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(54) **A laminate, especially for use as underroofing**

Mehrschichtwerkstoff, insbesondere zur Verwendung als Unterdach

Stratifié, en particulier utilisé comme sous-toiture

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WO-A-00/37751
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Description

[0001] The present invention relates to a water vapour permeable laminate, especially for use as an underroofing or underslating for roofs.

[0002] A heat insulated roof structure normally comprises an outer roof covering, such as tiles, an underslating or underroofing in the form of a substantially water impermeable plastic film or laminate, a layer of heat insulation, and an inner vapour barrier in the form of a plastic film or laminate. The purpose of the underslating is to prevent rainwater and drift snow having passed through the roof cover from penetrating into the heat insulation. Normally, small amounts of moisture are diffusing through the vapour barrier from the room under the roof structure and into the insulation layer. In order to minimise the risk of rot in the wooden structure, such moisture has to be removed. Traditionally, this is done by forming a ventilating space between the underslating and the insulation, which ventilating space communicates with the ambient atmosphere. It is also known to dispense with that ventilating space. In the latter case the underslating should fulfil two apparently contradicting conditions, namely be substantially impermeable to moisture from the outside towards the inside, but permeable to moisture from the inside towards the outside.

[0003] WO00/37751 discloses a water vapour barrier having a water absorbing material defined between first and second water impervious membranes. The basic idea is to provide a water vapour barrier having the additional ability of removing moisture in a construction part, e.g. a roof structure, before it accumulates to a problematic level. The water vapour barrier of WO00/37751 is therefore not suitable for use as understating or underroofing because it allows some extent of vapour penetration through both of its membranes.

[0004] The present invention provides an improved water vapour permeable laminate, which is suited for use as an underroofing or understating for roofs in a non-ventilated roof structure.

[0005] Thus, the present invention provides a water vapour permeable laminate comprising an outer layer formed by a first film or foil of a material having a water vapour diffusion resistance independent of relative humidity of air in contact therewith the first film being perforated, and an inner layer having at least some areas formed by a non-perforated second film of the type having a water vapour diffusion resistance, which varies in dependency of the relative humidity of air in contact therewith, such that the water vapour diffusion resistance is reduced, when the relative humidity increases, and vice versa, characterized in that the first and second films are directly interconnected at their adjoining surfaces without an intermediate layer, and that the water vapour diffusion resistance of the outer layer exceeds the maximum water vapour diffusion resistance of the second film.

[0006] Preferably, the total inner layer or film is made from the same plastic material. It should be understood, however, that the inner layer could be made from mutually spaced areas of such material having a diffusion resistance, which is dependent on the relative humidity of the contacting air, and the said spaced areas could be interconnected by connecting areas of film or foil being substantially impervious to water vapour or having a diffusion resistance being less dependent on the relative humidity of the contacting air.

[0007] Such laminate prevents water stemming from for example driving rain or drift snow from penetrating there through and into the insulation layer and the roof structure. On the other hand, when the relative humidity in the room under the underslating or underroofing is high water vapour may diffuse through the second film and through the perforations of the first film or foil out into the ambient atmosphere. Thus, the laminate according to the invention functions like a one-way valve allowing moisture to pass from the inner room under the roof covering and outwards into the outer atmosphere, only.

[0008] The diffusion resistance of the outer layer in a non-perforated condition must be relatively high even when the relative humidity (RH) on the outer side thereof is high. In a preferred embodiment the diffusion resistance of the outer layer exceeds 20 m and preferably 90 m air column.

[0009] Preferably, the diffusion resistance of the inner layer is less than 18 m, 15m, 10m, 5m or 1m air column at a relative humidity (RH) of at least 80% at an exposed inner surface of the inner layer. More preferred the diffusion resistance of the inner layer is much less, namely between 0.02 and 0.6 m air column at a relative humidity of at least 80% at the exposed inner surface of the inner layer.

[0010] The outer layer or the first film is perforated in order to allow water vapour to pass outwardly from the inner space of the building into the outer atmosphere. On the other hand, the laminate according to the invention should be substantially impermeable to water. Therefore, the perforations of the first film or foil of the outer layer are preferably substantially impermeable to liquid water, but permeable to water vapour.

[0011] The perforations of the first film or foil may be substantially uniformly distributed over the area of the outer layer. Alternatively, the perforations may be concentrated in certain mutually spaced areas, which may, for example be band shaped, circular, rectangular, etc. The perforations may be made in any suitable manner, such as by punching, corona discharge, flame perforation or rendered breathable by an overload of fillers or defined between overlapping edge portions of for example band shaped parts.

[0012] Each of the perforations in the first film or foil may have a substantially uniform cross-sectional shape along its length transversely to the film or foil. However, in order to reduce the resistance against water vapour passing from the inner space of the building and outwardly through the underslating or laminate and still prevent liquid water on the outside of the laminate from penetrat-

ing the outer layer thereof the cross-sectional area of at least some of the perforations of the first film or foil may increase from the outer surface of the film or foil towards the inner surface thereof. This means that each of said at least some perforations are funnel-shaped from the inner surface of the film or foil towards the outer surface thereof.

[0013] In order to prevent liquid water from penetrating the laminate according to the invention from the outer side thereof the minimum dimension or diameter of each of at least the majority of the perforations of the first film or foil of the outer layer is preferably smaller than 1.5 mm, preferably at the outer surface of the outer layer and the said minimum dimension or diameter of each of said majority of the perforations are preferably between 0.001 and 0.5 mm.

[0014] In order to allow water vapour to pass through the laminate according to the invention from the inner side thereof the resistance to diffusion of water vapour from the exposed surface of the inner layer to the outer surface of the outer layer should preferably be equal to or less than 0.6 m air column at a relative humidity of at least 80% at said exposed surface of the inner layer.

[0015] The second film of the inner layer may be made from any material having a varying diffusion resistance against water vapour as described above. According to the invention such material may be selected from the group consisting of polyamide, ethylene-vinyl alcohol copolymer, polyvinyl alcohol, polyurethane, protein derivatives, methylcellulose, cellophane, linseed oil alkyd, and bone glue.

[0016] The first film or foil of the outer layer may be made from any film or foil which in its imperforated condition is substantially impervious to water vapour. Thus, the first film or foil may be made from one or more of the materials selected from the group consisting of aluminium and other metals, polyethylene, polypropylene, polyethylene terephthalate, metallised polyethylene terephthalate, and polyvinylidene chloride.

[0017] The first and second films may be directly interconnected at their adjoining surfaces.

[0018] The present invention further comprises a roof structure comprising an outer roofing and an inner roofing or underroofing impervious to water, and the roof structure according to the invention is characterised in that the inner roofing comprises any of the above described embodiments of the laminate according to the invention, the outer layer of said laminate being positioned adjacent to the inner surface of the outer roofing.

[0019] The invention will now be further described with reference to the drawings, in which

Fig. 1 is a sectional view of a roof structure including an underroofing or underslating formed by a laminate according to the invention, and

Fig. 2 is a sectional view of a preferred embodiment of the laminate according to the invention.

[0020] Fig. 1 is a sectional view of a roof structure according to the invention. This roof structure of a building (not shown) includes a wooden structure comprising a plurality of upper and lower battens 10 and 11, respectively, extending between the roof ridge and the eaves, and counter battens 12 extending transversely to the battens 10 and 11. A roof covering 13 made up by tiles or other roofing plates is fastened to the upper battens 10. The roof structure further comprises an insulating layer 14, which is arranged between the upper battens 10 and the lower battens 11, and which may, for example, be made from stone wool or fibre glass. Furthermore, a ceiling lining 15 may be fastened to the bottom surfaces of the lower battens.

[0021] It is important to prevent water resulting for example from driving rain or drift snow having passed through the roof covering 13 from penetrating into the insulating layer 14, because a high humidity therein may give rise to rot and promote growth of fungi and other micro-organisms. For this reason an underroofing or underslating in the form of a laminate 16 in accordance with the invention and shown in further detail in Fig. 2 is arranged between the bottom surfaces of the upper battens 10 and the upper surface of the insulating layer 14. A further laminate or vapour barrier 17, which may be of the type disclosed in applicant's international patent application WO 00/37751 or WO 96/33321, may be arranged between the lower surface of the insulating layer 14 and the upper surfaces of the lower battens 11. The purpose of this laminate 17 is described in more detail in the above international patent application.

[0022] Fig 2 is a cross-sectional view of an embodiment of the laminate 16 according to the invention. This laminate 16 comprises an upper or outer layer 18, which may be in the form of a plastic film or a metal foil and a lower or an inner layer or plastic film 19.

[0023] The upper layer 18 is made from a material, which is not only impermeable to liquid water, but also substantially impermeable to water vapour. However, in order to allow water vapour to pass through the upper layer 18 it is provided with a great plurality of small through openings or perforations 21. The diameter of each of these perforations 21 is so small that liquid water cannot pass through the perforations from the outer surface of the upper layer. The perforations may be distributed uniformly over the total area of the upper layer or be arranged in mutually spaced groups as shown in Fig. 2. The lower or inner layer 19 is a non-perforated plastic film of the type having a water vapour diffusion resistance, which is reduced when the relative humidity of the air in contact therewith increases, and vice versa. Preferably, the water vapour diffusion resistance of the inner layer 19 is between 0.02 and 0.6 m air column at a relative humidity of at least 80% at the inner surface thereof.

[0024] The underroofing 16 in accordance with the present invention prevents liquid water from passing there through, and the water vapour diffusion resistance of the of the material from which the film or foil is made

is high. Therefore, no or negligible amounts only of water vapour will pass inwardly through the outer layer 18. If, however, for some reason the humidity of the insulating layer and of the air around the wooden roof structure remains high for a longer period of time, detrimental micro-organisms may attack the wooden roof structure. Therefore, it is important that the humidity of the air in the space defined between the upper laminate 16 and the lower laminate 17 in figure 1 is kept below a certain upper limit.

[0025] This may be obtained by the laminate or underroofing 16 according to the invention. When the humidity of the air enclosed in the space between the laminates 16 and 17 increases the water vapour diffusion resistance of the lower or inner layer 19 of the laminate 16 decreases so that water vapour may pass out into the ambient atmosphere via the perforations 21 in the outer layer 18. Preferably, the resistance to diffusion of water vapour from the exposed surface of the inner layer 19 to the outer surface of the outer layer 18 of the laminate 16 is equal to or less than 0.6 m air column at a relative humidity of at least 80% at inner surface of the inner layer 19.

[0026] It should be understood that var ous modifications and changes of the embodiments of the laminate and of the roof structure described above could be made without departing from the scope of the present invention as defined in the attached claims.

Claims

1. Water vapour permeable laminate (16) comprising
an outer layer (18) formed by a first film or foil of a material having a water vapour diffusion resistance independent of relative humidity of air in contact therewith, the first film being perforated, and
an inner layer (19) having at least some areas formed by a non-perforated second film of the type having a water vapour diffusion resistance, which varies in dependency of the relative humidity of air in contact therewith, such that the water vapour diffusion resistance is reduced, when the relative humidity increases, and vice versa,
characterized in that
said first and second films are directly interconnected at their adjoining surfaces without an intermediate layer, and that the water vapour diffusion resistance of the outer layer (18) exceeds the maximum water vapour diffusion resistance of the second film (19).

2. A laminate according to claim 1, wherein the perforations (21) of the first film or foil (18) are concentrated in certain mutually spaced areas.

3. A laminate according to claim 1 or 2, wherein the cross-sectional area of at least some of the perforations (21) of the first film or foil (18) is increasing from the outer surface of the film or foil towards the inner surface thereof.

4. A laminate according to any of the claims 1-3, wherein the minimum dimension or diameter of each of at least the majority of the perforations (21) of the first film or foil of the outer layer (18) is smaller than 1.5 mm, preferably at the outer surface of the outer layer.

5. A laminate according to any of the claims 1 - 4, wherein the diffusion resistance of the material used for the first film or foil exceeds 20 m and preferably 90 m air column in its non-perforated condition.

6. A laminate according to any of the claims 1 - 5, wherein the diffusion resistance of the inner layer (19) is less than 18 m air column at a relative humidity of at least 80% at an exposed inner surface of the inner layer.

7. A laminate according to claim 6, wherein the diffusion resistance of the inner layer (19) is between 0.02 and 0.6 m air column at a relative humidity of at least 80 % at the exposed inner surface of the inner layer.

8. A laminate according to any of the claims 1-7, wherein the second film (19) of the inner layer is made from a material selected from the group consisting of polyamide, ethylenevinyl alcohol-copolymer, polyvinyl alcohol, polyurethane, protein derivatives, methyl cellulose, cellophane, linseed oil alkyd, and bone glue.

9. A laminate according to any of the claims 1-8, wherein the first film or foil of the outer layer (18) is made from one or more of the materials selected from the group consisting of aluminium and other metals, polyethylene, polypropylene, polyethylene terephthalate, metallised polyethylene terephthalate, and polyvinylidene chloride

10. A roof structure comprising an outer roofing (13) and an inner roofing (16) impervious to water, **characterised in that** the inner roofing comprises a laminate (16) according to any of the claims 1-9, the outer layer (18) of said laminate being positioned adjacent to the inner surface of the outer roofing (13).

Patentansprüche

1. Wasserdampfdurchlässiger Verbundstoff (16), umfassend
eine Außenschicht (18), die durch eine erste Folie oder Membran eines Materials ausgebildet ist, welches einen Wasserdampfdiffusionswiderstand aufweist, der unabhängig von der relativen Feuchtigkeit der damit in Kontakt befindlichen Luft ist, wobei die

erste Folie perforiert ist, und
eine Innenschicht (19) mit wenigstens einigen Bereichen, die durch eine zweite nicht perforierte Folie des Typs mit einem Wasserdampfdiffusionswiderstand ausgebildet ist, der sich in Abhängigkeit von der relativen Feuchtigkeit der damit in Kontakt befindlichen Luft verändert, sodass der Wasserdampfdiffusionswiderstand geringer wird, wenn die relative Feuchtigkeit ansteigt und umgekehrt,
dadurch gekennzeichnet, dass
die erste und zweite Folie an ihren angrenzenden Flächen ohne eine Zwischenschicht direkt miteinander verbunden sind und dass der Wasserdampfdiffusionswiderstand der Außenschicht (18) größer ist als der maximale Wasserdampfdiffusionswiderstand der zweiten Folie (19).

2. Verbundstoff nach Anspruch 1, wobei die Perforationen (21) der ersten Folie oder Membran (18) in bestimmten zueinander beabstandeten Bereichen konzentriert sind.

3. Verbundstoff nach Anspruch 1 oder 2, wobei die Querschnittsfläche mindestens einiger der Perforationen (21) der ersten Folie oder Membran (18) von der Außenfläche der Folie oder Membran zur Innenfläche davon zunimmt.

4. Verbundstoff nach einem der Ansprüche 1-3, wobei die Mindestabmessung oder der Mindestdurchmesser jeder mindestens des Hauptanteils der Perforationen (21) der ersten Folie oder Membran der Außenschicht (18) vorzugsweise an der Außenfläche der Außenschicht kleiner als 1,5 mm ist.

5. Verbundstoff nach einem der Ansprüche 1-4, wobei der Diffusionswiderstand des für die erste Folie oder Membran verwendeten Materials in ihrem nicht perforierten Zustand ist größer als 20 m und vorzugsweise 90 m Luftsäule ist.

6. Verbundstoff nach einem der Ansprüche 1-5, wobei der Diffusionswiderstand der Innenschicht (19) bei einer relativen Feuchtigkeit von mindestens 80 % an einer freiliegenden Innenfläche der Innenschicht kleiner als 18 m Luftsäule ist.

7. Verbundstoff nach Anspruch 6, wobei der Diffusionswiderstand der Innenschicht (19) bei einer relativen Feuchtigkeit von mindestens 80 % an der freiliegenden Innenfläche der Innenschicht zwischen 0,02 und 0,6 m Luftsäule ist.

8. Verbundstoff nach einem der Ansprüche 1-7, wobei die zweite Folie (19) der Innenschicht aus einem Material hergestellt ist, ausgewählt aus der Gruppe, bestehend aus Polyamid, Ethylenvinyl-Alkohol-Copolymer, Polyvinylalkohol, Polyurethan, Proteinderivaten, Methylcellulose, Cellophan, Leinölalkyd und Knochenleim.

9. Verbundstoff nach einem der Ansprüche 1-8, wobei die erste Folie oder Membran der Außenschicht (18) aus einem oder mehreren Materialien hergestellt ist, ausgewählt aus der Gruppe, bestehend aus Aluminium und anderen Metallen, Polyethylen, Polypropylen, Polyethylenterephthalat, metallisiertes Polyethylenterephthalat und Polyvinylidenchlorid.

10. Dachkonstruktion, umfassend eine Außendachhaut (13) und eine wasserundurchlässige Innendachhaut (16), **dadurch gekennzeichnet, dass** die Innendachhaut einen Verbundstoff (16) nach einem der Ansprüche 1-9 umfasst, wobei die Außenschicht (18) des Verbundstoffs an die Innenfläche der Außendachhaut (13) angrenzend angeordnet ist.

Revendications

1. Stratifié perméable à la vapeur d'eau (16) comprenant
une couche extérieure (18) formée par un premier film ou une première feuille d'un matériau présentant une résistance à la diffusion de vapeur d'eau sensiblement indépendante de l'humidité relative de l'air en contact avec celui/celle-ci, le premier film étant perforé, et
une couche intérieure (19) ayant au moins certaines zones formées par un second film non perforé du type présentant une résistance à la diffusion de vapeur d'eau, qui varie en fonction de l'humidité relative de l'air en contact avec celui-ci, de telle sorte que la résistance à la diffusion de vapeur d'eau est réduite lorsque l'humidité relative augmente, et inversement
caractérisé en ce que
lesdits premier et second films sont directement interconnectés au niveau de leurs surfaces adjacentes sans couche intermédiaire, et **en ce que** la résistance à la diffusion de vapeur d'eau de la couche extérieure (18) dépasse la résistance à la diffusion de vapeur d'eau maximale du second film (19) à une humidité relative de l'air à son contact d'au moins 80 % de HR.

2. Stratifié selon la revendication 1, dans lequel les perforations (21) du premier film ou de la première feuille (18) sont concentrées dans certaines zones espacées les unes des autres.

3. Stratifié selon la revendication 1 ou 2, dans lequel la surface en coupe transversale d'au moins certaines des perforations (21) du premier film ou de la première feuille (18) augmente de la surface extérieure du film ou de la feuille vers la surface intérieure de celui/celle-ci.

4. Stratifié selon l'une quelconque des revendications 1 à 3, dans lequel la dimension ou le diamètre minimum de chacune d'au moins la majorité des perforations (21) du premier film ou de la première feuille de la couche extérieure (18) est inférieur(e) à 1,5 mm, de préférence au niveau de la surface extérieure de la couche extérieure.

5. Stratifié selon l'une quelconque des revendications 1 à 4, dans lequel la résistance à la diffusion du matériau utilisé pour le premier film ou la première feuille correspond à une colonne d'air de plus de 20 m et de préférence de 90 m de dans son état non perforé.

6. Stratifié selon l'une quelconque des revendications 1 à 5, dans lequel la résistance à la diffusion de la couche intérieure (19) correspond à une colonne d'air de moins de 18 m à une humidité relative d'au moins 80 % au niveau d'une surface intérieure exposée de la couche intérieure.

7. Stratifié selon la revendication 6, dans lequel la résistance à la diffusion de la couche intérieure (19) correspond à une colonne d'air comprise entre 0,02 et 0,6 m à une humidité relative d'au moins 80 % au niveau de la surface intérieure exposée de la couche intérieure.

8. Stratifié selon l'une quelconque des revendications 1 à 7, dans lequel le second film (19) de la couche intérieure est fait dans un matériau choisi dans le groupe constitué par le polyamide, un copolymère éthylène-alcool vinylique, l'alcool polyvinylique, le polyuréthane, les dérivés protéiques, la méthylcellulose, la cellophane, un alkyde d'huile de lin et la colle d'os.

9. Stratifié selon l'une quelconque des revendications 1 à 8, dans lequel le premier film ou la première feuille de la couche extérieure (18) est fait(e) dans un ou plusieurs des matériaux choisis dans le groupe constitué par l'aluminium et d'autres métaux, le polyéthylène, le polypropylène, le polyéthylène téréphtalate, le polyéthylène téréphtalate métallisé et le polychlorure de vinylidène.

10. Structure de toit comprenant une couverture extérieure (13) et une couverture intérieure (16) imperméable à l'eau, **caractérisée en ce que** la couverture intérieure comprend un stratifié (16) selon l'une quelconque des revendications 1 à 9, la couche extérieure (18) dudit stratifié étant positionnée adjacente à la surface intérieure de la couverture extérieure (13).

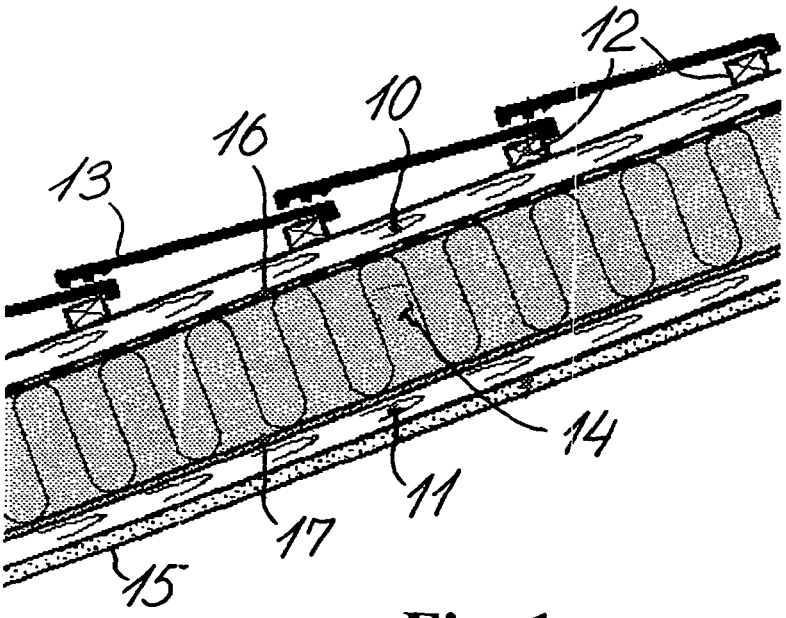

Fig. 1

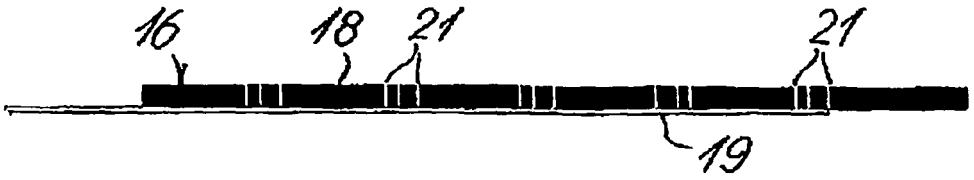

Fig. 2

REFERENCES CITED IN THE DESCRIPTION

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- WO 9633321 A **[0021]**