It is an object of the present invention to provide a waterproof sound-permeable hood having excellent waterproofness and excellent sound permeability. The waterproof sound-permeable hood of the present invention is formed of a waterproof material, which hood includes a waterproof sound-permeable means provided on at least one of portions respectively facing to the ears of a wearer who wears the waterproof material, wherein the waterproof sound-permeable means includes a waterproof sound-permeable membrane having a sound-transmission loss of not greater than 5 db.
WATERPROOF SOUND-PERMEABLE HOOD

TECHNICAL FIELD

[0001] The present invention relates to a waterproof sound-permeable hood having excellent waterproofness and excellent sound permeability.

BACKGROUND ART

[0002] Conventionally, rainwear to be used in daily life or for work, such as raincoats and rain jackets, are each provided with a waterproof hood for preventing the head of a wearer from becoming wet with raindrops or the like. Such a waterproof hood is formed of a waterproof material such as a waterproof fabric or a waterproof sheet. However, when a hole or break occurs in the waterproof material by, for example, abrasion while wearing or stress during washing, the waterproofness of the waterproof hood becomes lost. Therefore, in view of improving the durability against, for example, abrasion while wearing, a material obtained by the waterproof treatment of a relatively thick fabric of polyamide, polyester, or any other resin is often used as a waterproof material forming a waterproof hood.

[0003] In the meantime, a waterproof hood usually has such a structure as to cover the head (the parietal region, the temporal region, and the occipital region) of a wearer. Therefore, when a waterproof hood is worn, the waterproof hood also covers both ears of the wearer. In addition, as described above, a waterproof hood is often formed of a relatively thick waterproof material. However, such a waterproof hood formed of a relatively thick waterproof material has a very low sound permeability. Therefore, when a waterproof hood is worn, ambient sounds are difficult to hear, which causes the following problems. For example, the wearer may have difficulty in making a conversation while wearing the waterproof hood. Alternatively, the wearer may miss an alarm from a device or the like at a worksite.

[0004] Thus, to improve sound permeability during wearing, various proposals have been made for waterproof hoods having openings in positions respectively corresponding to the ears of a wearer (e.g., Patent Documents 1 and 2). However, the waterproof hoods disclosed in Patent Documents 1 and 2 had a problem that raindrops infiltrate through the openings.

PRIOR ART DOCUMENTS

Patent Documents


SUMMARY OF THE INVENTION

Problems to be Solved by the Invention

[0007] The present invention was completed in view of the above problems, and it is an object of the present invention to provide a waterproof sound-permeable hood having excellent waterproofness and excellent sound permeability.

Means of Solving the Problems

[0008] The waterproof sound-permeable hood of the present invention, which can solve the above problems, is formed of a waterproof material, which hood comprises a waterproof sound-permeable means provided on at least one of portions respectively facing to the ears of a wearer who wears the waterproof material, wherein the waterproof sound-permeable means comprises a waterproof sound-permeable membrane having a sound-transmission loss of not greater than 5 db. The use of a waterproof sound-permeable membrane having a sound-transmission loss of not greater than 5 db as the waterproof sound-permeable means makes it possible to improve the waterproofness of a waterproof sound-permeable hood without deteriorating the sound permeability of the waterproof sound-permeable hood.

[0009] As the waterproof sound-permeable membrane, there may be preferred those which have at least one porous polytetrafluoroethylene layer. In addition, as the waterproof sound-permeable membrane, there can also be used those which are obtained by the water-repellent treatment of non-woven fabrics, meshes, and any other materials so as to have waterproofness.

[0010] The waterproof sound-permeable means may preferably have at least one protective layer to protect the waterproof sound-permeable membrane. In addition, the at least one protective layer may preferably be firmly attached to the waterproof sound-permeable membrane.

[0011] In the waterproof sound-permeable hood of the present invention, one embodiment may be preferred in which the waterproof sound-permeable means comprises a holing member having a cylindrical swaging part and a holding part formed on one end of the cylindrical swaging part and wherein the holding member holds the waterproof sound-permeable membrane in the holding part and is fixed to the waterproof material by the cylindrical swaging part. The holding member may preferably have a gap between the waterproof sound-permeable membrane and the holding part, which gap is sealed with a sealing member.

EFFECTS OF THE INVENTION

[0012] According to the present invention, a waterproof sound-permeable hood having excellent waterproofness and excellent sound permeability can be obtained.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] FIG. 1 This is a perspective view showing one embodiment of the waterproof sound-permeable hood, of which waterproof sound-permeable means has a holding member.
[0014] FIG. 2 This is a side view of the waterproof hood shown in FIG. 1.
[0015] FIG. 3 This is a sectional view of the holding member.
[0016] FIG. 4 This is a perspective view of the holding member.
[0017] FIG. 5 This is a sectional view of the holding member fixed to the waterproof material.
[0018] FIG. 6 This is a perspective view showing another embodiment of the waterproof sound-permeable hood, of which waterproof sound-permeable means does not have a holding member.
FIG. 7 This is a side view of the waterproof sound-permeable hood shown in FIG. 6.

MODE FOR CARRYING OUT THE INVENTION

The following will describe one embodiment of the waterproof sound-permeable hood of the present invention by reference to the drawings. FIG. 1 is a perspective view showing one embodiment of the waterproof sound-permeable hood, of which waterproof sound-permeable means has a holding member. FIG. 2 is a side view of the waterproof sound-permeable hood shown in FIG. 1.

As shown in FIGS. 1 and 2, the waterproof sound-permeable hood of the present invention is formed of a waterproof material, which hood comprises a waterproof sound-permeable means provided on at least one of portions respectively facing to the ears of a wearer who wears the waterproof material, wherein the waterproof sound-permeable means comprises a waterproof sound-permeable membrane having a sound-transmission loss of not greater than 5 db.

Waterproof Sound-Permeable Means

The waterproof sound-permeable means to be used in the present invention is not particularly limited, so long as the waterproof sound-permeable means has a waterproof sound-permeable membrane having a sound-transmission loss of not greater than 5 db. As the embodiment of the waterproof sound-permeable means to be used in the present invention, there can be mentioned an embodiment in which the waterproof sound-permeable means is formed only of a waterproof sound-permeable membrane; an embodiment in which the waterproof sound-permeable means is formed of a waterproof sound-permeable membrane and a protective layer to protect the waterproof sound-permeable membrane; and an embodiment in which the waterproof sound-permeable means is formed of a waterproof sound-permeable membrane and a holding member described later.

Waterproof Sound-Permeable Membrane

The following will describe a waterproof sound-permeable membrane having a sound-transmission loss of not greater than 5 db, which membrane is used for the waterproof sound-permeable means (the membrane may hereinafter be referred to simply as a “waterproof sound-permeable membrane”).

The waterproof sound-permeable membrane has a sound-transmission loss of not greater than 5 db, preferably not greater than 3 db, and more preferably not greater than 1 db. When the sound-transmission loss is greater than 5 db, the waterproof sound-permeable means has an increased sound-transmission loss, and therefore, a waterproof sound-permeable hood having excellent sound permeability cannot be obtained. The lower limit of the sound-transmission loss of the waterproof sound-permeable membrane is not particularly limited, but is, of course, greater than 0 db. There will be described later about the method of measuring the sound-transmission loss of the waterproof sound-permeable membrane in the present invention.

The mass per unit area of the waterproof sound-permeable membrane, for example, when a single-layer membrane of porous polytetrafluoroethylene as described later is used as the waterproof sound-permeable membrane, may preferably be not smaller than 0.5 g/m², more preferably not smaller than 1.0 g/m², and still more preferably not smaller than 2.0 g/m², but may preferably be not greater than 20 g/m², more preferably not greater than 10 g/m², and still more preferably not greater than 5 g/m². When the mass per unit area of the waterproof sound-permeable membrane is smaller than 0.5 g/m², a problem may arise with handleability during the production of the waterproof sound-permeable membrane. When the mass per unit area of the waterproof sound-permeable membrane is greater than 20 g/m², the sound permeability of the waterproof sound-permeable means has a tendency to be decreased. The mass per unit area of the waterproof sound-permeable membrane is determined by, for example, cutting the waterproof sound-permeable membrane into a 10 cm square and measuring the mass of the square with a precision balance.

The thickness of the waterproof sound-permeable membrane may preferably be not smaller than 3 μm, more preferably not smaller than 4 μm, and still more preferably not smaller than 5 μm, but may preferably be not greater than 150 μm, more preferably not greater than 33 μm, and still more preferably not greater than 10 μm. When the thickness of the waterproof sound-permeable membrane is smaller than 3 μm, a problem may arise with handleability during the production of the waterproof sound-permeable membrane. When the thickness of the waterproof sound-permeable membrane is greater than 150 μm, the sound permeability of the waterproof sound-permeable means has a tendency to be decreased. The measurement of the thickness of the waterproof sound-permeable membrane is based on the average thickness measured with a dial thickness gauge (the measurement of the average thickness was carried out using a 1/1000 mm dial thickness gauge, available from Teclock Corporation, in the state where no load was applied other than the spring load of the gauge body).

The waterproof sound-permeable membrane is not particularly limited, so long as the sound-transmission loss is not greater than 5 db, but may be a single-layer membrane or a multi-layer membrane in which two or more layers are laminated. As the material forming the waterproof sound-permeable membrane, there can be mentioned many polymer materials including, for example, silicone rubber; polyurethane; polyamide; polyester; polyolefin such as polyethylene and polypropylene; and fluoropolymer. As the fluoropolymer, there may be preferred, for example, polytetrafluoroethylene (PTFE), tetrafluoroethylene-hexafluoropropylene copolymer (FEF), tetrafluoroethylene-(perfluoroalkyl)vinyl ether copolymer (PFA), and polytetrafluoroethylene (PTFE). In addition, as the waterproof sound-permeable membrane, there can also be used those which are obtained by the water-repellent treatment of nonwoven fabrics, meshes, and any other materials so as to have waterproofness.

As the waterproof sound-permeable membrane to be used in the present invention, there may be preferred those which have at least one layer of porous polytetrafluoroethylene (which may hereinafter be referred to as a “porous PTFE film”). In this case, as the waterproof sound-permeable membrane, there can be used a single-layer membrane formed only of a porous PTFE film layer, or a multi-layer membrane in which a porous PTFE film layer is laminated with a layer formed of another material. Among these, a single-layer membrane formed only of a porous PTFE film layer may be more preferred in view of the sound permeability of the waterproof sound-permeable membrane.
The porous PTFE film means one obtained by preparing a shaped material from a paste obtained by mixing a fine powder of polytetrafluoroethylene (PTFE) with a forming aid; removing the forming aid from the shaped material; and then stretching the shaped material in planar form at high temperature and high speed, and therefore, the porous PTFE film has a porous structure. That is, the porous PTFE film is formed of nodes, which are aggregates of polytetrafluoroethylene primary particles connected to one another by minute crystal ribbons; and fibrils, which are bundles of fully elongated crystal ribbons pulled out from the primary particles. The spaces defined by the fibrils and the nodes connecting the fibrils become pores. The porosity, the maximum pore diameter, and any other properties, which are described later, of the porous PTFE film can be controlled by stretch ratio and any other factors.

The maximum pore diameter of the porous PTFE film may preferably be not smaller than 0.01 μm, more preferably not smaller than 0.1 μm, but may preferably be not greater than 15 μm, more preferably not greater than 10 μm. When the maximum pore diameter is smaller than 0.01 μm, it is difficult to produce the porous PTFE film. On the other hand, when the maximum pore diameter is greater than 15 μm, the waterproofness of the porous PTFE film has a tendency to be decreased, and the strength of the film also becomes decreased. Thus, it is likely to be difficult to handle the porous PTFE film in the subsequent steps such as lamination.

The porosity of the porous PTFE film may preferably be not smaller than 50%, more preferably not smaller than 60%, but may preferably be not greater than 98%, more preferably not greater than 95%. When the porosity of the porous PTFE film is not smaller than 50%, the sound permeability of the film can be ensured. When the porosity of the porous PTFE film is not greater than 98%, the strength of the film can be ensured.

The maximum pore diameter of the porous PTFE film is the value measured in accordance with the requirements of ASTM F-316. Using the apparent density (ρ) measured in accordance with the apparent density measurements of JIS K 6885, the porosity of the porous PTFE film is determined by calculation with the following formula, where the true density of the PTFE is regarded as being 2.2 g/cm³:

\[ \text{Porosity (％)} = \frac{100(1 - \frac{\rho}{2.2})}{2.2} \]

The porous PTFE film may preferably have greater air permeability. When expressed in the Gurley number, the air permeability of the porous PTFE film may preferably be not greater than 50 sec, more preferably not greater than 10 sec. When the air permeability of the porous PTFE film is greater than 50 sec in the Gurley number, the sound permeability of the porous PTFE film becomes decreased. The air permeability (Gurley number) of the porous PTFE film is measured based on JIS P 8117.

When the porous PTFE film is used, the surfaces inside the pores of the porous PTFE film may preferably be coated with a water- and oil-repellent polymer. The reason for this is as follows. If contaminants, such as machine oils, beverages, and laundry detergents, penetrate into, or are held in, the pores of the porous PTFE film, the contaminants become a cause to reduce the hydrophobicity of the porous PTFE film and to deteriorate the waterproofness of the porous PTFE film. However, the coating of the surfaces inside the pores of the porous PTFE film with a water- and oil-repellent polymer (which may hereinafter be referred to as a “coating polymer”) makes it possible to prevent contaminants, such as machine oils, beverages, and laundry detergents, from penetrating into, or being held in, the pores of the porous PTFE film.

As the coating polymer, there can be used, for example, a polymer having fluorine-containing side chains. The details of such a polymer and a method for the combined use of the polymer in the porous PTFE film are disclosed in WO 94/22928 and other publications. An example thereof is shown below.

As the coating polymer, there can preferably be used a polymer having fluorine-containing side chains (the fluorinated alkyl moiety thereof may preferably have from 6 to 16 carbon atoms), the polymer being obtained by polymerizing a fluoroalkyl acrylate and/or a fluoroalkyl methacrylate, represented by the following general formula (1):

\[ CF_2(CF_2)_n CH_2CH_2-O-CR=CH_2 \]

wherein \( n \) is an integer of from 3 to 13 and \( R \) is hydrogen or a methyl group.

To coat the inside of the pores of the porous PTFE film with the polymer, an aqueous micro-emulsion of the polymer (having an average particle diameter of from 0.01 μm to 0.5 μm) is prepared using a fluorine-containing surfactant (e.g., ammonium perfluorooctanolate), and the inside of the pores of the porous PTFE film is impregnated with the aqueous micro-emulsion, followed by heating. As a result of the heating, the water and the fluorine-containing surfactant are removed, and at the same time, the polymer having fluorine-containing side chains is melted to coat the surfaces inside the pores of the porous PTFE film such that the continuous pores are maintained. Thus, a porous PTFE film having high water repellency and high oil repellency can be obtained.

Alternatively, as another coating polymer, there can be used, for example, “AF Polymer” available from E. I. du Pont de Nemours and Company, and “CYTOP (registered trademark)” available from Asahi Glass Co., Ltd. To coat the surfaces inside the pores of the porous PTFE film with each polymer, the polymer may be dissolved in an inert solvent, such as “FLUORINERT (registered trademark)” available from 3M Company, and the porous PTFE film may be impregnated with the resulting solution, and then, the solvent may be removed by evaporation.

Protective Layer

The waterproof sound-permeable means to be used in the present invention may preferably have at least one protective layer that protects the waterproof sound-permeable membrane. The inclusion of a protective layer makes it possible to prevent an external force from being applied to the waterproof sound-permeable membrane when the waterproof sound-permeable hood is used, thereby preventing the waterproof sound-permeable membrane from being damaged. The waterproof sound-permeable means may preferably have a protective layer on each side of the waterproof sound-permeable means.
The protective layer is not particularly limited, so long as the protective layer does not deteriorate the effect of the present invention. As the protective layer, porous members, such as meshes, nets, foam rubbers, sponges, nonwoven fabrics, woven fabrics, and knits, may be preferred because such porous members each have sufficient strength and also ensure the sound permeability of the waterproof sound-permeable means. Each of these porous member may preferably have through pores of substantially the same shape, which is not the case if the protective layer is not preferably chosen. When through pores are formed uniformly throughout the porous member, if through pores of substantially the same shape are formed uniformly throughout the porous member, the sound permeability and the strength are uniform throughout the porous member, and therefore, there can be obtained a waterproof sound-permeable means having sound permeability and strength, both of which are uniform throughout the waterproof sound-permeable means.

The thickness of the protective layer may preferably be not smaller than 10 μm, more preferably not smaller than 100 μm, and may preferably be not greater than 1,000 μm, more preferably not greater than 500 μm. When the thickness of the protective layer is smaller than 10 μm, a problem may arise with handleability during the production of the protective layer. When the thickness of the protective layer is greater than 1,000 μm, the sound permeability of the waterproof sound-permeable means becomes decreased. The method of measuring the thickness of the protective layer is the same as that of the waterproof sound-permeable membrane.

When a porous member is used as the protective layer, the maximum pore diameter of the protective layer may preferably be not smaller than 10 μm, more preferably not smaller than 100 μm, and may preferably be not greater than 5 mm, more preferably not greater than 1 mm. When the maximum pore diameter of the protective layer is smaller than 10 μm, the sound permeability of the waterproof sound-permeable means may significantly be decreased. On the other hand, when the maximum pore diameter of the protective layer is greater than 5 mm, the open pores may become so large that the protective effect on the waterproof sound-permeable means cannot be obtained. The maximum pore diameter can be measured using a microscope.

In addition, the porosity of the protective layer may preferably be not smaller than 10%, more preferably not smaller than 50%, but may preferably be not greater than 95%, more preferably not greater than 90%. When the porosity of the protective layer is not smaller than 10%, the sound permeability of the waterproof sound-permeable means can be ensured. When the porosity of the protective layer is not greater than 90%, the strength of the protective layer can be ensured to effectively protect the waterproof sound-permeable means. The porosity is measured in the same manner as described for the waterproof sound-permeable membrane.

Examples of the material of the protective layer may include polyolefin resins such as polyethylene and polypropylene; polyester resins such as polyester terephthalate and polycarbonate; thermoplastic resins such as polyimide resins; and metals such as stainless steel. As described later, when the protective layer is firmly attached to the waterproof sound-permeable membrane, the material of the protective layer may preferably be a thermoplastic resin having a lower melting point than that of the waterproof sound-permeable membrane. This is because such a thermoplastic resin can be fusion-bonded to the waterproof sound-permeable membrane by thermal lamination, without using an adhesive.

Specific examples by product name of the protective layer may include “Net Eyelet #25” available from Morito Co., Ltd. In addition, specific examples by product name of the protective layer to be brought in firm contact with the waterproof sound-permeable membrane may include “Conwed (registered trademark) Net NN6065” available from Nisiki Plasto Co., Ltd.

In the waterproof sound-permeable means to be used in the present invention, the at least one protective layer may preferably be firmly attached to the waterproof sound-permeable membrane.

The waterproof sound-permeable membrane needs to be made thin to ensure the sound permeability of the waterproof sound-permeable means. Thus, a pinhole or break may easily occur in the waterproof sound-permeable membrane, for example, stress during washing, and there is fear that the waterproofness of the waterproof sound-permeable membrane may be lost. Therefore, the at least one protective layer may preferably be firmly attached to the waterproof sound-permeable membrane to support the waterproof sound-permeable membrane. The protective layer may be firmly attached to one side of the waterproof sound-permeable membrane, or the protective layer may be firmly attached to each side of the waterproof sound-permeable membrane. In view of the sound permeability of the waterproof sound-permeable means, the protective layer may preferably be firmly attached to only one side of the waterproof sound-permeable membrane.

The protective layer to be firmly attached to the waterproof sound-permeable membrane may preferably be a net, a nonwoven fabric, or any other materials formed of a resin, in view of strength and fusion bondability. Examples of the resin may include “Delnet (registered trademark) (integrially formed polypropylene product) RB0404-12P” available from Delstar Technologies, Inc. In addition, examples of the resin nonwoven fabric may include “ECOOL (registered trademark) (polyester nonwoven fabric) 3151A” available from Toyobo Co., Ltd., in view of, for example, sound permeability.

The method of firmly attaching the protective layer to the waterproof sound-permeable membrane is not particularly limited, but examples thereof may include adhesion using an adhesive; and melt bonding by thermal lamination. When an adhesive is used and a porous product is used as the waterproof sound-permeable membrane, the adhesive may block a large portion of the pores of the waterproof sound-permeable membrane, and there is fear that the sound permeability of the waterproof sound-permeable means may significantly be decreased. However, if a thermoplastic resin having a lower melting point than that of the waterproof sound-permeable membrane is used as the material of the protective layer and is fusion-bonded by thermal lamination, the number of the pores of the waterproof sound-permeable membrane to be blocked by the thermoplastic resin can be reduced, and this prevents the sound permeability of the waterproof sound-permeable means from decreasing, which may be preferred.

When the protective layer is firmly attached to the waterproof sound-permeable membrane, the sound-transmission loss of the waterproof sound-permeable membrane, to which the protective layer has been firmly attached (which may hereinafter be referred to as “laminated waterproof sound-permeable membrane”), may preferably be not greater than 5 dB, more preferably not greater than 4 dB, and still more
preferably not greater than 3 db. When the sound-transmission loss of the laminated waterproof sound-permeable membrane is greater 5 db, the sound-transmission loss of the waterproof sound-permeable means is increased, and therefore, a waterproof sound-permeable hood having excellent sound permeability cannot be obtained. The method of measuring the sound-transmission loss of the laminated waterproof sound-permeable membrane in the present invention is the same as that of the waterproof sound-permeable membrane.

Holding Member

[0051] In the waterproof sound-permeable hood of the present invention, there is a preferred embodiment in which the waterproof sound-permeable means comprises a holding member having a cylindrical swaging part and a holding part formed on one end of the cylindrical swaging part, and the holding member holds the waterproof sound-permeable membrane in the holding part and is fixed to the waterproof material by the cylindrical swaging part.

[0052] Referring to FIGS. 3 to 5, the following will describe one example of the waterproof sound-permeable means using the holding member. FIG. 3 is a sectional view of the holding member. FIG. 4 is a perspective view of the holding member. FIG. 5 is a sectional view of the holding member fixed to the waterproof material.

Holding Member

[0053] The holding member 20 has a cylindrical swaging part 21 and a holding part 22 formed around one end of the cylindrical swaging part 21, the holding part 22 having such a large outer diameter as to correspond in size to the inward folding when supporting the waterproof sound-permeable membrane. In addition, in this embodiment, the waterproof sound-permeable membrane 11 has protective layers 12a and 12b on the respective sides thereof such that the protective layer 12a is firmly attached to the waterproof sound-permeable membrane 11. As shown in FIGS. 3 and 4, after the waterproof sound-permeable membrane 11 and the protective layers 12a and 12b are laminated on the holding part 22, the edge of the holding part 22 is folded inwardly. Thus, the edges of the waterproof sound-permeable membrane 11 and the protective layers 12a and 12b are attached together so as to be sandwiched by the holding part 22.

[0054] The material of the holding part 20 is not particularly limited, but examples thereof may include metals such as brass, and resins.

[0055] The inner diameter of the cylindrical swaging part is not particularly limited, but may preferably be not smaller than 5 mm, more preferably not smaller than 5 mm, and still more preferably not smaller than 8 mm, and may preferably not greater than 80 mm, more preferably not greater than 60 mm, and still more preferably not greater than 40 mm. When the inner diameter of the cylindrical swaging part is set to be not smaller than 5 mm and not greater than 80 mm, the sound permeability of the waterproof sound-permeable means can be ensured, and the attachment of the cylindrical swaging part to the waterproof material becomes facilitated.

[0056] In addition, as shown in FIG. 3, in the holding member 20, the gap between the waterproof sound-permeable membrane 11 and the holding section 22 may preferably be sealed with a sealing member 23.

[0057] When the gap between the waterproof sound-permeable membrane and the holding section 22 is sealed with the sealing member 23, the waterproof performance of the waterproof sound-permeable hood can further be improved. Examples of the sealing member to be used for the sealing may include resins such as silicone resins, polyamide resins, polyester resins, polyvinyl acetate resins, and polyurethane resins. These resins can appropriately be used alone, or two or more kinds of these resins can also appropriately be used as a mixture.

[0058] Then, as shown in FIG. 5, the holding member 20 is attached and fixed to a waterproof material 2 by causing the cylindrical swaging part 21 to directly break through and penetrate the waterproof material 2, to which the holding member 20 is to be attached; fitting a female ring 24 around the cylindrical swaging part 21 extending to the opposite side of the waterproof material 2, and then crushing the end of the cylindrical swaging part 21 by a pressing force from the inner direction. The use of the holding member in this manner makes it possible to form a sound-permeable opening in the waterproof material and attach a waterproof sound-permeable membrane to the waterproof material at one time, resulting in an improvement of workability.

Waterproof Sound-Permeable Hood

[0059] Referring to FIGS. 1 and 2, the following will describe the structure of the waterproof sound-permeable hood of the present invention.

[0060] The waterproof sound-permeable hood of the present invention is formed of a waterproof material, and comprises a waterproof sound-permeable means provided on at least one of portions respectively facing to the ears of a wearer who wears the waterproof material.

[0061] The waterproof sound-permeable hood of the present invention may include not only those which are used alone as hoods, but also those which have been attached to rainwears such as rain jackets and raincoats, and those which are attachable to and detachable from these rainwears.

[0062] As shown in FIGS. 1 and 2, the waterproof sound-permeable hood 1 of the present invention is formed of the waterproof material 2, and the main unit of the waterproof sound-permeable hood 1 has such a structure as to cover the head (parietal region, the temporal region, and the occipital region) of a wearer. The structure of the main unit of the waterproof sound-permeable hood 1 is not particularly limited, so long as the main unit of the waterproof sound-permeable hood 1 covers at least the head of a wearer. For example, the main unit of the waterproof sound-permeable hood 1 may cover the cheeks or the neck of a wearer. Alternatively, the connecting portion between the main unit of the waterproof sound-permeable hood 1 and a rainwear, such as a rain jacket, may be formed in an integrated manner.

[0063] The waterproof material is not particularly limited, so long as it has waterproofness, but examples thereof may include waterproof sheets formed of resins or rubbers; waterproof fabrics obtained by impregnating fabrics, such as woven fabrics or knitted fabrics, with resins or rubbers; and waterproof laminated products having the lamination of a fabric such as a woven fabric or a knitted fabric with a sheet formed of a resin or a rubber. In view of improving the feel of the waterproof laminated product against the wearer's skin, the lamination may preferably include a woven fabric or a knitted fabric as a lining. Among these, the waterproof material forming the waterproof sound-permeable hood of the
present invention may preferably have the lamination of a woven fabric, a waterproof moisture-permeable membrane, and a lining, such that the woven fabric serves as the outer material and the main unit of the lamination.

Examples of the resin and the rubber to be used for the waterproof sheet and the waterproof fabric may include polyurethane resins; polyester resins such as polyethylene terephthalate and polybutyrene terephthalate; acrylic resins; polyolefin resins such as polyethylene and polypropylene; polyamide resins; vinyl chloride resins; synthetic rubbers; natural rubbers; and fluoro-containing resins.

In addition, the fibers forming the woven fabric and the knitted fabric may be either natural fibers or synthetic fibers. Examples of the natural fibers may include plant fibers such as cotton and linen; and animal fibers such as silk, wool, and any other animal hairs. In addition, examples of the synthetic fibers may include polyamide fibers; polyester fibers; and acrylic fibers. In particular, when the fibers are used for clothing or any other products, polyamide fibers, polyester fibers, and any other fibers may be preferred in view of characteristics such as flexibility, strength, durability, cost, and lightweight.

In addition, in a preferred embodiment of the waterproof laminated product having the lamination of a fabric such as a woven fabric or a knitted fabric with a sheet formed of a resin or a rubber, a waterproof moisture-permeable sheet is used as the waterproof sheet included in the waterproof laminated product. The waterproof moisture-permeable sheet is a flexible sheet having “waterproofness” and “moisture permeability.” That is, the waterproof laminated product can be provided with “moisture permeability” as well as the “waterproofness” described above. For example, the water vapor of perspiration generated from the human body of a wearer is released through the waterproof laminated product to the outside. This makes it possible to prevent stuffiness while wearing. The “moisture permeability” as used herein refers to the property of allowing the transmission of water vapor. The desired “moisture permeability” may preferably be not smaller than 50 g/m²·h, more preferably not smaller than 100 g/m²·h, based on the rate of moisture permeability as measured by, for example, the JIS L 1099 B-2 method.

Examples of the waterproof moisture-permeable sheet may include films formed of hydrophilic resins such as polyurethane resins, polyester resins, silicone resins, and polyvinyl alcohol resins; and porous films formed of hydrophobic resins (which may hereinafter be referred to simply as “hydrophobic porous films”) such as polyester resins, polyolefin resins, e.g., polyethylene and polypropylene, fluorine-containing resins, and polyurethane resins subjected to water-repellent treatment. The “hydrophobic resins” as used herein refers to resins in which the contact angle of a water droplet placed on the surface of a smooth and flat plate formed of each of the resins is not smaller than 60 degrees (as measured at a temperature of 25°C), more preferably not smaller than 80 degrees.

In the hydrophobic porous sheet, its porous structure having pores (continuous pores) in the inside thereof maintains the moisture permeability, while the hydrophobic resin forming the base material of the sheet prevents water from infiltrating the pores. Thus, the hydrophobic porous sheet exhibits waterproofness as the entire sheet. Among these, the waterproof moisture-permeable sheet may preferably be a porous film formed of a fluorine-containing resin, more preferably a porous PTFE film.

The shape, the size, and the number of attached units of the waterproof sound-permeable means included in the waterproof sound-permeable hood of the present invention are not particularly limited, but may appropriately be modified or changed depending on the waterproof sound-permeable membrane, the protective layer, and the holding member to be used. For example, when a porous PTFE film is used as the waterproof sound-permeable membrane and the holding member to be used has a cylindrical swaging part having an inner diameter of 9 mm, the number of attached units of the waterproof sound-permeable means may preferably be at least one and not greater than six.

ANOTHER EMBODIMENT

Referring to FIGS. 6 and 7, the following will describe another embodiment of the waterproof sound-permeable hood of the present invention, where a holding member is not used. FIG. 6 is a perspective view showing the waterproof sound-permeable hood in an embodiment in which a waterproof sound-permeable means does not have a holding member. FIG. 7 is a side view of the waterproof sound-permeable hood shown in FIG. 6.

In the waterproof sound-permeable hood of the present embodiment, the waterproof sound-permeable means 10 does not have a holding member, but is formed only of the waterproof sound-permeable membrane 11, or is formed of a laminated product of the waterproof sound-permeable membrane 11 with a protective layer 12. The waterproof sound-permeable means 10 is attached to the waterproof hood 1 so as to close each sound-permeable opening 2a provided in the waterproof material 2 forming the waterproof hood 1. The method of attaching the waterproof sound-permeable means 10 is not particularly limited. For example, the waterproof sound-permeable membrane 11 and the protective layer 12 may be cut into a predetermined size and then may be sewn onto, or fusion-bonded to, the waterproof material 2 so as to close each sound-permeable opening 2a.

The waterproof sound-permeable membrane or the laminated waterproof sound-permeable membrane may be sewn onto the waterproof material using a sewing machine or any other means. As the material of the sewing thread to be used for the sewing, the following materials may be used alone, or any mixture of the following materials may also be used: cotton; silk; linen; polyynosics; polyamide resins; polyester resins; vinyl com resins; and polyurethane resins. Polyamide resins or polyester resins may preferably be used in view of strength and heat resistance. The thickness of the sewing thread may appropriately be adjusted depending on the thickness of the laminated product to be sewn and the required strength of the final product. The method of sewing is not particularly limited, so long as the sewing is carried out using one or more threads. As the form of the stitch, lock stitch, single chain stitch, double chain stitch, or any other stitch may preferably be used, and there can be mentioned sewing in a linear, curved, zigzag, or any other manner.

In addition, examples of the method of melt bonding the waterproof sound-permeable membrane or the laminated product of the waterproof sound-permeable membrane with the support may include an indirectly melt bonding method using a sheet formed of a hot-melt resin (which may hereinafter be referred to simply as “hot-melt sheet”). As the hot-melt sheet, there can be mentioned “Gore-Seam (registered trademark) Sheet Adhesive” available from Japan Gore-Tex Inc. In addition, as the hot-melt resin of the hot-melt
sheet, there can be used the same as the one to be used for a hot-melt resin layer of a seam-sealing tape described later. As the conditions for melt bonding using the hot-melt sheet, there can be employed the same as those for compression-bonding a seam-sealing tape.

In addition, as shown in FIG. 6, the portion where the waterproof sound-permeable membrane or the laminated waterproof sound-permeable membrane has been sewn or fusion-bonded may preferably be subjected to seam-sealing treatment. The seam-sealing treatment further improves the waterproofness and the strength of the waterproof sound-permeable hood obtained.

The method of seam-sealing treatment is not particularly limited, so long as the waterproofness can be ensured for the seam portion or the fusion-bonded portion. For example, when the waterproof sound-permeable membrane or the laminated waterproof sound-permeable membrane is sewn onto the waterproof material, there may be preferred a method of closing the needle hole portions with a resin, because higher waterproofness can be attained. As the method of closing the needle hole portions with a resin, there can be mentioned a method of applying a resin to the seam portion and a method of adhering or melt bonding a tape-shaped resin (seam-sealing tape). The method using a seam-sealing tape may be preferred, because the seam-sealed portion has a higher waterproof durability. In addition, when the waterproof sound-permeable membrane or the laminated waterproof sound-permeable membrane is fusion-bonded to the waterproof material, the strength of the waterproof sound-permeable hood obtained is decreased. Therefore, the fusion-bonded portion is subjected to seam-sealing treatment using a seam-sealing tape or any other means, thereby improving the strength of the waterproof sound-permeable hood obtained.

As the seam-sealing tape to be used for the seam-sealing treatment of the seam portion or the fusion-bonded portion in the waterproof sound-permeable hood of the present invention, there can appropriately be used a tape in which a low melting-point adhesive resin is laminated on the back face (the seam side) of a base material tape formed of a high melting-point resin, preferably a seam-sealing tape in which a hot-melt resin layer is provided on the back face of a base material tape. The front face (the side exposed to the outside) of the base material tape may be subjected to lamination processing with a knit, a mesh, or any other material. As the seam-sealing tape, there can appropriately be used, for example, seam-sealing tapes such as "T-2000" and "FU-700" available from San Chemicals, Ltd., and seam-sealing tapes such as "MF-1212" and "MF-10F" available from Nishinbo Industries, Inc., each using a polyurethane resin film as the base material tape and using a polyurethane hot-melt resin as the adhesive resin; and “GORE-SEAM (registered trademark) Tape” available from Japan Gore-Tex Inc., using a porous PTFE film as the base material tape and using a polyurethane hot-melt resin as the adhesive resin.

As the hot-melt resin of the seam-sealing tape, the following various resins may be used alone, or two or more kinds of the following various resins may also be used as a mixture; polyethylene resins or copolymer resins thereof; polyamide resins; polyester resins; butyl resin; polyvinyl acetate resins or copolymer resins thereof; cellulose derivative resins; polyethylene methacrylate resins; polyvinyl ether resins; polyethylene resins; polycarbonate resins; and polyvinyl chloride resins. When the hot-melt resin is used for a clothing product, polyurethane resins may be preferred.

The thickness of the hot-melt resin layer of the seam-sealing tape may preferably be not smaller than 25 μm, more preferably not smaller than 50 μm, but may preferably be not greater than 400 μm, more preferably not greater than 200 μm. When the thickness of the hot-melt resin layer is smaller than 25 μm, the amount of resin is too small, which makes it difficult to completely cover the irregularities of threads in the needle holes, and there is fear that the waterproofness of the seam portion becomes insufficient. On the other hand, when the thickness of the hot-melt resin layer is greater than 400 μm, there occurs the possibility that the thermal compression bonding of the tape may need a long time for sufficiently melting the hot-melt resin layer, thereby decreasing productivity, or may cause a thermal damage on the waterproof sound-permeable means, to which the tape is to be adhered. In addition, if the time for thermal compression bonding is shortened, the hot-melt resin layer does not sufficiently melt, resulting in that sufficient adhesive strength and sufficient waterproofness cannot be obtained.

These seam-sealing tapes can be used for melt bonding processing with an existing hot air sealer that applies hot air to the hot-melt resin layer side of each tape, and causes the compression bonding of the tape to an adherend with a pressure roll in the state where the resin is being melted. There can be used, for example, “QHE-800” available from Queen Light Electronic Industries Ltd., or “5000E” available from W. L. Gore & Associates, Inc. In addition, to achieve the melt bonding processing of a short seam portion in an easier and simpler manner, the seam-sealing tape may be subjected to thermal compression bonding with a commercially available heat press machine or iron. In this case, heat and pressure are applied to the seam-sealing tape layered on the seam portion. The conditions for thermal compression bonding of the seam-sealing tape may appropriately be set depending on the softening point of the hot-melt resin to be used for the tape, the melt bonding speed, and any other factors.

**EXAMPLE**

The present invention will hereinafter be described in detail by reference to Example; however, the present invention is not limited to the following Example, and various modifications, changes, and embodiments, which are made without departing from the spirit of the present invention, are all included within the scope of the present invention.

**Evaluation Methods**

1. Sound-Transmission Loss

The sound-transmission loss was measured using “Transmission Loss Tube Kit (Type 4206-T)” and “PULSE sound and vibration analysis hardware (Type 3560-C)” available from Brüel & Kjær Sound & Vibration Measurement A/S. The measurement conditions were as follows: a small tube (having an inner diameter of 29 mm) was used as a transmission loss tube kit; and noise to be generated from a sound source was 120 db. The measurement was carried out in the state where the end opposite to the end, at which the sound source was disposed, of the transmission loss tube was closed, and also in the state where the opposite end was open. The sound-transmission loss was determined using analysis soft-
ware "PULSE LabShop Version 10.1.0.15" available from Briel & Kjær Sound & Vibration Measurement A/S.

2. Waterproofness

[0082] The waterproofness of waterproof sound-permeable hoods was evaluated by visually checking the presence or absence of water leakage in the artificial rain test which was carried out using an artificial rain chamber under the conditions of a precipitation amount of not smaller than 50 mm/h and a period of 30 minutes.

3. Durability Against Washing

[0083] The durability against washing of waterproof sound-permeable hoods was evaluated by carrying out the above waterproof test after repeating the washing twenty times.

[0084] The step of washing the hood using a household fully-automatic washing machine (available from Matsushita Electric Industrial Co., Ltd.; model number "NA-F70PX1") and hanging the hood to dry at room temperature for 24 hours was regarded as one cycle of the washing. Washing was carried out using 40 liters of tap water and 30 g of synthetic laundry detergent ("Attack (registered trademark)" available from Kao Corporation) for 6 minutes, followed by rinsing twice and dewatering for 5 minutes.

4. Sound Permeability

[0085] A bell alarm clock ("G07Y5G" available from DAILY) was placed 2 m away from a subject wearing a rain jacket ("RO3 Rain Jacket" available from Japan Gore-Tex Inc.), to which each of hoods obtained in the following Production Examples is attached, or to which no hood is attached, such that the bell alarm clock was placed on one side of the subject, or in other words, placed so as to be directed to one ear of the subject. When the bell alarm clock was sounded in the state where the hood was worn, and also in the state where no hood was worn, noise near the ear of the subject was measured with a sound level meter (Sound Level Meter "NL-20" available from Rion Co., Ltd.). When the hood was worn, the detection section of the sound level meter was provided within the hood.

Laminated Waterproof Sound-Permeable Membrane

[0086] A mesh laminate as a laminated waterproof sound-permeable membrane was prepared as follows: a porous PTFE film (available from Japan Gore-Tex Inc.), and having a thickness of 8.5 μm, a mass per unit area of 2.3 g/m², an air permeability (Gurley number) of 0.032 sec., and a porosity of 87.4%, was used as a waterproof sound-permeable membrane; a polypropylene mesh ("Couved (registered trademark) net (having a thickness of 0.48 μm and a mass per unit area of 100 g/m²") available from Nisseki Plasto Co., Ltd.) was used as a protective layer; and the protective layer was firmly attached to the waterproof sound-permeable membrane by thermal lamination (at 170°C. for 5 seconds). The sound-transmission loss was measured for the obtained mesh laminate. The result is shown in Table 1.

Waterproof Material Having Waterproof Sound-Permeable Means

[0087] A waterproof material having waterproof sound-permeable means was prepared by attaching the mesh laminate as the laminated waterproof sound-permeable membrane obtained as described above to a waterproof material ("EB FPL70WDH/6366-WR" available from Japan Gore-Tex Inc.). For the attachment of the mesh laminate, a net eyelet (available from Morito Co., Ltd.; the cylindrical swaging part thereof has an inner diameter of 9 mm and the protective layer thereof is a wire fabric) was used as a holding member, and the number of attached mesh laminate was one. The gap between the holding portion of the mesh eyelet and the mesh laminate was sealed with a silicone resin.

[0088] The structure of the waterproof sound-permeable means according to the present Example will be specifically described by reference to FIG. 5. That is, the fabric corresponds to the waterproof material 2; the porous PTFE film forming the mesh laminate corresponds to the waterproof sound-permeable membrane 11; and the polypropylene mesh corresponds to the protective layer 12a. In addition, the mesh eyelet corresponds to the holding member 20 and the female ring 24; the wire fabric included in the mesh eyelet corresponds to the protective layer 12b; and the silicone resin corresponds to the sealing member 23.

[0089] The sound-transmission loss was measured for the obtained waterproof material having the waterproof sound-permeable means. Further, as a comparative example, the sound-transmission loss of the waterproof material and the sound-transmission loss of the waterproof material including an opening having an inner diameter of 10 mm were also measured. The results are shown in Table 1.

| Mesh laminate | 2.76 |
| Waterproof material having waterproof sound-permeable means | 8.75 |
| Waterproof material (having opening) | 1.70 |

Waterproof Hoods

Production Example 1

[0090] A waterproof hood was prepared by sewing a waterproof laminate ("EB FPL70/6366-WR" available from Japan Gore-Tex Inc.) as a waterproof material. The seam was sealed using a seam-sealing tape ("CORE-SEAM (registered trademark) Tape" available from Japan Gore-Tex Inc.). A waterproof sound-permeable hood was prepared by attaching a waterproof sound-permeable means to each of the portions of the obtained waterproof hood, which portions respectively face to the right and left ears of a wearer. The waterproof sound-permeable means had the same structure as used in the waterproof material having the waterproof sound-permeable means, and the number of attached means was one for each of the portions facing to the right and left ears of the wearer.

[0091] When a waterproof test and a durability-against-washing test were carried out for the obtained waterproof sound-permeable hood, water leakage was not observed in either test. In addition, a sound permeability test was carried out for the waterproof sound-permeable hood. The result is shown in Table 2.

Production Example 2

[0092] A waterproof hood was prepared using the same waterproof laminated product and seam-sealing tape as those
which were used in Production Example 1. A sound permeability test was carried out for the obtained waterproof hood. The result is shown in Table 2.

Production Example 3

[0093] A waterproof hood was prepared using the same waterproof laminated product and seam-sealing tape as those which were used in Production Example 1. The waterproof hood obtained was provided with an opening having an inner diameter of 25 mm each on the portions respectively facing to the right and left ears of a wearer to prepare a sound-permeable hood. A sound permeability test was carried out for the obtained sound-permeable hood. The result is shown in Table 2.

<table>
<thead>
<tr>
<th>TABLE 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sound noise measured value (db)</td>
</tr>
<tr>
<td>Waterproof sound-permeable hood</td>
</tr>
<tr>
<td>Waterproof hood</td>
</tr>
<tr>
<td>Sound-permeable hood</td>
</tr>
<tr>
<td>No hood</td>
</tr>
</tbody>
</table>

INDUSTRIAL APPLICABILITY

[0094] The present invention is useful for waterproof hoods having excellent waterproofness and excellent sound permeability.

EXPLANATION OF SYMBOLS


What is claimed is:

1. A waterproof sound-permeable hood formed of a waterproof material, which hood comprises a waterproof sound-permeable means provided on at least one of portions respectively facing to the ears of a wearer who wears the waterproof material, wherein the waterproof sound-permeable means comprises a waterproof sound-permeable membrane having a sound-transmission loss of not greater than 5 db.

2. The waterproof sound-permeable hood according to claim 1, wherein the waterproof sound-permeable membrane comprises at least one porous polytetrafluoroethylene layer.

3. The waterproof sound-permeable hood according to claim 1, wherein the waterproof sound-permeable means comprises at least one protective layer to protect the waterproof sound-permeable membrane.

4. The waterproof sound-permeable hood according to claim 3, wherein the at least one protective layer is firmly attached to the waterproof sound-permeable membrane.

5. The waterproof sound-permeable hood according to claim 1, wherein the waterproof sound-permeable means comprises a holding member having a cylindrical swaging part and a holding part formed on one end of the cylindrical swaging part and wherein the holding member holds the waterproof sound-permeable membrane in the holding part and is fixed to the waterproof material by the cylindrical swaging part.

6. The waterproof sound-permeable hood according to claim 5, wherein the holding member has a gap between the waterproof sound-permeable membrane and the holding part, which gap is sealed with a sealing member.