force generated in a second direction diametrically opposite to the first direction, and a proportion of a sum of amplitude peaks multiples of 0.333 Hz ± 0.005 Hz among the amplitude peaks included in the first predetermined number with respect to the sum of amplitude peaks of the first predetermined number; and evaluating the absorbent article to be comfortable in a case where the sum of amplitude peaks of the first predetermined number is equal to or more than 0.0179 gf·s and equal to or less than

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0.021 gf·s, and the proportion is equal to or more than 23.5% and equal to or less than 32.2%, wherein the first predetermined number is five.

[0010]

In another form of the invention there is provided an absorbent article provided with a skin-contact surface sheet that is designed to contact with a skin of a wearer, and a gist thereof is that a sum of amplitude peaks of frequency spectrum obtained by stroking a top surface of the skin-contact surface sheet along the first direction based on a predetermined measurement condition and performing Fourier transform with respect to waveform data in a time axis of a frictional resistance force generated in a second direction diametrically opposite to the first direction is equal to or less than 0.07 gf·s, and an inclination of a linear approximation straight line of the frequency spectrum is less than -0.90.

[0010a]

Where the terms "comprise", "comprises", "comprised" or "comprising" are used in this specification (including the claims) they are to be interpreted as specifying the presence of the stated features, integers, steps or components, but not precluding the presence of one or more other features, integers, steps or components, or group thereto.

[Brief Description of Drawings]

[0011]

[Fig. 1] Fig. 1 is an exploded plan view of a disposable diaper according to an embodiment of the present invention.

[Fig. 2] Fig. 2 is a cross-sectional view of a disposable diaper 10 taken along line F-F illustrated in Fig. 1.

[Fig. 3] Fig. 3 is a schematic configuration diagram of a measurement apparatus 100 and an evaluation apparatus 200 used in a method of evaluating comfort of an absorbent article according to the embodiment of the present invention.

[Fig. 4] Fig. 4 is a flow diagram of the comfort evaluation method of the absorbent article according to the embodiment of the present invention.

[Fig. 5] Figs. 5(a) and 5(b) are diagrams illustrating an example of waveform data obtained by the measurement apparatus 100 according to the embodiment of the present invention.

[Fig. 6] Figs. 6(a) and 6(b) are diagrams illustrating an example of data after Fourier transform according to the embodiment of the present invention.

[Fig. 7] Fig. 7 is a graph illustrating results of evaluating the comfort of the absorbent article based on association between a proportion (3_sum/sum) of an amplitude peak having a frequency of a multiple of 0.333 Hz with respect to corresponding five peeks,

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and a measurement value of a brain function according to NIRS.

[Fig. 8] Figs. 8(a) and 8(b) are diagrams illustrating the NIRS measurement value of Example and Comparative Example according to the embodiment of the present invention.

[Fig. 9] Figs. 9(a) and 9(b) are graphs illustrating linear approximation straight lines in a case where an x-axis (frequency axis) and a y-axis (amplitude axis) of data after the Fourier transform according to the embodiment of the present invention are expressed as logarithm.

[Fig. 10] Fig. 10 is a graph illustrating a result of evaluating the comfort of the absorbent article based on association between an inclination of the linear approximation straight line according to the embodiment of the present invention and

the measurement value of the brain function according to the NIRS.

[Fig. 11] Fig. 11 is a graph illustrating a result of evaluating the comfort of the absorbent article based on the association between the inclination of the linear approximation straight line according to the embodiment of the present invention and the measurement value of the brain function according to the NIRS.

[Description of Embodiments]

[0012]

Next, a description will be made regarding an embodiment of a method of evaluating comfort of an absorbent article according to the present invention with reference to the drawings. Incidentally, the same or similar reference numerals are attached to the same or similar parts in the following description of the drawings. Meanwhile, the drawings are schematic, and it should be noted that a ratio of each dimension is different from an actual one.

[0013]

Therefore, detailed dimensions or the like should be determined in consideration of the following description. In addition, among the drawings, there may include parts having dimensional relations or ratios differently from one another.

[0014]

(1) Overall Schematic Configuration of Disposable Diaper

Fig. 1 is an exploded plan view of a disposable diaper 10 according to an embodiment. Fig. 2 is a cross-sectional view of the disposable diaper 10 taken along line F-F illustrated in Fig. 1. Incidentally, the exploded plan view illustrated in Fig. 1 is a diagram in a state in which a leg stretching portion 75 and a leg side gather 80 are stretched until a state in which wrinkles are not formed in a top sheet 50, a side flap 70 and the like, that configure the disposable diaper 10.

[0015]

As illustrated in Figs. 1 and 2, the disposable diaper 10 includes a front waistline region 20, a crotch region 25 and a rear waistline region 30. The front waistline region 20 is a part in contact with a front waistline portion (abdominal portion) of a wearer. In addition, the rear waistline region 30 is a part in contact with a rear waistline portion (back portion) of a wearer. The crotch region 25 is positioned between the front waistline region 20 and the rear waistline region 30.

[0016]

Incidentally, in the embodiment, a direction from the front waistline region 20 toward the rear waistline region 30 is called a product longitudinal direction L, and a direction perpendicular to the product longitudinal direction L is called a product widthwise

direction W.

[0017]

The disposable diaper 10 is provided with an absorber 40 that straddles the crotch region 25, and extends toward at least any one between the front waistline region 20 and the rear waistline region 30 from the crotch region 25. The absorber 40 is configured of an absorbent core 40a and a core wrap 40b.

[0018]

The absorbent core 40a can be appropriately configured by using known components or materials, such as ground pulp and high absorbent polymer. The absorbent core 40a is wrapped in the sheet-shaped core wrap 40b.

[0019]

A liquid-permeable top sheet 50 (skin-contact surface sheet) is provided in a top surface (skin-contact surface side) of the absorber 40. In addition, a liquid-impermeable back sheet 60a is provided in a back side (non-skin-contact surface side) of the absorber 40. The back sheet 60a is arranged between the absorber 40 and an exterior sheet 60, and functions as a leak-proof sheet. The side flaps 70 are provided, respectively, in side edge portions in the product widthwise direction W of the absorber 40.

[0020]

The side flap 70 is configured by using one or two or more of plural sheets of nonwoven fabric overlapping one another. In addition, fastening tapes 90 are provided, respectively, in the pair of side flaps 70.

[0021]

A pair of leg stretching portions 75, which can expand and contract in the product longitudinal direction L, is provided in a top surface (the top sheet 50 side) of the absorber 40. In addition, a pair of leg side gathers 80, which extend along the product longitudinal direction L, is provided in inner sides (adjacent to the center in the product widthwise direction W) of the pair of leg stretching portions 75.

[0022]

The fastening tape 90 extends along the product widthwise direction W in the rear waistline region 30, and is fastened to the non-skin-contact surface of the front waistline region 20, thereby causing the disposable diaper 10 to be held by a body of a wearer.

[0023]

In the disposable diaper 10, a sum of a first predetermined number of amplitude peaks of a frequency spectrum obtained by stroking a top surface of the top sheet 50 (skin-contact surface sheet) along the product longitudinal direction L (a first direction)

based on a predetermined measurement condition and performing Fourier transform with respect to waveform data in a time axis of a frictional resistance force generated in a second direction diametrically opposite to the first direction is equal to or less than 0.025 gf-s, and a proportion of a sum of amplitude peaks of a second predetermined number of the frequency spectrum with respect to the sum of the first predetermined number of amplitude peaks is equal to or more than 20%.

[0024]

In addition, the disposable diaper 10 has a sum of the amplitude peaks of the frequency spectrum obtained by performing the Fourier transform with respect to the waveform data in the time axis of the frictional resistance force generated in the second direction diametrically opposite to the first direction when the top surface of the top sheet 50 (skin-contact surface sheet) is stroked along the product longitudinal direction L (the first direction) based on the predetermined measurement condition, the sum of equal to or less than 0.07 gf-s, and an inclination of a linear approximation straight line of the frequency spectrum, the inclination of less than -0.90.

[0025]

Incidentally, a description will be made below regarding the predetermined measurement condition, the sum of the first predetermined number of amplitude peaks, the sum of the amplitude peaks of the second predetermined number, the sum of the amplitude peaks of the frequency spectrum, and the inclination of the linear approximation straight line.

[0026]

(2) Overview of Comfort Evaluation Method

Next, a description will be made regarding the method of evaluating the comfort of the absorbent article which serves a ground for determining the sum of the amplitude peaks and the inclination of the linear approximation straight line of the disposable diaper 10 described above.

[0027]

Fig. 3 is a schematic configuration diagram of a measurement apparatus 100 and an evaluation apparatus 200 used in the method of evaluating the comfort of the absorbent article (for example, the disposable diaper) according to the embodiment.

[0028]

The measurement apparatus 100 measures a frictional resistance force and a coefficient of friction of a material (nonwoven fabric or the like) as a target of the measurement. In the embodiment, a 3D motion friction measuring instrument manufactured by Trinity-Lab Inc. is used as the measurement apparatus 100. To be specific, TL701x

manufactured by Trinity-Lab Inc. is used. Incidentally, a detailed specification of the measurement apparatus 100 will be further described below.

[0029]

The evaluation apparatus 200 is connected to the measurement apparatus 100. The evaluation apparatus 200 obtains data measured by the measurement apparatus 100, and performs storage, processing (the Fourier transform or the like), analysis or the like of the data. It is possible to use a general personal computer (for example, Windows (registered trademark) as the evaluation apparatus 200.

[0030]

Fig. 4 is a flow diagram of the comfort evaluation method of the absorbent article according to the embodiment. As illustrated in Fig. 4, the frictional resistance force (unit: gf) of a target material, in particular, the skin-contact surface sheet (surface sheet) of the disposable diaper is measured (S10) using the measurement apparatus 100.

[0031]

To be specific, the top surface of the skin-contact surface (the surface sheet) of the absorbent article is stroked along a Y direction, in particular, a conveying direction (the first direction) at the time of manufacturing the absorbent article based on the predetermined measurement condition to be described below, thereby obtaining the waveform data in the time axis of the frictional resistance force generated in a direction (the second direction) diametrically opposite (opposite by 180 degrees) to the Y direction (S20).

[0032]

Next, the Fourier transform is performed with respect to the obtained waveform data using the evaluation apparatus 200 (S30). Data having a frequency axis as a reference, in particular, the frequency spectrum is obtained from the time axis by performing the Fourier transform with respect to the obtained waveform data.

[0033]

Further, the waveform data after being subjected to the Fourier transform is analyzed using the evaluation apparatus 200 (S40). To be specific, data of the frequency spectrum (in particular, data of amplitude) is processed, and a graph or the like to be used in the comfort evaluation is generated.

[0034]

The evaluation apparatus 200 retains association between the analyzed data and a measurement value of a brain function according to near-infrared spectroscopy (NIRS), and evaluates the comfort of the absorbent article based on the association (S50). To be

specific, the evaluation apparatus 200 retains the association between a value of the data of the processed frequency spectrum, and the amount of variation in an oxygenated hemoglobin concentration (Oxy-Hb concentration (z-score)) as the measurement value of the NIRS.

[0035]

(3) Measurement Method

Next, a description will be made regarding details of the measurement method using the measurement apparatus 100. Table 1 illustrates a detailed measurement environment and measurement condition using the measurement apparatus 100.

[0036]

[Table 1]

measurement apparatus	TL701x manufactured by Trinity-Lab Inc
measurement environment	25°C, 55%RH
contact terminal	Bio Skin Plate manufactured by Trinity-Lab Inc. (made of urethane, surface with creases, skin thickness of 100 μm)
installation condition of target material	(1) A direction of friction is the Y direction (conveying direction (MD) at the time of manufacturing the absorbent article (disposable diaper)). (2) The absorber for the disposable diaper is arranged at a lower side of the target material (top sheet). (3) The installation is performed in the state of an outer member of the disposable diaper being removed.
vertical load (Fz)	10gf
measurement speed	3 cm/sec.
number of reciprocations	5
data adopted for analysis	Reciprocations are performed five times in a section of 3 cm. Data corresponding to three reciprocations (data of six sections) excluding an initial reciprocation and a last reciprocation among the obtained data is used.

[0037]

The frictional resistance force (unit: gf) of the skin-contact surface (surface sheet) of the absorbent article is measured based on the measurement condition (predetermined

measurement condition) illustrated in Table 1, thereby obtaining the waveform data. Figs. 5(a) and 5(b) illustrate examples of the waveform data obtained using the measurement apparatus 100. Fig. 5(a) illustrates an example of the waveform data according to Example, and Fig. 5(b) illustrates an example of the waveform data according to Comparative Example. As illustrated in Figs. 5(a) and 5(b), an x-axis is time, and a y-axis is the frictional resistance force along the Y direction (MD direction).

[0038]

Next, the Fourier transform using the evaluation apparatus 200 is performed with respect to the waveform data obtained using the measurement apparatus 100 as above. Figs. 6(a) and 6(b) illustrate examples of data after the Fourier transform. Fig. 6(a) corresponds to Fig. 5(a) and illustrates an example of data after the Fourier transform according to Example. Fig. 6(b) corresponds to Fig. 5(b) and illustrates an example of data after the Fourier transform according to Comparative Example. As illustrated in Figs. 6(a) and 6(b), the data is converted into data having the frequency axis as the reference by being subjected to the Fourier transform, and the x-axis becomes a frequency, and the y-axis becomes an amplitude of the frequency spectrum.

[0039]

(4) Analysis Method

Next, a description will be made regarding an analysis method of the waveform data after the Fourier transform described above. In the embodiment, two types of the analysis methods are used. To be specific, the analysis based on the proportion of amplitude peaks of a predetermined number with respect to the sum of a plurality of amplitude peaks of the frequency spectrum (Analysis Method 1), and the analysis based on the inclination of the linear approximation straight line in a case where the x-axis and the y-axis of the data after being subjected to the Fourier transform are expressed as logarithm (Analysis Method 2) are used.

[0040]

(4.1) Analysis Method 1

In Analysis Method 1, five peaks are extracted in order from the largest peak among the plurality of amplitude peaks using the data after the Fourier transform (see Figs. 6(a) and 6(b)). A peak having a frequency of a multiple of 0.333 Hz (in particular, 0.333 Hz $\pm$ 0.005 (5×10^{-3}) Hz) is extracted among the extracted five peaks.

[0041]

Next, a proportion of the extracted peak having the frequency of a multiple of 0.333 Hz with respect to the five peaks is calculated. To be specific, the proportion is calculated based on Formula 1.

[0042]

(a sum of the amplitude peaks of multiples of 0.333 Hz/a total sum of the five amplitude peaks) ×100(%)...(Formula 1)

In this manner, the sum of the first predetermined number of amplitude peaks of the frequency spectrum obtained by performing the Fourier transform (the sum of the five amplitude peaks in order from the largest peak), and the proportion of the sum of the amplitude peaks of the second predetermined number (the sum of the amplitude peaks of multiples of 0.333 Hz), which is smaller than the first predetermined number, with respect to the sum of the first predetermined number of amplitude peaks are calculated. In addition, the amplitude peaks of the second predetermined number are selected with the frequency of a multiple of 0.333 Hz as a reference. Incidentally, the frequency is not necessarily limited to the multiple of 0.333 Hz.

[0043]

Next, the comfort of the absorbent article is evaluated based on the sum of the first predetermined number of amplitude peaks and the sum of the second predetermined number of amplitude peaks, in particular, the association between the proportion of the peaks having the frequency of a multiple of 0.333 Hz with respect to the five peaks, and the measurement value of the brain function according to the NIRS.

[0044]

Table 2 illustrates an example of analysis results based on this analysis method.

[0045]

[Table 2]

Example 1	first time	second time	third time	average	unit
sum	16.35	19.0	18.2	17.9	gf·s
3_sum	5.46	7.04	0	4.2	gf·s
3_sum/sum	33	37	0	23.5	%

Comparative Example 1					
sum	12.34	24.28	10.2	15.6	gf·s
3_sum	1.78	6.14	0	2.6	gf·s
3_sum/sum %	14	25	0	13.2	%

Example 2					
sum	18.84	25.25	18.8	21.0	gf·s
3_sum	4.29	7.75	8.14	6.7	gf·s
3_sum/sum %	23	31	43	32.3	%

Comparative Example 2

sum	19.24	27.43	21.5	22.7	gf·s
3_sum	6.5	2	5.22	4.6	gf·s
3_sum/sum %	34	7	24	21.8	%

Comparative Example 3

sum	27.12	22.47	46.6	32.1	gf·s
3_sum	4.69	0	0	1.6	gf·s
3_sum/sum %	17	0	0	5.8	%

Comparative Example 4

sum	19.32	11.258	45.9	25.5	gf·s
3_sum	1.46	0.998	13.5	5.3	gf·s
3_sum/sum %	8	9	29	15.3	%

Comparative Example 5

sum	18.55	52.21	23.8	31.5	gf·s
3_sum	1.44	2.84	2.39	2.2	gf·s
3_sum/sum %	8	5	10	7.7	%

Comparative Example 6

sum	71.64	80.62	73.2	75.2	gf·s
3_sum	0	0	4.56	1.5	gf·s
3_sum/sum %	0	0	6	2.1	%

[0046]

[Table 3]

	Example 1	Example 2
type	nonwoven fabric	nonwoven fabric
type (details)	through air	mixed fiber spunbond
basis weight	22 g/m^2	50 g/m^2
type of fiber	PE/PET	PP/polyurethane
diameter of fiber	1.3/2.2 dtex	1.5~4.0 dtex

	Comparative Example 1	Comparative Example 2	Comparative Example 3	Comparative Example 4	Comparative Example 5	Comparative Example 6
type	nonwoven fabric	fabric	nonwoven fabric	nonwoven fabric	nonwoven fabric	fabric
type (details)	through air	pile fabric	through air	through air	spunbond	knit
part (material)	top sheet	rayon	top sheet	top sheet	outer sheet	rayon/nylon /polyurethane

[0047]

The sum of Table 2 indicates the total sum of the five amplitude peaks, and 3_sum indicates the sum of the amplitude peaks of multiples of 0.333 Hz. In addition, 3_sum/sum indicates a value of (the sum of the amplitude peaks of multiples of 0.333 Hz/the total sum of the five amplitude peaks) × 100 (%). In the example illustrated in Table 1, the same measurement is performed three times, and an average value of the respective values is used. Incidentally, the example having a numerical value of "0" means that the frequency of a multiple of 0.333 Hz has not appeared.

[0048]

In addition, as illustrated in Table 3, Example 1 and Example 2 are the disposable diapers manufactured by the applicant using a nonwoven fabric. Comparative Examples 1 and 3 to 5 are also the disposable diapers using the nonwoven fabric. Comparative Examples 2 and 6 are not the disposable diaper, but a fabric of a pile fabric or knit.

[0049]

Hereinafter, a description will be made regarding each configuration of disposable diapers according to Example 1 and Example 2. A nonwoven fabric sheet according to Example 1 is configured of a fiber configuration of an upper layer and a fiber configuration of a lower layer to be described hereinafter, and is the nonwoven fabric sheet provided with a convex-and-concave pattern of total 22 g/m2, of which the upper layer is 7 g/m2 and the lower layer is 15 g/m2, and a pitch between neighboring convex portions being set to about 3 mm.

[0050]

(a) Configuration of Lower Layer

In a first step to be described below, a composite fiber having the following configuration is supplied, as a third fiber (the fiber configuration for the lower layer) to a first card machine to form a first web having mass per unit area of 15 g/m2, and the first web is subjected to a predetermined processing to form the lower layer of the nonwoven fabric sheet of Example 1.

- Core component of fiber: polyethylene terephthalate (PET, a melting point of about 260℃)
- Sheath component of fiber: high-density polyethylene (HDPE, a melting point of about 130℃)
- Fineness: 2.2 dtex
- Fiber length: 45 mm

[0051]

(b) Second Upper Layer Fiber

- Core component: PET (the melting point of 260℃)
- Sheath component: HDPE (the melting point of 130℃)
- Fineness: 2.2 dtex
- Fiber length: 45 mm

In addition, a weight ratio of the fiber in the upper layer fiber of a first upper layer fiber and a second upper layer is set such that the first upper layer fiber is 70%, and the second upper layer fiber is 30%.

[0052]

(c) Method of Manufacturing Nonwoven Fabric Sheet

In the first step, the third fiber is supplied to the first card machine to obtain the first web.

[0053]

In a second step, the first upper layer fiber and the second upper layer fiber are supplied to a second card machine at a predetermined mixing ratio to obtain a second web, and the second web is superimposed on the first web, thereby obtaining a composite web.

[0054]

In a third step, the composite web is placed on a circumferential surface of a suction drum. The suction drum has an inner cylinder in the state of being fixed and a breathable outer cylinder which is concentric with the inner cylinder, and rotates in a machine direction MD. The composite web is placed on the circumferential surface of the outer cylinder, and proceeds in the machine direction MD, together with the outer cylinder, at a required speed, for example, at a speed of 100 m/min. A suction zone is formed in the inner cylinder. A first manifold and a second manifold are positioned above the suction zone, and the outer cylinder is interposed between the suction zone, and the first and second manifolds.

[0055]

Each of the first and second manifolds has a plurality of nozzles that is arranged in an axial direction of the suction drum, that is, in a crossing direction CD perpendicular to the machine direction MD, with a required pitch. The nozzle of the first manifold and the nozzle of the second manifold are aligned to be parallel to the machine direction MD, and each of the nozzles has a required diameter of opening, for example, a diameter of 1 mm. A heated air, which has passed through a heater set to a required temperature, for example, 200℃, is injected from each of the nozzles of the first manifold, as a first jet air, toward the composite web. The amount of injection of the first jet air is adjusted by injection pressure, and for example, the first jet air is injected at a proportion of 10

Nl/m2 with respect to a unit surface area of the composite web. Subsequently, a heated air, which has passed through the heater set to a required temperature, for example, 280℃, is injected from each of the nozzles of the second manifold, as a second jet air, toward the composite web. The second jet air is injected at a proportion of, for example, 23 Nl/m2 with respect to the unit surface area of the composite web by adjusting the injection pressure thereof. In the composite web, the first upper layer fiber, the second upper layer fiber, and the third fiber, which are positioned right below the nozzles, move in order in a width direction of the composite web as the first jet air and the second jet air are injected in order so that a primary valley portion is preliminarily formed right below the nozzles, and a raised portion is preliminarily formed between the nozzle and the nozzle arranged in the crossing direction CD. A nozzle pitch of the first manifold and the second manifold is set to 3 mm.

[0056]

In a fourth step, the composite web passes through a dryer. In the dryer, a heated air at a temperature (for example, 140℃), at which a top surface of the fiber configuring the web is allowed to be melt, is blown to the composite web, and various types of the fiber are welded to each other to be in a stable state in which the primary raised portion and the primary valley portion, which have been already formed, are not easily deformed.. These raised portion and valley portion are to be a raised portion and a valley portion of the nonwoven fabric sheet.

[0057]

The composite web exiting the dryer is cooled to be at a room temperature, and thus, becomes the nonwoven fabric sheet that can be used as a wearable article.

[0058]

In addition, a nonwoven fabric sheet according to Example 2 is a nonwoven fabric sheet obtained using an "elastic fiber" and an "extensible fiber" described in JP 2011-226011 A. Here, a gear pitch of a gear stretcher is set to 2.2 mm, and an interval of nozzles of a steam treatment is set to 1.0 mm.

[0059]

Table 4 illustrates an example of the amplitude peaks of multiples of 0.333 Hz extracted in the first measurement illustrated in Table 2. Incidentally, in Table 2, only Example 1, Comparative Example 1, Comparative Example 3 and Comparative Example 4 are illustrated.

[0060]

[Table 4]

Example 1	frequency 10^{-3}Hz	amplitude gf·s
1	499	7.52
2	665	1.19
3	997	2.65
4	1496	3.37
5	1662	1.62
sum		16.35
3_sum		5.46
3_sum/sum		33.4

Comparative Example 1	frequency 10^{-3}Hz	amplitude gf·s
1	501	7.43
2	1503	2.13
3	2504	1.00
4	334	0.90
5	668	0.88
sum		12.34
3_sum		1.78
3_sum/sum		14.42

Comparative Example 3	frequency 10^{-3}Hz	amplitude gf·s
1	502	16.40
2	1507	3.26
3	1004	2.77
4	670	2.61
5	335	2.08
sum		27.12
3_sum		4.69
3_sum/sum		17.29

Comparative Example 4	frequency 10^{-3}Hz	amplitude gf·s
1	501	8.89
2	0	3.88
3	1503	3.46
4	1002	1.63
5	1669	1.46
sum		19.32
3_sum		1.46
3_sum/sum		7.56

[0061]

As illustrated in Table 4, the sum of the amplitude peaks of multiples of 0.333 Hz (333×10^{-3}) ± 0.005 (5×10^{-3}) Hz is calculated as 3_sum. For example, in Example 1, 665 Hz, 997 Hz and 1,662 ($\times 10^{-3}$) Hz are extracted as the corresponding frequencies.

[0062]

Fig. 7 is a graph illustrating results of evaluating the comfort of the absorbent article based on the association between the proportion of the amplitude peak having the frequency of a multiple of 0.333 Hz with respect to the corresponding five peeks (3_sum/sum), and the measurement value of the brain function according to the NIRS. In addition, Table 5 illustrates the corresponding proportion and the measurement value of the brain function according to the NIRS (Oxy-Hb concentration (z-score)).

[0063]

[Table 5]

	number	sum (average value)	3_sum/sum	NIRS measurement value		
				classification	right hemisphere	left hemisphere
Example 1	1	17.9	23.5	high value	0.54	0.83
Example 2	2	21.0	32.2	high value	0.94	1.05
Comparative Example 1	8	15.6	13.2	no data		
Comparative Example 2	3	22.7	21.8	high value	0.36	0.50
Comparative Example 3	4	32.1	5.8	low value	-0.03	0.23
Comparative Example 4	5	25.5	15.3	low value	-0.25	-0.19
Comparative Example 5	6	31.5	7.7	low value	0.06	0.23
Comparative Example 6	7	75.2	2.1	low value	-0.57	-0.24

[0064]
Numbers of "1" to "8" illustrated in Fig. 7 are "numbers" illustrated in Table 5, and correspond to Examples 1 and 2, and Comparative Examples 1 to 6. In addition, Figs. 8(a) and 8(b) illustrate the NIRS measurement value of each of Examples and Comparative Examples illustrated in Table 5.
[0065]
As illustrated in Figs. 7 to 8(b) and Table 5, in a case where a material (Examples 1 and 2, and Comparative Example 2), of which sum is equal to or less than 0.025 gf·s (25 ×10-3 gf·s) and 3_sum/sum is equal to or more than 20%, is caused to contact with a skin surface of a lumbar area of a subject, the NIRS measurement value (Oxy-Hb concentration (z-score)) indicates a high value (equal to or more than 0.3) in both the right hemisphere (right-side head portion) and a left hemisphere (left-side head portion). Incidentally, the subject is set to an average of results obtained from 44 infants who are two to six months old after birth.
[0066]
Based on such the analysis result of data, a region in which sum is equal to or less than 0.025 gf·s (25×10^{-3} gf·s), and 3_sum/sum is equal to or more than 20% is associated with the high value of the NIRS measurement value. To be specific, Oxy-Hb concentration (z-score) of equal to or more than 0.3 is classified as the "high value", and Oxy-Hb concentration (z-score) of less than 0.3 is classified as a "low value".
[0067]
In other words, in a step of evaluating the comfort, the comfort of the absorbent article such as the disposable diaper is evaluated based on the association between the region in which the sum of the first predetermined number of amplitude peaks (sum) is equal to or less than 0.025 gf·s, and the proportion of the sum of the amplitude peaks of the second predetermined number of the frequency spectrum with respect to the sum of the first predetermined number of amplitude peaks (3_sum/sum) is equal to or more than 20%, and the NIRS measurement value higher than a predetermined value (0.3).
[0068]
(4.2) Analysis Method 2

In Analysis Method 2, the inclination of the linear approximation straight line of the frequency spectrum in a case where the x-axis and the y-axis of the data after being subjected to the Fourier transform are expressed as logarithm using the data after the Fourier transform (see Figs. 6(a) and 6(b)) is calculated. That is, in this analysis method, the sum of the amplitude peaks obtained by performing the Fourier transform, in particular, the sum of the amplitude peaks in the entire frequency (total

sum), and the inclination of the linear approximation straight line of the frequency spectrum in the case where the x-axis and the y-axis of the data after being subjected to the Fourier transform are expressed as logarithm are calculated.

[0069]

Next, the comfort of the absorbent article is evaluated based on the association among the sum of the amplitude peaks, the inclination of the linear approximation straight line of the frequency spectrum, and the measurement value of the brain function according to the NIRS.

[0070]

Table 6 illustrates an example of analysis results based on this analysis method.

[0071]

[Table 6]

Example 1	first time	second time	third time	average	unit
total sum of amplitudes	0.042	0.056	0.089	0.062	gf·s
inclination of approximation straight line	-0.856	-0.824	-0.823	-0.834	
Example 2					
total sum of amplitudes	0.047	0.059	0.049	0.052	gf·s
inclination of approximation straight line	-0.880	-0.901	-0.853	-0.878	
Comparative Example 1					
total sum of amplitudes	0.039	0.021	0.037	0.032	gf·s
inclination of approximation straight line	-0.847	-0.622	-0.792	-0.754	
Comparative Example 2					
total sum of amplitudes	0.043	0.053	0.048	0.048	gf·s
inclination of approximation straight line	-0.736	-0.747	-0.712	-0.732	
Comparative Example 3					
total sum of amplitudes	0.071	0.086	0.100	0.86	gf·s
inclination of approximation straight line	-0.961	-1.045	-1.051	-1.019	

Comparative Example 4

total sum of amplitudes	0.054	0.040	0.126	0.074	gf·s
inclination of approximation straight line	-0.975	-0.859	-1.068	-0.967	

Comparative Example 5

total sum of amplitudes	0.054	0.130	0.065	0.083	gf·s
inclination of approximation straight line	-0.947	-1.236	-0.991	-1.058	

Comparative Example 6

total sum of amplitudes	0.139	0.156	0.145	0.146	gf·s
inclination of approximation straight line	-1.063	-1.101	-1.045	-1.070	

[0072]

The total sum of amplitudes of Table 6 indicates the sum of the amplitudes in the entire frequency, and the inclination of approximation straight line indicates the inclination of the linear approximation straight line in a case where the x-axis (frequency axis) and the y-axis (amplitude axis) of the data after the Fourier transform are expressed as logarithm. In the example illustrated in Table 6, the same measurement is performed three times, and an average value of the respective values is used.

[0073]

Figs. 9(a) and 9(b) are graphs illustrating the linear approximation straight lines in a case where the x-axis and the y-axis of the data after the Fourier transform are expressed as logarithm, and values obtained by the Fourier transform are plotted. Fig. 9(a) is a graph illustrating a linear approximation straight line according to Example (Example 1), and Fig. 9(b) is a graph illustrating a linear approximation straight line according to Comparative Example (Comparative Example 4). In addition, a mathematical formula of the linear approximation straight line and a square value of R are illustrated in the graphs illustrated in Figs. 9(a) and 9(b).

[0074]

As illustrated in Figs. 9(a) and 9(b), an inclination of the linear approximation straight line according to Example is -0.856, and an inclination of the linear approximation straight line according to Comparative Example is -0.975.

[0075]

Fig. 10 is a graph illustrating a result of evaluating the comfort of the absorbent article

based on association between the inclination of the linear approximation straight line and the measurement value of the brain function according to the NIRS. In addition, Table 7 illustrates the inclination and the measurement value of the brain function according to the NIRS (Oxy-Hb concentration (z-score)).

[0076]

[Table 7]

	number	total sum of amplitudes	inclination of straight line	NIRS measurement value		
				classification	right hemisphere	left hemisphere
Example 1	1	0.062	-0.834	high value	0.54	0.83
Example 2	3	0.052	-0.676	high value	0.94	1.05
Comparative Example 1	2	0.032	-0.764	no data		
Comparative Example 2	4	0.048	-0.732	high value	0.38	0.60
Comparative Example 3	5	0.086	-1.019	low value	-0.03	0.23
Comparative Example 4	6	0.074	-0.97	low value	-0.25	-0.19
Comparative Example 5	7	0.083	-1.058	low value	0.06	0.23
Comparative Example 6	8	0.146	-1.070	low value	-0.57	-0.24

[0077]
Numbers of "1" to "8" illustrated in the graph of Fig. 10 are "numbers" illustrated in Table 7, and correspond to Examples 1 and 2 and Comparative Examples 1 to 6.
[0078]
As illustrated in Fig. 10 and Table 7, in a case where a material (Examples 1 and 2, and Comparative Example 2), of which the total sum of amplitudes is equal to or less than 0.07 gf-s and the inclination of the linear approximation straight line is less than -0.90, is caused to contact with a skin surface of a lumbar area of a subject, the NIRS measurement value (Oxy-Hb concentration (z-score)) indicates a high value (equal to or more than 0.3) in both the right hemisphere (right-side head portion) and a left hemisphere (left-side head portion).
[0079]
Based on such the analysis result of data, a region in which the total sum of amplitudes is equal to or less than 0.07 gf-s, and the inclination of the linear approximation straight line is less than -0.90 is associated with the high value of the NIRS measurement value. To be specific, Oxy-Hb concentration (z-score) of equal to or more than 0.3 is classified as the "high value", and Oxy-Hb concentration (z-score) of less than 0.3 is classified as a "low value" as similarly to Analysis Method 1.
[0080]
In other words, in a step of evaluating the comfort, the comfort of the absorbent article such as the disposable diaper is evaluated based on the association between the region in which the total sum of amplitudes of the frequency spectrum is equal to or less than 0.07 gf-s, and the inclination of the linear approximation straight line is less than -0.90, and the NIRS measurement value higher than a predetermined value (0.3).
[0081]
(5) Action and Effect

Next, a description will be made regarding action and an effect of the absorbent article (disposable diaper), and the comfort evaluation method described above.
[0082]
First, according to the measurement using the NIRS, it has been found that an infant wearing the disposable diaper feels by distinguishing a difference in the tactile sensation of the nonwoven fabric used in the surface sheet or the like of the disposable diaper. Fig. 11 illustrates the NIRS measurement value (Oxy-Hb concentration (z-score)) in a case where the disposable diaper is worn by the infant, and the NIRS measurement value in a case where a mother of the infant strokes the buttocks of the

infant.

[0083]

The "diaper 1" and the "diaper 2" of Fig. 11 are values of Oxy-Hb concentration (z-score) in a case where disposable diaper is worn. The z-score of the "diaper 2" is 0.94, which is favorable, while the z-score of the "diaper 1" is 0.14. Meanwhile, "mother's palm" is Oxy-Hb concentration (z-score) in a case where a mother strokes the buttocks of her infant. As illustrated in Fig. 11, the z-score in a case where the buttocks of the infant is stroked by mother's palm indicates a high value (about 1.17), but it is understood that the z-score is different depending on a difference in specification used for the surface sheet of the disposable diaper. In general, it has been found that a brain feels comfort as the z-score is high, and the comfort evaluation method according to the embodiment is obtained by focusing on such a difference in the z-score depending on the specification of the disposable diaper (nonwoven fabric).

[0084]

To be specific, as described above, the comfort at the time of wearing the absorbent article such as the disposable diaper is evaluated by associating a value relating to the frequency spectrum of the frictional resistance force which may increase the z-score, and the z-score. It can be referred that the frictional resistance force measured based on the measurement condition described above represents a situation in a pseudo manner in a case where a mother strokes the buttocks of her infant, and a case where the disposable diaper is worn.

[0085]

Accordingly, a range based on the frequency spectrum of such a frictional resistance force, in particular, the region in which sum is equal to or less than 0.025 gf-s (25×10^{-3} gf-s), and 3_sum/sum is equal to or more than 20% (in the case of Analysis Method 1), or the region in which the total sum of amplitudes of the frequency spectrum is equal or less than 0.07 gf-s, and the inclination of the linear approximation straight line is less than -0.90 (in the case of Analysis Method 2) is associated with the high value of the NIRS measurement value, and in this manner, it is possible to evaluate that a material (disposable diaper) having the frequency spectrum representing a value of the corresponding region has high comfort.

[0086]

In other words, according to the comfort evaluation method of the absorbent article described above, it is possible to objectively evaluate the comfort of the absorbent article by associating the measurement value according to the NIRS, and a physical property of the disposable diaper (the surface sheet or the like).

[0087]
Further, in a case where the disposable diaper 10 having a numerical range as described above is worn, for a wearer, it is obvious that a measurement value according to the NIRS increases so that it is possible to improve the comfort at the time of being worn. In addition, it is possible to objectively further improve the comfort at the time of being worn, by increasing the measurement value according to the NIRS.
[0088]
(6) Other Embodiments

As described above, the content of the present invention has been disclosed through the embodiment according to the present invention, but the discussion and drawings forming a part of this disclosure should not be understood as those limiting the present invention. It is obvious for a person skilled in the art to obtain various alternate embodiments, examples and operational techniques from this disclosure.
[0089]
For example, in the embodiment described above, TL701x manufactured by Trinity-Lab Inc. is used as the measurement apparatus 100 and further the contact terminal configured by using the Bio Skin Plate (artificial skin) is used, but the measurement apparatus 100 is not necessarily limited to the corresponding product. Another measurement apparatus may be used in a case where it is possible to obtain the same measurement result as in TL701x manufactured by Trinity-Lab Inc.
[0090]
In the embodiment (Analysis Method 1) described above, the amplitude peak is selected using the frequency of a multiple of 0.333 Hz as the reference, but the corresponding frequency is not necessarily limited to 0.333 Hz. For example, a frequency of which amplitude peaks have many multiples thereof that overlap with one another may be determined based on the data illustrated in Figs. 6(a) and 6(b).
[0091]
In the embodiment described above, the description has been made by exemplifying the disposable diaper, but an applicable range of the present invention is not limited to the disposable diaper, and the present invention can be applied to another absorbent article to be in contact with a wearer's skin, for example, a sanitary napkin or the like. In addition, in the embodiment described above, the description has been made by exemplifying the disposable diaper for an infant, but the present invention is not limited to the disposable diaper for the infant, and can be applied to, for example, a disposable diaper for an elderly person.
[0092]

In this manner, it is a matter of course that the present invention includes various embodiments or the like which are not described herein. Therefore, a technical range of the present invention should be defined only by matters used to define the invention according to a scope of claims reasonable from the above-described description.

[0093]

Incidentally, the entire content of Japanese Patent Application No. 2013-065134 (filed on March 26, 2013) has been incorporated in the specification of the present application by reference.

[Industrial Applicability]

[0094]

It is possible to provide an absorbent article of which comfort at the time of being worn is objectively further improved based on association between a measurement value according to the near-infrared spectroscopy (NIRS) and a physical property of the absorbent article.

[Reference Signs List]

[0095]

10 ... disposable diaper
20 ... front waistline region
25 ... crotch region
30 ... rear waistline region
40 ... absorber
40a ... absorbent core
40b ... core wrap
50 ... top sheet
60 ... exterior sheet
60a ... back sheet
70 ... side flap
75 ... leg stretching portion
80 ... leg side gather
90 ... fastening tape
100 ... measurement apparatus
200 ... evaluation apparatus

2014245946 24 Sep 2018

The claims defining the invention are as follows:

1. A method for evaluating comfort of an absorbent article provided with a skin-contact surface sheet that abuts against a skin of a wearer, comprising the following steps of:

calculating a sum of amplitude peaks of a first predetermined number selected in order from a largest amplitude peak of frequency spectrum obtained by stroking a top surface of the skin-contact surface sheet along a first direction based on a predetermined measurement condition and performing Fourier transform with respect to waveform data in a time axis of a frictional resistance force generated in a second direction diametrically opposite to the first direction, and a proportion of a sum of amplitude peaks multiples of 0.333 Hz ± 0.005 Hz among the amplitude peaks included in the first predetermined number with respect to the sum of amplitude peaks of the first predetermined number; and

evaluating the absorbent article to be comfortable in a case where the sum of amplitude peaks of the first predetermined number is equal to or more than 0.0179 gf·s and equal to or less than 0.021 gf·s, and the proportion is equal to or more than 23.5% and equal to or less than 32.2%,

wherein

the first predetermined number is five.

FIG. 1

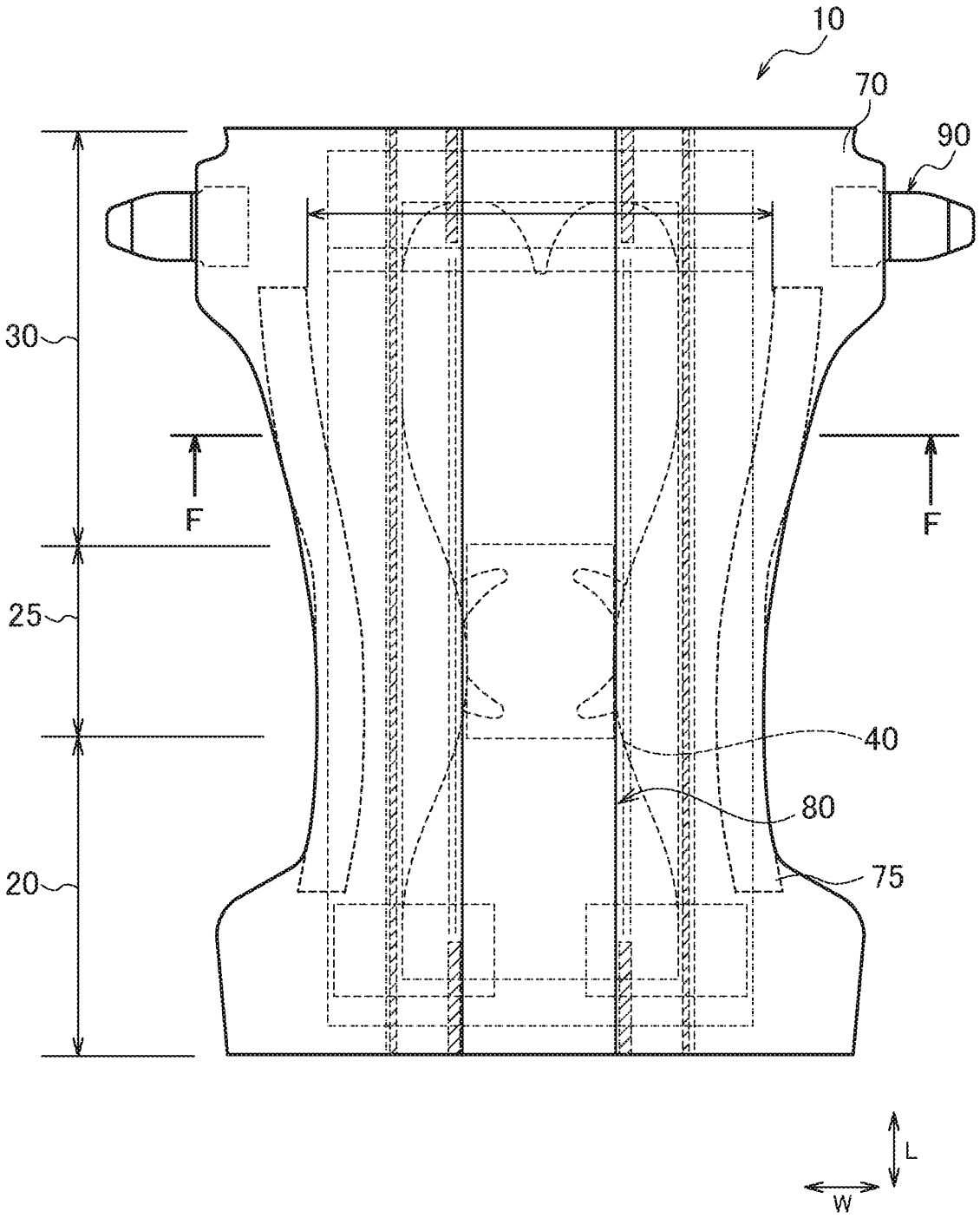


FIG. 2

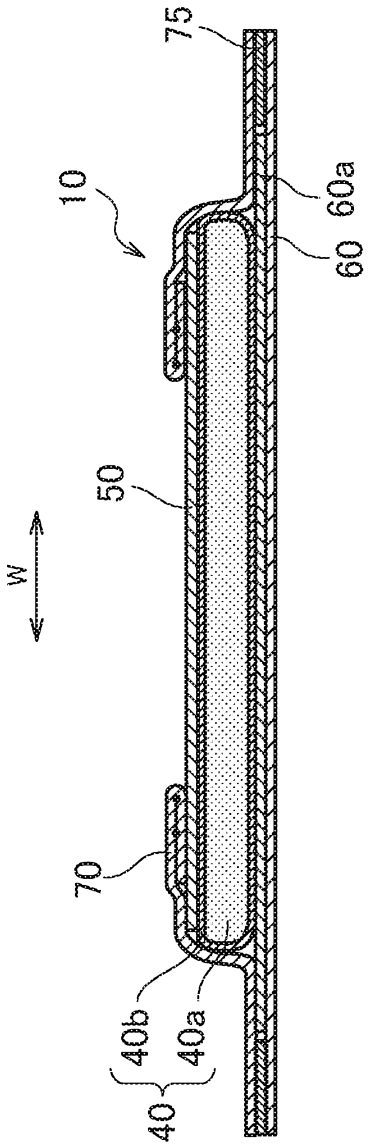


FIG. 3

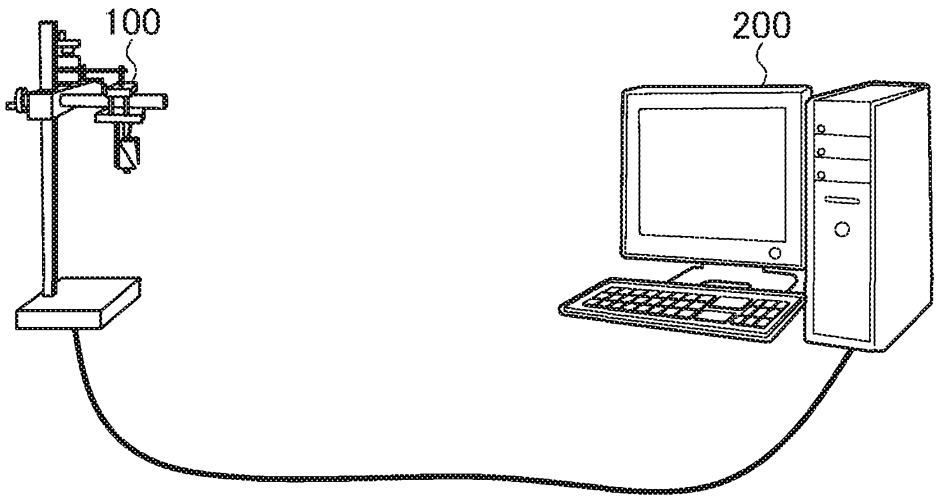


FIG. 4

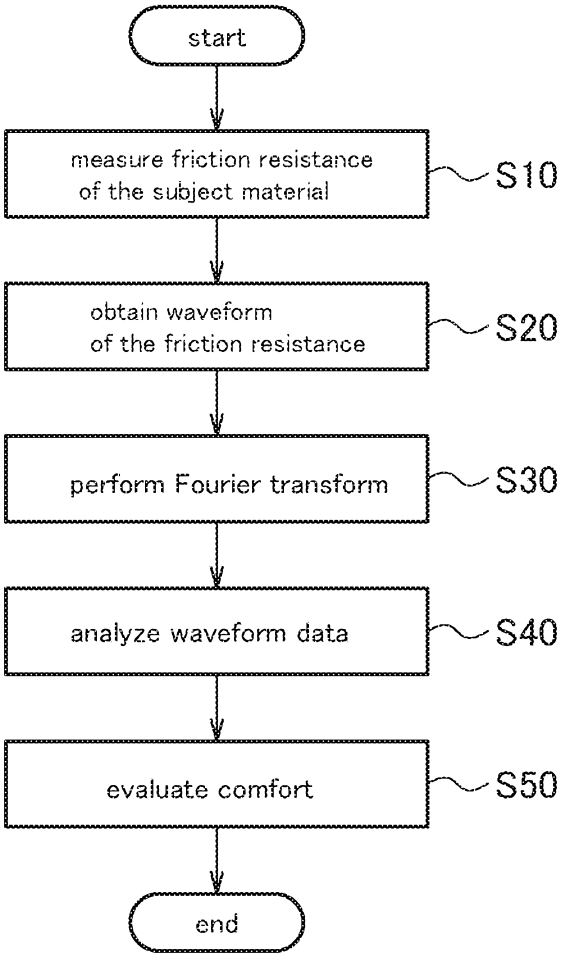

start
measure friction resistance of the subject material
S10
obtain waveform of the friction resistance
S20
perform Fourier transform
S30
analyze waveform data
S40
evaluate comfort
S50
end

FIG. 5

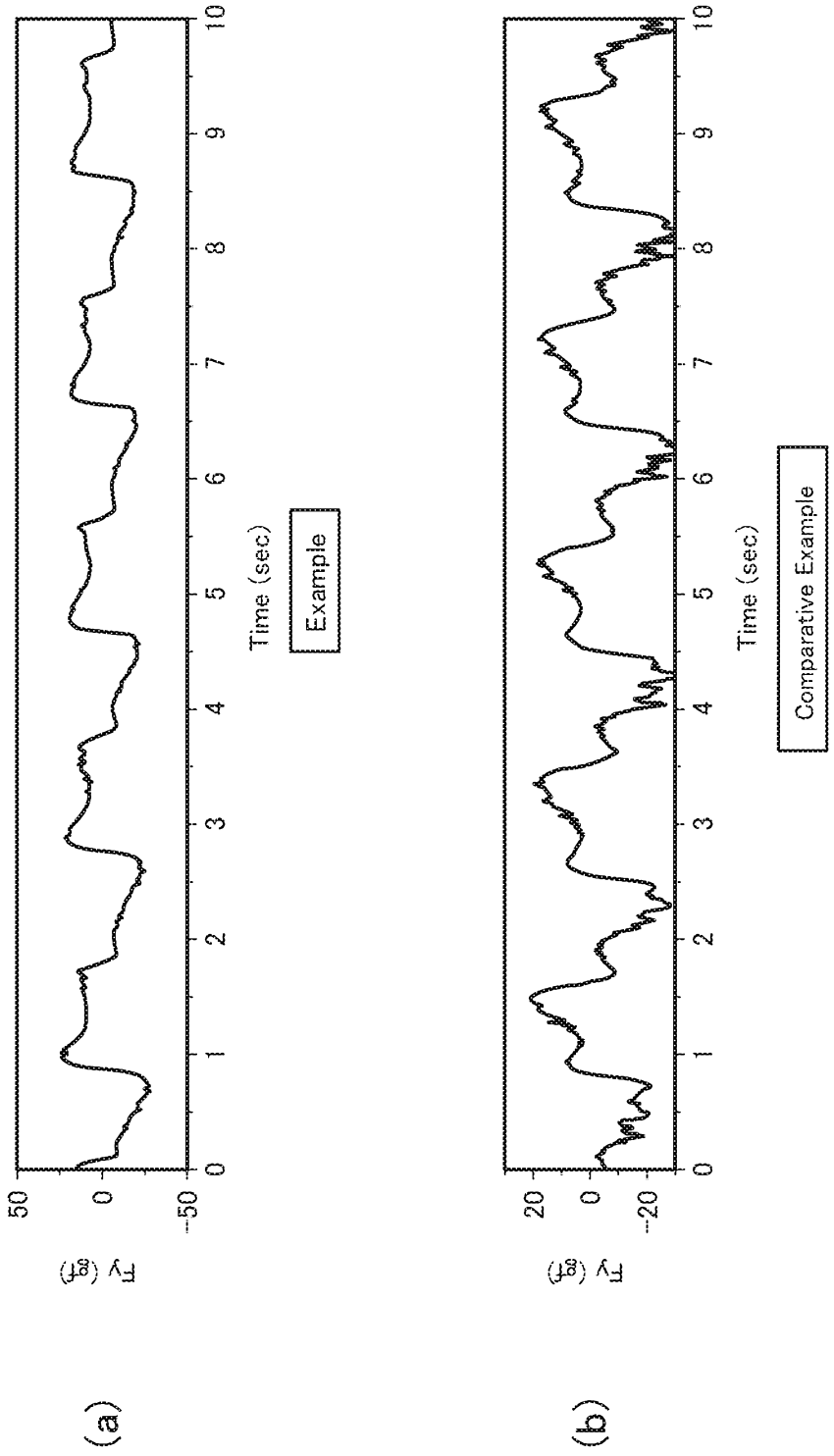

(a)
Fy (gf)
50
0
-50
0
1
2
3
4
5
6
7
8
9
10
Time (sec)
Example
(b)
Fy (gf)
20
0
-20
0
1
2
3
4
5
6
7
8
9
10
Time (sec)
Comparative Example

FIG. 6

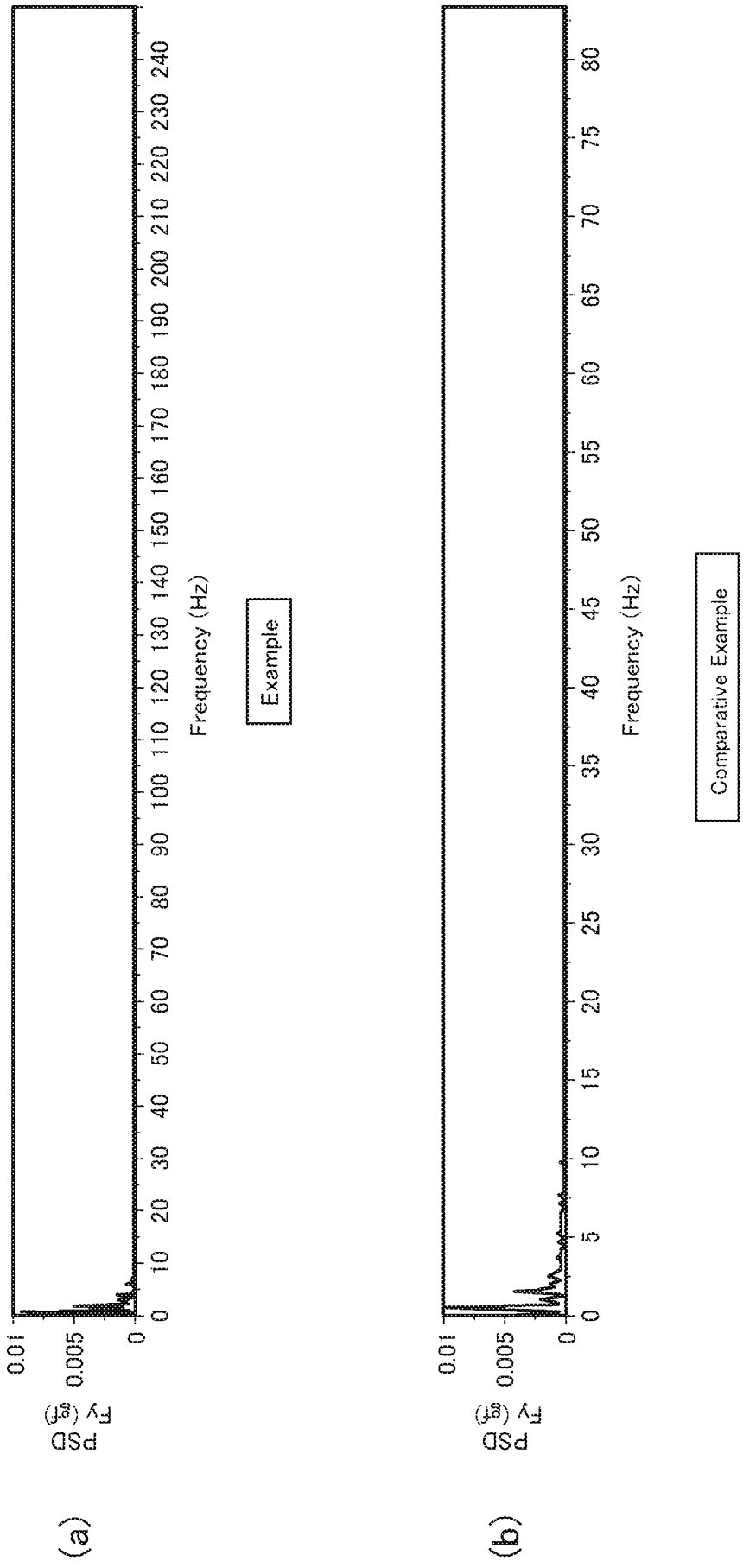

(a)
PSD
Fy (gf)
0.01
0.005
0
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240
Frequency (Hz)
Example
(b)
PSD
Fy (gf)
0.01
0.005
0
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80
Frequency (Hz)
Comparative Example

FIG. 7

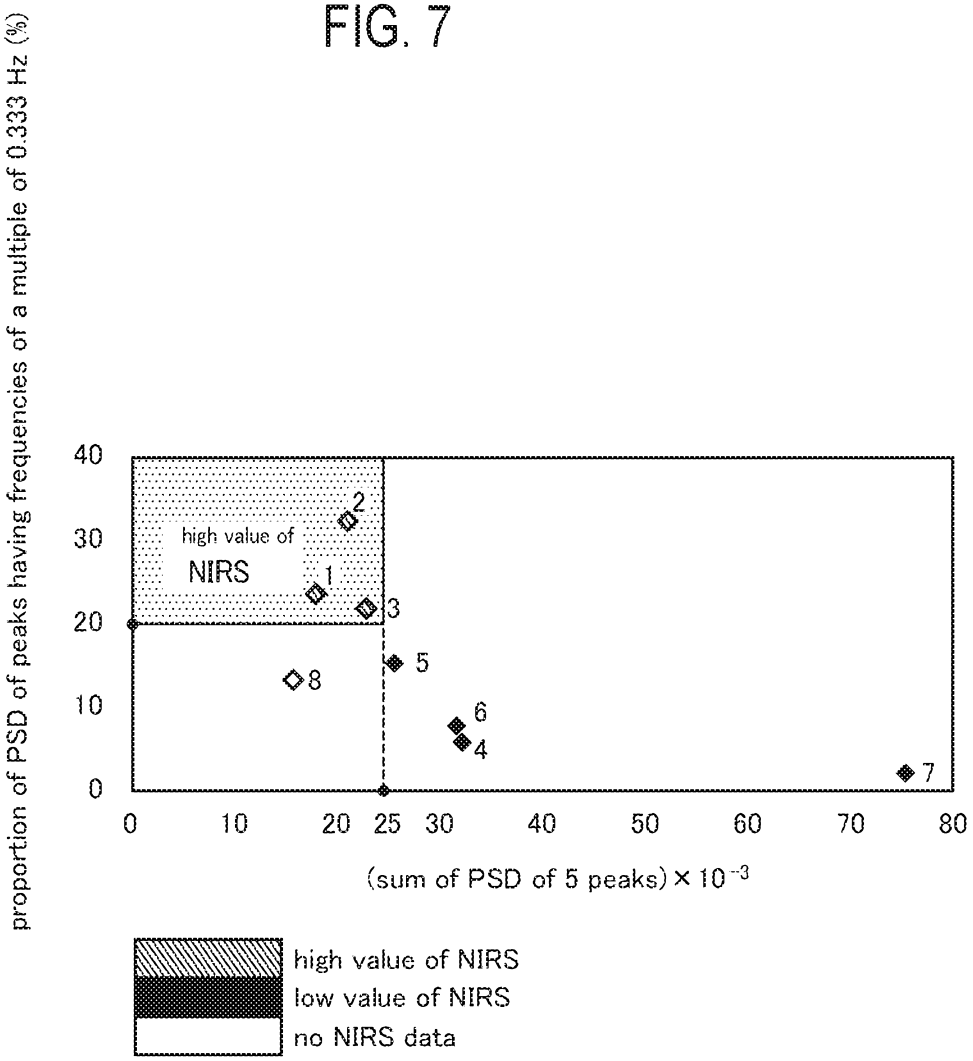

proportion of PSD of peaks having frequencies of a multiple of 0.333 Hz (%)
40
30
20
10
0
high value of
NIRS
1
2
3
5
8
6
4
7
0
10
20
25
30
40
50
60
70
80
(sum of PSD of 5 peaks) × 10 -3
high value of NIRS
low value of NIRS
no NIRS data

FIG. 8

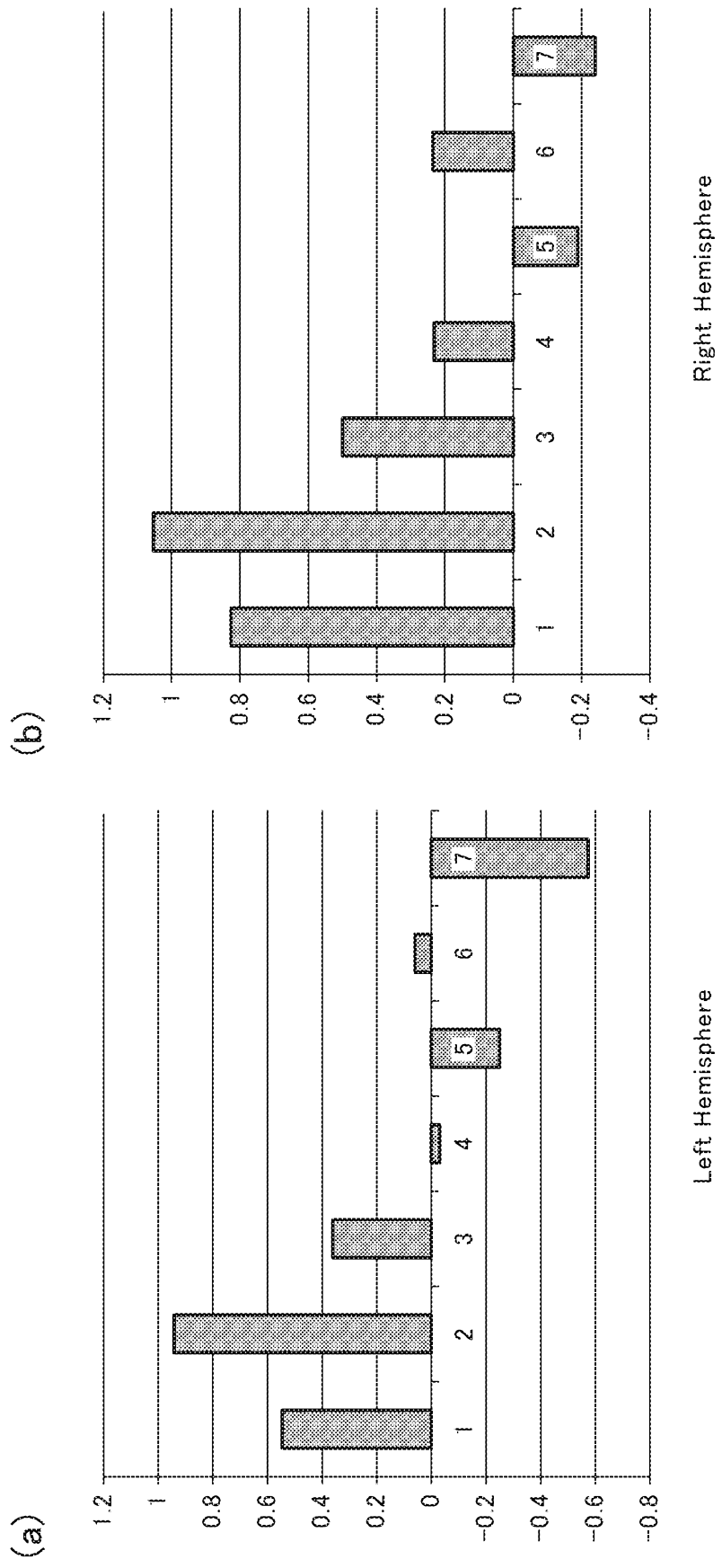
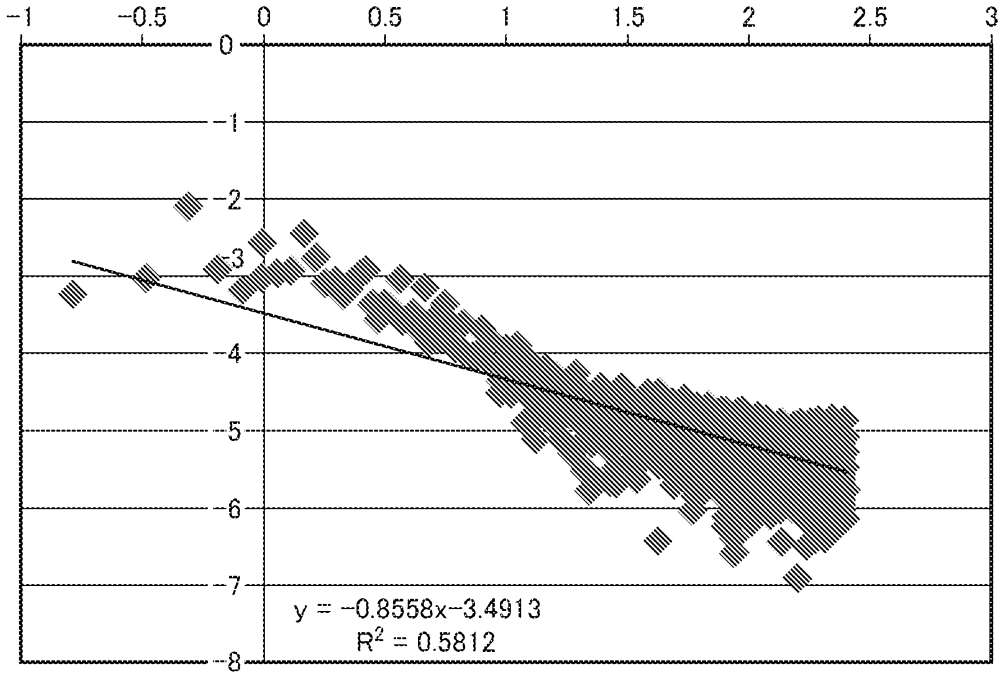

(b)
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
1
2
3
4
5
6
7
Right Hemisphere
(a)
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
1
2
3
4
5
6
7
Left Hemisphere

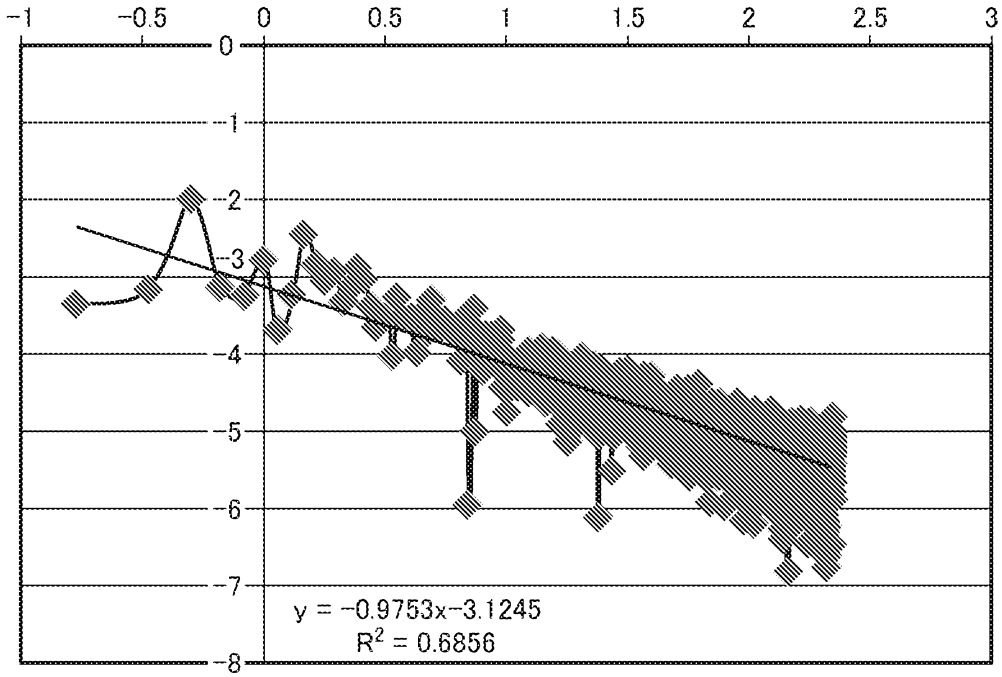
FIG. 9

(a)



Example

(b)



Comparative Example

FIG. 10

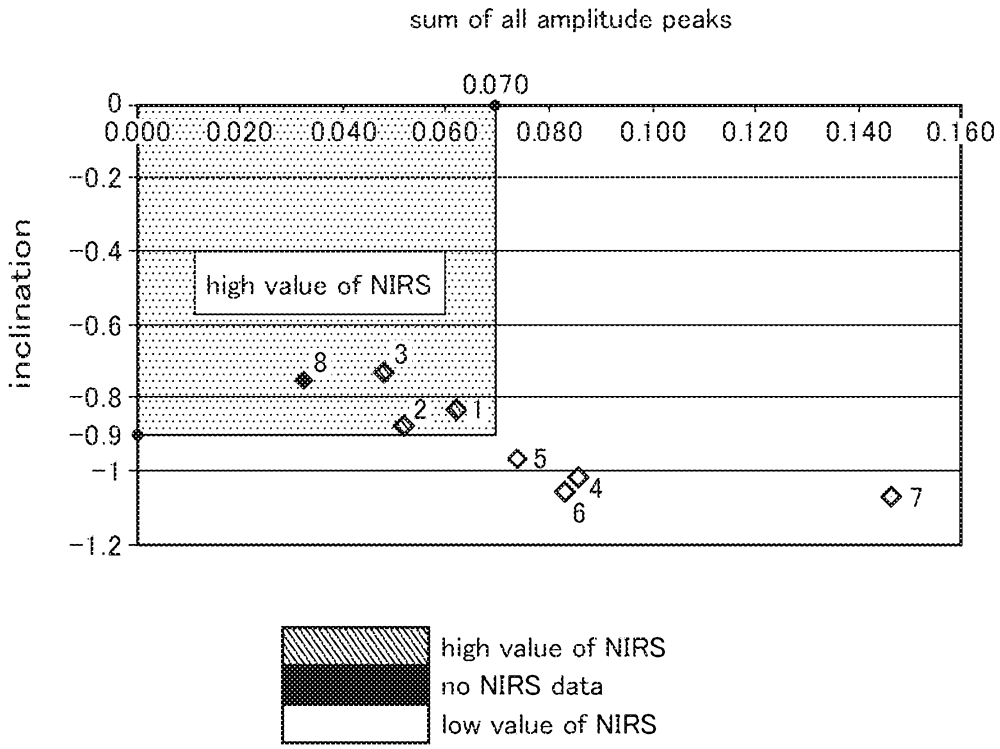
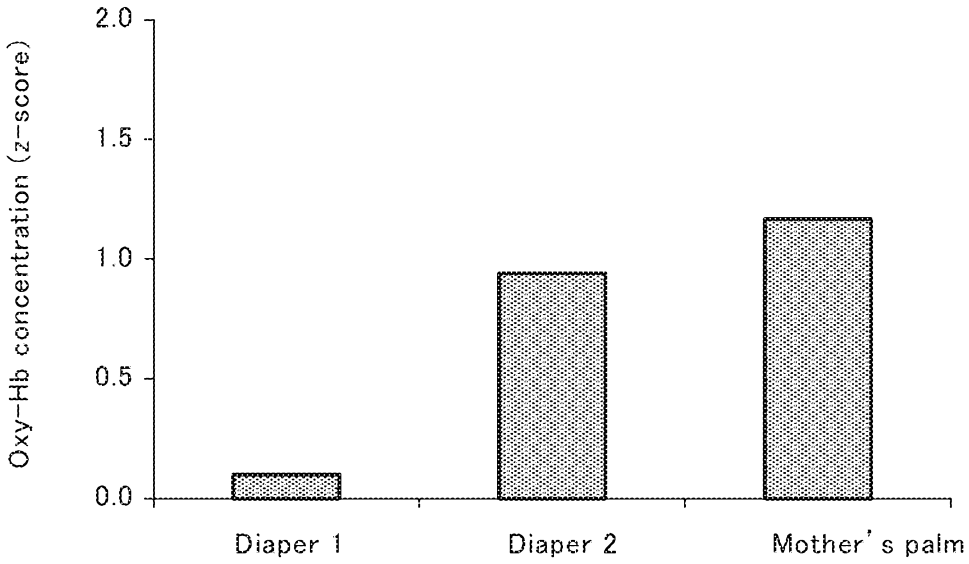

sum of all amplitude peaks
0.070
0
0.000
0.020
0.040
0.060
0.080
0.100
0.120
0.140
0.160
-0.2
-0.4
-0.6
-0.8
-0.9
-1
-1.2
inclination
high value of NIRS
8
3
2
1
5
4
6
7
high value of NIRS
no NIRS data
low value of NIRS

FIG. 11


2.0
1.5
1.0
0.5
0.0
Oxy-Hb concentration (z-score)
Diaper 1
Diaper 2
Mother's palm