

Multilayer foil

The present invention relates to a multilayer foil with low water vapor transmission and with low oxygen transmission, and with particular suitability for blister packs for medicaments.

The barrier effect of polymeric materials and foils with respect to water vapor is generally independent of the barrier effect with respect to oxygen. Accordingly, materials exhibiting a good vapor barrier will not necessarily also exhibit a good barrier with respect to oxygen and to odors, and vice versa. The only material that exhibits a barrier effect in a moderate to good range of values not only with respect to oxygen but also with respect to water vapor is polyvinylidene chloride (PVDC). PCTFE, polyolefins, and other polymers exhibit a good to very good water vapor barrier but a very low oxygen barrier. EVOH (ethylene-vinyl alcohol copolymer) exhibits a very good oxygen barrier, but a low water vapor barrier. There is currently no available polymeric packaging foil that is marketable, i.e. that can be produced cost-effectively, and that exhibits a high water vapor barrier alongside a high oxygen barrier. On the other hand, modern medicaments are increasingly proving to be sensitive to water vapor and oxygen. The requirements placed upon the barrier effect exhibited by packaging foils for medicaments are accordingly ever more stringent. The requirement hitherto has been for a large barrier effect mainly with respect to water vapor, but packaging foils for modern medicaments now also have to exhibit a large barrier effect with respect to oxygen.

Thermoformable plastics foils are widely used for the

packaging of food and drink, medicaments, and other products. The products known as blister packs are important here. Blister packs have a shape matched to the product and obtained by thermoforming of a flat, preferably transparent plastics foil. The packaging component that conforms to the respective product or contents is also termed base component, and after the contents have been charged it is sealed with a lid foil, preferably an aluminum foil, by a welding or sealing process. The packaging has to comply with particular requirements in respect of the barrier effect thereof with respect to water vapor, oxygen and sometimes other gases, such as carbon dioxide, and these requirements depend on the intended application. By way of example, a wide variety of medicaments require packaging exhibiting a water vapor transmission of less than $0.06 \text{ g}/(\text{m}^2 \cdot 24\text{h})$, and in some cases less than $0.04 \text{ g}/(\text{m}^2 \cdot 24\text{h})$. In the case of transparent foils, the only way of achieving water vapor transmission of less than $0.06 \text{ g}/(\text{m}^2 \cdot 24\text{h})$ is to use PCTFE as foil material with a thickness greater than $100 \mu\text{m}$. Water vapor transmission below $0.04 \text{ g}/(\text{m}^2 \cdot 24\text{h})$ has hitherto been achievable only by using aluminum foil, in particular by using what is known as "cold form foil". Aluminum foils of this type are not transparent and they moreover have low deformability, and cannot therefore be used to produce relatively small blisters, so that the foil area needed is substantially greater than when a thermoformable blister is used. Thermoformable plastics foils have to have not only a larger barrier effect but also other properties, such as sealability, freedom from streaks, low thickness, uniform thickness profile, and good processability. For the processability, especially advantageous features are good deformability, i.e. maximum uniformity of thickness distribution in the component after the

deforming process, and also maximum shape replication, minimum curl, and a small coefficient of friction, i.e. good slip capability with respect to the machinery parts contacted and the packaged contents. The curl
5 occurs in two- or multilayer composite foils when the coefficients of thermal expansion (CTEs) of the individual layer materials differ.

Thermoforming plastics foils for packaging exhibiting
10 barrier effect with respect to water vapor are known in the prior art.

EP 1 655 237 A1 discloses a thermoformed or cold-formed blister pack with a blister base component and with a
15 lid foil. The lid foil is composed of an aluminum foil of thickness from 10 to 30 μm which has been laminated or coated with, on a first side, a foil which can be peeled from the aluminum foil and which is made of at least one plastics layer based on thermoplastic or
20 thermoset polymers and, on the second side, sealed against the blister base component, a plastics foil based on polyvinyl chloride (PVC) having a foil thickness of from 10 to 40 μm , or polyvinylidene chloride (PVDC) having a foil thickness of from 10 to 40 μm , or
25 polypropylene (PP) having a foil thickness of from 6 to 35 μm , or polyethylene (PE) having a foil thickness of from 6 to 35 μm , or polyester having a foil thickness of from 5 to 10 μm , or polychlorotrifluoroethylene (PCTFE) having a foil thickness of from 8 to 30 μm , or
30 cycloolefin copolymers (COCs), or cycloolefin polymers (COPs) having a thickness of from 10 to 40 μm . The blister base component is composed, at least on the side sealed against the lid foil, of a material having a chemical structure compatible with that of the
35 plastics foils sealed against the blister base component. The foil that can be peeled from the aluminum foil is composed of one or more layers made of one or

more of the following plastics: PVC, PVDC, PCTFE, PP, PE, polyester, polyethylene naphthalate (PEN), polyamide (PA), COC, COP, polystyrene (PS), or cellophane.

5 EP 1 468 817 A1 relates to a lid foil for blister packs with thermoformed or cold-formed blister base components. The lid foil encompasses an aluminum foil of thickness from 5 to 30 μm which has been laminated, on
10 a side provided for sealing with respect to a blister base component, with a plastics foil based on PVC having a foil thickness of from 10 to 40 μm , or PVDC having a foil thickness of from 10 to 40 μm , or PP having a foil thickness of from 6 to 35 μm , or polyester having a foil thickness of from 5 to 15 μm ,
15 or PCTFE having a foil thickness of from 8 to 76 μm , or COC having a thickness of from 10 to 40 μm . Blister base components are composed by way of example of foils made of PVC, PP, PET, PE, and of composite foils, such as PVC/ACLAR[®] (PCTFE), PVC/PVDC, and COC, or Al-Al
20 blisters.

DE 602 09 812 T2 describes an at least single-layer polymer foil, where one of the layers encompasses a vinylidene chloride composition which encompasses 100
25 parts by weight of vinylidene chloride copolymer; from 0.1 to 10 parts by weight of stabilizer, from 0.1 to 10 parts by weight of lubricant, and from 0.1 to 10 parts by weight of hydrophilic clay. By way of example, the structure of the polymer foil is of the following type:
30 C/A/B, B/A/D/B, or C/A/D/C, where A stands for PVDC.

The packaging foils known in the prior art exhibit inadequate barrier effect with respect to water vapor and oxygen, or require the use of considerable amounts
35 of PCTFE, of an aluminum foil, or of inorganic additives. These measures are associated with increased costs in the case of PCTFE, or impair processability

and other properties, such as optical transparency.

PCTFE foil exhibits a very good water vapor barrier, but a low oxygen barrier. An increase in the thickness of a PCTFE foil can in principle raise the water vapor barrier, but because of indirect proportionality between material thickness and water vapor transmission the thickness of PCTFE needed rises rapidly into a range which is technically and economically very disadvantageous, and there is no possibility of achieving an oxygen barrier adequate for highly demanding packaging applications. PVDC, on the other hand, exhibits a very good oxygen barrier, but exhibits a water vapor barrier substantially smaller than that of PCTFE. If the same water vapor barrier is to be achieved with PVDC as with PCTFE, the thickness of PVDC has to be 165 % of the thickness of PCTFE. PVDC foils and, respectively, layers are usually produced by applying many thin sublayers. By way of example, the weight per unit area of PVDC required to achieve a water vapor barrier of $0.035 \text{ g}/(\text{m}^2 \cdot 24\text{h})$ (measured at a temperature of 38°C and a relative humidity of 90 %) would be about $400 \text{ g}/\text{m}^2$. This requires 40 passes through the machinery of a conventional industrial coating system in each case applying $10 \text{ g}/\text{m}^2$, or 27 passes at $15 \text{ g}/\text{m}^2$. Such a large number of passes through machinery is not achievable either technically or economically. The industrial processes known in the prior art produce PVDC layers with weight per unit area of up to at most $180 \text{ g}/\text{m}^2$.

The oxygen barrier exhibited by PVDC is only very slightly affected by moisture, whereas by way of example EVOH, which likewise exhibits a very good oxygen barrier, suffers major loss of oxygen barrier on exposure to moisture. In extreme cases, the magnitude of the loss in the case of EVOH extends to powers of

ten. EVOH is usually used in packaging for food or drink, but has also recently been used in pharmaceutical packaging.

5 It is an object of the present invention to provide a foil which exhibits a high barrier effect with respect to water vapor in combination with a barrier effect against oxygen, while use of material is at the same time efficient, and which provides good processability
10 and complies with design requirements, e.g. in respect of optical transparency. A particular intention is to provide a foil which is suitable for producing base components for blister packs.

15 The invention achieves the above object via a multilayer foil with the features of claim 1. Accordingly, the multilayer foil in question includes at least three layers, encompassing

20 - a first layer made of a polymer selected from the group consisting of polyvinyl chloride, copolymers made of vinyl chloride units and of one or more other monomers (VC copolymers), polyesters, polyolefins, polyacrylonitrile (PAN), copolymers
25 made of acrylonitrile units and of one or more other monomers (AN copolymers), mixtures made of polyvinyl chloride and of VC copolymers;

- a second layer made of a vinylidene chloride
30 polymer selected from the group consisting of polyvinylidene chloride, copolymers made of vinylidene chloride units and of one or more other monomers (VDC copolymers), mixtures made of polyvinylidene chloride and of VDC copolymers;
35 and

- a third layer made of a chlorotrifluoroethylene

polymer selected from the group consisting of polychlorotrifluoroethylene, copolymers made of chlorotrifluoroethylene units and of one or more other monomers (CTFE copolymers), mixtures made of
5 polychlorotrifluoroethylene and of CTFE copolymers.

The multilayer foil preferably encompasses a fourth layer made of a polymer selected from the group
10 consisting of polyvinyl chloride, copolymers made of vinyl chloride units and of one or more other monomers (VC copolymers), polyesters, polyolefins, polyacrylonitrile (PAN), copolymers made of acrylonitrile units and of one or more other monomers
15 (AN copolymers), mixtures made of polyvinyl chloride and of VC copolymers.

The polyesters used for the first and fourth layer preferably comprise polyethylene terephthalate (PET),
20 in particular amorphous PET (APET), and copolymers made of ethylene terephthalate units and of one or more other monomers. One particularly preferred copolymer is PETG, which is composed of ethylene terephthalate units and of cyclohexanedimethanol units.

25 The polyolefin used for the first and fourth layer especially preferably comprises polypropylene (PP), polyethylene (PE), cycloolefin copolymers (COCs), and cycloolefin polymers (COP).

30 For the purposes of the invention, the abbreviations PVC, PVDC, and PCTFE are used for the polymers of the first, second, and third layer, where

35 - PVC is a vinyl chloride polymer selected from the group consisting of polyvinyl chloride, copolymers made of vinyl chloride units or, respectively,

chloroethene units and of one or more other monomers (VC copolymers), and mixtures made of polyvinyl chloride and of VC copolymers;

- 5 - PVDC is a vinylidene polymer selected from the group consisting of polyvinylidene chloride, copolymers made of vinylidene chloride units or, respectively, 1,1-dichloroethane units and of one or more other monomers (VDC copolymers), mixtures
10 made of polyvinylidene chloride and of VDC copolymers;
and

- PCTFE is a chlorotrifluoroethylene polymer
15 selected from the group consisting of polychlorotrifluoroethylene, copolymers made of chlorotrifluoroethylene units and of one or more other monomers (CTFE copolymers), mixtures made of polychlorotrifluoroethylene and of CTFE copoly-
20 mers.

The sequence of the layers in the layer structure can be varied. The layers can be combined, thus obtaining layer structures made of PVC/PCTFE/PVDC,
25 PVC/PVDC/PCTFE, PVC/PVDC/PCTFE/PVC, PVC/PCTFE/PVC/PVDC, PVC/PVDC/PVC/PCTFE, and also equivalent layer structures in which the first and fourth layer include, instead of PVC, a polyester, polyolefin, polyacrylonitrile (PAN), or AN copolymer.

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The composition of material in the multilayer foil of the invention is in particular PVC/PVDC/PCTFE or PVC/PVDC/PCTFE/PVC.

- 35 The multilayer foil moreover encompasses one or more adhesive layers and one or more primer layers, where the individual adhesive layer and/or the individual

primer layer has/have been arranged between respectively two of the layers.

Figures will be used below to explain the invention in more detail;

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figure 1 shows a multilayer foil having three layers;
and

figure 2 shows a multilayer foil having four layers.

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Figure 1 shows an example of a multilayer foil 10 of the invention having three layers 1, 2, and 3, where the layer 1 is composed of at least 85 % by weight of PVC, based on the total weight of the layer 1; the
15 layer 2 is composed of at least 95 % by weight of PVDC, based on the total weight of the layer 2; and the layer 3 is composed of at least 95 % by weight of PCTFE, based on the total weight of the layer 3.

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In an embodiment of the invention, the multilayer foil 10 encompasses one or more primer layers 5 and/or one or more adhesive layers 6, arranged between respectively two of the layers 1, 2, and 3.

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Figure 2 shows another multilayer foil 11 of the invention, which encompasses a further layer 4, which is composed of at least 85 % by weight of PVC, based on the total weight of the layer 4. The reference signs 1, 2 and 3 in figure 2 have the same meaning as in
30 figure 1. In figure 2, a primer layer 5 and two adhesive layers 6 and 7 are moreover shown.

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The optional use of a primer layer 5 and/or of an adhesive layer 6, 7 depends on the respective process used to produce the multilayer foil 10, 11.

Primers are used to provide adhesion of PVDC dispersion

coatings, and dry lamination adhesives are used for the adhesive bonding of two foil webs. If the multilayer foil 10, 11 is produced, for example, by means of coextrusion of the layers 1, 2, 3, and 4, primer layers and adhesive layers are omitted. Production by means of coextrusion often uses what are known as tie layers for the bonding of the individual layers.

The layers 1, 2, 3, 4 of the multilayer foils 10 and 11 of the invention can also have been arranged in another sequence, for example in one of the following configurations:

1/3/2 (= PVC/PCTFE/PVDC);
15 1/3/4/2 (= PVC/PCTFE/PVC/PVDC); or
1/2/4/3 (= PVC/PVDC/PVC/PCTFE).

The multilayer foil 10, 11 can encompass, alongside the layers 1, 2, 3, and 4, further layers made of polymeric materials, aluminum, or paper.

It is preferable that each of the layers 1 and 4 encompasses up to 15 % by weight of additives, and that each of the layers 2 and 3 encompasses up to 5 % of additives, based on the total weight of the respective layer.

The layers 1, 4 preferably have a thickness of from 10 to 400 μm ; the layer 2 preferably has a thickness of from 9 to 120 μm ; and the layer 3 preferably has a thickness of from 15 to 210 μm .

The thickness of the layer 2 is in particular from 70 to 110 μm , and the weight per unit area thereof is in the range from 120 to 180 g/m^2 .

The reciprocal of the water vapor transmission of the

multilayer foil 10, 11 is greater by at least 5 % than the sum of the reciprocals of the water vapor transmissions of the individual layers in accordance with the following relationship

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$$\frac{1}{WVT_M} \geq 1.05 \sum_{j=1}^N \frac{1}{WVT_j}$$

where WVT_M is the water vapor transmission of the multilayer foil, WVT_j is the water vapor transmission of the j th layer, and N is a natural number greater than or equal to 3, and N is the number of layers in the multilayer foil.

It is preferable that the multilayer foil 10, 11 is greater by at least 10 %, preferably by at least 15 %, and in particular by at least 20 %, than the sum of the reciprocals of the water vapor transmissions of the individual layers.

The multilayer foil 10, 11 has a water vapor transmission of from 0.027 to 0.034 g/(m²·24h), at a temperature of 38 °C and at a relative humidity of 90 %, preferably from 0.027 to 0.031 g/(m²·24h). For the purposes of the invention, water vapor transmission is measured to DIN ISO 15106-3.

The oxygen transmission of the multilayer foil 10, 11 at a temperature of 23 °C, lower than that used to measure the water vapor transmission, and at a relative humidity of 50 % is from 0.10 to 0.22 cm³/(m²·24h), preferably from 0.13 to 0.14 cm³/(m²·24h). Oxygen transmission is determined to DIN ISO 15105-2 Annex A.

The multilayer foil 10, 11 of the invention has good thermoformability and is monolaterally or bilaterally sealable.

A multilayer foil 10, 11 is preferably colorless and transparent, colored and transparent, colored and opaque, or white and opaque.

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Another feature of the multilayer foil 10, 11 of the invention is that when heated it has very good thermoforming properties, far exceeding the thermoformability of conventional PVC/PCTFE composite foils. Because the multilayer foil 10, 11 of the invention has good thermoforming properties, the water vapor barrier is relatively little impaired by the thermoforming procedure. The multilayer foil 10, 11 of the invention therefore retains an unusually high water vapor barrier ("blister barrier") even when it has been thermoformed.

The high oxygen barrier exhibited by the multilayer foil 10, 11 of the invention is similar to the water vapor barrier in that it is relatively little impaired by the thermoforming procedure. Consequently, thermoforming can be used to produce blister packs from the multilayer foil 10, 11 of the invention, and these have a barrier effect that was hitherto not achievable with respect to water vapor and oxygen.

25

A particular feature of the multilayer foil of the invention is that, even after the thermoforming procedure, the reciprocal of the water vapor transmission of the multilayer foil is greater by at least 10 %, preferably by at least 15 %, and in particular by at least 20 %, than the sum of the reciprocals of the water vapor transmissions of the individual layers.

The thickness or, respectively, the weight per unit area of the optionally present primer layers and optionally present adhesive layers in the multilayer foil 10, 11 of the invention makes up only a small

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proportion of the total thickness or, respectively, the weight per unit area of the multilayer foil 10, 11, and the barrier effect exhibited by the primer layer and by the adhesive layer can therefore be ignored.

5

The invention provides a blister pack having a blister base component made of a multilayer foil 10, 11 having one or more of the abovementioned features.

10 Features of other advantageous embodiments of the blister pack of the invention are that:

- the blister base component has been subjected to a sealing process with a foil which has been sealed
15 against the blister base component;

- the foil sealed against the blister base component is composed of aluminum and has a thickness which is preferably from 5 to 80 μm ;

20

- the foil sealed against the blister base component is composed of plastic;

- the foil sealed against the blister base component
25 is an aluminum foil of thickness from 5 to 40 μm , which has been coated with a plastic on the side sealed against the blister base component, or which has been laminated with a plastics foil.

30 Examples

Production of multilayer foils

Four multilayer foils composed of materials as follows: PVC/PVDC/PCTFE/PVC were produced on an inline system having a plurality of coating units and, respectively,
35 lamination units, by steps (i)-(iv) stated below:

(i) coating of a first PVC foil with adhesion

promoter (primer) to prepare for the application of PVDC dispersion;

- 5 (ii) repeated coating with PVDC dispersion until cumulative area density was from 125 to 160 g/m² (dry application weight);
- 10 (iii) using a first dry lamination adhesive to apply a PCTFE foil to the PVDC layer by lamination; and
- (iv) using a second dry lamination adhesive to apply a second PVC foil to the PCTFE foil by lamination.

15

Water vapor transmission measurement

- a) Measurement of the water vapor transmission WVT_{rj} of single-layer reference foils made of PVC (thickness 127 μm), made of PCTFE (thickness 102 μm), and made of PVDC (thickness 75 and, respectively, 95 μm) to DIN ISO 15106-3.
- 20 b) Measurement of the water vapor transmission WVT_{Mm} of the multilayer foil to DIN ISO 15106-3.
- c) Determination of the thickness d_j of the polymer layer present in the multilayer foil via measurement of cross-sectional micrographs of the multilayer foil.
- 25 d) Calculation of the water vapor transmission WVT_j of the polymer layers present in the multilayer foil from the following equation:
- 30

$$WVT_j = WVT_{rj} \cdot d_{rj} / d_j$$

35 where d_{rj} indicates the thickness of the single-layer reference foil from step a) and d_j indicates the thickness determined in step c) of the polymer layer present in the multilayer foil.

- e) Calculation of the water vapor transmission WVT_{Mc} of the multilayer foil by analogy with resistances collected in series, i.e. in the form of sum of the reciprocals of the water vapor transmissions WVT_j from the following formula:

$$\frac{1}{WVT_{Mc}} = \sum_{j=1}^4 \frac{1}{WVT_j}$$

The measured and calculated values for the water vapor transmission of the multilayer foils produced in the invention are compared in table 1.

#	PVC μm	PVDC g/m^2	PCTFE μm	PVC μm	WVT_{Mm} measured $\text{g}/(\text{m}^2 \cdot 24\text{h})$	WVT_{Mc} calculated $\text{g}/(\text{m}^2 \cdot 24\text{h})$	$\Delta WVT =$ $(WVT_{Mc} - WVT_{Mm}) / WVT_{Mc}$ %
1	127	125.2	102.4	127	0.0333	0.0368	9.5
2	127	125.4	104.2	127	0.0279	0.0363	23.1
3	127	160.7	99.5	127	0.0315	0.0344	8.4
4	127	160.2	101.0	127	0.0279	0.0341	18.2

Table 1

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Surprisingly, it is found that the water vapor transmissions measured on the multilayer foils of the invention are smaller by at least 8.4 % than the values that will be expected on the basis of the combined effect of the individual polymer layers, i.e. the values obtained by taking the sum of the reciprocals of the water vapor transmissions.

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What is claimed is:

1. A multilayer foil (10, 11) having at least three layers, encompassing
 - a first layer (1) made of a polymer selected from the group consisting of polyvinyl chloride, copolymers made of vinyl chloride units and of one or more other monomers (VC copolymers), polyethylene terephthalate (PET), polyolefins, polyacrylonitrile (PAN), copolymers made of acrylonitrile units and of one or more other monomers (AN copolymers), mixtures made of polyvinyl chloride and of VC copolymers;
 - a second layer (2) made of a vinylidene chloride copolymer (PVDC) selected from the group consisting of polyvinylidene chloride, copolymers made of vinylidene chloride units and of one or more other monomers (VDC copolymers), mixtures made of polyvinylidene chloride and of VDC copolymers;
and
 - a third layer (3) made of a chlorotrifluoroethylene polymer (PCTFE) selected from the group consisting of polychlorotrifluoroethylene, copolymers made of chlorotrifluoroethylene units and of one or more other monomers (CTFE copolymers), mixtures made of polychlorotrifluoroethylene and of CTFE copolymers.
2. The multilayer foil (10, 11) as claimed in claim 1, characterized in that it encompasses a fourth layer (4) made of a polymer selected from

- the group consisting of polyvinyl chloride, copolymers made of vinyl chloride units and of one or more other monomers (VC copolymers), polyethylene terephthalate (PET), polyolefins, polyacrylonitrile (PAN), copolymers made of acrylonitrile units and of one or more other monomers (AN copolymers), mixtures made of polyvinyl chloride and of VC copolymers.
3. The multilayer foil (10, 11) as claimed in claim 1 or 2, characterized in that it encompasses one or more adhesive layers (6, 7), and one or more primer layers (5), where the adhesive layer (6, 7) and/or the primer layer (5) has/have been arranged between respectively two of the layers (1, 2, 3, 4).
4. The multilayer foil (10, 11) as claimed in claim 1 or 2, characterized in that each of the layers (1, 4) encompasses up to 15 % by weight of additives, and each of the layers (2, 3) encompasses up to 5 % by weight of additives, based on the total weight of the respective layer.
5. The multilayer foil (10, 11) as claimed in claim 1 or 2, characterized in that the first and fourth layer (1, 4) have a thickness of from 10 to 400 μm , the second layer (2) has a thickness of from 9 to 120 μm , and the third layer (3) has a thickness of from 15 to 210 μm .
6. The multilayer foil (10, 11) as claimed in claim 1 or 2, characterized in that the thickness of the second layer (2) is from 70 to 110 μm , and the weight per unit area thereof is from 120 to 180 g/m^2 .

7. The multilayer foil (10, 11) as claimed in claim 1 or 2, characterized in that the reciprocal of the water vapor transmission thereof is greater by at least 5 % than the sum of the reciprocals of the water vapor transmissions of the individual layers in accordance with the following relationship

$$\frac{1}{WVT_M} \geq 1.05 \sum_{j=1}^N \frac{1}{WVT_j}$$

where WVT_M is the water vapor transmission of the multilayer foil, WVT_j is the water vapor transmission of the j th layer, and N is a natural number greater than or equal to 3, and N is the number of layers in the multilayer foil.

8. The multilayer foil (10, 11) as claimed in claim 7, characterized in that the reciprocal of the water vapor transmission of the multilayer foil (10, 11) is greater by at least 10 %, preferably by at least 15 %, and in particular by at least 20 %, than the sum of the reciprocals of the water vapor transmissions of the individual layers.

9. The multilayer foil (10, 11) as claimed in claim 1 or 2, characterized in that it has a water vapor transmission of from 0.027 to 0.034 g/(m²·24h), at a temperature of 38 °C and at a relative humidity of 90 %, preferably from 0.027 to 0.031 g/(m²·24h).

10. The multilayer foil (10, 11) as claimed in claim 1 or 2, characterized in that it has an oxygen transmission of from 0.10 to 0.22 cm³/(m²·24h), at a temperature of 23 °C and at a relative humidity of 50 %, preferably from 0.13 to 0.14 cm³/(m²·24h).

11. The multilayer foil (10, 11) as claimed in one or more of claims 1 to 10, which is thermoformable.
12. The multilayer foil (10, 11) as claimed in claim 11, characterized in that after a thermoforming procedure the reciprocal of the water vapor transmission is greater by at least 10 %, preferably by at least 15 %, and in particular by at least 20 %, than the sum of the reciprocals of the water vapor transmissions of the individual layers.
13. The multilayer foil (10, 11) as claimed in one or more of claims 1 to 12, characterized in that it is monolaterally or bilaterally sealable.
14. The multilayer foil (10, 11) as claimed in one or more of claims 1 to 13, characterized in that it is colorless and transparent, colored and transparent, colored and opaque, or white and opaque.
15. The multilayer foil (10, 11) as claimed in claim 3, characterized in that the primer layer (5) has a weight per unit area of from 0.5 to 20 g/m².
16. The multilayer foil (10, 11) as claimed in claim 3, characterized in that the adhesive layer (6, 7) has a weight per unit area of from 1 to 30 g/m².
17. The multilayer foil (10, 11) as claimed in one or more of claims 1 to 16, characterized in that it has layer structure selected from the following group: PVC/PCTFE/PVDC, PVC/PVDC/PCTFE, PVC/PVDC/PCTFE/PVC, PVC/PCTFE/PVC/PVDC, PVC/PVDC/PVC/PCTFE, and also equivalent layer

structures in which the first and fourth layer include, instead of PVC, a polyester, polyolefin, polyacrylonitrile (PAN), or AN copolymer.

- 5 18. A blister pack, the blister base component of which is composed of a multilayer foil as claimed in claims 1 to 17.
- 10 19. The blister pack as claimed in claim 18, characterized in that the blister base component has been sealed by a foil which has been sealed against the blister base component.
- 15 20. The blister pack as claimed in claim 19, characterized in that the foil sealed against the blister base component is composed of aluminum and preferably has a thickness of from 5 to 80 μm .
- 20 21. The blister pack as claimed in claim 19, characterized in that the foil sealed against the blister base component is composed of plastic.
- 25 22. The blister pack as claimed in claim 19, characterized in that the foil sealed against the blister base component is an aluminum foil with a thickness of from 5 to 40 μm , which, on the side sealed against the blister base component, has been coated with a plastic, or has been laminated with a plastics foil.

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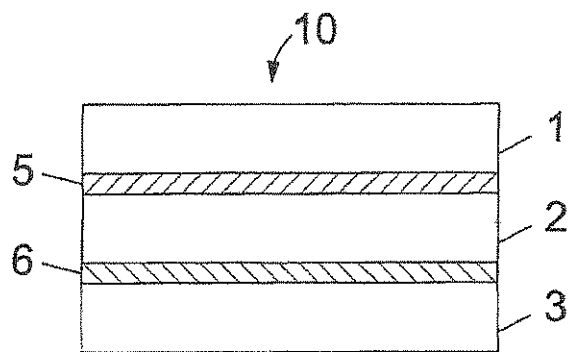


Fig. 1

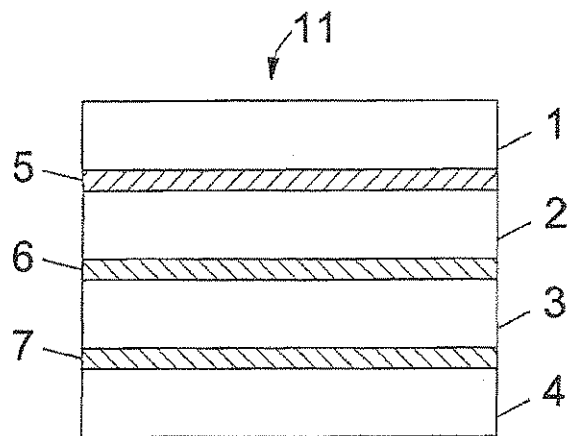


Fig. 2

Multilayer foil

The present invention relates to a multilayer foil with low water vapor transmission and with low oxygen transmission, and with particular suitability for blister packs for medicaments.

The barrier effect of polymeric materials and foils with respect to water vapor is generally independent of the barrier effect with respect to oxygen. Accordingly, materials exhibiting a good vapor barrier will not necessarily also exhibit a good barrier with respect to oxygen and to odors, and vice versa. The only material that exhibits a barrier effect in a moderate to good range of values not only with respect to oxygen but also with respect to water vapor is polyvinylidene chloride (PVDC). PCTFE, polyolefins, and other polymers exhibit a good to very good water vapor barrier but a very low oxygen barrier. EVOH (ethylene-vinyl alcohol copolymer) exhibits a very good oxygen barrier, but a low water vapor barrier. There is currently no available polymeric packaging foil that is marketable, i.e. that can be produced cost-effectively, and that exhibits a high water vapor barrier alongside a high oxygen barrier. On the other hand, modern medicaments are increasingly proving to be sensitive to water vapor and oxygen. The requirements placed upon the barrier effect exhibited by packaging foils for medicaments are accordingly ever more stringent. The requirement hitherto has been for a large barrier effect mainly with respect to water vapor, but packaging foils for modern medicaments now also have to exhibit a large barrier effect with respect to oxygen.

Thermoformable plastics foils are widely used for the

packaging of food and drink, medicaments, and other products. The products known as blister packs are important here. Blister packs have a shape matched to the product and obtained by thermoforming of a flat, preferably transparent plastics foil. The packaging component that conforms to the respective product or contents is also termed base component, and after the contents have been charged it is sealed with a lid foil, preferably an aluminum foil, by a welding or sealing process. The packaging has to comply with particular requirements in respect of the barrier effect thereof with respect to water vapor, oxygen and sometimes other gases, such as carbon dioxide, and these requirements depend on the intended application. By way of example, a wide variety of medicaments require packaging exhibiting a water vapor transmission of less than $0.06 \text{ g}/(\text{m}^2 \cdot 24\text{h})$, and in some cases less than $0.04 \text{ g}/(\text{m}^2 \cdot 24\text{h})$. In the case of transparent foils, the only way of achieving water vapor transmission of less than $0.06 \text{ g}/(\text{m}^2 \cdot 24\text{h})$ is to use PCTFE as foil material with a thickness greater than $100 \mu\text{m}$. Water vapor transmission below $0.04 \text{ g}/(\text{m}^2 \cdot 24\text{h})$ has hitherto been achievable only by using aluminum foil, in particular by using what is known as "cold form foil". Aluminum foils of this type are not transparent and they moreover have low deformability, and cannot therefore be used to produce relatively small blisters, so that the foil area needed is substantially greater than when a thermoformable blister is used.

Thermoformable plastics foils have to have not only a larger barrier effect but also other properties, such as sealability, freedom from streaks, low thickness, uniform thickness profile, and good processability. For the processability, especially advantageous features are good deformability, i.e. maximum uniformity of thickness distribution in the component after the

deforming process, and also maximum shape replication, minimum curl, and a small coefficient of friction, i.e. good slip capability with respect to the machinery parts contacted and the packaged contents. The curl
5 occurs in two- or multilayer composite foils when the coefficients of thermal expansion (CTEs) of the individual layer materials differ.

Thermoforming plastics foils for packaging exhibiting
10 barrier effect with respect to water vapor are known in the prior art.

EP 1 655 237 A1 discloses a thermoformed or cold-formed blister pack with a blister base component and with a
15 lid foil. The lid foil is composed of an aluminum foil of thickness from 10 to 30 μm which has been laminated or coated with, on a first side, a foil which can be peeled from the aluminum foil and which is made of at least one plastics layer based on thermoplastic or
20 thermoset polymers and, on the second side, sealed against the blister base component, a plastics foil based on polyvinyl chloride (PVC) having a foil thickness of from 10 to 40 μm , or polyvinylidene chloride (PVDC) having a foil thickness of from 10 to 40 μm , or
25 polypropylene (PP) having a foil thickness of from 6 to 35 μm , or polyethylene (PE) having a foil thickness of from 6 to 35 μm , or polyester having a foil thickness of from 5 to 10 μm , or polychlorotrifluoroethylene (PCTFE) having a foil thickness of from 8 to 30 μm , or
30 cycloolefin copolymers (COCs), or cycloolefin polymers (COPs) having a thickness of from 10 to 40 μm . The blister base component is composed, at least on the side sealed against the lid foil, of a material having a chemical structure compatible with that of the
35 plastics foils sealed against the blister base component. The foil that can be peeled from the aluminum foil is composed of one or more layers made of one or

more of the following plastics: PVC, PVDC, PCTFE, PP, PE, polyester, polyethylene naphthalate (PEN), polyamide (PA), COC, COP, polystyrene (PS), or cellophane.

5 EP 1 468 817 A1 relates to a lid foil for blister packs with thermoformed or cold-formed blister base components. The lid foil encompasses an aluminum foil of thickness from 5 to 30 μm which has been laminated, on
10 a side provided for sealing with respect to a blister base component, with a plastics foil based on PVC having a foil thickness of from 10 to 40 μm , or PVDC having a foil thickness of from 10 to 40 μm , or PP having a foil thickness of from 6 to 35 μm , or polyester having a foil thickness of from 5 to 15 μm ,
15 or PCTFE having a foil thickness of from 8 to 76 μm , or COC having a thickness of from 10 to 40 μm . Blister base components are composed by way of example of foils made of PVC, PP, PET, PE, and of composite foils, such as PVC/ACLAR[®] (PCTFE), PVC/PVDC, and COC, or Al-Al
20 blisters.

DE 602 09 812 T2 describes an at least single-layer polymer foil, where one of the layers encompasses a vinylidene chloride composition which encompasses 100
25 parts by weight of vinylidene chloride copolymer; from 0.1 to 10 parts by weight of stabilizer, from 0.1 to 10 parts by weight of lubricant, and from 0.1 to 10 parts by weight of hydrophilic clay. By way of example, the structure of the polymer foil is of the following type:
30 C/A/B, B/A/D/B, or C/A/D/C, where A stands for PVDC.

The packaging foils known in the prior art exhibit inadequate barrier effect with respect to water vapor and oxygen, or require the use of considerable amounts
35 of PCTFE, of an aluminum foil, or of inorganic additives. These measures are associated with increased costs in the case of PCTFE, or impair processability

and other properties, such as optical transparency.

PCTFE foil exhibits a very good water vapor barrier, but a low oxygen barrier. An increase in the thickness of a PCTFE foil can in principle raise the water vapor barrier, but because of indirect proportionality between material thickness and water vapor transmission the thickness of PCTFE needed rises rapidly into a range which is technically and economically very disadvantageous, and there is no possibility of achieving an oxygen barrier adequate for highly demanding packaging applications. PVDC, on the other hand, exhibits a very good oxygen barrier, but exhibits a water vapor barrier substantially smaller than that of PCTFE. If the same water vapor barrier is to be achieved with PVDC as with PCTFE, the thickness of PVDC has to be 165 % of the thickness of PCTFE. PVDC foils and, respectively, layers are usually produced by applying many thin sublayers. By way of example, the weight per unit area of PVDC required to achieve a water vapor barrier of $0.035 \text{ g}/(\text{m}^2 \cdot 24\text{h})$ (measured at a temperature of 38°C and a relative humidity of 90 %) would be about $400 \text{ g}/\text{m}^2$. This requires 40 passes through the machinery of a conventional industrial coating system in each case applying $10 \text{ g}/\text{m}^2$, or 27 passes at $15 \text{ g}/\text{m}^2$. Such a large number of passes through machinery is not achievable either technically or economically. The industrial processes known in the prior art produce PVDC layers with weight per unit area of up to at most $180 \text{ g}/\text{m}^2$.

The oxygen barrier exhibited by PVDC is only very slightly affected by moisture, whereas by way of example EVOH, which likewise exhibits a very good oxygen barrier, suffers major loss of oxygen barrier on exposure to moisture. In extreme cases, the magnitude of the loss in the case of EVOH extends to powers of

ten. EVOH is usually used in packaging for food or drink, but has also recently been used in pharmaceutical packaging.

- 5 It is an object of the present invention to provide a foil which exhibits a high barrier effect with respect to water vapor in combination with a barrier effect against oxygen, while use of material is at the same time efficient, and which provides good processability and complies with design requirements, e.g. in respect
10 of optical transparency. A particular intention is to provide a foil which is suitable for producing base components for blister packs.
- 15 The invention achieves the above object via a multilayer foil with the features of claim 1. Accordingly, the multilayer foil in question includes at least three layers, encompassing
- 20 - a first layer made of a polymer selected from the group consisting of polyvinyl chloride, copolymers made of vinyl chloride units and of one or more other monomers (VC copolymers), polyesters, polyolefins, polyacrylonitrile (PAN), copolymers
25 made of acrylonitrile units and of one or more other monomers (AN copolymers), mixtures made of polyvinyl chloride and of VC copolymers;
- 30 - a second layer made of a vinylidene chloride polymer selected from the group consisting of polyvinylidene chloride, copolymers made of vinylidene chloride units and of one or more other monomers (VDC copolymers), mixtures made of polyvinylidene chloride and of VDC copolymers;
35 and
- a third layer made of a chlorotrifluoroethylene

polymer selected from the group consisting of polychlorotrifluoroethylene, copolymers made of chlorotrifluoroethylene units and of one or more other monomers (CTFE copolymers), mixtures made of
5 polychlorotrifluoroethylene and of CTFE copolymers.

The multilayer foil preferably encompasses a fourth layer made of a polymer selected from the group
10 consisting of polyvinyl chloride, copolymers made of vinyl chloride units and of one or more other monomers (VC copolymers), polyesters, polyolefins, polyacrylonitrile (PAN), copolymers made of acrylonitrile units and of one or more other monomers
15 (AN copolymers), mixtures made of polyvinyl chloride and of VC copolymers.

The polyesters used for the first and fourth layer preferably comprise polyethylene terephthalate (PET),
20 in particular amorphous PET (APET), and copolymers made of ethylene terephthalate units and of one or more other monomers. One particularly preferred copolymer is PETG, which is composed of ethylene terephthalate units and of cyclohexanedimethanol units.

25 The polyolefin used for the first and fourth layer especially preferably comprises polypropylene (PP), polyethylene (PE), cycloolefin copolymers (COCs), and cycloolefin polymers (COP).

30 For the purposes of the invention, the abbreviations PVC, PVDC, and PCTFE are used for the polymers of the first, second, and third layer, where

35 - PVC is a vinyl chloride polymer selected from the group consisting of polyvinyl chloride, copolymers made of vinyl chloride units or, respectively,

chloroethene units and of one or more other monomers (VC copolymers), and mixtures made of polyvinyl chloride and of VC copolymers;

- 5 - PVDC is a vinylidene polymer selected from the group consisting of polyvinylidene chloride, copolymers made of vinylidene chloride units or, respectively, 1,1-dichloroethane units and of one or more other monomers (VDC copolymers), mixtures
10 made of polyvinylidene chloride and of VDC copolymers;
and

- PCTFE is a chlorotrifluoroethylene polymer
15 selected from the group consisting of polychlorotrifluoroethylene, copolymers made of chlorotrifluoroethylene units and of one or more other monomers (CTFE copolymers), mixtures made of polychlorotrifluoroethylene and of CTFE copoly-
20 mers.

The sequence of the layers in the layer structure can be varied. The layers can be combined, thus obtaining layer structures made of PVC/PCTFE/PVDC,
25 PVC/PVDC/PCTFE, PVC/PVDC/PCTFE/PVC, PVC/PCTFE/PVC/PVDC, PVC/PVDC/PVC/PCTFE, and also equivalent layer structures in which the first and fourth layer include, instead of PVC, a polyester, polyolefin, polyacrylonitrile (PAN), or AN copolymer.

30

The composition of material in the multilayer foil of the invention is in particular PVC/PVDC/PCTFE or PVC/PVDC/PCTFE/PVC.

- 35 The multilayer foil moreover encompasses one or more adhesive layers and one or more primer layers, where the individual adhesive layer and/or the individual

primer layer has/have been arranged between respectively two of the layers.

Figures will be used below to explain the invention in more detail;

5

figure 1 shows a multilayer foil having three layers; and

figure 2 shows a multilayer foil having four layers.

10

Figure 1 shows an example of a multilayer foil 10 of the invention having three layers 1, 2, and 3, where the layer 1 is composed of at least 85 % by weight of PVC, based on the total weight of the layer 1; the layer 2 is composed of at least 95 % by weight of PVDC, based on the total weight of the layer 2; and the layer 3 is composed of at least 95 % by weight of PCTFE, based on the total weight of the layer 3.

20 In an embodiment of the invention, the multilayer foil 10 encompasses one or more primer layers 5 and/or one or more adhesive layers 6, arranged between respectively two of the layers 1, 2, and 3.

25 Figure 2 shows another multilayer foil 11 of the invention, which encompasses a further layer 4, which is composed of at least 85 % by weight of PVC, based on the total weight of the layer 4. The reference signs 1, 2 and 3 in figure 2 have the same meaning as in figure 1. In figure 2, a primer layer 5 and two adhesive layers 6 and 7 are moreover shown.

The optional use of a primer layer 5 and/or of an adhesive layer 6, 7 depends on the respective process used to produce the multilayer foil 10, 11.

35

Primers are used to provide adhesion of PVDC dispersion

coatings, and dry lamination adhesives are used for the adhesive bonding of two foil webs. If the multilayer foil 10, 11 is produced, for example, by means of coextrusion of the layers 1, 2, 3, and 4, primer layers and adhesive layers are omitted. Production by means of coextrusion often uses what are known as tie layers for the bonding of the individual layers.

The layers 1, 2, 3, 4 of the multilayer foils 10 and 11 of the invention can also have been arranged in another sequence, for example in one of the following configurations:

1/3/2 (= PVC/PCTFE/PVDC);
15 1/3/4/2 (= PVC/PCTFE/PVC/PVDC); or
1/2/4/3 (= PVC/PVDC/PVC/PCTFE).

The multilayer foil 10, 11 can encompass, alongside the layers 1, 2, 3, and 4, further layers made of polymeric materials, aluminum, or paper.

It is preferable that each of the layers 1 and 4 encompasses up to 15 % by weight of additives, and that each of the layers 2 and 3 encompasses up to 5 % of additives, based on the total weight of the respective layer.

The layers 1, 4 preferably have a thickness of from 10 to 400 μm ; the layer 2 preferably has a thickness of from 9 to 120 μm ; and the layer 3 preferably has a thickness of from 15 to 210 μm .

The thickness of the layer 2 is in particular from 70 to 110 μm , and the weight per unit area thereof is in the range from 120 to 180 g/m^2 .

The reciprocal of the water vapor transmission of the

multilayer foil 10, 11 is greater by at least 5 % than the sum of the reciprocals of the water vapor transmissions of the individual layers in accordance with the following relationship

5

$$\frac{1}{WVT_M} \geq 1.05 \sum_{j=1}^N \frac{1}{WVT_j}$$

where WVT_M is the water vapor transmission of the multilayer foil, WVT_j is the water vapor transmission of the j th layer, and N is a natural number greater than or equal to 3, and N is the number of layers in the multilayer foil.

It is preferable that the multilayer foil 10, 11 is greater by at least 10 %, preferably by at least 15 %, and in particular by at least 20 %, than the sum of the reciprocals of the water vapor transmissions of the individual layers.

The multilayer foil 10, 11 has a water vapor transmission of from 0.027 to 0.034 g/(m²·24h), at a temperature of 38 °C and at a relative humidity of 90 %, preferably from 0.027 to 0.031 g/(m²·24h). For the purposes of the invention, water vapor transmission is measured to DIN ISO 15106-3.

The oxygen transmission of the multilayer foil 10, 11 at a temperature of 23 °C, lower than that used to measure the water vapor transmission, and at a relative humidity of 50 % is from 0.10 to 0.22 cm³/(m²·24h), preferably from 0.13 to 0.14 cm³/(m²·24h). Oxygen transmission is determined to DIN ISO 15105-2 Annex A.

The multilayer foil 10, 11 of the invention has good thermoformability and is monolaterally or bilaterally sealable.

A multilayer foil 10, 11 is preferably colorless and transparent, colored and transparent, colored and opaque, or white and opaque.

5

Another feature of the multilayer foil 10, 11 of the invention is that when heated it has very good thermoforming properties, far exceeding the thermoformability of conventional PVC/PCTFE composite foils. Because the
10 multilayer foil 10, 11 of the invention has good thermoforming properties, the water vapor barrier is relatively little impaired by the thermoforming procedure. The multilayer foil 10, 11 of the invention therefore retains an unusually high water vapor barrier
15 ("blister barrier") even when it has been thermoformed.

The high oxygen barrier exhibited by the multilayer foil 10, 11 of the invention is similar to the water vapor barrier in that it is relatively little impaired
20 by the thermoforming procedure. Consequently, thermoforming can be used to produce blister packs from the multilayer foil 10, 11 of the invention, and these have a barrier effect that was hitherto not achievable with respect to water vapor and oxygen.

25

A particular feature of the multilayer foil of the invention is that, even after the thermoforming procedure, the reciprocal of the water vapor transmission of the multilayer foil is greater by at least 10 %, preferably by at least 15 %, and in particular by at
30 least 20 %, than the sum of the reciprocals of the water vapor transmissions of the individual layers.

The thickness or, respectively, the weight per unit area of the optionally present primer layers and optionally present adhesive layers in the multilayer
35 foil 10, 11 of the invention makes up only a small

proportion of the total thickness or, respectively, the weight per unit area of the multilayer foil 10, 11, and the barrier effect exhibited by the primer layer and by the adhesive layer can therefore be ignored.

5

The invention provides a blister pack having a blister base component made of a multilayer foil 10, 11 having one or more of the abovementioned features.

10 Features of other advantageous embodiments of the blister pack of the invention are that:

- the blister base component has been subjected to a sealing process with a foil which has been sealed
15 against the blister base component;

- the foil sealed against the blister base component is composed of aluminum and has a thickness which is preferably from 5 to 80 μm ;

20

- the foil sealed against the blister base component is composed of plastic;

- the foil sealed against the blister base component
25 is an aluminum foil of thickness from 5 to 40 μm , which has been coated with a plastic on the side sealed against the blister base component, or which has been laminated with a plastics foil.

30 **Examples**

Production of multilayer foils

Four multilayer foils composed of materials as follows: PVC/PVDC/PCTFE/PVC were produced on an inline system having a plurality of coating units and, respectively,
35 lamination units, by steps (i)-(iv) stated below:

(i) coating of a first PVC foil with adhesion

promoter (primer) to prepare for the application of PVDC dispersion;

- 5 (ii) repeated coating with PVDC dispersion until cumulative area density was from 125 to 160 g/m² (dry application weight);
- 10 (iii) using a first dry lamination adhesive to apply a PCTFE foil to the PVDC layer by lamination; and
- (iv) using a second dry lamination adhesive to apply a second PVC foil to the PCTFE foil by lamination.

15

Water vapor transmission measurement

- a) Measurement of the water vapor transmission WVT_{rj} of single-layer reference foils made of PVC (thickness 127 μm), made of PCTFE (thickness 102 μm), and made of PVDC (thickness 75 and, respectively, 95 μm) to DIN ISO 15106-3.
- 20 b) Measurement of the water vapor transmission WVT_{Mm} of the multilayer foil to DIN ISO 15106-3.
- c) Determination of the thickness d_j of the polymer layer present in the multilayer foil via measurement of cross-sectional micrographs of the multilayer foil.
- 25 d) Calculation of the water vapor transmission WVT_j of the polymer layers present in the multilayer foil from the following equation:
- 30

$$WVT_j = WVT_{rj} \cdot d_{rj} / d_j$$

35 where d_{rj} indicates the thickness of the single-layer reference foil from step a) and d_j indicates the thickness determined in step c) of the polymer layer present in the multilayer foil.

e) Calculation of the water vapor transmission WVT_{Mc} of the multilayer foil by analogy with resistances collected in series, i.e. in the form of sum of the reciprocals of the water vapor transmissions WVT_j from the following formula:

$$\frac{1}{WVT_{Mc}} = \sum_{j=1}^4 \frac{1}{WVT_j}$$

The measured and calculated values for the water vapor transmission of the multilayer foils produced in the invention are compared in table 1.

#	PVC μm	PVDC g/m^2	PCTFE μm	PVC μm	WVT_{Mm} measured $\text{g}/(\text{m}^2 \cdot 24\text{h})$	WVT_{Mc} calculated $\text{g}/(\text{m}^2 \cdot 24\text{h})$	$\Delta WVT =$ $(WVT_{Mc} - WVT_{Mm}) / WVT_{Mc}$ %
1	127	125.2	102.4	127	0.0333	0.0368	9.5
2	127	125.4	104.2	127	0.0279	0.0363	23.1
3	127	160.7	99.5	127	0.0315	0.0344	8.4
4	127	160.2	101.0	127	0.0279	0.0341	18.2

Table 1

Surprisingly, it is found that the water vapor transmissions measured on the multilayer foils of the invention are smaller by at least 8.4 % than the values that will be expected on the basis of the combined effect of the individual polymer layers, i.e. the values obtained by taking the sum of the reciprocals of the water vapor transmissions.

What is claimed is:

1. A multilayer foil (10, 11) having at least three layers, encompassing
 - a first layer (1) made of a polymer selected from the group consisting of polyvinyl chloride, copolymers made of vinyl chloride units and of one or more other monomers (VC copolymers), polyethylene terephthalate (PET), polyolefins, polyacrylonitrile (PAN), copolymers made of acrylonitrile units and of one or more other monomers (AN copolymers), mixtures made of polyvinyl chloride and of VC copolymers;
 - a second layer (2) made of a vinylidene chloride copolymer (PVDC) selected from the group consisting of polyvinylidene chloride, copolymers made of vinylidene chloride units and of one or more other monomers (VDC copolymers), mixtures made of polyvinylidene chloride and of VDC copolymers;
and
 - a third layer (3) made of a chlorotrifluoroethylene polymer (PCTFE) selected from the group consisting of polychlorotrifluoroethylene, copolymers made of chlorotrifluoroethylene units and of one or more other monomers (CTFE copolymers), mixtures made of polychlorotrifluoroethylene and of CTFE copolymers.
2. The multilayer foil (10, 11) as claimed in claim 1, characterized in that it encompasses a fourth layer (4) made of a polymer selected from

the group consisting of polyvinyl chloride, copolymers made of vinyl chloride units and of one or more other monomers (VC copolymers), polyethylene terephthalate (PET), polyolefins, polyacrylonitrile (PAN), copolymers made of acrylonitrile units and of one or more other monomers (AN copolymers), mixtures made of polyvinyl chloride and of VC copolymers.

3. The multilayer foil (10, 11) as claimed in claim 1 or 2, characterized in that it encompasses one or more adhesive layers (6, 7), and one or more primer layers (5), where the adhesive layer (6, 7) and/or the primer layer (5) has/have been arranged between respectively two of the layers (1, 2, 3, 4).

4. The multilayer foil (10, 11) as claimed in claim 1 or 2, characterized in that each of the layers (1, 4) encompasses up to 15 % by weight of additives, and each of the layers (2, 3) encompasses up to 5 % by weight of additives, based on the total weight of the respective layer.

5. The multilayer foil (10, 11) as claimed in claim 1 or 2, characterized in that the first and fourth layer (1, 4) have a thickness of from 10 to 400 μm , the second layer (2) has a thickness of from 9 to 120 μm , and the third layer (3) has a thickness of from 15 to 210 μm .

6. The multilayer foil (10, 11) as claimed in claim 1 or 2, characterized in that the thickness of the second layer (2) is from 70 to 110 μm , and the weight per unit area thereof is from 120 to 180 g/m^2 .

7. The multilayer foil (10, 11) as claimed in claim 1 or 2, characterized in that the reciprocal of the water vapor transmission thereof is greater by at least 5 % than the sum of the reciprocals of the water vapor transmissions of the individual layers in accordance with the following relationship

$$\frac{1}{WVT_M} \geq 1.05 \sum_{j=1}^N \frac{1}{WVT_j}$$

where WVT_M is the water vapor transmission of the multilayer foil, WVT_j is the water vapor transmission of the j th layer, and N is a natural number greater than or equal to 3, and N is the number of layers in the multilayer foil.

8. The multilayer foil (10, 11) as claimed in claim 7, characterized in that the reciprocal of the water vapor transmission of the multilayer foil (10, 11) is greater by at least 10 %, preferably by at least 15 %, and in particular by at least 20 %, than the sum of the reciprocals of the water vapor transmissions of the individual layers.

9. The multilayer foil (10, 11) as claimed in claim 1 or 2, characterized in that it has a water vapor transmission of from 0.027 to 0.034 g/(m²·24h), at a temperature of 38 °C and at a relative humidity of 90 %, preferably from 0.027 to 0.031 g/(m²·24h).

10. The multilayer foil (10, 11) as claimed in claim 1 or 2, characterized in that it has an oxygen transmission of from 0.10 to 0.22 cm³/(m²·24h), at a temperature of 23 °C and at a relative humidity of 50 %, preferably from 0.13 to 0.14 cm³/(m²·24h).

11. The multilayer foil (10, 11) as claimed in one or more of claims 1 to 10, which is thermoformable.
12. The multilayer foil (10, 11) as claimed in claim 11, characterized in that after a thermoforming procedure the reciprocal of the water vapor transmission is greater by at least 10 %, preferably by at least 15 %, and in particular by at least 20 %, than the sum of the reciprocals of the water vapor transmissions of the individual layers.
13. The multilayer foil (10, 11) as claimed in one or more of claims 1 to 12, characterized in that it is monolaterally or bilaterally sealable.
14. The multilayer foil (10, 11) as claimed in one or more of claims 1 to 13, characterized in that it is colorless and transparent, colored and transparent, colored and opaque, or white and opaque.
15. The multilayer foil (10, 11) as claimed in claim 3, characterized in that the primer layer (5) has a weight per unit area of from 0.5 to 20 g/m².
16. The multilayer foil (10, 11) as claimed in claim 3, characterized in that the adhesive layer (6, 7) has a weight per unit area of from 1 to 30 g/m².
17. The multilayer foil (10, 11) as claimed in one or more of claims 1 to 16, characterized in that it has layer structure selected from the following group: PVC/PCTFE/PVDC, PVC/PVDC/PCTFE, PVC/PVDC/PCTFE/PVC, PVC/PCTFE/PVC/PVDC, PVC/PVDC/PVC/PCTFE, and also equivalent layer

structures in which the first and fourth layer include, instead of PVC, a polyester, polyolefin, polyacrylonitrile (PAN), or AN copolymer.

- 5 18. A blister pack, the blister base component of which is composed of a multilayer foil as claimed in claims 1 to 17.
- 10 19. The blister pack as claimed in claim 18, characterized in that the blister base component has been sealed by a foil which has been sealed against the blister base component.
- 15 20. The blister pack as claimed in claim 19, characterized in that the foil sealed against the blister base component is composed of aluminum and preferably has a thickness of from 5 to 80 μm .
- 20 21. The blister pack as claimed in claim 19, characterized in that the foil sealed against the blister base component is composed of plastic.
- 25 22. The blister pack as claimed in claim 19, characterized in that the foil sealed against the blister base component is an aluminum foil with a thickness of from 5 to 40 μm , which, on the side sealed against the blister base component, has been coated with a plastic, or has been laminated with a plastics foil.