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(54) **SPACER FOR AN INSULATING GLAZING UNIT**

(57) A spacer (100) for an insulating glazing unit comprising at least two glazing panes and an intervening space between the same, is adapted to be positioned in the intervening space and comprises a spacer body (120) extending in a longitudinal direction (Z) and made of plastic material and a multilayer diffusion barrier (110) disposed on the spacer body (120). The multilayer diffusion barrier (110) comprises at least two polymer layers and at least two barrier layers. Each of the barrier layers is made of metallic material or ceramic material. A thickness of at least one of the barrier layers is equal to or less than 9 nm.

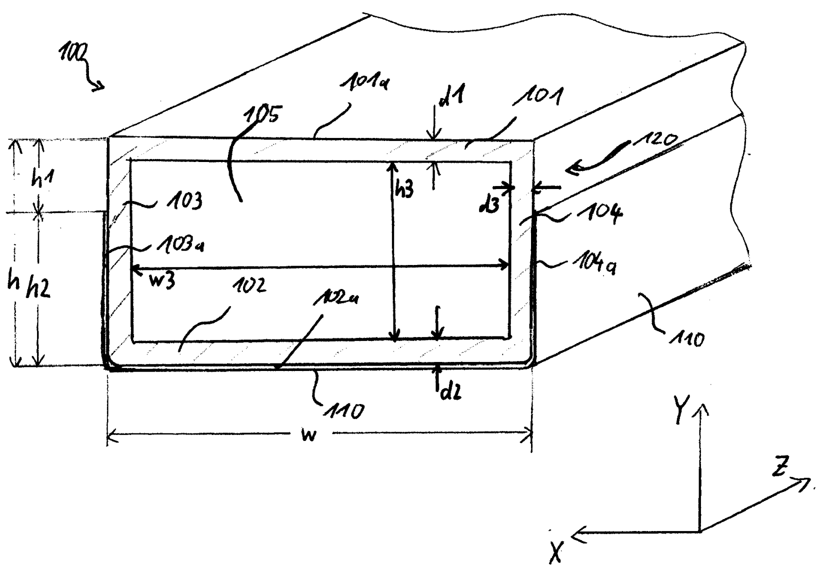

Fig. 3

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Description

[0001] The present invention relates to a spacer for an insulating glazing unit, an insulating glazing unit comprising such a spacer, and the use of a foil stack as a multilayer diffusion barrier of such a spacer.

[0002] Insulating glazing units (IGUs) having at least two glazing panes, which are held apart from each other with an interspace therebetween filled with a gas like Argon, are well known. Such IGUs are used in window, door and façade elements. Usually, the separation of the glazing panes is secured by a spacer frame which could be rectangular or of another shape like triangular depending on the IGU shape and is inserted between the glazing panes and positioned along the edges of the glazing panes. In case of a rectangular spacer frame, the spacer frame is either assembled from four straight pieces of the spacer using four corner connectors or is bent from one piece of the spacer and closed by one linear connector at only one position. WO 2014/063801 A1 provides a good overview over the developments in this technical field.

[0003] Spacers have been manufactured from plastic (synthetic) material having a low specific heat conductivity. However, such plastic material does not satisfy the requirements of diffusion impermeability. Therefore, diffusion barriers are used to ensure diffusion impermeability of plastic spacers.

[0004] DE 198 07 454 A1, DE 33 02 659 A1, WO 2004/081331 A1, WO 2012/055553 A1, and WO 99/41481 A1 disclose spacers for insulation glazing units comprising a diffusion barrier.

[0005] WO 2013/104507 A1 discloses a spacer with a diffusion barrier, which comprises at least one polymer foil with a thickness of 10 μm to 100 μm, at least one polymer layer with a thickness of 5 μm to 80 μm, and two or more metallic or ceramic layers with a thickness of 10 nm to 1500 nm on the polymer foil.

[0006] An object of the present invention is to provide an improved diffusion barrier for a spacer for IGUs with good thermal, mechanical, and sealing properties.

[0007] This object is achieved by a spacer according to claim 1 or claim 13 or an insulating glazing unit according to claim 14 or a use of a foil stack as a multilayer diffusion barrier of a spacer according to claim 15.

[0008] Further developments of the invention are given in the dependent claims.

[0009] The spacer provides excellent thermal performance. At least one of the barrier layers of the spacer has a thickness of equal to or less than 9 nm. Even if this barrier layer is made of a metal with a relatively high specific heat conductivity such as aluminium, its contribution to the overall thermal transmittance of the spacer between the glazing panes is very small due to its small thickness.

[0010] The multilayer diffusion barrier provides excellent reliability. There are at least two barrier layers. In case of a local failure of one of the barrier layers occurring, e.g., during and after a bending operation or during transport and storage of the spacer, there is at least one further barrier layer available to prevent diffusion. The spacer may comprise three, four or more barrier layers.

[0011] The multilayer diffusion barrier can be manufactured at comparatively low costs by defining a specific maximum thickness for the metal or ceramic layers adapted to the technical field of spacers and selecting correspondingly coated polymer foils, which are either commercially available and glued to foil stacks or manufactured as foil stacks on corresponding order.

[0012] The barrier layers can be made of metallic material such as aluminium or another metal like, e.g., chromium, zinc, iron, lead, silver, copper, gold, or titanium and/or alloys or mixtures thereof, or can be made of ceramic material such as silicon oxides, in particular SiO_2, and/or silicon nitrides, or another ceramic material.

[0013] A sufficient barrier effect to avoid diffusion through the spacer can be ensured. A metal layer with a thickness of about ten covalent diameters of the corresponding metal atoms is necessary to achieve a sufficient barrier effect to avoid diffusion of insulating gas from the intervening space through the spacer and diffusion of moisture from outer environment into the intervening space. Nine covalent diameters are also sufficient but eight are not. In case of aluminium with a covalent radius of about 0.12 nm, ten covalent diameters correspond to a thickness of about 2.4 nm. This value represents a minimum aluminium thickness for a diffusion barrier layer excluding manufacturing tolerances. It is considered to be critical for diffusion tightness that the actual aluminium thickness of one layer is not below this value.

[0014] For a different material than aluminium, the numbers have to be adapted to the specific properties of the material.

[0015] There are different techniques for bending a spacer for achieving a closed frame to be inserted between the glazing panes of the IGU. The bending can be classified into so-called warm bending, wherein the spacer is heated at least locally at the portion to be subject to the bending before the bending process to make it more flexible, and so-called cold bending at room temperature of about 20°C. In particular in case of cold bending, a barrier layer of the multilayer diffusion barrier on the outer surface of the spacer body is stretched due to the bending. The thickness of the barrier layer in the stretched portion is thinner than in the unbent state. Thus, the aluminium thickness of the barrier layer in the unbent state (in which the spacer is manufactured) must be larger than the above minimum value required for a sufficient barrier effect.

[0016] The thickness of the barrier layer may be selected larger than the above thickness corresponding to the above minimum of 10 or 9 times the covalent atomic diameter for materials like aluminium or chromium, zinc, steel, gold, silver, etc. taking into account manufacturing capabilities or requirements like tolerances, material properties, mechanical stresses, etc.. A safety margin may also be included. Nine covalent atomic diameters of Al correspond to about 2.2 nm, of Cr to about 2.5 nm, of Zn to about 2.2 nm, of Ag to about 2.6 nm such that a single barrier layer may have a thickness in a range with a lower limit in the range of 2.2 nm to 3 nm (2.2 nm, 2.3 nm, 2.4 nm, 2.5 nm, 2.6 nm, 2.7 nm, 2.8 nm, 2.9 nm, or 3.0 nm) and an upper limit of 9 nm or 8 nm or 7 nm or 6 nm or 5 nm. The above specification of the minimum and maximum values excludes manufacturing tolerances, i.e., the actual thickness of a manufactured barrier layer may not be less than the required minimum value. In other words, a thickness of 2.1 nm or a thickness of 9.1 nm are not covered.

[0017] With current technologies, it may be difficult to produce a barrier layer with a thickness of only 10 or 9 times the covalent atomic diameter. Therefore, the lower limit of the above range may be 3.5 nm, 4 nm, 4.5 nm, 5 nm, 5.5 nm, 6 nm, 6.5 nm, or 7 nm.

[0018] The thickness of each of the polymer layers can be in the range from 1 μm to 500 μm, in the range from 5 μm to 200 μm, in the range from 10 μm to 100 μm, in the range from 10 μm to 50 μm, or in the range from 10 μm to 20 μm.

[0019] The multilayer diffusion barrier can be obtained by using a foil stack comprising two or more foils and connecting the same to the spacer body. Joining two neighboring foils with an adhesive for forming the foil stack can be made easier if there is a metallic or ceramic barrier layer between the polymer layers.

[0020] Additional features and advantages result from the description of exemplary embodiments by reference to the figures, which show in

Fig. 1 a spacer according to a first embodiment disposed between two glazing panes of an IGU,

Fig. 2 a spacer frame formed by bending the spacer in a rectangular shape,

Fig. 3a cross-section of the spacer in an X-Y-plane,

Fig. 4 in a) a cross-section of two foils in a separate state and in b) a cross-section of a multi-layer diffusion barrier formed as a foil stack comprising the two foils,

Fig. 5 a cross-section of another multilayer diffusion barrier,

Fig. 6 a cross-section of a spacer according to a second embodiment,

Fig. 7 in a) to e) cross-sections of spacers according to third to seventh embodiments, and

Fig. 8 in a) and b) modified multilayer diffusion barriers.

[0021] Embodiments of the present teachings will be described in more detail below with reference to the figures.

[0022] A first embodiment will be described with reference to Figs. 1 to 5. Coordinates will be specified in the following according to a coordinate system shown in Fig. 1.

[0023] Fig. 1 shows an IGU comprising two glazing panes 151, 152 and a spacer 100. The spacer 100 is positioned between the two glazing panes 151, 152. The spacer 100 extends along a longitudinal direction Z. A width direction (a horizontal direction in the figure) perpendicular to the longitudinal direction Z is defined as an X-direction. The glazing panes 151, 152 are positioned on both sides of the spacer 100 in the X-direction. A height direction perpendicular to the width direction X and the longitudinal direction Z is defined as a Y-direction. The glazing panes 151, 152 extend in the Y-Z-plane.

[0024] Fig. 1 shows a spacer 100 with a rectangular cross-section in the X-Y-plane. The cross-section of the spacer 100 is essentially constant along the longitudinal direction Z. The spacer 100 is connected to the glazing panes 151, 152 by a sealant 161 inserted between the spacer 100 and the glazing panes 151, 152. The glazing panes 151, 152 and the spacer 100 define an intervening space 153. The intervening space 153 is filled with an inert gas such as argon, xenon, or krypton. An adhesive and sealing material 157 is provided on an outer side of the spacer 100 opposite to the intervening space 153.

[0025] The spacer 100 comprises a hollow chamber 105. The hollow chamber 105 extends along the Z-direction and is closed in the cross-section in the X-Y-plane. The term "closed" in this context means that the hollow chamber 105 is completely surrounded by walls of the spacer 100 in the cross-section in the X-Y-plane, wherein the walls may have openings. An inner wall 101 on the side of the intervening space 153 comprises through holes 106. The through holes 106 connect the hollow chamber 105 and the intervening space 153 and enable gas exchange between the hollow chamber 105 comprising a desiccant and the intervening space 153.

[0026] Fig. 2 shows a spacer frame 150 formed from a single piece of the spacer 100 bent into a rectangular shape. The spacer frame 150 comprises four 90° corners. Open ends of the spacer 100 are connect with a linear connector 54 which is inserted into the hollow chamber 105 of the spacer 100. The spacer frame 150 is inserted between the glazing panes 151, 152 shown in Fig. 1. The spacer frame 150 keeps the glazing panes 151, 152 apart by the predetermined distance and seals the intervening space 153.

[0027] Fig. 3 shows an enlarged view of the cross-section of the spacer 100. The spacer 100 comprises a spacer body 120. The spacer body 120 is made of a plastic material such as PBT GF 30, SAN GF 20, SAN GF 25, SAN GF 30, or SAN GF 35. The hollow chamber 105 is surrounded by the inner wall 101 extending in the longitudinal direction Z and in the width direction X, an outer wall 102 extending the longitudinal direction Z and in the width direction X, and two side walls 103, 104 extending in the Y-Z-plane. The side walls 103, 104 connect the inner wall 101 and the outer wall 102 and are essentially perpendicular to the inner wall 101 and the outer wall 102.

[0028] A thickness d1 of the inner wall 101 is in the range from 0.5 mm to 1.5 mm such as 0.7 mm, 0.8 mm, 0.9 mm and 1 mm. A thickness d2 of the outer wall 102 is in the range from 0.2 mm to 1.2 mm, or in the range from 0.5 mm to 1.0 mm such as 0.5 mm, 0.6 mm, and 0.7 mm. A thickness d3 of each of the side walls 103, 104 is in the range from 0.2 mm to 1.5 mm, or in the range from 0.5 mm to 1.0 mm such as 0.5 mm, 0.6 mm, and 0.7 mm. A width w of the spacer body 120 in the X-direction is in the range from 5 mm to 50 mm such as 5 mm, 6 mm, 8 mm, 10 mm, 12 mm, 14 mm, 16 mm, 18 mm, 20 mm, 22 mm, 24 mm, 30 mm, 40 mm, or 50 mm. A height h of the spacer body 120 in the height direction Y is in the range from 4 mm to 12 mm, or in the range from 5 mm to 10 mm such as 6 mm or 7 mm or 8 mm. A width w3 of the essentially rectangular hollow chamber 105 is in the range from 3 mm to 48 mm, or in the range from 4 mm to 46 mm such as 10 mm, 12 mm, 14 mm, or 16 mm. A height h3 of the hollow chamber 105 is in the range from 3 mm to 11 mm, or in the range from 4 mm to 7 mm such as 5 mm or 6 mm.

[0029] Outer surfaces 103a, 104a of the side walls 103, 104 of the spacer body 120 face the glazing panes 151, 152 (not shown in Fig. 3) in an assembled state of the IGU. The outer surfaces 103a, 104a of the side walls 103, 104 are connected to the glazing panes 151, 152 via the sealant 161 in-between. An outer surface 101a of the inner wall 101 faces the intervening space 153 between the glazing panes 151, 152. An outer surface 102a of the outer wall 102 faces the opposite direction. The term "outer" is used for the above surfaces 101a, 102a, 103a, 104a, because these surfaces face the outside of the spacer body 120 opposite to the hollow chamber 105. The terms "inner" and "outer" are used for the walls 101 and 102, respectively, because these walls will face the intervening space 153 between the glazing panes 151, 152 and will face the outside opposite to the intervening space 153, respectively, in the assembled state of the IGU in usual use.

[0030] A multilayer diffusion barrier 110 is disposed on the outer surface 102a of the outer wall 102 and on the outer surfaces 103a, 104a of the side walls 103, 104. The multilayer diffusion barrier 110 extends along the entire length of the spacer body 120 in the longitudinal direction Z. The multilayer diffusion barrier 110 extends over the entire width w of the outer surface 102a in the width direction X. The multilayer diffusion barrier 110 extends over parts of the outer surfaces 103a, 104a of the side walls 103, 104 on the side of the outer wall 102 over a height h2 in the height direction Y. Remaining parts of the outer surfaces 103a, 104a of the side walls 103, 104 on the side of the inner wall 101 with a height h1 in the height direction Y are not covered by the multilayer diffusion barrier 110. The height h1 is in the range from 1 mm to 7 mm. The height h2 is in the range from 3 mm to 9 mm or in the range from 3.5 mm to 9 mm. The height h of the spacer body 120 as the sum of the heights h1 and h2 is in the range from 6 mm to 10 mm.

[0031] Fig. 4a) shows cross-sections of a first foil 10 and a second foil 20 for a foil stack used as the multilayer diffusion barrier 110 in a plane perpendicular to a plane in which the foils 10, 20 extend in a separate state. The first foil 10 comprises a polymer layer 1. The polymer layer 1 of the first foil 10 is coated with a metallic layer 2 on a lower surface. An upper and a lower direction are denoted by arrows in the figure. The metallic layer 2 is made of aluminium and serves as a barrier layer. The second foil 20 comprises a polymer layer 1. The polymer layer 1 of the second foil 20 is coated with a metallic layer 2 on a lower surface and with a metallic layer 2 on an upper surface. Each of the polymer layers 1 of the first and second foils 10, 20 has a thickness of 15 μm. Each of the metallic layers 2 has a thickness of 8 nm. The polymer layers 1 are made of PBT or PET. The metallic layers are made of aluminium.

[0032] Fig. 4b) shows a cross-section of a foil stack in a plane perpendicular to the plane in which the foil stack extends. The first foil 10 and the second foil 20 are joined in the foil stack to form the multilayer diffusion barrier 110. An upper surface of the second foil 20, i.e., an upper surface 2a of the metallic layer 2 on top of the second foil 20 is joined to a lower surface of the first foil 10, i.e., to a lower surface 2b of the metallic layer 2 of the first foil 10 by an adhesive layer 3.

[0033] An upper surface of the foil stack, i.e., an upper surface 1a of the polymer layer 1 of the first foil 10 is glued to the outer surface 102a of the outer wall 102 of the spacer body 120 and the parts of the outer surfaces 103a, 104a of the side walls 103, 104 on the side of the outer wall 102 using an adhesive. A lower surface of the foil stack, i.e., a lower surface 2c of the metallic layer 2 of the second foil 20 faces away from the outer wall 102 and the side walls 103, 104, i.e. from the spacer body 120.

[0034] Fig. 5 shows a cross-section of a modified foil stack in a plane perpendicular to the plane in which the foil stack extends. The foil stack can be used as the multilayer diffusion barrier 110 of the spacer 100 instead of the foil stack shown in Fig. 4b). The foil stack comprises a third foil 30, a fourth foil 40, and a fifth foil 50.

[0035] The third foil 30 is arranged on top of the foil stack. The structure of the third foil 30 is similar to the structure of the second foil 20. The third foil 30 comprises a polymer layer 1. Each of a lower surface and an upper surface of the polymer layer 1 of the third foil 30 is coated with a metallic layer 2.

[0036] The fourth foil 40 is arranged below the third foil 30 and above a fifth foil 50. The structure of the fourth foil 40 is similar to the structure of the first foil 10. The fourth foil 40 comprises a polymer layer 1. A lower surface of the polymer layer 1 of the fourth foil 40 is coated with a metallic layer 2. An upper surface of the polymer layer

1 of the fourth foil 40 is not coated. The upper surface of the polymer layer 1 of the fourth foil 40 is glued to a lower surface of the lower metallic layer 2 of the third foil 30 by an adhesive layer 3.

[0037] The fifth foil 50 is arranged below the fourth foil 40. The structure of the fifth foil 50 is similar to the structures of the second and third foils 20, 30. The fifth foil 50 comprises a polymer layer 1. Each of an upper surface and a lower surface of the polymer layer 1 of the fifth foil 50 is coated with a metallic layer 2. An upper surface of the upper metallic layer 2 of the fifth foil 50 is glued to a lower surface of the metallic layer 2 of the fourth foil 40 by an adhesive layer 3. The metallic layers 2 of the foils 30, 40, 50 are made of aluminium. The polymer layers 1 are made of PBT or PET. The thicknesses of the polymer layers 1 and the metallic layers 2 are the same as the thicknesses of the polymer layers 1 and the metallic layers 2 of the foils 10, 20 shown in Figs. 4a), respectively.

[0038] An upper surface of the foil stack, i.e., an upper surface of the upper metallic layer 2 of the third foil 30 is glued to the outer surface 102a of the outer wall 102 of the spacer body 120 and the parts of the outer surfaces 103a, 104a of the side walls 103, 104 on the side of the outer wall 102. A lower surface of the foil stack 110, i.e., a lower surface of the lower metallic layer 2 of the fifth foil 50 faces away from the spacer body 120.

[0039] The above-mentioned values for the thicknesses of the polymer layers 1 and the metallic layers 2 have to be understood as manufacturing values. When the spacer 100 comprising the multilayer diffusion barrier 110 formed by one of the foil stacks shown in Figs. 4b) and 5 is bent to obtain the rectangular spacer frame 150 shown in Fig. 2, the polymer layers 1 and the metallic layers 2 of the foil stack disposed on an outer side of the spacer body 120 with respect to a neutral axis or neutral line are stretched. Assuming a bending radius of about 3 mm and a height h of the spacer body 120 of about 7 mm and assuming that the neutral axis or neutral line is disposed roughly in the middle of the spacer body 120 in the height direction Y such that the part of the spacer body 120 disposed on the outer side has a height of about 3.5 mm (half of the height h of the spacer body 120), the layers 1, 2 are stretched by about 54 % in length along the longitudinal direction Z because of the bending. Assuming a Poisson modulus of Aluminium of 0.33, the thicknesses of the layers 1, 2 in the stretched state are about 18 % lower than their thicknesses before the bending. For the metallic layers 2 this means a reduction in thickness from 8 nm to about 6.56 nm. This thickness is still sufficient to ensure diffusion-tightness because it is larger than the minimum aluminium thickness of 2.4 nm. Consequently, the multilayer diffusion barrier 110 keeps sufficient diffusion properties even when it is stretched due to bending of the spacer 100.

[0040] The metallic layers 2 of the foils 10, 20, 30, 40, 50 serve as barrier layers. In this embodiment, the barrier layers 2 of the foils 10, 20, 30, 40, 50 are made of aluminium. However, some or all of the barrier layers 2 can be made of other metals or of ceramic materials. In this embodiment, all polymer layers 1 of the foils 10, 20, 30, 40, 50 have the same thickness and all barrier layers 2 have the same thickness. However, some or all polymer layers 1 can have different thicknesses, and some or all barrier layers 2 can have different thicknesses.

[0041] A second embodiment will be described with reference to Fig. 6.

[0042] Fig. 6 shows a cross-section of a spacer 200 according to a second embodiment in the X-Y-plane. The spacer 200 is similar to the spacer 100. The same elements are denoted by the same reference numbers. The spacer 200 comprises spacer body 120 with an essentially rectangular cross-section. The spacer body 120 of the spacer 200 is made of a plastic material such as PBT or SAN. Corners between the outer wall 102 and the side walls 103, 104 are rounded.

[0043] The spacer body 120 comprises reinforcing elements 107, 108 for stiffening the spacer body 120. The reinforcing elements 107 and 108 are made of metal such as steel and are diffusion-proof. The reinforcing elements 107, 108 are disposed on parts of the outer surfaces 103a, 104a of the side walls 103, 104 and on parts of the outer surface 102a of the outer wall 102. The reinforcing elements 107, 108 extend along the longitudinal direction Z and cover parts of the outer surfaces 103a, 104a of the side walls 103, 104. Ends 109a of the reinforcing elements 107, 108 on the side walls 103, 104 are positioned on the outer surfaces 103a, 104a of the side walls 103, 104. The reinforcing elements 107, 108 extend along the rounded corners between the side walls 103, 104 and the outer wall 102 and cover parts of the outer surface 102a of the outer wall 102 on the sides of the sides walls 103, 104. There is a gap on the outer surface 102a of the outer wall 102 between ends 109b of the reinforcing elements 107, 108 in the width direction X.

[0044] The multilayer diffusion barrier 110 is disposed in the gap between the ends 109b of the reinforcing elements 107, 108 on the outer surface 102a of the outer wall 102. The multilayer diffusion barrier 110 is connected to the ends 109b of the reinforcing elements 107, 108. The connection is diffusion-proof. Accordingly, the reinforcing elements 107, 108 and the multilayer diffusion barrier 110 form a continuous diffusion barrier covering the side walls 103, 104 and the outer wall 102 and prevent diffusion of the inert gas contained in the intervening space 153 through the spacer 200 and also diffusion of moisture into the intervening space 153 through the spacer 200.

[0045] When the spacer 200 is bent to form the closed frame 150 shown in Fig. 2, a wall portion of the outer wall 102 covered by the multilayer diffusion barrier 110 is moved towards the inner wall 101 into the hollow chamber 105. Thus, stretching of the multilayer diffusion barrier 110 disposed on this wall portion is reduced or avoided. Due to the use of the improved multilayer diffusion barrier 110, it is not necessary that this wall portion moves to or close to the neutral axis or neutral line. (The term "neutral axis" in this context does not necessarily denote a straight line but can denote a curved line or a curved plane.)

[0046] Third to seventh embodiments will be described with reference to Figs. 7a) to 7e).

[0047] Fig. 7a) shows a cross-section of a spacer 300 according to a third embodiment in the X-Y-plane. The spacer 300 is similar to the spacer 100. The same elements are denoted by the same reference numbers. The spacer body 120 of the spacer 300 is made of a plastic material such as PBT or SAN. The spacer body 120 of the spacer 300 comprises two U-shaped reinforcing elements 107a, 108a covering the outer surfaces 103a, 104a of the side walls 103, 104 and parts of the outer surface 101a of the inner wall 101 and of the outer surface 102a of the outer wall 102 in the corner regions between the side walls 103, 104 and the inner wall 101 and the outer wall 102. The reinforcing elements 107a, 108a extend along the longitudinal direction Z with constant cross-section and are made of metal such as steel. The multilayer diffusion barrier 110 is disposed on the outer surface 102a of the outer wall 102 but not on the side walls 103, 104.

[0048] Fig. 7b) shows a cross-section of a spacer 400 according to a fourth embodiment in the X-Y-plane. The spacer 400 is similar to the spacer 100. The same elements are denoted by the same reference numbers. The spacer body 120 of the spacer 400 is made of a plastic material such as PBT or SAN. The spacer body 120 of the spacer 400 comprises two L-shaped reinforcing elements 107b, 108b embedded in corner regions between the inner wall 101 and the side walls 103, 104. The reinforcing elements 107b, 108b extend along the longitudinal direction Z with constant cross-section and are made of metal such as steel. The spacer body 120 further comprises two reinforcing elements 107c, 108c in the form of wires extending along the longitudinal direction Z and embedded in corner regions between the outer wall 102 and the side walls 103, 104. The multilayer diffusion barrier 110 is disposed on the outer surface 102a of the outer wall 102 but not on the outer surfaces 103a, 104a, of the side walls 103, 104.

[0049] Fig. 7c) show a cross-section of a spacer 500 according to a fifth embodiment in the X-Y-plane. The spacer 500 is similar to the spacer 400. The same elements are denoted by the same reference numbers. The spacer body 120 of the spacer 500 comprises two further L-shaped reinforcing elements 107d, 108d instead of the reinforcing elements 107c, 108c of the spacer 400. The reinforcing elements 107d, 108d extend along the longitudinal direction Z with constant cross-section and are made of metal such as steel. The thickness of the reinforcing elements 107b, 108b in the corner regions between the inner wall 101 and the side walls 103, 104 may be larger than the thickness of the reinforcing elements 107d, 108d in the corner regions between the outer wall 102 and the side walls 103, 104. In this case, the neutral axis or neutral line is moved towards the inner wall 101 due to the larger mass in the corner regions between the inner wall 101 and the side walls 103, 104, which can be advantageous for bending.

[0050] Fig. 7d) show a cross-section of a spacer 600 according to a sixth embodiment in the X-Y-plane. The spacer 600 is similar to the spacer 100. The same elements are denoted by the same reference numbers. The spacer body 120 of the spacer 600 is made of a plastic material such as PBT or SAN. The spacer body 120 of the spacer 600 comprises two reinforcing elements 107e, 108e in the form of flat metal sheets. The reinforcing elements 107e, 108e are embedded in and parallel to the side walls 103, 104. The reinforcing elements 107e, 108e extend along the longitudinal direction Z with constant cross-section. The multilayer diffusion barrier 110 is disposed on the outer surfaces 102a, 103a, 104a of the outer wall 102 and the side walls 103, 104.

[0051] Fig. 7e) show a cross-section of a spacer 700 according to a seventh embodiment in the X-Y-plane. The spacer 700 is similar to the spacers 100 and 200. The same elements are denoted by the same reference numbers. The spacer body 120 of the spacer 700 is made of a plastic material such as PBT or SAN. Corners between the outer wall 102 and the side walls 103, 104 of the spacer body 120 of the spacer 700 are rounded.

[0052] The spacer body 120 comprises two L-shaped reinforcing elements 107f, 108f embedded in corner regions between the inner wall 101 and the side walls 103, 104. The reinforcing elements 107f, 108f extend along the longitudinal direction Z and are made of metal such as steel. Each of the reinforcing elements 107f, 108f comprises a portion extending in the inner wall 101 and a portion extending in one of the side walls 103, 104. The portion extending in the inner wall 101 has a length 11 in the width direction X and a thickness d1 in the height direction Y. The portion extending in one of the side walls 103, 104 has a length 12 in the height direction Y and a thickness d2 in the width direction X. The length 11 is in the range from 0.5 mm to 5 mm. The length 12 is in the range from 3 mm to 8 mm. The thickness d1 is in the range from 0.05 mm to 0.25 mm. The thickness d2 is two to four times the thickness d1. The thickness d2 can be three times the thickness d1.

[0053] The multilayer diffusion barrier 110 is disposed on the outer surface 102a of the outer wall 102 and on parts of the outer surfaces 103a, 104a, of the side walls 103, 104 on the side of the outer wall 102. The multilayer diffusion barrier 110 extends over the entire width of the outer wall 102 in the width direction X and extends over a height h2 in the height direction Y on the outer surfaces 103a, 104a of the side walls 103, 104. Parts of the outer surfaces 103a, 104a of the side walls 103, 104 on the side of the inner wall 101 extending over a height h1 in the height direction Y are not covered by the multilayer diffusion barrier 110. The height h1 is in the range from 1 mm to 7 mm. The height h2 is in the range from 3 mm to 9 mm or in the range from 3.5 mm to 9 mm. The height h of the spacer body 120 as the sum of the heights h1 and h2 is in the range from 5 mm to 10 mm.

[0054] The above disposal of the diffusion barrier 110 on the outer surface 102a and on parts of the outer surfaces 103a, 104a of the spacer body 120 of the spacer 700 can also be applied to the spacers of the other embodiments. The partial coverage of the outer surfaces 103a, 104a of the side walls 103, 104 on the side of the outer wall 102 by the multilayer diffusion barrier 110 avoids diffusion of the inert gas contained in the intervening space 153 as well as of moisture from the external environment into the intervening space 153 through the side walls 103, 104 and along the glazing panes 151, 152. If the outermost layer of the multilayer diffusion barrier 110 is a metallic barrier layer 2, it further facilitates the adhesion of the spacer to the glazing panes 151, 152 by the sealant 161.

[0055] The parts of the outer surfaces 103a, 104a of the side walls 103, 104 on the side of the inner wall 101 are not covered by the multilayer diffusion barrier 110 to avoid that the multilayer diffusion barrier 110 is visible from a position on a side of the IGU in the width direction X in IGUs comprising more than two glazing panes 151, 152.

[0056] The foil stacks shown in Figs. 4b) and 5 can be used as the multilayer diffusion barrier 110 of any of the spacers 200 to 700. The foil stacks can be easily disposed on the outer surfaces 102a, 103a, 104a of the outer wall 102 and the side walls 103, 104, e.g., by gluing.

[0057] Stretching of the multilayer diffusion barrier 110 during bending can be avoided or dramatically reduced if the multilayer diffusion barrier 110 is disposed only on a part of the outer surface 102a of the outer wall 102 that collapses onto the neutral axis or neutral line during the bending as described for the second embodiment. Such disposal of the multilayer diffusion barrier 110 avoids or dramatically reduces the above described thinning of barrier layers 2 due to the bending and reduces the risk of mechanical damage of the multilayer diffusion barrier 110. Parts of the surface of the outer wall 102 of the spacer body 120 that are not covered by the multilayer diffusion barrier 110 have to be covered by some other diffusion-proof material to avoid leakage of gas through the spacer.

[0058] However, the multilayer diffusion barrier 110 can also be disposed on parts of the spacer body 120 that do not collapse onto the neutral axis or neutral line. The thicknesses of the barrier layers 2 are sufficient for diffusion-tightness even if the multilayer diffusion barrier 110 is stretched due to bending.

[0059] Adhesion to secondary sealant materials 157 to be disposed on the outer side of the spacer frame 150 opposite to the intervening space 153 between the glazing panes 151, 152 of the IGU can be improved if the outermost layer of the multilayer diffusion barrier 110 is a metallic barrier layer 2.

[0060] The risk of a failure of the multilayer diffusion barrier 110 due to mechanical damage can be reduced if the multilayer diffusion barrier 110 comprises at least three barrier layers 2.

[0061] The plastic material of the spacer body 120 can be selected from a group comprising various materials, which can be selected to improve the thermal and mechanical properties of the spacer body 120. The plastic material of the spacer body 120 can be selected from a group comprising polyethylene (PE), polycarbonate (PC), polypropylene (PP), polystyrene, polybutadiene, polynitrile, polyester, polyurethane, polymethylmetacrylate, polyacrylate, polyamide, polyethylenterephthalate (PET), polybutylenterephthalate (PBT), acrylonitrile-butadiene-styrene (ABS), acrylic ester-styrene-acrylonitrile (ASA), acrylonitrile-butadiene-styrene-polycarbonate (ABS/PC), styrene-acrylonitrile (SAN), PET/PC, PBT/PC, PMMA, PBT/PET, PP/PE, PVC, PC/ASA, PPE/PPO, and copolymers or mixtures thereof, which can each be formed partially or completely of bio materials formed of renewable resources.

[0062] The materials of the polymer layers 1 can be selected from a group comprising any common polymer material such as the ones listed above for the plastic material of the spacer body 120. The materials of the polymer layers 1 can be selected from gas-tight polymers such as EVOH.

[0063] The stiffness of the spacer body 120 can be increased by using, e.g., reinforcing fibers, agents, or other elements. The spacer body 120 can comprise reinforcing fibers such as glass fibers, carbon fibers, aramid fibers, polyethylene fibers, natural fibers, basalt fibers, ceramic fibers, metal fibers, and/or reinforcing agents such as nanoparticles, mineral fillers, sheet silicates and layered silicates, metal powder, talkum and the like. Reinforcing fibers can be selected from different kinds of fibers such as steel fibers, hollow glass fibers, natural fibers, etc. Examples of natural fibers are cotton, jute, hemp, sisal, or regenerated cellulose fibers such as Cordenka or Lenzing. The fibers can be short, long, or endless. Further examples of additives that can be included in the spacer body 120 are montmorillonites, liquid crystal polymers, mica particles, titanium(IV) oxide, wollastonite, hollow or non-hollow spheres of glass, glass particles, hollow or non-hollow ceramic spheres, ceramic particles, and mineral fillers such as kaolin, talc, mica, titanium oxide, calcium carbonate, silicon dioxide and layered silicates, in particular in the form of nanoparticles. These lists of materials are not conclusive.

[0064] The spacer body 120 can comprise reinforcing elements selected from a group comprising tapes, strips, angled or flat sheets 107e, 108e, and/or wires 107c, 108c of metal or a composite fiber-plastics material, fiber bundles, nets, films, L-shaped or U-shaped profiles 107a, 107b, 107d, 107f, 108a, 108b, 108d, 108f. The reinforcing elements can be embedded in the spacer body 120 and/or can be disposed on surfaces of the walls 101, 102, 103, 104 of the spacer body 120.

[0065] The spacer body 120 can be made of SAN and comprise glass bubbles corresponding to 10 % to 25 % of its mass and glass fibers corresponding to 20 % to 25

% of its mass. The spacer body 120 can be made of SAN and comprise wollastonite corresponding to 35 % of its mass or basalt fibers corresponding to 20 % to 35 % of its mass.

[0066] In the above embodiments, the multilayer diffusion barrier 110 is used. The multilayer diffusion barrier 110 can be replaced by a modified multilayer diffusion barrier.

[0067] The modified multilayer diffusion barrier comprises at least one polymer layer and at least three barrier layers. At least one of the at least three barrier layers is a metallic barrier layer, at least one of the at least three barrier layers is a ceramic barrier layer, and at least one of the at least three barrier layers is a polymer barrier layer.

[0068] The material of the at least one polymer layer of the modified multilayer diffusion barrier can be selected from the materials listed above for the polymer layers 1 of the multilayer diffusion barrier 110. The thickness of the at least one polymer layer of the modified multilayer diffusion barrier can be selected from the same range as the thicknesses of the polymer layers 1 of the multilayer diffusion barrier 110.

[0069] The material of the polymer barrier layer of the modified multilayer diffusion barrier can be selected from a group of gas-tight polymers such as ethylene vinyl alcohol (EVOH). The thickness of the polymer barrier layer of the modified multilayer diffusion barrier can be selected from the same range as the thicknesses of the polymer layers 1 of the multilayer diffusion barrier 110.

[0070] The material of the ceramic barrier layer of the modified multilayer diffusion barrier can be selected from the ceramic materials listed above for the barrier layers 2 of the multilayer diffusion barrier 110. The thickness of the ceramic barrier layer of the modified multilayer diffusion barrier can be selected from the same range as the thicknesses of the barrier layers 2 of the multilayer diffusion barrier 110.

[0071] The material of the metallic barrier layer of the modified multilayer diffusion barrier can be selected from the metallic materials listed above for the barrier layers 2 of the multilayer diffusion barrier 110. The thickness of the metallic barrier layer of the modified multilayer diffusion barrier can be selected from the same range as the thicknesses of the barrier layers 2 of the multilayer diffusion barrier 110.

[0072] The combination of the polymer barrier layer, the ceramic barrier layer, and the metallic barrier layer provides a low gas and moisture permeation rate and therefore very good diffusion tightness. Using the barrier layers of different materials, an excellent gas- and moisture-tightness in a bending zone in a corner of a spacer frame can be achieved.

[0073] Fig. 8a shows a cross-section of a modified multilayer diffusion barrier 111 in a plane perpendicular to the plane in which the multilayer diffusion barrier 111 extends. The multilayer diffusion barrier 111 can be disposed on an outer surface of the spacer body 120 instead of the multilayer diffusion barrier 110. Similar to the multilayer diffusion barrier 110, the multilayer diffusion barrier 111 is formed as a foil stack. The multilayer diffusion barrier 111 comprises a polymer layer 1 on top of the foil stack. A polymer barrier layer 2"' is disposed below the polymer layer 1. A ceramic barrier layer 2" is disposed below the polymer barrier layer 2"'. A metallic barrier layer 2' is disposed below the ceramic barrier layer 2". The polymer barrier layer 2"' and the ceramic barrier layer 2" are disposed between the polymer layer 1 and the metallic barrier layer 2'. The order of the polymer barrier layer 2"' and the ceramic barrier layer 2" can be exchanged. Either the polymer layer 1 or the metallic barrier layer 2' can be joined to an outer surface of the spacer body 120 by an adhesive. If the metallic barrier layer 2' is the outer layer of the modified diffusion barrier 111, which faces away from the spacer body 120, good adhesion to the adhesive and sealing material 157 and/or to the sealant 161 can be ensured.

[0074] The polymer layer 1 of the multilayer diffusion barrier 111 is similar to the polymer layers 1 of the multilayer diffusion barrier 110. The material of the polymer layer 1 of the multilayer diffusion barrier 111 is PET. The thickness of the polymer layer 1 of the multilayer diffusion barrier 111 is 15 μm.

[0075] The material of the polymer barrier layer 2"' is EVOH. The thickness of the polymer barrier layer 2"' is 15 μm.

[0076] The ceramic barrier layer 2" of the multilayer diffusion barrier 111 is similar to barrier layers 2 of the multilayer diffusion barrier 110 that are made of ceramic material. The material of the ceramic barrier layer 2" of the multilayer diffusion barrier 111 is SiO_2. The thickness of the ceramic barrier layer 2" of the multilayer diffusion barrier 111 is 8 nm.

[0077] The metallic barrier layer 2' of the multilayer diffusion barrier 111 is similar to barrier layers 2 of the multilayer diffusion barrier 110 that are made of metallic material. The material of the metallic barrier layer 2' of the multilayer diffusion barrier 111 is aluminium. The thickness of the metallic barrier layer 2' of the multilayer diffusion barrier 111 is 8 nm.

[0078] The multilayer diffusion barrier 111 can be formed by depositing the polymer barrier layer 2"', the ceramic barrier layer 2", and the metallic barrier layer 2' onto the polymer layer 1. For example, the polymer layer 1 and the polymer barrier layer 2"' can be coextruded to create a carrier foil. Then, the ceramic barrier layer 2" and the metallic barrier layer 2' can be deposited onto the carrier foil in two separate deposition steps.

[0079] It is possible to manufacture foils, for example, by depositing the ceramic barrier layer 2" or the metallic barrier layer 2' onto the polymer layer 1 or the polymer barrier layer 2"', which act as carrier layers. The multilayer diffusion barrier 111 can be formed by joining the separate foils by an adhesive. For example, if the order of the polymer barrier layer 2"' and the ceramic barrier layer 2" in Fig. 8a is exchanged, one foil can be formed by depositing the ceramic barrier layer 2" onto the polymer layer 1. Another foil can be formed by depositing the metallic barrier layer 2' onto the polymer barrier layer 2"'. The two foils can be joined by an adhesive between the ceramic barrier layer 2" of the one foil and the polymer barrier layer 2'" of the other foil to form the multilayer diffusion barrier 111.

[0080] Fig. 8b shows a cross-section of a modified multilayer diffusion barrier 112 in a plane perpendicular to the plane in which the multilayer diffusion barrier 112 extends. The multilayer diffusion barrier 112 is similar to the multilayer diffusion barrier 111. The multilayer diffusion barrier 112 can be used instead of the multilayer diffusion barrier 110. The multilayer diffusion barrier 112 comprises the polymer layer 1, the polymer barrier layer 2"', the ceramic barrier layer 2", and the metallic barrier layer 2' of the multilayer diffusion barrier 111. The multilayer diffusion barrier 112 comprises an additional polymer 1 below the metallic barrier layer 2'. The additional polymer layer 1 is made of PET. The polymer barrier layer 2"', the ceramic barrier layer 2", and the metallic barrier layer 2' are disposed between the two polymer layers 1 (the polymer layer 1 and the additional polymer layer 1). The order of the polymer barrier layer 2'" and the ceramic barrier layer 2" can be exchanged.

[0081] The multilayer diffusion barrier 112 can be formed by coextruding the polymer layer 1 and the polymer barrier layer 2"' to create a carrier foil. Then the ceramic barrier layer 2" is deposited onto the carrier foil to create a first foil. The first foil is joined by an adhesive to a second foil manufactured by depositing the metallic barrier layer 2' onto the polymer layer 1, which acts as a carrier layer. If the order of the polymer barrier layer 2'" and the ceramic barrier layer 2" is exchanged, a possible way to manufacture the multilayer diffusion barrier 112 is to join three separate foils by an adhesive, the three foils being: the polymer layer 1 on which the ceramic barrier layer 2" has been deposited, the polymer barrier layer 2"', and the polymer layer 1 on which the metallic barrier layer 2' has been deposited.

[0082] The multilayer diffusion barrier 111 of Fig. 8a and the multilayer diffusion barrier 112 of Fig. 8b can be considered as separate foils (barriers), which can be combined to create a foil stack. For example, two or three or four or more of the foils (barriers) 111 or 112 can be joined in the foil stack to form a multilayer diffusion barrier. Combinations of foils (barriers) 111 and 112 are possible.

[0083] It is explicitly stated that all features disclosed in the description and/or the claims are intended to be disclosed separately and independently from each other for the purpose of original disclosure as well as for the purpose of restricting the claimed invention independent of the composition of the features in the embodiments and/or the claims. It is explicitly stated that all value ranges or indications of groups of entities disclose every possible intermediate value or intermediate entity for the purpose of original disclosure as well as for the purpose of restricting the claimed invention, in particular as limits of value ranges.

Claims

1. Spacer (100; 200; 300; 400; 500; 600; 700) for an insulating glazing unit comprising at least two glazing panes (151, 152) and an intervening space (153) between the same, the spacer (100; 200; 300; 400; 500; 600; 700) being adapted to be positioned in the intervening space (153) and comprising a spacer body (120) extending in a longitudinal direction (Z) and made of plastic material and a multilayer diffusion barrier (110) disposed on the spacer body (120), wherein
   the multilayer diffusion barrier (110) comprises at least two polymer layers (1) and at least two barrier layers (2),
   each of the barrier layers (2) is made of metallic material or ceramic material, and
   a thickness of at least one of the barrier layers (2) is equal to or less than 9 nm.

2. Spacer (100; 200; 300; 400; 500; 600; 700) according to claim 1, wherein the thicknesses of two or more or each of the barrier layers (2) are each equal to or less than 9 nm.

3. Spacer (100; 200; 300; 400; 500; 600; 700) according to claim 1 or 2, wherein two neighbouring ones of the at least two polymer layers (1) are separated by a barrier layer (2).

4. Spacer (100; 200; 300; 400; 500; 600; 700) according to any of the preceding claims, wherein the thickness of each barrier layer (2) is equal to or larger than 2.2 nm.

5. Spacer (100; 200; 300; 400; 500; 600; 700) according to any of the preceding claims, wherein
   the multilayer diffusion barrier (110) comprises at least two foils (10, 20),
   each foil (10, 20) consists of one of the at least two polymer layers (1) coated on one or on both sides with one of the at least two metallic or ceramic barrier layers (2), and
   the at least two foils are joined by an adhesive (3) in-between.

6. Spacer (100; 200; 300; 400; 500; 600; 700) according to any of the preceding claims, wherein the spacer body (120) comprises, seen in a cross-section (X-Y) perpendicular to the longitudinal direction (Z), a hollow chamber (105).

7. Spacer (100; 200; 300; 400; 500; 600; 700) according to any of the preceding claims, wherein
   the spacer body (120) comprises an inner wall (101)

adapted to face the intervening space (153) between the two glazing panes (151, 152) of the insulation glazing unit, an outer wall (102) on the side opposite to the inner wall (101), and two side walls (103, 104) that are essentially perpendicular to the inner and outer walls (101, 102) and connect the inner and outer walls (101, 102), and
the multilayer diffusion barrier (110) is disposed on the outer wall (102) and optionally on at least parts of the side walls (103, 104).

8. Spacer (100; 200; 300; 400; 500; 600; 700) according to any of the preceding claims, wherein the spacer (100; 200; 300; 400; 500; 600; 700) is adapted to be cold-bendable.

9. Spacer (100; 200; 300; 400; 500; 600; 700) according to any of the preceding claims, wherein an outermost layer of the multilayer diffusion barrier (110) facing away from the spacer body (120) is a metallic barrier layer (2).

10. Spacer (100; 200; 300; 400; 500; 600; 700) according to any of the preceding claims, wherein the multilayer diffusion barrier (110) comprises at least three barrier layers (2) each having a maximum thickness of 9 nm.

11. Spacer (100; 200; 300; 400; 500; 600; 700) according to any of the preceding claims, wherein
the plastic material of the spacer body (120) is selected from a group comprising polyethylene (PE), polycarbonate (PC), polypropylene (PP), polystyrene, polybutadiene, polynitrile, polyester, polyurethane, polymethylmetacrylate, polyacrylate, polyamide, polyethylenterephthalate (PET), polybutylenterephthalate (PBT), acrylonitrile-butadiene-styrene (ABS), acrylic ester-styrene-acrylonitrile (ASA), acrylonitrile-butadiene-styrene-polycarbonate (ABS/PC), styrene-acrylonitrile (SAN), PET/PC, PBT/PC, PMMA, PBT/PET, PP/PE, PVC, PC/ASA, PPE/PPO, and copolymers or mixtures thereof, which can each be formed partially or completely of bio materials formed of renewable resources, and
the spacer body (120) optionally comprises reinforcing fibers such as glass fibers, carbon fibers, aramid fibers, polyethylene fibers, natural fibers, basalt fibers, ceramic fibers, metal fibers, and/or reinforcing agents such as nanoparticles, mineral fillers, sheet silicates and layered silicates, metal powder, talkum and the like.

12. Spacer (100; 200; 300; 400; 500; 600; 700) according to any of the preceding claims, wherein the spacer body (120) comprises reinforcing elements selected from a group comprising tapes, strips, angled or flat sheets (107e, 108e), and/or wires (107c, 108c) of metal or a composite fiber-plastics material, fiber bundles, nets, films, L-shaped or U-shaped profiles (107a, 107b, 107d, 107f, 108a, 108b, 108d, 108f).

13. Spacer (100; 200; 300; 400; 500; 600; 700) for an insulating glazing unit comprising at least two glazing panes (151, 152) and an intervening space (153) between the same, the spacer (100; 200; 300; 400; 500; 600; 700) being adapted to be positioned in the intervening space (153) and comprising a spacer body (120) extending in a longitudinal direction (Z) and made of plastic material and a multilayer diffusion barrier (111; 112) disposed on the spacer body (120), wherein
the multilayer diffusion barrier (111; 112) comprises at least one polymer layer (1) and at least three barrier layers (2', 2", 2"'),
at least one of the barrier layers (2') is made of metallic material,
at least one of the barrier layers (2") is made of ceramic material, and
at least one of the barrier layers (2"') is made of ethylene vinyl alcohol.

14. Insulating glazing unit comprising a spacer (100; 200; 300; 400; 500; 600; 700) according to any one of the preceding claims.

15. Use of a foil stack comprising at least two foils (10, 20) as a multilayer diffusion barrier (110) of a spacer (100; 200; 300; 400; 500; 600; 700) for insulation glazing units, wherein each of the foils (10, 20) comprises a polymer layer (1) coated on one or on both sides with a metallic or ceramic layer (2),
a thickness of at least one of the metallic or ceramic layers (2) is equal to or less than 9 nm, and the foils (10, 20) are joined by an adhesive (3) in-between.

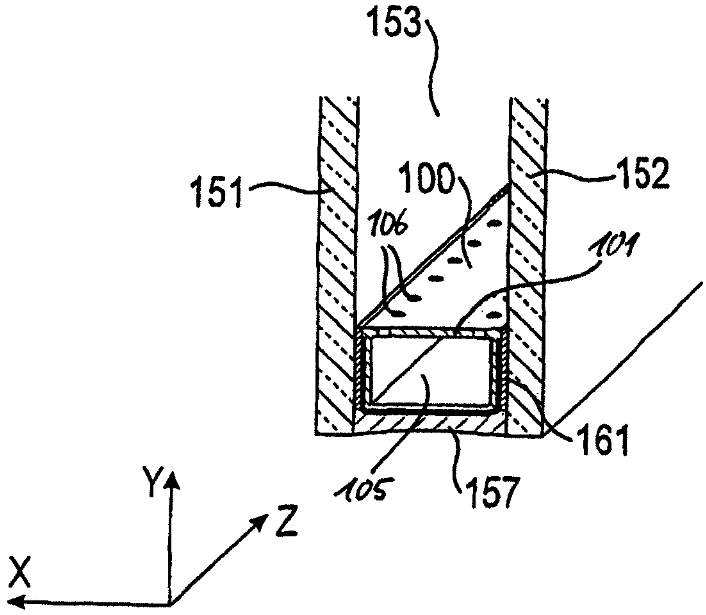


Fig. 1

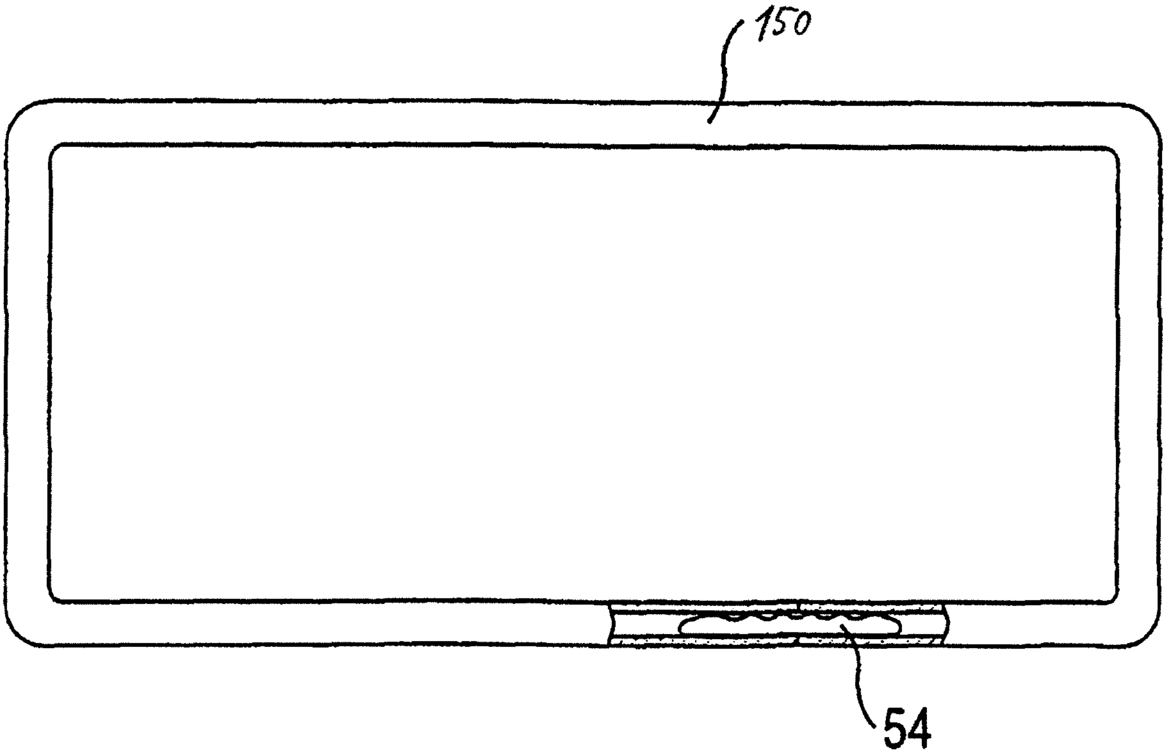
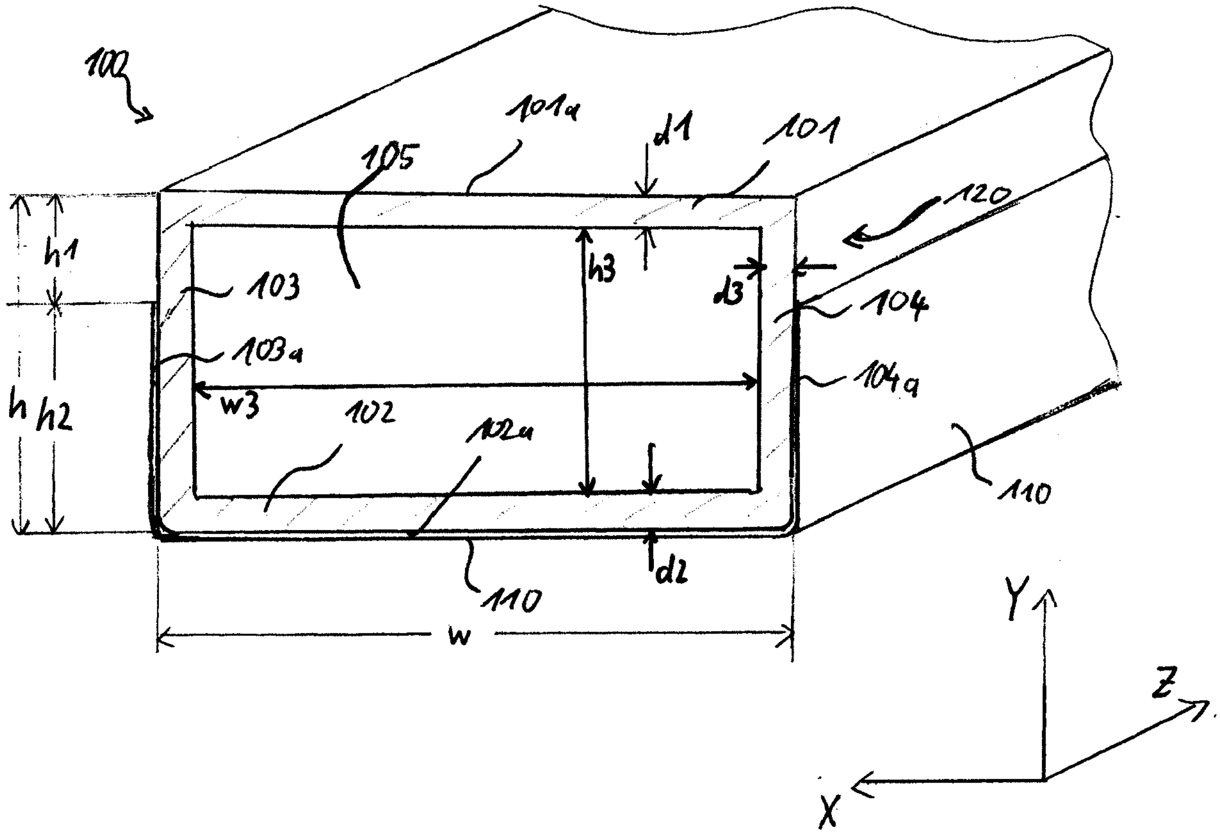


Fig. 2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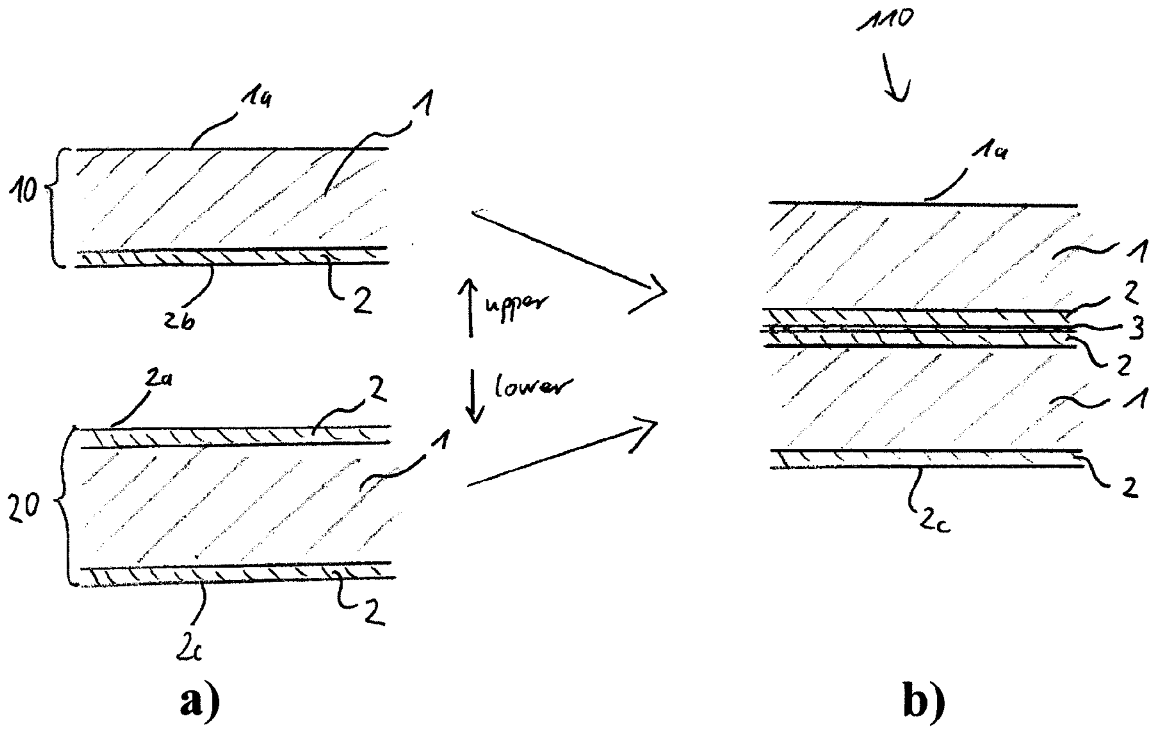
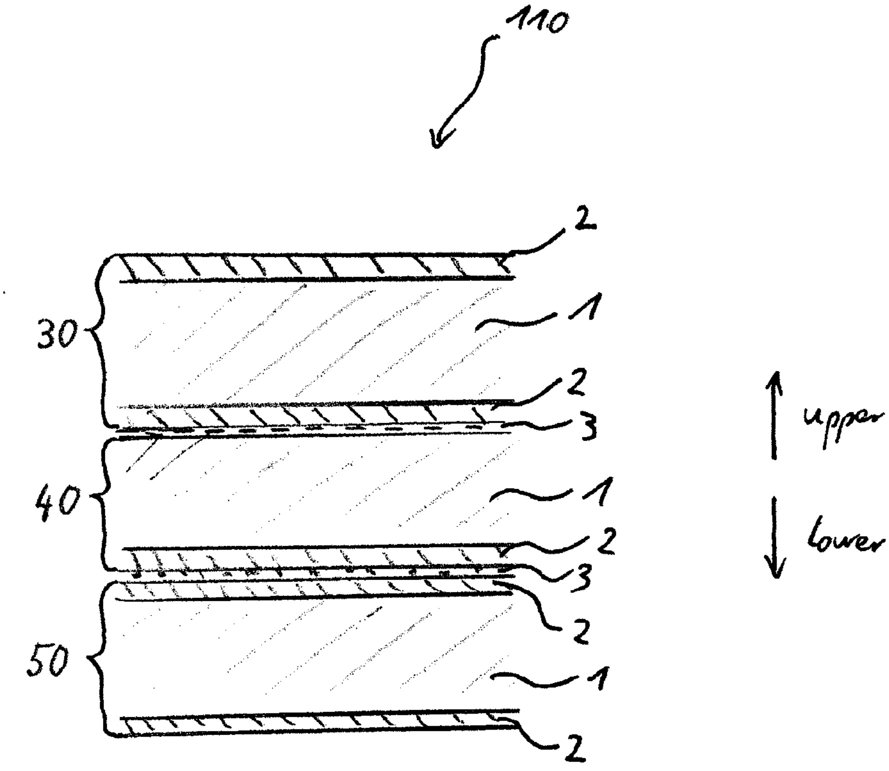
101a
d1
101
105
120
h1
h3
103
d3
104
103a
104a
h
h2
w3
102
102a
110
d2
110
w
Y
Z
X

Fig. 3



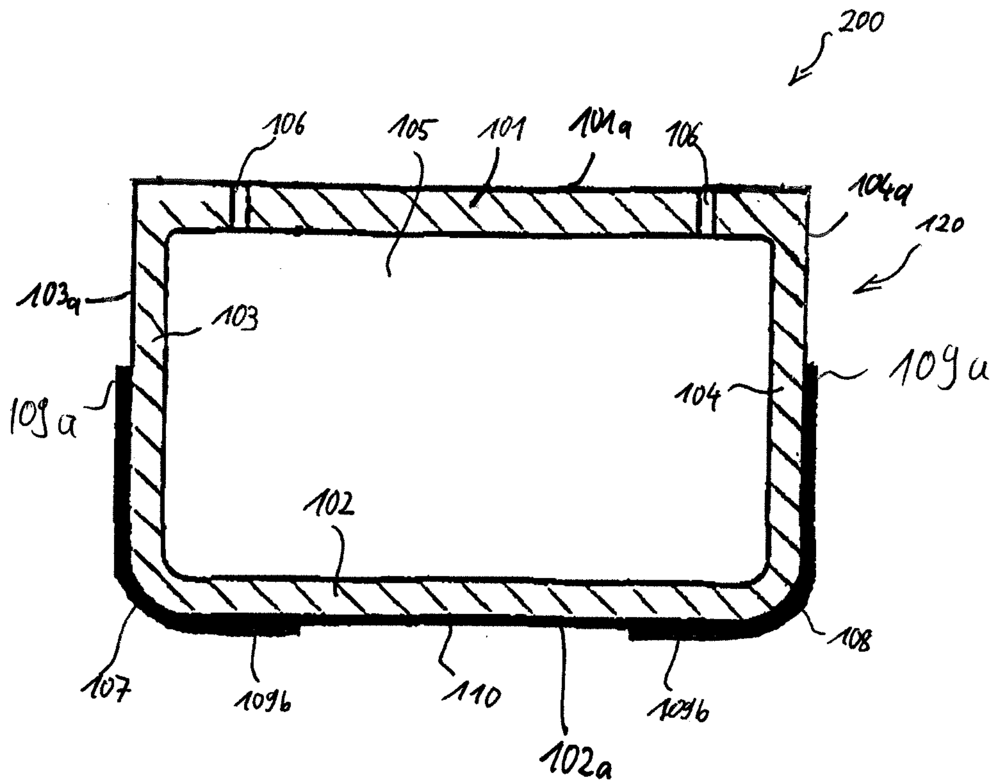
1a
1
10
2b
2
2a
2
20
1
2c
2
upper
lower
110
1a
1
2
3
2
1
2
2c
a)
b)

Fig. 4



110
2
30
1
2
3
40
1
2
3
2
50
1
2
upper
lower

Fig. 5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109a
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109b
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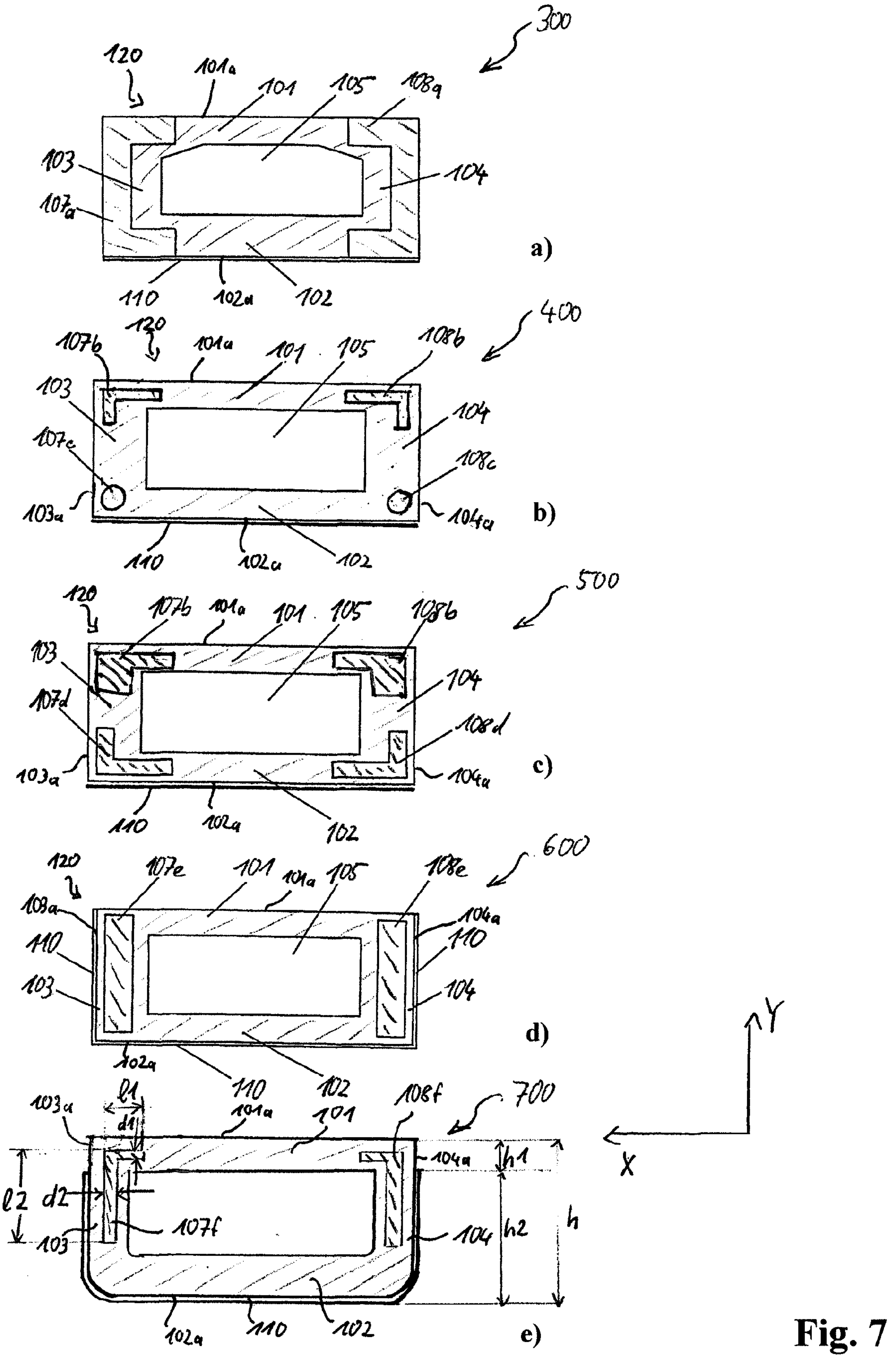
102a
109b
108

Fig. 6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101
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107a
110
102a
102
400
107b
108b
107c
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104a
500
107d
108d
600
107e
108e
700
108f
107f
l1
d1
l2
d2
h1
h2
h
Y
X

a)

b)

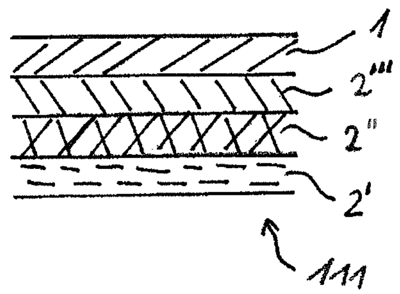
c)

d)

e)

Fig. 7

a)



b)

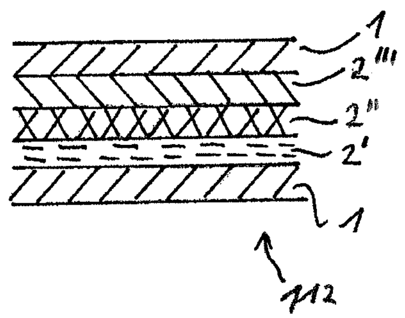


Fig. 8

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EUROPEAN SEARCH REPORT

Application Number
EP 16 16 8426

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X,D	WO 2013/104507 A1 (SAINT GOBAIN [FR]) 18 July 2013 (2013-07-18) * figures 1-3 * * page 3, line 16 - page 5, line 23 * * page 7, line 19 - page 9, line 13 *	13,14	
A	WO 2016/046081 A1 (SAINT GOBAIN [FR]) 31 March 2016 (2016-03-31) * figures 1,2,5 * * page 3, line 12 - page 6, line 35 * * page 11, line 15 - page 12, line 24 *	1-15	

TECHNICAL FIELDS SEARCHED (IPC)

E06B

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
The Hague	17 October 2016	Blancquaert, Katleen

CATEGORY OF CITED DOCUMENTS

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17-10-2016

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