(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 1 974 619 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
12.06.2019 Bulletin 2019/24

(21) Application number: **05781509.4**

(22) Date of filing: **30.08.2005**

(51) Int Cl.:
A41D 31/00 *(2019.01)* ***B63C 11/04*** *(2006.01)*
A41D 13/00 *(2006.01)*

(86) International application number:
PCT/JP2005/015749

(87) International publication number:
WO 2007/026395 (08.03.2007 Gazette 2007/10)

(54) **MATERIAL FOR UNDERWATER SUIT AND UNDERWATER SUIT MAKING USE OF THE SAME**

MATERIAL FÜR TAUCHERANZUG UND DIESES VERWENDENDER TAUCHERANZUG

MATÉRIAU POUR COMBINAISON SOUS-MARINE ET COMBINAISON SOUS-MARINE UTILISANT LEDIT MATÉRIAU

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC NL PL PT RO SE SI SK TR

(43) Date of publication of application:
01.10.2008 Bulletin 2008/40

(73) Proprietor: **Yamamoto, Tomizo**
Osaka-Shi, Osaka 544-0005 (JP)

(72) Inventor: **Yamamoto, Tomizo**
Osaka-Shi, Osaka 544-0005 (JP)

(74) Representative: **Abel & Imray**
Westpoint Building
James Street West
Bath BA1 2DA (GB)

(56) References cited:
GB-A- 2 268 440
GB-A- 2 270 829
JP-A- 2004 300 598
JP-U- 3 114 295
JP-U- 3 125 694
JP-U- 60 176 997
JP-U- 62 100 296
US-A- 5 359 735

EP 1 974 619 B1

Description

Technical Field

[0001] The present invention relates to a material for underwater suits and an underwater suit using the same.

Background Art

[0002] Underwater suits can be divided into wet and dry suits, each of which includes suits for diving, surfing, and triathlon. The wet suit is intended to be used by placing water in the suit to provide a heat-retaining effect. Thus, the heat-retaining effect is exerted by water being filled between the body and wet suit and warmed by body temperature. Conversely, the dry suit is intended to have a structure preventing the influx of sea water into the suit to keep the inside thereof in a dry state to provide a heat-retaining effect.

[0003] As a material for these underwater suits, an elastic foam such as natural or synthetic rubber is generally used which has a stretchable fabric such as jersey laminated to its surface. For example, Patent Document 1 discloses a wet suit composed of a cloth material in which a woven or knitted fabric having elasticity is laminated to both sides of a foaming rubber material, wherein the space between the cloth material and the body of a wearer is wetted with water by its exposure, in which holes are provided in part or whole of the foaming rubber material.

[0004] This wet suit does not give unpleasant feelings such as swelter and squalor to the wearer in the case of competitive sports such as triathlon where exercises are performed on land while wearing a wet suit because the holes provided in the foaming rubber material give a good air permeability. It has been also described that the wet suit can be suitably worn without impairing mobility when the wearer moves from underwater to land because the water infiltrating in the suit is instantaneously discharged with air to the outside.

Patent Document 1: Japanese Patent Laid-Open No. 6-312692 (See Claim 1 and paragraph no. 0017)

[0005] The wet suit described in Patent Document 1 has the advantage of having a good air permeability on land because the holes provided in the foaming rubber material pierce through. However, in water, not only the water specially warmed in the suit is discharged thereoutside through the holes, but also external cold water flows into the suit through the holes. Thus, the heat-retaining effect thereof is low.

[0006] In addition, the wet suit described in Patent Document 1 is provided with heat-retaining properties and buoyancy by using the foaming rubber material, but the effects of thereof is not sufficient because the amount of air retained by the foaming rubber material is small. Even if air is present in the holes, it is discharged and can not be retained because the holes are formed by piercing the foaming rubber material. Thus, the suit can not be sufficiently provided with heat-retaining properties and buoyancy.

[0007] In view of the above-described problems, an object of the present invention is to provide a material for underwater suits, having high heat-retaining effect and buoyancy, and an underwater suit using the same.

[0008] GB 2268440 A (Middleton, Nigel John) published 12 January 1994 discloses a thermal insulative fabric, which takes advantage of the low thermal conductivity of enclosed air within a chamber, comprises two layers of closed cell elastomer, one of the layers being punctuated to provide air pockets between the layers. Also this fabric provides an increased buoyancy factor, and thus confers advantages with regard to safety and survival in the instance of cold water emersion. The fabric is intended for use in the surface water sport field where buoyancy combined with efficient retention of body heat are essential for comfort and survival.

Disclosure of the Invention

[0009] In accordance with aspects of the invention, there is provided a material used for wet suits for diving, a material used for wet suits for surfing, and a material used for wet suits for triathlon, as defined in the appended claims.

[0010] The material comprises an elastic foam layer having plural recess portions formed on at least one side thereof. When the material is used as a wet suit, in which case the recess portions of the elastic foam layer are opened toward the side of the body, it can retain a large amount of water because of the accumulation of water in the recess portions, which makes a film of water prone to be formed between the body and the suit. In addition, not only the warmed water is hardly discharged to the outside, but also external cold water less easily penetrates, because the recess portions do not pierce through the elastic foam layer. Thus, a wet suit having a high heat-retaining effect is obtained.

[0011] "Material for underwater suits, having an elastic foam layer" is a concept including a monolayer material consisting of only an elastic foam layer and a laminated material consisting of other layers laminated to the elastic foam layer. The recess portions may be also formed on both sides of the elastic foam layer.

[0012] The opening of the recess portion has a diameter of, for example, 2 to 6 mm, preferably 4 mm. The depth of the recess portion is, for example, 0.5 to 5 mm, preferably 1 to 4 mm. A deviation from the above-described range cannot provide favorable heat-retaining effect and buoyancy.

[0013] A different layer may be laminated to the elastic foam layer; it may be laminated to the surface of the side where recess portions are not formed (hereinafter referred to as "recess non-formed surface") or may be laminated to the recessed surface. Non-limiting examples of the different layer include an elastic foam, a stretchable fabric such as jersey, a layer using a coating agent, and

a coating layer such as metal foil.

[0014] The lamination of a different layer to the recessed surface will lead to the closing of the openings of the recess portions by the different layer, and therefore is suitable when air is desired to be retained in the recess portions to enhance the heat-retaining properties and buoyancy of an underwater suit. Specifically, a closing layer impermeable to both air and water is laminated to the recessed surface of the elastic foam layer directly or via another layer to close the openings of the recess portions. Under this situation, the whole insides of the recess portions are prevented from being filled by the closing layer or another layer. Air is less susceptible to leakage to the outside of the recess and water less easily penetrates into the recess, because the recess does not pierce through the elastic foam layer and has the opening closed by a closing layer impermeable to both air and water. Thus, air can be retained in the recess, which imparts stable buoyancy to the laminated material. Here, the material is suitable for suits for triathlon, requiring buoyancy under water.

[0015] The material for the closing layer is not limited, provided that it is a material impermeable to both air and water, but preferably an elastic foam having closed cells. An elastic foam can strengthen the heat-retaining properties and buoyancy through the cells contained therein.

[0016] In addition, the closing layer may be laminated to the elastic foam layer directly or by inserting another layer in between. In other words, the closing layer just has to be able to close the openings of the recess portions of the elastic foam layer directly or indirectly. Non-limiting examples of another layer include a stretchable fabric such as jersey, a layer using a coating agent, and a coating layer such as metal foil.

[0017] The elastic foam comprising the elastic foam layer or closing layer is preferably Neoprene Rubber (registered trademark; hereinafter omitted), but may be natural rubber, a synthetic rubber such as chloroprene rubber, isoprene rubber, butyl rubber, styrene-butadiene rubber, butadiene rubber, nitrile rubber, ethylene-propylene rubber, or chlorosulfonated polyethylene rubber, or a synthetic resin.

[0018] A coating layer containing hollow microcapsules or nanocapsules is laminated to at least one side of the elastic foam layer. Alternatively, in the case of a laminated body having the elastic foam layer and/or the closing layer, the coating layer containing hollow microcapsules or nanocapsules may be also present on at least one surface of the laminated body or between arbitrary layers of the laminated body. The material for the coating layer or microcapsules or nanocapsules is not limited. The containment of hollow microcapsules or nanocapsules in the coating layer can enhance the heat-retaining properties and buoyancy because the laminate contains air cells.

[0019] Further, when the closing layer is laminated to the recessed surface of the elastic foam layer directly or via another layer to close the openings of the recess portions, air is less susceptible to leakage to the outside of the recess portions and water less easily penetrates into the recess portions. Thus, the use thereof of the wet suit enables the retaining of air in the recess portions, and can impart stable buoyancy to the suit.

Brief Description of the Drawings

[0020]

Figure 1 is a cross-sectional view of an exemplary material comprising an underwater suit;

Figure 2 is a cross-sectional view of a modification of the material of Figure 1;

Figure 3 is a cross-sectional view of a second exemplary material comprising an underwater suit;

Figure 4 is a cross-sectional view of a material used for wet suits for diving in accordance with a first embodiment of the invention;

Figure 5 is a cross-sectional view of a material used for wet suits for surfing in accordance with a second embodiment of the invention; and

Figure 6 is a cross-sectional view of a material used for wet suits for triathlon in accordance with a third embodiment of the invention.

Description of Symbols

[0021]

1 Recess portion

2 Elastic foam layer

3 Stretchable fabric

4 Coating layer

5 Closing layer

Best Mode for Carrying Out the Invention

[0022] The embodiments of the present invention are described below with reference to the drawings.

[0023] Figure 1 is a cross-sectional view of an exemplary material comprising an underwater suit. As shown in Figure 1, the material composing an underwater suit of this example is composed of an elastic foam layer 2 having plural recess portions 1 formed on one side thereof, a stretchable fabric 3 laminated to the recess non-formed surface of the elastic foam layer 2, and a coating layer 4 formed on the recessed surface of elastic foam layer 2. The lamination between the elastic foam layer 2

and the stretchable fabric 3 is properly fixed using any adhesive, but may be fixed by another means. In addition, when the' coating layer 4 itself has adhesiveness such as tackiness, it may be laminated using the adhesiveness. The material for underwater suits thus formed is arranged so that the recessed surface faces the side of the body, and subjected to sewing or the like in a three-dimensional manner so as to fit the body to form an underwater suit.

[0024] The elastic foam layer 2 consists of an elastic foam having closed cells. As the elastic foam, neoprene rubber is used, but another natural or synthetic rubber or a synthetic resin may be employed. The elastic foam layer 2 has a thickness of, but not limited to, about 1 to 10 mm, preferably 1 to 8 mm, more preferably 4 to 5 mm.

[0025] A plurality of recess portions 1 having circular cross sections are formed on one side of the elastic foam layer 2. By way of non-limiting example, the recess portion 1 has an opening diameter of 3 mm, a depth of 1 mm, and a minimal distance to the circumference of an adjacent recess portion of about 4 mm. Two to three recess portions 1 per cm^2 are preferable because sufficient heat-retaining properties and buoyancy can be imparted. The recess portions 1 are regularly arranged lengthwise and crosswise on one side of the elastic foam layer 2. In this respect, the elastic foam layer 2 may be formed in a unified manner, or may be formed by laminating an elastic foam 2b having a multiplicity of through-holes to an elastic foam 2a having a sheet form as shown in Figure 2. The portion surrounded by the through-hole and the elastic foam 2a having a sheet form forms the recess portion 1.

[0026] As the stretchable fabric 3, nylon or polyester jersey fabric is used, but another woven fabric or knit employing a synthetic or natural fiber having a good air permeability may be used. The stretchable fabric 3 is preferable because it can follow body movement owing to the stretchability thereof. The stretchable fabric 3 has a thickness of 0.2 to 1.5 mm, preferably about 0.5 mm.

[0027] The coating layer 4 contains hollow nanocapsules or microcapsules. The inclusion of air in nanocapsules or microcapsules results in the containment of air cells in the coating layer 4, which enhances the heat-retaining properties and buoyancy. The coating layer 4 coated on the recessed surface of the elastic foam layer 2 may be laminated to only the region excluding the recess portions 1 as shown in Figure 1, or may be coated along the interior surface of the recess portions 1 so that the recess portions 1 are not wholly filled therewith.

[0028] The nanocapsule or microcapsule is a hollow capsule containing no core substance in the shell; the material for the shell is suitably polyurethane resin, but may be composed of a thermoplastic substance selected from the group consisting of polyamide, polybutadiene, acrylonitril, methyl methacrylate and vinylidene chloride resins, or a mixture thereof. The blending amount of the nanocapsule or microcapsule is preferably 1 to 10% by weight based on the coating layer.

[0029] Non-limiting examples of the coating layer 4 include a layer using a coating agent, or metal foil; a well-known material may be employed if it can contain nanocapsules or microcapsules. Coating agents include, but not limited to, urethane resin, fluororesin, olefin resin and silicon resin coating agents. When provided on the surface of the underwater suit cloth, the coating layer 4 is preferably an amphipathic coating agent having hydrophilicity and hydrophobicity. Examples thereof include a coating agent containing a surfactant. An underwater suit capable of repelling water in the air and having affinity with water in water to reduce flow resistance can be made.

[0030] The metal foil is a metal material made in the form of a film. This metal foil may be used by sticking to another layer using an adhesive or the like. The film-like metal foil is an ultra-thin film having a thickness of about 70 microns and effectively exerts heat-insulating and heat-retaining properties. The fatigue of a wearer due to heat loss can be reduced. A material for the metal foil is preferably titanium, but gold, silver, aluminium, lead, or the like may be also used. Nanocapusules or microcapsules are coated on the surface of a metal foil of any of the above materials using a coating agent so that these capsules are disposed in dots.

[0031] According to the above-described constitution, when the material of this example is used as an underwater suit, in which case the recessed surface of the elastic foam layer 2 faces the side of the body, a large amount of water can be retained and a film of water is prone to be formed between the body and the suit, because water is accumulated in the recess portions 1. In addition, not only warmed water is hardly discharged to the outside, but also external cold water less easily penetrates because the recess portions 1 do not pierce through the elastic foam layer 2. Thus, the underwater suit will have a high heat-retaining effect.

[0032] Further, when the material is used as a dry suit, a large amount of air can remain in the recess portions 1. The air in the recess portions 1 is hardly discharged to the outside because the recess portions 1 do not pierce through. Thus, the synergistic effect of the air remaining in recess portions 1 and the closed cells present in the elastic foam layer 2 enables the sufficient exertion of the heat-retaining properties and buoyancy.

[0033] Figure 3 is a cross-sectional view of a second exemplary material comprising an underwater suit. As shown in Figure 3, this example is characterized in that a closing layer 5 consisting of an elastic foam is laminated to the recessed surface of the elastic foam layer 2 to close the openings of the recess portions 1, and has other basic constitutions similar to those of the above-described example. The lamination between the elastic foam layer 2 and the closing layer 5 is properly fixed using any adhesive, but may be fixed by another means.

[0034] Specifically, the material composing an underwater suit of the second example is composed of the elastic foam layer 2 having the plural recess portions 1 formed on one side thereof, a stretchable fabric 3 lami-

nated to the recess non-formed surface of the elastic foam layer 2, a closing layer 5 laminated to the recessed surface of the elastic foam layer 2, and coating layer 4 laminated to the surface of closing layer 5. As shown in Figure 3, the coating layer 4 is arranged so as to face the side of the body. In this respect, elastic foam layer 2 may be reversed with closing layer 5 positioned in the outer side direction. Thus, the coating layer 4, the elastic foam layer 2, the closing layer 5 laminated to the recessed surface of the elastic foam layer 2, and the stretchable fabric 3 may be laminated in that order from the side of the body. The material for underwater suits thus formed is subjected to sewing or the like in a three-dimensional manner so as to fit the body to form an underwater suit.

[0035] The closing layer 5 consists of an elastic sheet foam. As the elastic foam, Neoprene Rubber is used as is the case with the elastic foam layer 2, but another natural or synthetic rubber or a synthetic resin may be employed. In addition, the elastic foam has closed cells. The closing layer 5 has a thickness of, but not limited to, about 1 to 10 mm, preferably about 4 to 5 mm.

[0036] Air can be stored in the recess portions 1 because the openings of the recess portions 1 formed on elastic foam layer 2 are closed by the closing layer 5. The air in the recess portions 1 is less susceptible to leakage. Thus, stable heat-retaining properties and buoyancy can be imparted to the underwater suit. This example is suitable for a suit for triathlon requiring buoyancy.

[0037] Embodiments of the invention are described below in detail.

[0038] Figure 4 is a cross-sectional view showing a material used for wet suits for diving in accordance with a first embodiment of the invention. As shown, according to the material in this embodiment, a coating layer 4a, an elastic foam layer 2, a coating layer 4b laminated to the recess non-formed surface of the elastic foam layer 2, a second elastic foam layer 6 having a sheet form, the coating layer 4b, and a stretchable fabric 3 are laminated in that order from the side of the body. The thicknesses of the elastic foam layer 2, the second elastic foam layer 6, and the stretchable fabric 3 are 5 mm, 5 mm, and 0.5 mm, respectively. In this respect, the thicknesses of the elastic foam layer 2, the second elastic foam layer 6, and the stretchable fabric 3 may be varied in the ranges of 1 to 10 mm, 1 to 10 mm, and 0.2 to 1.5 mm, respectively.

[0039] The second elastic foam layer 6 consisted of an elastic foam having closed cells. As the elastic foam, Neoprene Rubber is used, but another natural or synthetic rubber or a synthetic resin may be employed.

[0040] The coating layer 4 contains nanocapsules. The nanocapsule used is NC948 from Nomura Trading Co., Ltd., but not limited thereto. An amphipathic coating agent is used for the coating layer 4a on the side of the recessed surface of elastic foam layer 2. The amphipathic coating
agent is obtained by uniformly mixing 13 parts by weight of a polyurethane polymer, 7 parts by weight of polytetrafluoroethylene fine powder, 2 parts by weight of silicon oil, and 2 parts by weight of sodium dodecyl sulfate in the following solvents; 2 parts by weight of acetone, 3 parts by weight of methyl isobutylene ketone (MIBK), 55 parts by weight of toluene, 5 parts by weight of butyl acetate, and 11 parts by weight of diacetone alcohol. In this respect, the amount of the polyurethane polymer may be varied in the range of 8 to 18 parts by weight; that of the polytetrafluoroethylene fine powder, 2 to 12 parts by weight; that of silicon oil, 1 to 7 parts by weight; that of sodium dodecyl sulfate, 1 to 7 parts by weight; that of acetone, 1 to 7 parts by weight; that of methyl isobutylene ketone (MIBK), 1 to 8 parts by weight; that of toluene, 50 to 60 parts by weight; that of butyl acetate, 1 to 10 parts by weight; and that of diacetone alcohol, 6 to 16 parts by weight. In addition, metal foils of titanium are used in the coating layers 4b between the elastic foam layer 2 and the second foam layer 6 and between the second foam layer 6 and the stretchable fabric 3.

[0041] When the material is used as a wet suit, in which case the recessed surface of the elastic foam layer 2 faces the side of the body, a film of water is prone to be formed between the body and the suit because water is accumulated in the recess portions 1. In addition, not only warmed water is hardly discharged to the outside, but also external cold water less easily penetrates, because the recess portions 1 do not pierce through the elastic foam layer 2. Thus, the wet suit will have a high heat-retaining effect.

[0042] Figure 5 is a cross-sectional view showing a material used for wet suits for surfing in accordance with a second embodiment of the invention. As shown, according to the material in this embodiment, a coating layer 4a, an elastic foam layer 2, a coating layer 4b laminated to the recess non-formed surface of the elastic foam layer 2, a stretchable fabric 3, a coating layer 4b, a second elastic foam layer 6 having a sheet form, and the coating layer 4a are laminated in
that order from the side of the body. The stretchable fabric 3 hardly absorbs water because it positions between the elastic foam layer 2 and the second elastic foam layer 6. Thus, this reduces a change in weight of the whole material. The thicknesses of the elastic foam layer 2, the second elastic foam layer 6, and the stretchable fabric 3 are 5 mm, 5 mm, and 0.5 mm, respectively. In this respect, the thicknesses of elastic foam layer 2, second elastic foam layer 6, and jersey fabric 3 may be varied in the ranges of 1 to 10 mm, 1 to 10 mm, and 0.2 to 1.5 mm, respectively.

[0043] The coating layer 4b contains nanocapsules. The nanocapsule used is NC948 from Nomura Trading Co., Ltd., but not limited thereto. An amphipathic coating agent is used for the coating layers 4a on the recessed surface of the elastic foam layer 2 and the surface of the second elastic foam layer 6. The amphipathic coating agent is obtained by uniformly mixing 13 parts by weight of a polyurethane polymer, 7 parts by weight of poly-

tetrafluoroethylene fine powder, 2 parts by weight of silicon oil, and 2 parts by weight of sodium dodecyl sulfate in the following solvents: 2 parts by weight of acetone, 3 parts by weight of methyl isobutylene ketone (MIBK), 55 parts by weight of toluene, 5 parts by weight of butyl acetate, and 11 parts by weight of diacetone alcohol. In this respect, the amount of the polyurethane polymer may be varied in the range of 8 to 18 parts by weight/ that of the polytetrafluoroethylene fine powder, 2 to 12 parts by weight; that of silicon oil, 1 to 7 parts by weight; that of sodium dodecyl sulfate, 1 to 7 parts by weight; that of acetone, 1 to 7 parts by weight; that of methyl isobutylene ketone (MIBK), 1 to 8 parts by weight; that of toluene, 50 to 60 parts by weight; that of butyl acetate, 1 to 10 parts by weight; and that of diacetone alcohol, 6 to 16 parts by weight. In addition, metal foils of titanium are used for the coating layers 4b between the elastic foam layer 2 and the stretchable fabric 3 and between the stretchable fabric 3 and the second elastic foam layer 6.

[0044] When the material of this embodiment is used as a wet suit, in which case the recessed surface of the elastic foam layer 2 faces the side of the body, a film of water is prone to be formed between the body and the suit because water is accumulated in the recess portions 1. In addition, not only warmed water is hardly discharged to the outside, but also external cold water less easily penetrates, because recess portions 1 do not pierce through the elastic foam layer 2. Thus, the wet suit will have a high heat-retaining effect.

[0045] Figure 6 is a cross-sectional view showing a material used for wet suits for triathlon in accordance with a third embodiment of the invention. As shown, according to the material in this embodiment, a coating layer 4a, a closing layer 5, a stretchable fabric 3, an elastic foam layer 2, a second elastic foam layer 6, and coating layer 4a are laminated in that order from the side of the body. The stretchable fabric 3 hardly absorbs water because it is positioned between the elastic foam layer 2 (and second elastic foam layer 6) and the closing layer 5. Thus, this reduces a change in weight of the whole material. The thicknesses of the closing layer 5, the stretchable fabric 3, the elastic foam layer 2, and the second elastic foam layer 6 are 5mm, 0.5 mm, 5 mm, and 5 mm, respectively. In this respect, the thicknesses of closing layer 5, jersey fabric 3, elastic foam layer 2, and second elastic foam layer 6 may be varied in the ranges of 1 to 10 mm, 0.2 to 1.5 mm, 1 to 10 mm, and 1 to 10 mm, respectively.

[0046] The coating layer 4a contains nanocapsules. The nanocapsule used is NC948 from Nomura Trading Co., Ltd., but not limited thereto. An amphipathic coating agent is used for the coating layers 4a on the surface of the closing layer 5 and the surface of the second elastic foam layer 6. The amphipathic coating agent is obtained by uniformly mixing 13 parts by weight of a polyurethane polymer, 7 parts by weight of polytetrafluoroethylene fine powder, 2 parts by weight of silicon oil, and 2 parts by weight of sodium dodecyl sulfate in the following solvents: 2 parts by weight of acetone, 3 parts by weight of methyl isobutylene ketone (MIBK), 55 parts by weight of toluene, 5 parts by weight of butyl acetate, and 11 parts by weight of diacetone alcohol. In this respect, the amount of the polyurethane polymer may be varied in the range of 8 to 18 parts by weight; that of the polytetrafluoroethylene fine powder, 2 to 12 parts by weight; that of silicon oil, 1 to 7 parts by weight; that of sodium dodecyl sulfate, 1 to 7 parts by weight; that of acetone, 1 to 7 parts by weight; that of methyl isobutylene ketone (MIBK), 1 to 8 parts by weight; that of toluene, 50 to 60 parts by weight; that of butyl acetate, 1 to 10 parts by weight; and that of diacetone alcohol, 6 to 16 parts by weight.

[0047] Air can be stored in the recess portions 1 because the openings of the recess portions 1 on the elastic foam layer 2 are closed by the closing layer 5. Thus, stable heat-retaining properties and buoyancy can be imparted to the underwater suit. This embodiment is suitable for a suit for triathlon requiring buoyancy.

Industrial Applicability

[0048] According to the invention, when the material is used as a wet suit, in which case the recess portions of the elastic foam layer are opened toward the side of the body, a large amount of water can be retained and a film of water is prone to be formed between the body and the suit, because water is accumulated in the recess portions. In addition, not only warmed water is hardly discharged to the outside, but also external cold water less easily penetrates because the recess portions do not pierce through the elastic foam layer. Thus, a wet suit having a high heat-retaining effect can be made.

[0049] Further, when a closing layer is laminated to the recessed surface of the elastic foam layer directly or via another layer to close the openings of the recess portions, air is less susceptible to leakage to the outside of the recess portions and water less easily penetrates into the recess portions. Thus, the use thereof in the wet suit enables the retaining of air in the recess portions, and can impart stable buoyancy to the suit.

Claims

1. A material used for wet suits for diving comprising a first coating layer (4a), a first elastic foam layer (2) having a plurality of isolated hole-shaped recess portions formed on one side thereof, a second coating layer (4b) laminated to the recess non-formed surface of the first elastic foam layer (2), a second elastic foam layer (6) having a sheet form, a third coating layer (4b) and a stretchable fabric (3) laminated in that order from the side of the body, wherein the first, second and third coating layers (4a, 4b) contain hollow nanocapsules, an amphipathic coating agent is used for the first coating layer (4a) on the side of the

recessed surface of elastic foam layer (2), and metal foils of titanium are used in the second and third coating layers (4b).

2. A material used for wet suits for surfing comprising a first coating layer (4a), a first elastic foam layer (2) having a plurality of isolated hole-shaped recess portions formed on one side thereof, a second coating layer (4b) laminated to the recess non-formed surface of the first elastic foam layer (2), a stretchable fabric (3), a third coating layer (4b), a second elastic foam layer (6) having a sheet form and a fourth coating layer (4a) laminated in that order from the side of the body, wherein the second and third coating layers (4b) contains hollow nanocapsules, an amphipathic coating agent is used for the first coating layer (4a) on the side of the recessed surface of elastic foam layer (2), and metal foils of titanium are used in the second and third coating layers (4b).

3. A material used for wet suits for triathlon comprising a first coating layer (4a), a closing layer (5) impermeable to both air and water, a stretchable fabric (3), a first elastic foam layer (2) having a plurality of isolated hole-shaped recess portions formed on one side thereof, a second elastic foam layer (6) and a second coating layer (4a) laminated in that order from the side of the body, wherein the closing layer (5) is laminated to the recessed surface of the first elastic foam layer (2) to close the openings of the recess portions, the first and second coating layers (4a) contain hollow nanocapsules, and an amphipathic coating agent is used for the first and second coating layers (4a).

Patentansprüche

1. Material zur Verwendung für Nassanzüge zum Tauchen, mit einer ersten Überzugsschicht (4a), einer ersten elastischen Schaumschicht (2) mit einer Mehrzahl von auf einer Seite derselben gebildeten, getrennten lochförmigen Aussparungsbereichen, einer zweiten Überzugsschicht (4b), die auf die nicht mit Aussparungen versehene Oberfläche der ersten elastischen Schaumschicht (2) laminiert ist, einer zweiten elastischen Schaumschicht (6) mit Flächenkörperform, einer dritten Überzugsschicht (4b) und einem dehnbaren Textilmaterial (3), die in dieser Reihenfolge ausgehend von der Körperseite zusammenlaminiert sind, wobei die erste, zweite und dritte Überzugsschicht (4a, 4b) hohle Nanokapseln enthalten, wobei ein amphipathisches Überzugsmittel für die erste Überzugsschicht (4a) auf der Seite der der mit Aussparungen versehenen Oberfläche der elastischen Schaumschicht (2) verwendet wird und wobei Metallfolien aus Titan in der zweiten und dritten Überzugsschicht (4b) verwendet werden.

2. Material zur Verwendung für Nassanzüge zum Surfen, mit einer ersten Überzugsschicht (4a), einer ersten elastischen Schaumschicht (2) mit einer Mehrzahl von auf einer Seite derselben gebildeten, getrennten lochförmigen Aussparungsbereichen, einer zweiten Überzugsschicht (4b), die auf die nicht mit Aussparungen versehene Oberfläche der ersten elastischen Schaumschicht (2) laminiert ist, einem dehnbaren Textilmaterial (3), einer dritten Überzugsschicht (4b), einer zweiten elastischen Schaumschicht (6) mit Flächenkörperform und einer vierten Überzugsschicht (4a), die in dieser Reihenfolge ausgehend von der Körperseite zusammenlaminiert sind, wobei die zweite und dritte Überzugsschicht (4b) hohle Nanokapseln enthalten, wobei ein amphipathisches Überzugsmittel für die erste Überzugsschicht (4a) auf der Seite der der mit Aussparungen versehenen Oberfläche der elastischen Schaumschicht (2) verwendet wird und wobei Metallfolien aus Titan in der zweiten und dritten Überzugsschicht (4b) verwendet werden.

3. Material zur Verwendung für Nassanzüge für Triathlon, mit einer ersten Überzugsschicht (4a), einer Sperrschicht (5), die undurchlässig sowohl für Luft als auch für Wasser ist, einem dehnbaren Textilmaterial (3), einer ersten elastischen Schaumschicht (2) mit einer Mehrzahl von auf einer Seite derselben gebildeten, getrennten lochförmigen Aussparungsbereichen, einer zweiten elastischen Schaumschicht (6) und einer zweiten Überzugsschicht (4a), die in dieser Reihenfolge ausgehend von der Körperseite zusammenlaminiert sind, wobei die Sperrschicht (5) auf die mit mit Aussparungen versehene Oberfläche der ersten elastischen Schaumschicht (2) laminiert ist, um die Öffnungen der Aussparungsbereiche zu verschließen, wobei die erste und die zweite Überzugsschicht (4a) hohle Nanokapseln enthalten und wobei ein amphipathisches Überzugsmittel für die erste und die zweite Überzugsschicht (4a) verwendet wird.

Revendications

1. Matériau utilisé pour des combinaisons humides de plongée comprenant une première couche de revêtement (4a), une première couche de mousse élastique (2) ayant une pluralité de parties de renfoncements isolées en forme d'orifices formées dans un côté de celle-ci, une deuxième couche de revêtement (4b) stratifiée sur la surface non formée en renfoncement de la première couche de mousse élastique (2), une seconde couche de mousse élastique (6) ayant une forme de feuille, une troisième couche de revêtement (4b) et un tissu étirable (3) stratifiés dans cet ordre depuis le côté du corps, dans lequel la première, la deuxième et la troisième couche de

revêtement (4a, 4b) contiennent des nanocapsules creuses, un agent de revêtement amphipathique est utilisé pour la première couche de revêtement (4a) sur le côté de la surface renfoncée de la couche de mousse élastique (2), et des feuilles métalliques de titane sont utilisées dans la deuxième et la troisième couche de revêtement (4b).

2. Matériau utilisé pour des combinaisons humides de surf comprenant une première couche de revêtement (4a), une première couche de mousse élastique (2) ayant une pluralité de parties de renfoncements isolées en forme d'orifices formées sur un côté de celle-ci, une deuxième couche de revêtement (4b) stratifiée sur la surface non formée en renfoncement de la première couche de mousse élastique (2), un tissu étirable (3), une troisième couche de revêtement (4b), une seconde couche de mousse élastique (6) ayant une forme de feuille et une quatrième couche de revêtement (4a) stratifiées dans cet ordre depuis le côté du corps, dans lequel la deuxième et la troisième couche de revêtement (4b) contiennent des nanocapsules creuses, un agent de revêtement amphipathique est utilisé pour la première couche de revêtement (4a) sur le côté de la surface renfoncée de la couche de mousse élastique (2), et des feuilles métalliques de titane sont utilisées dans la deuxième et la troisième couche de revêtement (4b).

3. Matériau utilisé pour des combinaisons humides de triathlon comprenant une première couche de revêtement (4a), une couche de fermeture (5) imperméable à l'air et à l'eau, un tissu étirable (3), une première couche de mousse élastique (2) ayant une pluralité de parties de renfoncements isolées en forme d'orifices formées sur un côté de celle-ci, une seconde couche de mousse élastique (6) et une seconde couche de revêtement (4a) stratifiées dans cet ordre depuis le côté du corps, dans lequel la couche de fermeture (5) est stratifiée sur la surface renfoncée de la première couche de mousse élastique (2) afin de fermer les ouvertures des parties de renfoncements, la première et la seconde couche de revêtement (4a) contiennent des nanocapsules creuses, et un agent de revêtement amphipathique est utilisé pour la première et la seconde couche de revêtement (4a).

Figure 1

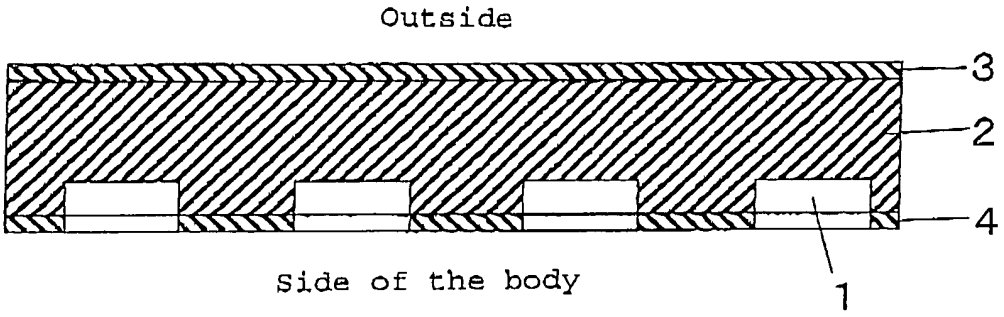


Figure 2

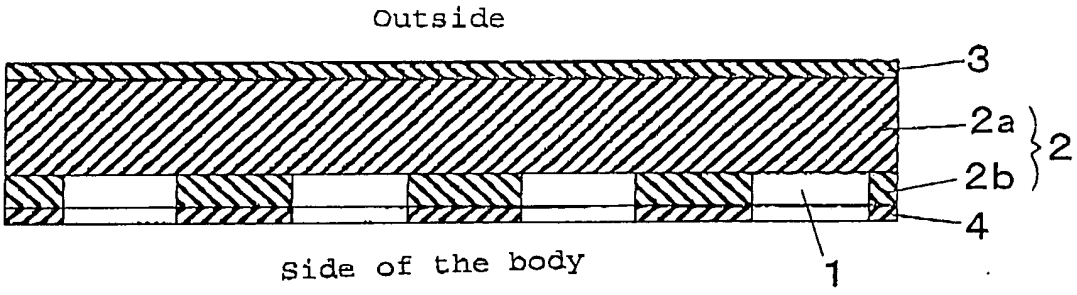


Figure 3

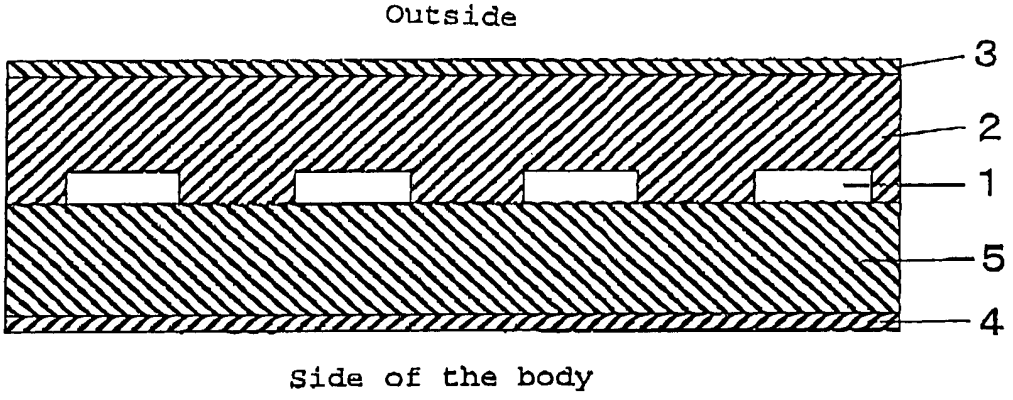


Figure 4

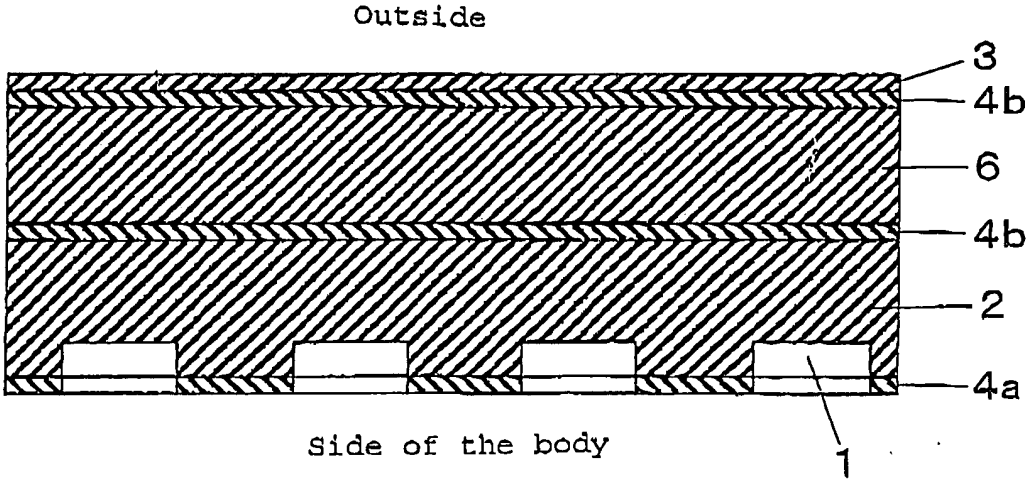


Figure 5

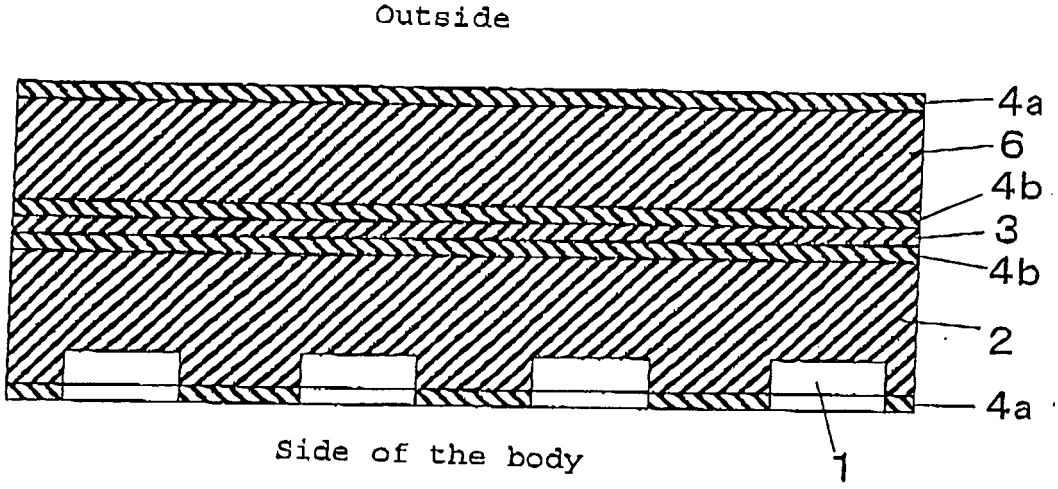
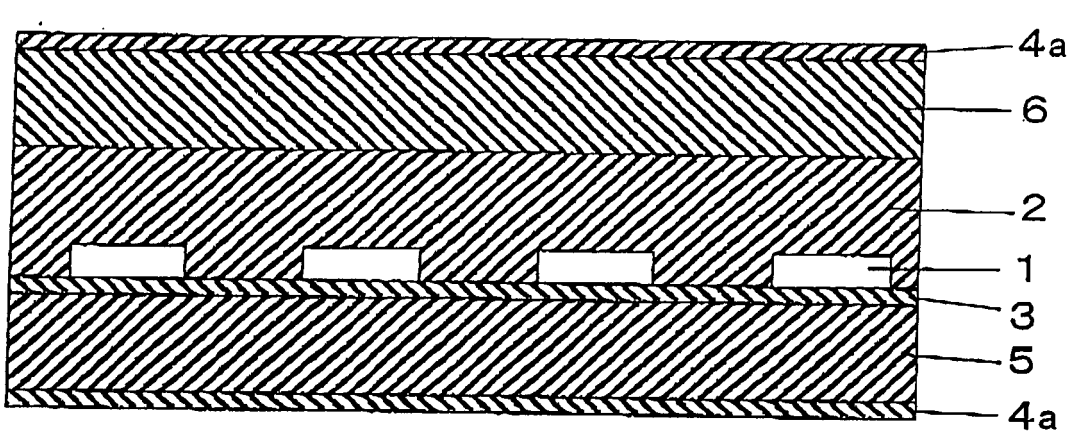


Figure 6



REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 6312692 A **[0004]**
- GB 2268440 A, Middleton, Nigel John **[0008]**