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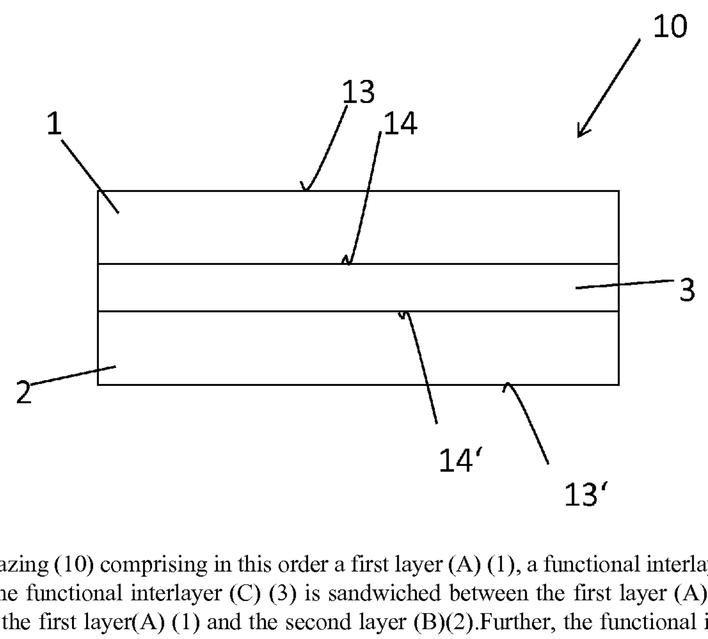
(54) Title: LAMINATED GLAZING, LIGHTING UNIT AND METHOD FOR PRODUCING A LAMINATED GLAZING

Fig. 1



(57) Abstract: A laminated glazing (10) comprising in this order a first layer (A) (1), a functional interlayer (C) (3) and a second layer (B) (2) is provided, wherein the functional interlayer (C) (3) is sandwiched between the first layer (A) (1) and the second layer (B) (2) and is arranged parallel to the first layer(A) (1) and the second layer (B)(2).Further, the functional interlayer (C)(3) comprises at least one organic luminescent colorant which is homogeneously distributed within the material forming the functional interlayer (C) (3). The first layer (A) (1) and the second layer (B) (2) are optically transparent layers produced in a float glass process having an air-side (14, 14') and a tin-side (13, 13') and the air-side (14) of the first layer (A) (1) and the air side (14') of the second layer (B) (2) are arranged such that they face towards the functional interlayer (C) (3). Further aspects of the invention relate to a lighting unit comprising a laminated glazing and to methods for producing a laminated glazing.

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Laminated glazing, lighting unit and method for producing a laminated glazing

Description

The invention relates to a laminated glazing comprising a composite structure of laminated layers comprising a first layer (A), a second layer (B) and an interlayer (C). Further aspects of the invention relate to a lighting unit comprising a laminated glazing and to methods for producing a laminated glazing.

Laminated safety glass, comprising sheets of glass and plastic, are used in areas where structural integrity after fracture is highly desired or required for safety reasons, especially but not exclusive in the fields of architectural glazing or automotive glazing.

The surface may be used for this purpose in illuminated form or in not illuminated form, where the illumination may be produced by suitable light sources. It is possible that the complete surface is illuminated, but it is also possible to apply pattern onto the surface. It is further possible to use different light sources, whereby for example colored or blocked lighting effects are produced. The surfaces may be used for example in buildings, furniture, cars, trains, planes and ships as well as in facades, skylights, glass roofs, stair treads, glass bridges, canopies and railings.

US 2015/308659 A1 concerns a glazing unit which includes sheets of glass and of plastic laminated between the glass sheets, and luminophores, wherein the glazing unit includes at least three glass sheets and at least two plastic films inserted in alternation between the glass sheets. The selection of at least three glass sheets associated with at least two intermediate films of plastic allows a three-dimensional image to be obtained.

US 2013/0252001 A1 concerns a laminated glazing for information display comprising an assembly of at least two transparent sheets of inorganic glass or of a strong organic material, joined together by an interlayer of a thermoformable material or by multilayer foils incorporating such interlayers, whereby said glazing being characterized in that a luminophore material of the hydroxyterephthalate type, combined with an antioxidant additive, is added into said interlayer by depositing the luminophore on the interlayer. Further, in US 2013/0252001 A1 a device for displaying an image on transparent glazing is disclosed, comprising a laminated glazing as mentioned before and a source generating concentrated UV radiation of the laser type.

Document DE 10 2014 015 695 A1 describes a laminated glazing having a pulyvinylbutyral interlayer comprising a luminophore. The interlayer is obtained by extruding a polymer melt comprising the luminophore. Lutetium aluminium garnet (LuAG) and a diluting agent are mixed with the polymer prior to extrusion.

WO 2007/023083 concerns a glass assembly comprising phosphorescent, luminescent substance and two outer cover glass parts, which are indirectly or directly connected, between which the luminescent substance is sandwiched.

The glass or lighting elements known in the prior art suffer from the drawback that the preparation of the lighting unit respectively the interlayer in the laminated glass is complicated, and the lighting units obtained are therefore expensive. When illuminated, glass sheets larger than 50 cm in one direction usually exhibit inhomogeneous color and light intensity due to light absorption and greenish color of glass sheets. Further, undesired light scattering in the laminated glass of known lighting elements is observed when the laminated glass comprises glass sheets produced in a float glass process.

It is an object of the present invention over the prior art to provide an improved glazing which may be used in a lighting unit and which allows distribution of light with desired light color and light intensity distribution.

It is a further object of the present invention to provide an improved laminated glazing which may be used in a lighting unit in which undesired scattering of light is avoided.

A laminated glazing comprising in this order a first layer (A), a functional interlayer (C) and a second layer (B), wherein the functional interlayer (C) is sandwiched between the first layer (A) and the second layer (B) and is arranged parallel to the first layer (A) and the second layer (B). Further, the functional interlayer (C) comprises at least one organic luminescent colorant which is homogeneously distributed within the material forming the functional interlayer (C). The first layer (A) and the second layer (B) are optically transparent layers produced in a float glass process having an air-side and a tin-side and the air-side of the first layer (A) and the air side of the second layer (B) are arranged such that they face towards the functional interlayer (C).

The laminated glazing may be prepared using lamination processes for producing laminated safety glasses which are known in the art. Especially the functional interlayer (C) is preferably based on layers usually used in laminated safety glasses. The functional interlayer (C) includes at least one luminous colorant which is homogeneously distributed in the material forming the functional interlayer (C). The provided laminated glazing may be combined with a light source in order to form a lighting unit. Such lighting units may be used in the architectural, e.g. buildings and furniture, or automotive or aeronautic field.

When used in a lighting unit, light may be coupled into the laminated glazing from at least one of the edges. Preferably, light is coupled into the laminated glazing such that the light exhibits internal reflection, especially total internal reflection. Light is partially absorbed and re-emitted by the luminous coating. The luminous coating emits the light at arbitrary angles, thus allowing the re-emitted light to exit the laminated glazing. By use of the luminous coating the light is intentionally scattered so that the re-emitted light does not exhibit total internal reflection.

First layer (A) and second layer (B)

The material of the first layer (A) and the material of the second layer (B) are optically transparent layers obtained by means of a float glass process. In a float glass process, molten glass material floats on a bed of molten metal, typically tin. The side of the glass material which has faced the bed of molten metal is called tin-side and the opposite side is called air-side. A small quantity of the metal diffuses into the glass material and forms impurities which may scatter light. Tin impurities in float glass may be easily detected by shining short wavelength (for example 254 nm) UV light onto the glass surface. The tin-side fluoresces under UV-light wherein the air-side does not.

It has been found that undesired scattering of light in the glazing unit of the present invention is reduced by laminating the functional interlayer (C) to the air-side of the first layer (A) and to the air-side of the second layer (B), respectively.

The material for the first layer (A) and/or the second layer (B) is preferably selected from the group comprising low-iron glass, glass with an optical transmission >90%, heat strengthened glass and chemically strengthened glass. Suitable low iron float glass is available under the trade names e.g. Pilkington Optiwhite, Guardian UltraClear Float Glass, SGG Planiclear, SGG Diamont.

Low-iron glass or “white glass” is a type of high-clarity glass that is made from silica with very low amounts of iron. This low level of iron removes the greenish-blue tint that can be seen especially on larger and thicker sizes of normal glass. Low-iron glass has a low iron content of less than 500 ppm (0.05%), preferably less than 200 ppm (0.02%) and especially preferred less than 100 ppm (0.01%).

Optionally, the first layer (A) and/or the second layer (B) is coated with at least one functional layer. The functional layer is preferably a color effect coating, low-emissivity (low-e) coating, sun-protection coating, metal coating, metal oxide coating or any other coating. Preferably, the coating is located on the surface facing away from the functional interlayer (C). Thus, the coating is preferably applied to the tin-side of the first layer (A) and/or of the second layer (B).

The layer thickness of the first layer (A) is preferably 0.1 to 50 mm, more preferably 0.5 to 30 mm, most preferably 1.5 to 12 mm.

The layer thickness of the second layer (B) is preferably 0.1 to 50 mm, more preferably 0.5 to 30 mm, most preferably 1.5 to 12 mm.

The first layer (A) and/or second layer (B) might have an additional imprint.

An additional film might be located on the first layer (A) and/or (B). The film might be imprinted, having a certain optical transparency e.g. but not limited to for advertisements using the invention as backlight.

The light transmission of the first layer (A) and/or the second layer (B) is preferably at least 30%, preferably 30% to 100%, more preferably at least 50%, even more preferably 50% to 100%, most preferably at least 80%, even more most preferably 90% to 100%. The light transmission is preferably determined as light transmission TL for visible light based on EN 410:2011. The wavelength of visible light is from 380 nm to 780 nm.

It is possible that not the complete first layer (A) and/or second layer (B) is optically transparent, but only a part of layer (A) and/or (B). Further, it is possible that only the first layer (A) is optically transparent and the second layer (B) is opaque.

Suitable examples for an opaque second layer (B) include polished glass (metal coated glass), a metal foil, a metal sheet or frosted glass, respectively partially frosted glass.

It is also possible that the transparency is wavelength sensitive, i.e. optically transparent also means that the light transmission mentioned before is only for yellow light or only for green light or only for red light or only for blue light, but the light transmission is lower for light of other wavelengths. This is for example the case when first layer (A) and/or second layer (B) is a wavelength sensitive glass, for example a toned glass layer. It is also possible to use wavelength sensitive polymer layers, for example toned polymer layers.

At least one of the first layer (A) or second layer (B) may comprise one or more functional features like a coating or printing for decorative or informative purposes, a sensor element for pressure (touch panel), heat, light, humidity, pH-value -for example to switch the light source-, or an integrated solar cell or a solar cell foil, for example for power supply of the light source. The first layer (A) and the second layer (B) usually have independently of each other a thickness of 0.1 to 50 mm, preferably 0.5 to 30 mm, more preferably 1.5 to 12 mm.

The area of the first layer (A) and second layer (B) may be the same or different and is preferably the same. The area is usually 0.05 to 25 m^2, preferably 0.08 to 15 m^2, more preferably 0.09 to 10 m^2.

At least one dimension of first layer (A) and second layer (B) is usually 0.1 to 10 m, preferably 0.25 to 5 m, more preferably 0.3 to 3 m.

Functional interlayer (C)

The functional interlayer (C) is arranged between the first layer (A) and the second layer (B) and is arranged parallel to the first layer (A) and second layer (B). At least one organic luminescent colorant is homogeneously distributed within the material forming the functional interlayer (C).

Additionally, the functional interlayer (C) may comprise additives such as stabilizers, UV-light absorbers, IR-light absorbers, flame retardants, plasticizers and inorganic particles.

Suitable stabilizers include radical stabilizers and light stabilizers. Examples for suitable inorganic particles include TiO_2 particles, SnO particles and $CaCO_3$ particles.

The material of the functional interlayer (C) may be any material which is useful in laminated glass. Therefore, suitable materials for the functional interlayer (C) are known by a person skilled in the art. The advantage of the present invention is that material for the first layer (A), second layer (B), and functional interlayer (C) may be used which are usually employed in laminated glass.

Preferably, the functional interlayer (C) is based on an ionomer (ionoplast), polymethlymethacrylate (PMMA), acid copolymers of α-olefins and α,β-ethylenically unsaturated carboxylic acids, ethylene vinyl acetate (EVA), polyvinyl acetal (for example poly(vinylbutyral)) (PVB), including acoustic grades of poly(vinyl acetal), thermoplastic polyurethane (TPU), polyethylenes (for example metallocene-catalyzed linear low density polyethylenes), polyolefin block elastomers, ethylene acrylate ester copolymers (for example poly(ethylene-co-methyl-acrylate) and poly(ethylene-co-butyl acrylate)), silicone elastomers, epoxy resins and mixtures thereof.

Suitable ionomers are derived from acid copolymers. Suitable acid copolymers are copolymers of α-olefins and α,β-ethylenically unsaturated carboxylic acids having 3 to 8 carbon atoms. The acid copolymers usually contain at least 1% by weight of α,β-ethylenically unsaturated carboxylic acids based on the total weight of the copolymers. Preferably, the acid copolymers contain at least 10% by weight, more preferably 15% to 25% by weight and most preferably 18% to 23% by weight of α,β-ethylenically unsaturated carboxylic acids based on the total weight of the copolymers.

The α-olefins mentioned before usually comprise 2 to 10 carbon atoms. Preferably, the α-olefins are selected from the group consisting of ethylene, propylene, 1-butene, 1-pentene, 1-heptene, 1-hexene, 3-methyl1-butene, 4-methyl-1-pentene and mixtures thereof. More preferably, the α-olefin is ethylene. The α,β-ethylenically unsaturated carboxylic acids are preferably selected from the group consisting of acrylic acid, methacrylic acid, itaconic acid, maleic acid, maleic anhydride, fumaric acid, monomethyl maleic acid and mixtures thereof, preferably acrylic acid, methacrylic acid and mixtures thereof.

The acid copolymers may further contain other unsaturated copolymers like methyl acrylate, methyl methacrylate, ethyl acrylate, ethyl methacrylate, propyl acrylate, propyl methacrylate, isopropyl acrylate, isopropyl methacrylate, butyl acrylate, butyl methacrylate, isobutyl acrylate, isobutyl methacrylate, tert-butyl acrylate, tert-butyl methacrylate, octyl acrylate, octyl methacrylate, undecyl acrylate, undecyl methacrylate, octadecyl acrylate, octadecyl methacrylate, dodecyl acrylate, dodecyl methacrylate, 2-ethyl hexyl acrylate, 2-ethyl hexyl methacrylate, isobornyl acrylate, isobornyl methacrylate, lauryl acrylate, lauryl methacrylate, 2-hydroxy ethyl acrylate, 2-hydroxy ethyl methacrylate, glycidyl acrylate, glycidyl methacrylate, poly(ethylene glycol) acrylate, polyethylene glycol (meth)acrylate, poly(ethylene glycol) methylether acrylate, poly(ethylene glycol) methylether methacrylate, poly(ethylene glycol) ether methacrylate, poly(ethylene glycol)behenyl ether acrylate, poly(ethylene glycol)behenyl ether methacrylate, poly(ethylene glycol)4-nonylphenylether acrylate, poly(ethylene glycol)4-nonylphenylether methacrylate, poly(ethylene glycol)phenyl ether acrylate, poly(ethylene glycol)phenyl ether methacrylate, dimethyl maleate, diethyl maleate, dibutyl maleate, dimethyl fumarate, diethyl fumarate, dibutyl fumarate, dimenthyl fumarate, vinyl acetate, vinyl propionate, and mixtures thereof. Preferably, the other unsaturated comonomers are selected from the group consisting of methyl acrylate, methyl methacrylate, butyl acrylate, butyl methacrylate, glycidyl methacrylate, vinyl acetate and mixtures thereof. The acid copolymers may comprise up to 50% by weight, preferably up to 30% by weight, more preferably up to 20% by weight of other unsaturated copolymers, based on the total weight of the copolymer.

The preparation of the acid copolymers mentioned before is known in the art and described for example in US 3,404,134, US 5,028,674, US 6,500,888, and US 6,518,635.

To obtain the ionomers, the acid copolymers are partially or fully neutralized with metallic ions. Preferably, the acid copolymers are 10% to 100%, more preferably 10% to 50%, most preferably 20% to 40% neutralized with metallic ions, based on the total number of moles of carboxylate groups in the ionomeric copolymer. The metallic ions may be monovalent, divalent, trivalent or multivalent or mixtures of said metallic ions. Preferable monovalent metallic ions are sodium, potassium, lithium, silver, mercury, copper and mixtures thereof. Preferred divalent metallic ions are beryllium, magnesium, calcium, strontium, barium, copper, cadmium, mercury, tin, lead, iron, cobalt, nickel, zinc, and mixtures thereof. Preferred trivalent metallic ions are aluminum, scandium, iron, yttrium and mixtures thereof. Preferred multivalent metallic ions are titanium, zirconium, hafnium, vanadium, tantalum, tungsten, chromium, cerium, iron and mixtures thereof. It is preferred that when the metallic ion is multivalent, complexing agents, such as stearate, oleate, salicylate and phenylate radicals are included (see US 3,404,134). More preferred metallic ions are selected from the group consisting of sodium, lithium, magnesium, zinc, aluminum and mixtures thereof. Furthermore preferred metallic ions are selected from the group consisting of sodium, zinc and mixtures thereof. Most preferred is zinc as a metallic ion. The acid copolymers may be neutralized as disclosed for example in US 3,404,134.

The ionomers usually have a melt index (MI) of, less than 10 g/10 min, preferably less than 5 g/10 min, more preferably less than 3 g/10 min as measured at 190 °C by ASTM method D1238. Further, the ionomers usually have a flexural modulus, greater than 40000 psi, preferably greater than 50000 psi, more preferably greater than 60000 psi, as measured by ASTM method D638.

The ionomer resins are typically prepared from acid copolymers having a MI of less than 60 g/10 min, preferably less than 55 g/10 min, more preferably less than 50 g/10 min, most preferably less than 35 g/10 min, as determined at 190 °C by ASTM method D1238.

Suitable ionomers are mentioned in US 8,080,726 B2.

Preferably, the functional interlayer (C) is based on an ionomer, whereby preferred ionomers are mentioned before, polyvinylbutyral (PVB), polyvinylacetal, ethylene-vinylacetate (EVA), ethylene/vinylalcohol/vinylacetal copolymer and epoxy pouring resins. Commercial materials for the functional interlayer (C) are Trosifol®, Butacite®, Saflex®, S-Lec®, and SentryGlas®.

The thickness of the functional interlayer (C) is usually from 0.05 mm to 10 mm, more preferably from 0.2 mm to 6 mm, most preferably from 0.3 mm to 5 mm.

Preferably, the functional interlayer (C) is formed as a single layer wherein the at least one organic luminescent colorant is homogeneously distributed within the material forming the functional interlayer (C).

Preferably, the functional interlayer (C) is a laminate comprising at least two layers, wherein the at least one organic luminescent colorant is homogeneously distributed within the layers forming the functional interlayer (C). The material of each of the layers of the laminate may be selected independently from materials suitable in laminated glass. In particular, the materials disclosed for the functional interlayer (C) are suitable. The material of the at least two layers may be chosen such that each layer is made from a different material. Alternatively, two or more layers of the same material may be used.

The area of the functional interlayer (C) may be identical with or different from the area of the first layer (A) and/or second layer (B). Preferably, the area of layers (A), (B) and functional interlayer (C) are identical. Suitable areas for the functional interlayer (C) are the same as mentioned for layers (A) and (B). The functional interlayer (C) may be comprised by several pieces of functional interlayer of smaller area, tiled side-by-side to be combined to become one larger functional interlayer.

Organic luminous colorant

Suitable luminescent colorants are selected from organic luminescent colorants, whereby luminescent means fluorescent or phosphorescent.

Suitable organic luminescent colorants are in principle all organic dyes or pigments which can absorb light of a particular wavelength and convert it to light of another wavelength, which can be dissolved or distributed homogeneously in a polymeric matrix, and which have sufficient stability to thermal and radiative stress. Preferred organic pigments are, for example, perylene pigments.

Typically, suitable organic pigments have a mean particle size to DIN 13320 of 0.01 to 10 µm, preferably 0.1 to 1 µm.

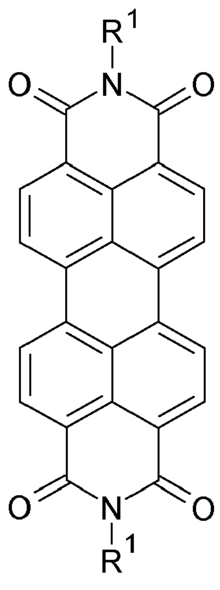
Suitable organic fluorescent dyes fluoresce in the visible range of the spectrum and are, for example, the green-, orange- or red-fluorescing fluorescent dyes listed in the Colour Index. Preferred organic fluorescent dyes are functionalized naphthalene or rylene derivatives.

Preferred naphthalene derivatives are green-, orange- or red-fluorescing fluorescent dyes comprising a naphthalene unit. Preference is further given to naphthalene derivatives which bear one or more substituents selected from halogen, cyano, benzimidazole, or one or more radicals bearing carbonyl functions. Suitable carbonyl functions are, for example, carboxylic esters, dicarboximides, carboxylic acids, carboxamides. Preferred rylene derivatives comprise a perylene unit. A preferred embodiment relates to green-, orange- or red-fluorescing perylenes.

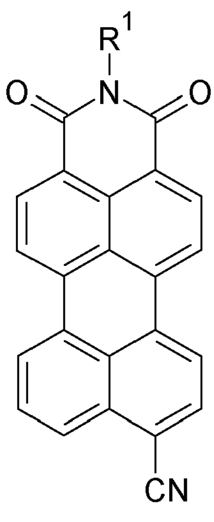
Preference is given to perylene derivatives which bear one or more substituents selected from halogen, cyano, benzimidazole, or one or more radicals bearing carbonyl functions. Suitable carbonyl functions are, for example, carboxylic esters, carboximides, carboxylic acids, carboxamides

Preferred perylene derivatives are, for example, the perylene derivatives specified in WO2007/006717 on page 1 , line 5 to page 22, line 6.

In a particularly preferred embodiment, suitable organic fluorescent dyes are perylene derivatives selected from Formulae II to VI



II



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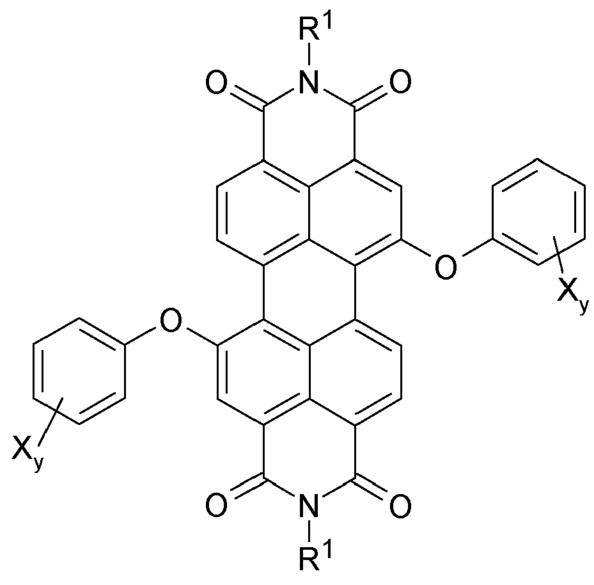

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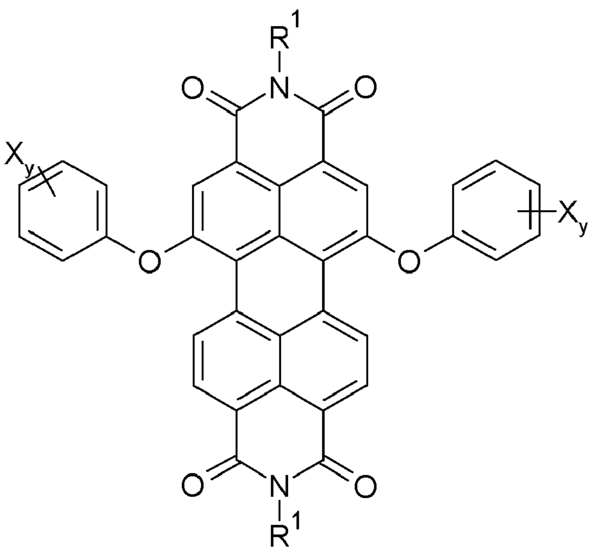
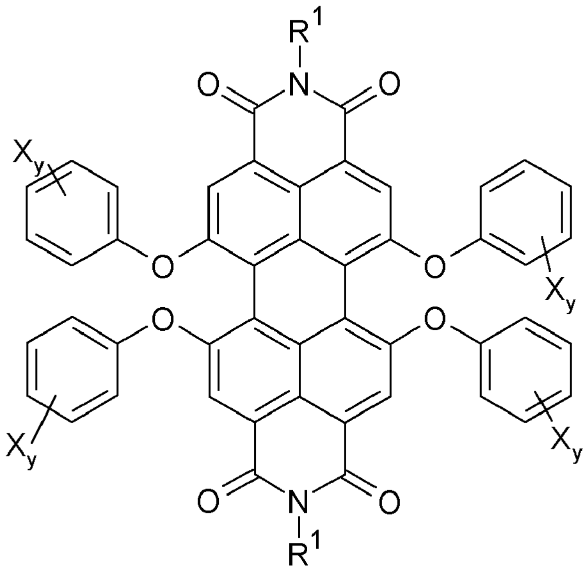


V



VI

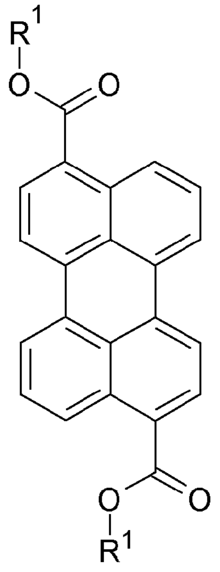
where R^1 is a linear or branched C_1-C_{18} alkyl radical, a C_4-C_8 cycloalkyl radical which may be mono- or polysubstituted by halogen or by linear or branched C_1-C_{18} alkyl, or phenyl or naphthyl, where phenyl and naphthyl may be mono- or polysubstituted by halogen or by linear or branched C_1-C_{18} alkyl. In one embodiment, R^1 in Formulae II to VI represents compounds with what is called swallowtail substitution, as specified in WO 2009/037283 A1 at page 16 line 19 to page 25 line 8. In a preferred embodiment, R^1 is a 1-alkylalkyl, for example 1-ethylpropyl, 1-propylbutyl, 1-butylpentyl, 1-pentylhexyl or 1-hexylheptyl. In Formulae II to VI, X represents substituents in the ortho and/or para position. X is preferably linear or branched C_1 to C_{18} alkyl. "y" indicates the number of substituents X. "y" is a number from 0 to 3. More preferably, R^1 in Formulae II to VI is 2,4-di(tert-butyl)phenyl or 2,6-disubstituted phenyl, especially preferably 2,6-diphenylphenyl, 2,6-diisopropylphenyl. Especially preferably, X is tert-butyl in the ortho/para position and/or secondary alkyl, especially isopropyl, in the ortho positions or phenyl in the ortho positions.

According to a specific aspect of this embodiment, the organic fluorescent dyes are selected from N,N'-bis(2,6-diisopropylphenyl)-1 ,6-di(2,6-diisopropylphenoxy)-perylene-3,4:9,10- tetracarboximide, N,N'-bis(2,6-diisopropylphenyl)-1 ,7-di(2,6-diisopropylphenoxy)-perylene- 3,4:9,10-tetracarboximide and mixtures thereof.

According to a further specific aspect of this embodiment, the organic fluorescent dye is N-(2,6-di(isopropyl)phenyl)perylene-3,4-dicarboxylic monoimide.

A further preferred fluoresecent dye is a dye of the Formula VI, e.g. N,N'-bis(2,6- diisopropylphenyl)-1 ,6,7,12-tetraphenoxyperylene-3,4:9,10-tetracarboxdiimide (Lumogen® Red 300).

In a further particularly preferred embodiment, suitable organic fluorescent dyes are perylene derivatives selected from Formulae VII to X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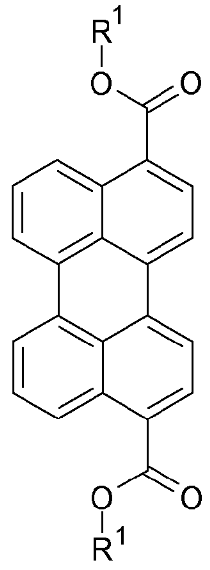
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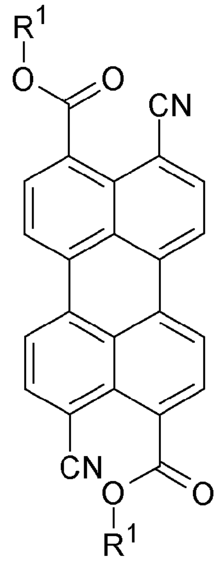
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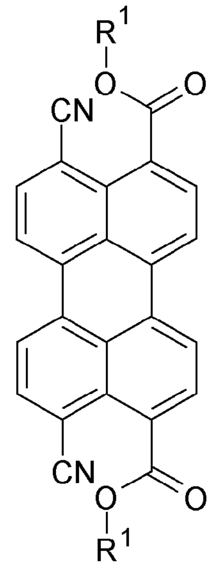

X

where R^1 in Formulae VII to X is a linear or branched C_1-C_{18} alkyl radical, a C_4-C_8 cycloalkyl radical which may be mono- or polysubstituted by halogen or by linear or branched C_1-C_{18} alkyl, or phenyl or naphthyl, where phenyl and naphthyl may be mono- or polysubstituted by halogen or by linear or branched C_1-C_{18} alkyl.

In one embodiment, R^1 in Formulae VII to X represents compounds with what is called swallow-tail substitution, as specified in WO 2009/037283 A1 at page 16 line 19 to page 25 line 8. In a preferred embodiment, R^1 is a 1-alkylalkyl, for example 1-ethylpropyl, 1-propylbutyl, 1-butylpentyl, 1-pentylhexyl or 1-hexylheptyl.

Especially preferably, R^1 in Formulae VII to X is linear or branched C_1 to C_{18} alkyl, especially n-butyl, sec-butyl, 2-ethylhexyl. Especially preferably, R^1 in Formulae VII to X is also isobutyl.

According to a specific aspect of this embodiment, the organic fluorescent dyes are selected from 3,9-dicyanoperylene-4,10-bis(sec-butyl carboxylate), 3,10-dicyanoperylene-4,9-bis(sec-butyl carboxylate) and mixtures thereof.

According to a further specific aspect of this embodiment, the organic fluorescent dyes are selected from 3,9-dicyanoperylene-4,10-bis(isobutyl carboxylate), 3,10-dicyanoperylene-4,9-bis(isobutyl carboxylate) and mixtures thereof.

Further preferred fluorescent dyes are Disperse Yellow 199, Solvent Yellow 98, Disperse Yellow 13, Disperse Yellow 1 1 , Disperse Yellow 239, Solvent Yellow 159.

In a preferred embodiment, the at least one organic fluorescent colorant is selected from N,N'-bis(2,6-diisopropylphenyl)-1 ,7-di(2,6-diisopropylphenoxy)perylene-3,4:9,10-tetracarboxdiimide, N,N'-bis(2,6-diisopropylphenyl)-1 ,6-di(2,6-diisopropylphenoxy)perylene-3,4:9,10- tetracarboxdiimide, 3,9-dicyanoperylene-4,10-bis(sec-butyl carboxylate), 3,10-dicyanoperylene- 4,9-bis(sec-butyl carboxylate), 3,9-dicyanoperylene-4,10-bis(isobutyl carboxylate), 3,10- dicyanoperylene-4,9-bis(isobutyl carboxylate), N-(2,6-di(isopropyl)phenyl)perylene-3,4- dicarboxylic monoimide and mixtures thereof.

In a preferred embodiment, the at least one luminescent colorant comprises at least two different organic fluorescent dyes. For example, a green-fluorescing fluorescent dye can be combined with a red-fluorescing fluorescent dye. Green-fluorescing fluorescent dyes are understood to mean especially those yellow dyes which absorb blue light and emit green or yellow-green fluorescent light. Suitable red dyes absorb either the blue light of the LED directly or absorb the green light emitted by other dyes present, and transmit red fluorescent light.

In a less preferred embodiment, the at least one luminescent colorant comprises only a single organic fluorescent dye, for example an orange fluorescent dye.

According to the invention, the at least organic luminescent colorant is embedded in the material forming the functional interlayer. The material of the functional interlayer serves as matrix material for the at least one luminescent colorant.

When the organic fluorescent colorants are pigments, these are homogeneously dispersed in the matrix. Organic fluorescent dyes may be present either dissolved in the matrix or as a homogeneously distributed mixture. The organic fluorescent dyes are preferably present dissolved in the matrix.

Adhesion promoter

Preferably, the side of the first layer (A) and/or the side of the second layer (B) which is in contact with the functional interlayer (C) is treated with an adhesion promoter. The use of an adhesion promoter is especially preferred when the functional interlayer (C) is based on an ionomer (ionoplast).

The first layer (A) and/or the second layer (B) are obtained by means of a float glass process. It is preferred to apply an adhesion promoter to the air-side of the first layer (A) and/or the air-side of the second layer (B), respectively. The use of an adhesion promoter for lamination of an interlayer based on an ionomer is usually not required if a float glass is used and the interlayer is laminated to the tin-sides of the glass layers. In laminated safety glass known in the art the used float glass sheets are thus arranged such that the tin-sides face the interlayer in order to avoid the use of an adhesion promoter.

A suitable adhesion promoter for lamination of a functional interlayer (C) based on an ionomer such as SentryGlas® is based on gamma-aminopropyltriethoxysilane as active ingredient. For application of the adhesion promoter to a float glass layer, the active ingredient is preferably used in a solution comprising as further components 2-propanol, water and acetic acid. The adhesion promoter solution may for example be applied by spraying the solution onto the surface and subsequently drying the surface.

Preferably, the laminated glazing consists of in this order a first layer (A), a functional interlayer (C) and a second layer (B).

Alternatively, the laminated glazing comprises in this order a first layer (A) a functional interlayer (C) and a second layer (B) and further comprises at least one support layer which is laminated to the first layer (A) or the second layer (B) by means of an additional interlayer. A laminated glazing consisting of in this order a first layer (A) a functional interlayer (C) and a second layer (B) may be used as an intermediate product wherein the at least one support layer is laminated to either the first layer (A) or the second layer (B) by means of the additional interlayer. In a preferred embodiment, two support layers are used wherein a first support layer is laminated to the tin-side of the first layer (A) using a first interlayer und a second support layer is laminated to the tin-side of the second layer (B) using a second interlayer.

The at least one support layer is preferably selected from a transparent polymer, a glass, especially glass produced in a float glass process, metals, or a combination of at least two of these materials. The materials described with respect to the first layer (A) and the second layer (B) are suitable materials for the at least one support layer. In case of the second support layer, the material may also be selected from an opaque material such as, for example polished glass (metal coated glass), a metal foil, a metal sheet or frosted glass, respectively partially frosted glass. Further, non-transparent polymer layers may be used.

The transparent polymer is preferably selected from the group comprising PVC (polyvinylchloride), PMMA (polymethyl methacrylate), PC (polycarbonate), PS (polystyrene), PPO (polypropylene oxide), PE (polyethylene), LDPE (low density polyethylene), LLDPE (linear low density polyethylene), PEN (polyethylene naphthalate), PP (polypropylene), LDPP (low density polypropylene), PET (polypropylene terephthalate), glycol modified polyethylene terephthalate, PES (polyether sulfones), PI (polyimides) and mixtures thereof.

A suitable PMMA is commercially available under the trade name Plexiglas.

The materials described with respect to the functional interlayer (C) are also suitable for use with the at least one additional interlayer.

Preferably the at least one support layer is laminated to the tin-side of the first layer (A) and/or to the tin-side of the second layer (B).

Preferably, the at least one support layer has a color effect coating, low-emissivity (low-e) coating, sun-protection coating, metal coating, metal oxide coating or any other coating. If the material of the support layer is a material produced in a float glass process it is preferred to apply the coating to the air-side of the support layer.

Lighting unit

A further aspect of the invention is providing a lighting unit comprising one of the described laminated glazings and at least one light source.

The at least one light source is preferably arranged at the edge of the laminated glazing such that light emitted by the at least one light source is coupled into the laminated glazing. This means that the at least one light source is preferably arranged in a way that the radiation is irradiated parallel to the functional interlayer (C). Preferably, the at least one light source is arranged in the middle of the total height of the laminated glazing.

If the laminated glazing is of a rectangular shape, the at least one light source may be arranged at one of the four edges of the laminated glazing. Preferably, the lighting unit comprises at least two light sources which are preferably arranged at opposing edges of the laminated glazing.

In the case that more than one light source is employed and more than one light source is arranged on the same edge of the laminated glazing, the light sources are preferably arranged in a line preferably with identical distance to the layers of the laminated glazing.

The number of light sources usually depends on the desired luminous intensity and the efficiency of the light source and the area of the laminated glazing.

In the case that the light sources are arranged at two edges of the laminated glazing opposite to each other, it is possible to reduce inhomogeneities for example because of light absorption in the layers of the laminated glazing.

Additionally or alternatively, the at least one light source is arranged such that the light emitted by the at least one light source is incident on one of the major surfaces of the laminated glazings at an angle of from 0° and 90° with respect to the surface normal, wherein an angle of from 45 to 90° is preferred and an angle of incidence parallel to the surface normal is especially preferred. The major surfaces of the glazings are the two surfaces with the largest surface area.

The at least one light source may be any light source known by a person skilled in the art as useful for lighting units.

Preferably, the light source is selected from the group consisting of LEDs (light emitting diode), OLEDs (organic light emitting diode), laser and gas-discharge lamps. Preferably, the light source is selected from the group consisting of LEDs and OLEDs, more preferred are LEDs.

Preferred light sources show a low power consumption, a low mounting depth and very flexible wavelength ranges, which can be chosen depending on the necessity (a small wavelength range or a broad wavelength range).

Suitable wavelength ranges for the light source are for example 440 to 470 nm (blue), 515 to 535 nm (green) and 610 to 630 nm (red). Depending on the desired color of light, for example in the case of white light, light sources with different wavelengths may be combined or light sources having the desired color of light (for example white light) can be employed. The emission spectrum of an OLED may for example selectively adjusted by the device structure of the OLED.

Therefore, the at least one light source preferably emits light in a wavelength range of 250 to 1000 nm, preferably of 360 to 800 nm. More preferably, the light source emits light with a wavelength (peak wavelength) of 360 to 475 nm.

The half width of the emission spectrum of the light source is for example less than 35 nm.

In the lighting unit according to the present invention one or more light sources can be used. Preferably, 1 to 200 light sources, more preferably 1 to 100 light sources, most preferably 1 to 50 light sources are used in the lighting unit according to the present application.

Said light sources emit in an identical wavelength range or in different wavelength ranges, i. e. said light sources emit with the same color of light or with different colors of light. Preferably, the light sources employed in the lighting unit according to the present application emit in the same color of light or in three different colors of light, i.e. usually red, green and blue. By combination of the emission of red, green and blue emitting light sources desired different light colors can be adjusted.

The at least one light source preferably shows a directional light radiation. The angle of radiation (half value angle) is preferably less than 120° more preferably less than 90°, most preferably less than 45°.

The lighting unit according to the present application comprises in a preferred embodiment at least one optical element which is arranged between the at least one light source and the laminated glazing, at the edge of said laminated glazing.

In the case that more than one light source is employed, it is possible to employ also more than one optical element, i.e. preferably as many optical elements as light sources are present.

Suitable optical elements are known by a person skilled in the art. Examples for suitable optical elements are lenses or cylindric lenses. The optical element(s) is (are) placed in the path of light emitted from the light source(s) into the edge of the laminated glazing. The optical element(s) can be attached (e.g. glued) directly to the light source(s), or can be attached (e.g. glued) to one edge of the laminated layers of the glazing, or can be attached to a profile, which fixes the position of light source(s), to the position optical element(s) and of the laminated glazing to each other.

In a further preferred embodiment, which may be combined with the preferred embodiment (the presence of at least one optical element) mentioned before, the lighting unit comprises at least one light source at each edge of two edges of the laminated layers, especially at two edges which are opposite to each other.

The lighting unit according to the present application may be used in any useful application for lighting units. Examples for useful applications are the use of a lighting unit according to the present invention in buildings, furniture, cars, trains, planes and ships. In specific, present invention is useful in all applications, in which illuminated glass is of benefit.

The lighting units according to the present application are for example used in facades, skylights, glass roofs, stair treads, glass bridges, canopies, railings, car windows and train windows.

The present invention therefore further relates to the use of the inventive lighting unit in buildings, furniture, cars, trains, planes and ships as well as to the use of the inventive lighting unit in facades, skylights, glass roofs, stair treads, glass bridges, canopies, railings, car glazing, train glazing.

The present invention further relates to the use of the inventive lighting unit for control of radiation, especially UV radiation (100-400 nm), visible radiation (400 nm to 700 nm) and infrared radiation (700 nm to 1 mm), i.e. near infrared (700 nm to 1400 nm), short wave length infrared (1.4 μm to 3 μm), mid length infrared (3 μm to 8 μm), long wave length infrared (8 μm to 15 μm) and far infrared (15 μm to 1000 μm), for optical control and/or for acoustical control.

The present invention further relates to the use of the inventive lighting unit in insulating glass units, windows, rotating windows, turn windows, tilt windows, top-hung windows, swinging windows, box windows, horizontal sliding windows, vertical sliding windows, quarterlights, store windows, skylights, light domes, doors, horizontal sliding doors in double-skin facades, closed cavity facades, all-glass constructions, D3-facades (Dual, Dynamic Durable Facade), facade glass construction elements (e.g. but not limited to fins, louvres), interactive facades (facades reacting on an external impulse e.g. but not limited to a motion control, a radio sensor, other sensors) curved glazing, formed glazing, 3D three-dimensional glazing, wood-glass combinations, over head glazing, roof glazing, bus stops, shower wall, indoor walls, indoor separating elements in open space offices and rooms, outdoor walls, stair treads, glass bridges, canopies, railings, aquaria, balconies, privacy glass and figured glass.

The present invention further relates to the use of the inventive lighting unit for thermal insulation, i.e. insulation against heat, insulation against cold, sound insulation, shading and/or sight protection. The present invention is preferably useful when combined with further glass layers to an insulation glass unit (IGU), which can be used for building facades. The IGU might have a double (Pane 1 + Pane 2), or triple glazing (Pane 1 + Pane 2 + Pane 3), or more panes. The panes might have different thicknesses and different sizes. The panes might be of tempered glass, tempered safety glass, laminated glass, laminated tampered glass, safety glass. The lighting unit according to the present application may be used in any of the Panes 1, 2, 3. Materials can be put into the space between the panes. For example, but not limited such materials might be wooden objects, metal objects, expanded metal, prismatic objects, blinds, louvres, light guiding objects, light guiding films, light guiding blinds, 3-D light guiding objects, sun protecting blinds, movable blinds, roller blinds, roller blinds from films, translucent materials, capillary objects, honey comb objects, micro blinds, micro lamella, micro shade, micro mirrors insulation materials, aerogel, integrated vacuum insulation panels, holographic elements, integrated photovoltaics or combinations thereof.

The present invention further relates to the use of the inventive lighting unit in advertising panels, showcases, display facades, interactive facades, interactive bus stops, interactive train stations, interactive meeting points, interactive surfaces, motion sensors, light surfaces and background lighting, signage, pass protection. Optionally, a film and/or an imprinted film might be put on one or more surfaces.

The present invention further relates to the use of the inventive lighting unit in heat-mirror glazing, vacuum glazing, multiple glazing and laminated safety glass.

The present invention further relates to the use of the inventive lighting unit in transportation units, preferably in boats, in vessels, in spacecrafts, in aircrafts, in trains, in automotive, in trucks, in cars e.g. but not limited to windows, separating walls, light surfaces and background lighting, signage, pass protection, as sunroof, in the trunk lid, in the tailgate, for brake lights, for blinker, for position lights in said transportation units. Optional a film and/or an imprinted film might be put on one or more surfaces.

The present invention is preferentially useful when combined with further glass layers to an insulation glass unit (IGU), which can be used for building facades.

Preparation of the laminated glazing

Preferably, the method for producing a laminated glazing having in this order a first layer (A), a functional interlayer (C) and a second layer (B), comprises the steps of:

a. providing a polymer for producing the functional interlayer (C) and at least one organic luminescent colorant,
b. mixing of the polymer and the organic luminescent colorant,
c. forming the functional interlayer (C) by extruding the mixture,
d. providing the first layer (A) and second layer (B), wherein the first layer (A) and the second layer (B) are optically transparent layers produced in a float glass process having an air-side and a tin-side,
e. laminating the first layer (A) and the second layer (B) to the functional interlayer (C) such that the air side of the first layer (A) and the air side of the second layer (B) face towards the functional interlayer (C).

In the first step a) the materials for forming the functional interlayer (C) are provided. These materials include the polymer on which the functional interlayer (C) is based and the at least one organic luminescent colorant.

The polymer may be selected from any polymer useful for use as interlayer in laminated glazings as described with respect to the interlayer (C).

Preferably, the polymer for forming the functional interlayer (C) is based on an ionomer, whereby preferred ionomers are mentioned before, polyvinylbutyral (PVB), polyvinylacetal, ethylene-vinylacetate (EVA), ethylene/vinylalcohol/vinylacetal copolymer and epoxy pouring resins. Commercial materials for the functional interlayer (C) are Trosifol®, Butacite®, Saflex®, S-Lec®, and SentryGlas®.

The polymer is preferably provided in powder or in pellet form.

The at least one organic luminescent colorant is preferably be provided in form of a masterbatch. A masterbatch comprises a carrier and at least one luminescent colorant. The masterbatch may be provided in liquid form or in solid form, especially in powder or pellet form. The carrier may, for example, be chosen to be the same thermoplastic polymer as used as material for the interlayer. Alternatively, a different binder or a plasticizer may be chosen as carrier for the masterbatch. Further, the luminescent may be included in one or more of the additives used in the production of the interlayer so that the masterbatch comprises a mixture of one or more additive and the at least one luminescent colorant.

The at least one organic colorant may be selected from one or more organic dye or pigment as described with respect to the glazings.

The masterbatch may additionally comprise one or more additives selected from the group comprising stabilizers, UV-light absorbers, IR-light absorbers, flame retardants, plasticizers and inorganic particles. Suitable stabilizers include radical stabilizers and light stabilizers. Examples for suitable inorganic particles include TiO_2 particles, SnO particles and $CaCO_3$ particles. These additives may be included in the same masterbatch as the at least one luminescent colorant or may be provided in form of a separate masterbatch comprising a carrier and one or more additive.

The use of a masterbatch allows for easy dosing and mixing of the at least one colorant with the polymer for forming the functional interlayer (C). The masterbatch may be dosed to the polymer for forming the functional interlayer (C) based on weight or by volume.

After dosing the masterbatch to the polymer for forming the interlayer, mixing is performed. For example, the polymer in pellet form and masterbatch pellets may be mixed in a container or hopper.

Before and/or after mixing, the polymer for forming the functional interlayer (C) and/or the masterbatch may be dried in order to remove moisture. The polymers may absorb moister from air even if the polymer is not hygroscopic. Further, polymers such as polyvinylbutyral (PVB) may contain residual moisture which stems from the production process of the polymer.

If the masterbatch and/or the polymer are provided in liquid form, wherein the polymer, the at least one organic luminescent colorant and/or additives are dissolved or dispersed in a solvent, the solvent may be removed in the drying step.

Drying may be performed at elevated temperatures which are below the melting temperature of the respective polymer. Further, vacuum driers and/or dehumidifiers may be used to assist the drying process.

After mixing and optionally drying, the mixture comprising the polymer for forming the functional interlayer (C) and the at least one organic luminescent colorant is processed in an extrusion step.

The functional interlayer (C) is formed by extruding the obtained mixture. The mixture is fed to an extruder, for example a single screw or a twin-screw extruder. The mixture is heated above the melting temperature of the polymer for forming the functional interlayer and is then extruded through a die. The desired sheet-form of the functional interlayer (C) may be obtained by extruding through a flat die. The obtained functional interlayer (C) is cooled.

Optionally, a further drying step may be employed in order to reduce the moisture content in the obtained functional interlayer (C) prior to lamination.

After the functional interlayer (C) has been formed, the first layer (A) and the second layer (B) are provided. The first layer (A) and the second layer (B) may be selected independently from suitable materials as described with respect to the laminated glazings.

The first layer (A) and the second layer (B) are obtained by means of a float glass process. The material is preferably selected from the group comprising low-iron glass, glass with an optical transmission >90%, heat strengthened glass and chemically strengthened glass. Suitable low iron float glass is available under the trade names e.g. Pilkington Optiwhite, Guardian UltraClear Float Glass, SGG Planiclear, SGG Diamont.

The first layer (A) and the second layer (B) are selected from a glass material. Advantageously, glass materials have a low permeability for oxygen compared to polymer materials. Thus, when glass is used as material for the first layer (A) and the second layer (B) the at least one organic luminescent colorant is protected from exposure to oxygen and the stability of the colorant is improved.

The layers of the laminated glazing are laminated by any process known in the art, for example by stacking of the layers of the laminated glazing and laminating by for example placing it under vacuum in a vacuum bag and backing it in an autoclave, for example at 100 to 180 °C and for example at a pressure of from 2 to 20 bar and/or for example for 0.5 to 10 hours. In particular, a stack comprising in this order the first layer (A), the functional interlayer (C) and the second layer (B) is formed and subsequently laminated. For lamination, any air trapped inside the formed stack must be removed and subsequently the first layer (A) and the second layer (B), respectively, are joined by means of the functional interlayer by application of heat and/or pressure.

In order to facilitate the removal of trapped air, the functional interlayer (C) is preferred to have a surface of defined roughness. A rough surface of the functional interlayer (C) provides channels which allow air to flow out of the formed stack and thus assists in de-airing of the stack in the lamination process.

The surface roughness, which is measured by the average surface roughness depth Rz. Rz is preferably in the range of from 10 µm to 80 µm. A surface roughness Rz in the range of from 20 µm to 60 µm is especially preferred. The average surface roughness Rz is defined in DIN EN ISO 4287:2010-07 as the mean value of 5 individual roughness depths obtained from consecutive separate samples of the roughness profile. The roughness depth is given by the distance between the highest peak and the lowest valley in each sampled profile.

Preferably, the surface roughness of the functional interlayer (C) is irregular and does not form regular patterns in order to avoid moiré patterns in the obtained laminated glazings. Such a random pattern may comprise multitudes of discontinuous unoriented minute indentations and protuberances.

Preferably, the surface of the functional is structured by selecting the speed of extrusion such that melt fracture occurs and a patterned surface of the functional interlayer (C) is obtained.

Melt fracture occurs when the polymer exits an extruder at a speed which is above a critical speed. Extruding the same polymer at a speed below the critical speed will yield a smooth surface. The critical speed may, for example, be determined by gradually increasing the speed at which the polymer exits the die by increasing the flow rate of the polymer through the extruder and observing the surface of the extruded sheet.

Additionally or alternatively a surface pattern on the interlayer may be obtained by means of embossing and extrusion through custom dies with serrated lips. If embossing is employed, the extruded functional interlayer may be embossed by means of a roller which has a pattern imprinted on its surface.

If additional strength and stability of the laminated glazing is required, one or more support sheets and one or more additional interlayers may be provided in step d). In one embodiment, a stack is formed wherein a first support layer, a first interlayer, the first substrate (A), the functional interlayer (C), the second substrate (B) are stacked and are subsequently laminated. In a further embodiment, a stack is formed wherein a first support layer, a first interlayer, the first substrate (A), the functional interlayer (C), the second substrate (B) a second interlayer and a second support layer are stacked and are subsequently laminated.

Alternatively, a laminated glazing consisting essentially of the first substrate (A), the functional interlayer (C), the second substrate (B) may be produced in a first step and then laminated to one or more support layers by means of one or more additional interlayers.

The one or more additional interlayers may be obtained by any process known in the art and may be selected from any material suitable for producing laminated glazings. In particular, the polymers described with respect to the functional interlayer (C) are suitable.

The at least one support layer is preferably selected from a transparent polymer, a glass, especially glass produced in a float glass process, metals, or a combination of at least two of these materials. The materials described with respect to the first layer (A) and the second layer (B) are suitable materials for the at least one support layer. In case of the second support layer, the material may also be selected from an opaque material such as, for example polished glass (metal coated glass), a metal foil, a metal sheet or frosted glass, respectively partially frosted glass. Further, non-transparent polymer layers may be used.

The transparent polymer is preferably selected from the group comprising PVC (polyvinylchloride), PMMA (polymethyl methacrylate), PC (polycarbonate), PS (polystyrene), PPO (polypropylene oxide), PE (polyethylene), LDPE (low density polyethylene), LLDPE (linear low density polyethylene), PEN (polyethylene naphthalate), PP (polypropylene), LDPP (low density polypropylene), PET (polypropylene terephthalate), glycol modified polyethylene terephthalate, PES (polyether sulfones), PI (polyimides) and mixtures thereof.

A suitable PMMA is commercially available under the trade name Plexiglas.

For producing the proposed lighting unit one of the glazings as obtained by the proposed method in a first step. In a second step, at least one light source is mounted at an edge of the laminated layer. The light source is usually applied to the laminated glazing after lamination as known by a person skilled in the art.

Brief description of the drawings

Figure 1 shows a first embodiment of the laminated glazing,
Figure 2 shows a second embodiment of the laminated glazing,
Figures 3a to 3c show a first embodiment of the lighting unit,
Figures 4a to 4c show a second embodiment of the lighting unit,
Figures 5a and 5b show a third embodiment of the lighting unit,
Figures 6a and 6b show a fourth embodiment of the lighting unit, and
Figure 7 shows a fifth embodiment of the lighting unit.

Figure 1 shows a first embodiment of a laminated glazing 10 consisting of a sandwich structure comprising in this order a first layer (A) 1, a functional interlayer (C) 3 and a second layer (B) 2.

The first layer (A) 1 is optically transparent and is preferably a glass produced in a float glass process. Thus, the first layer (A) 1 has a tin-side 14, which has been in contact with molten metal during the production of the first layer, and an air-side 13. Likewise, the second layer (B) is optically transparent and is preferably a glass produced in a float glass process. The second layer (B) has a tin-side 14’ and an air-side 13’

The functional interlayer (C) 3 is based on a polymer, such as PVB, which serves as a matrix for an organic luminous colorant which is homogeneously distributed within the material of the functional interlayer (C) 3.

In the laminated glazing 10 the air-side 14 of the first layer (A) 1, which may optionally be treated with an adhesion promoter, is in direct contact with a first side of the functional interlayer (C) 3. A second side of the functional interlayer (C) 3 is in direct contact with the air-side 14’ of the second layer (B) 2 which may optionally be treated with an adhesion promoter.

Figure 2 shows a second embodiment of a laminated glazing 10 consisting of a sandwich structure comprising in this order a first support layer 16, a first interlayer 15, the first layer (A) 1, the functional interlayer (C) 3, the second layer (B) 2, a second interlayer 17 and a second support layer 18.

The support layers 16 and 18 may be used to provide additional strength and stability to the laminated glazing 10 as required by the individual application.

In figures 3a to 3c a first embodiment of a lighting unit according to the present invention is shown.

Figure 3a shows a side view, wherein X and X’ identify the viewing direction of figure 3b and Y is a detail shown in figure 3c. The lighting unit comprises a laminated glazing comprising a first layer (A) 1, a functional interlayer (C) 3 and a second layer (B) 2. Further, the lighting unit comprises a light source 4 which is arranged at an edge of the laminated glazing.

Figure 3b shows a cross sectional view of the lighting unit according to figure 3a. In the first embodiment, a plurality of light sources 4 is used. The light sources 4 are arranged such that the main direction 5 of the light beams emitted from the light sources 4 is directed onto the edge of the laminated glazing.

Figure 3c shows detail Y as marked in figure 3a. As can be seen in figure 3c, the light source 4 is arranged at half the height of the laminated glazing so that the main direction 5 of the light beams emitted from the light source 4 is directed into the functional interlayer 3. Further, the half-value angle 6 of the light emission of light source 4 is marked.

Light emitted by light source 4 is coupled into the functional interlayer 3 and is absorbed by the organic luminous colorant distributed within the functional interlayer 3. The luminous colorant re-emmits light in an omnidirectional manner (at arbitrary angles), so that the luminous colorant scatters the light of light source 4. One direction of the scattered light is marked by reference numeral 7 in figure 3c.

In figures 4a to 4c a second embodiment of a lighting unit according to the present invention is shown. The second embodiment of the lighting unit comprises an additional optical element 8 which is arranged between the light source 4 and the laminated glazing. In the shown embodiment the optical element 8 is a cylindrical lens.

In figures 5a and 5b a third embodiment of a lighting unit according to the present invention is shown. The third embodiment of the lighting unit comprises light sources 4 which are arranged on two opposing edges of the laminated glazing.

In figures 6a and 6b a fourth embodiment of a lighting unit according to the present invention is shown. The fourth embodiment of the lighting unit comprises a profile 9. The profile 9 fixes the position of light sources 4, to the position optical element 8 and of the laminated layers 1, 2 and 3 to each other.

Figure 7 shows a fifth embodiment of a lighting unit according to the present invention. The lighting unit comprises a laminated glazing 10 consisting of a sandwich structure comprising in this order a first layer (A) 1, a functional interlayer (C) 3 and a second layer (B) 2. Further, the lighting unit comprises a light source 5 which is arranged such that the main direction 5 of the light beams emitted from the light source 4 is parallel to the surface normal of one the major surfaces of the second layer (B) 2. The major surfaces of the second layer (B) 2 are the surfac-es with the largest surface area.

List of reference numerals

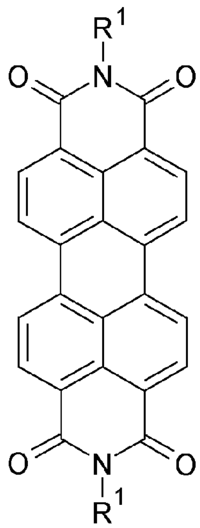
1	first layer (A)
2	second layer (B)
3	functional interlayer (C)
4	light source
5	main direction of the light beams emitted from the light source
6	angle of radiation (half-value angle)
7	one direction of light beams emitted from luminous particles
8	optical element
9	profile
10	laminated glazing
13, 13’	tin-side
14, 14’	air-side
15	first interlayer
16	first support layer
17	second interlayer
18	second support layer

Claims

1. A laminated glazing (10) comprising in this order a first layer (A) (1), a functional interlayer (C) (3) and a second layer (B) (2), wherein the functional interlayer (C) (3) is sandwiched between the first layer (A) (1) and the second layer (B) (2) and is arranged parallel to the first layer (A) (1) and the second layer (B) (2), characterized in that the functional interlayer (C) (3) comprises at least one organic luminescent colorant which is homogeneously distributed within the material forming the functional interlayer (C) (3) and in that the first layer (A) (1) and the second layer (B) (2) are optically transparent layers produced in a float glass process having an air-side (14, 14’) and a tin-side (13, 13’), wherein the air-side (14, 14’) of the first layer (A) (1) and of the second layer (B) (2) face towards the functional interlayer (C) (3).

2. The laminated glazing (10) of claim 1, characterized in that the at least one organic luminescent colorant is a naphthalene derivative, perylene derivative or a mixture of at least two of these dyes.

3. The laminated glazing (10) of claim 1 or 2, wherein the at least one organic luminescent colorant is selected from



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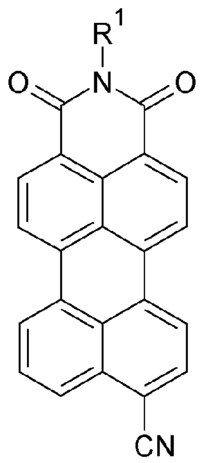

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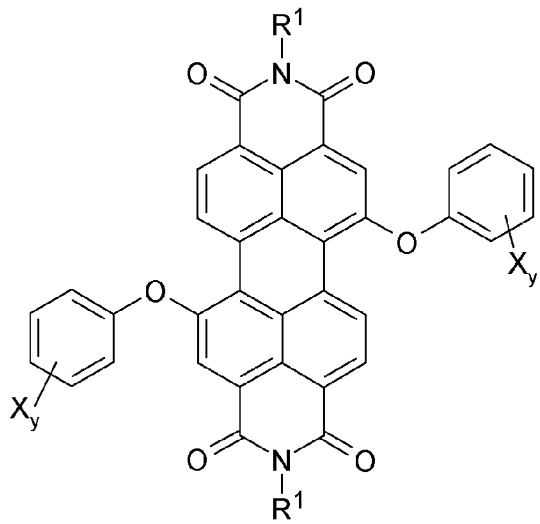

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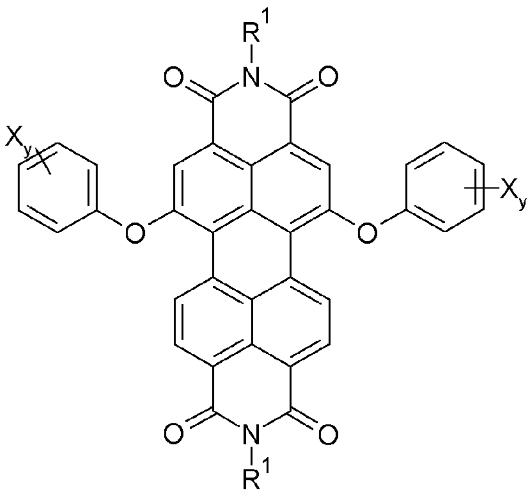

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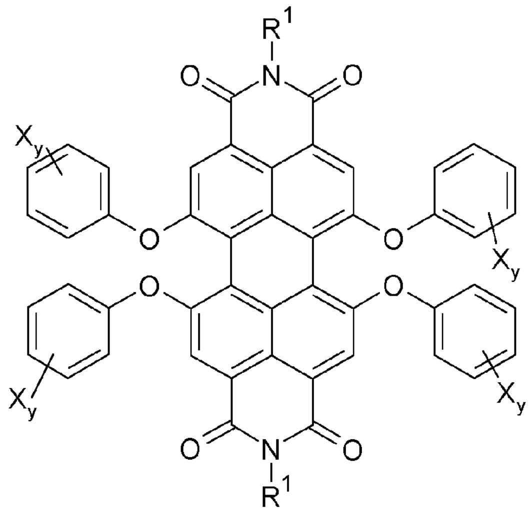

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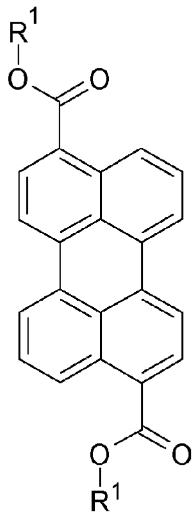

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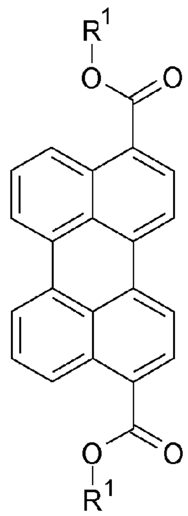

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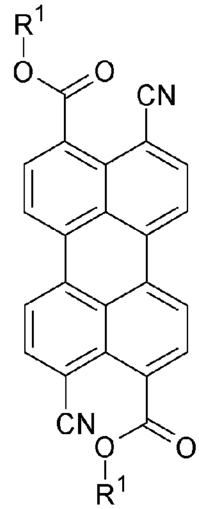
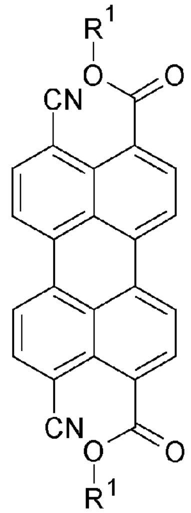


IX



X

and mixtures of at least two of these colorants, where R^1 is a linear or branched C_1-C_{18} alkyl radical, a C_4-C_8 cycloalkyl radical which may be mono- or polysubstituted by halogen or by linear or branched C_1-C_{18} alkyl, or phenyl or naphthyl, where phenyl and naphthyl may be mono- or polysubstituted by halogen or by linear or branched C_1-C_{18} alkyl;
X represents substituents in the ortho and/or para position and is linear or branched C_1 to C_{18} alkyl;
y is a number from 0 to 3.

4. The laminated glazing (10) of claim 3, wherein the at least one organic fluorescent colorant is selected from N,N'-bis(2,6-diisopropylphenyl)-1 ,7-di(2,6-diisopropyl- phenoxy)perylene-3,4:9,10-tetracarboxdiimide, N,N'-bis(2,6-diisopropylphenyl)-1 ,6-di(2,6-diisopropylphenoxy)perylene-3,4:9,10-tetracarboxdiimide, 3,9-dicyanoperylene-4,10-bis(sec-butyl carboxylate), 3,10-dicyanoperylene-4,9-bis(sec-butyl carboxylate), 3,9- dicyanoperylene-4,10-bis(isobutyl carboxylate), 3,10-dicyanoperylene-4,9-bis(isobutyl carbox-

ylate), N-(2,6-di(isopropyl)phenyl)perylene-3,4-dicarboxylic monoimide and mixtures thereof.

5. The laminated glazing (10) of claim 4, wherein the at least one organic fluorescent colorant is selected from N,N'-bis(2,6-diisopropylphenyl)-1 ,7-di(2,6- diisopropylphenoxy)perylene-3,4:9,10-tetracarboxdiimide, N,N'-bis(2,6-diisopropylphenyl)- 1 ,6-di(2,6-diisopropylphenoxy)perylene-3,4:9,10-tetracarboxdiimide and mixtures thereof.

6. The laminated glazing (10) of any one of claims 1 to 5, characterized in that the functional interlayer (C) (3) is based on an ionomer (ionoplast), polymethlymethacrylate (PMMA), acid copolymers of α-olefins and α,β-ethylenically unsaturated carboxylic acids, ethylene vinyl acetate (EVA), polyvinyl acetal, polyvinyl butyral (PVB), thermoplastic polyurethane (TPU), polyethylenes, polyolefin block elastomers, ethylene acrylate ester copolymers, silicone elastomers, epoxy resins and mixtures thereof.

7. The laminated glazing (10) of any one of claims 1 to 6, characterized in that the material of the first layer (A) (1) and/or the second layer (B) (2), is selected from the group comprising low-iron glass, glass with an optical transmission >90%, heat strengthened glass and chemically strengthened glass.

8. The laminated glazing (10) of any one of claims 1 to 7, characterized in that the air-side (14) of the first layer (A) (1) and/or the air side (14') of the second layer (B) (2) is treated with an adhesion promotor.

9. The laminated glazing (10) of any one of claims 1 to 8, characterized in that the laminated glazing (10) further comprises at least one support layer (16, 18) which is laminated to the tin-side (13) of the first layer (A) (1) or to the tin-side (13') of the second layer (B) (2) using an additional interlayer (15, 17).

10. The laminated glazing (10) of any one of claims 1 to 9, characterized in that the at least one support layer (16, 18) is selected from a transparent polymer, a glass, metals, or a combination of at least two of these materials.

11. A lighting unit comprising a laminated glazing (10) of any one of claims 1 to 10 and at least one light source (4).

12. Use of the lighting unit according to claim 11 in transportation units, in buildings and/or in advertising panels.

13. Method for producing a laminated glazing (10) having in this order a first layer (A) (1), a functional interlayer (C) (3) and a second layer (B) (2), comprising the steps of

    a. providing a polymer for producing the functional interlayer (C) (3) and at least one organic luminescent colorant,
    b. mixing of the polymer and the organic luminescent colorant,
    c. forming the functional interlayer (C) (3) by extruding the mixture,
    d. providing the first layer (A) (1) and second layer (B) (2), wherein the first layer (A) (1) and/or the second layer (B) (2) are optically transparent layers produced in a float glass process having an air-side (14, 14') and a tin-side (13, 13'), and
    e. laminating the first layer (A) (1) and the second layer (B) (2) to the functional interlayer (C) (3) such that the air side (14) of the first layer (A) and the air side (14') of the second layer (B) face towards the functional interlayer (C) (3).

14. The method of claim 13, wherein the speed of extrusion is selected such that melt fracture occurs and a patterned surface of the functional interlayer (C) (3) is obtained.

15. The method of claim 13 or 14, wherein the polymer is provided in pellet form, the organic luminescent colorant is provided in form of masterbatch pellets and the pellets are mixed according to step b).

Fig. 1

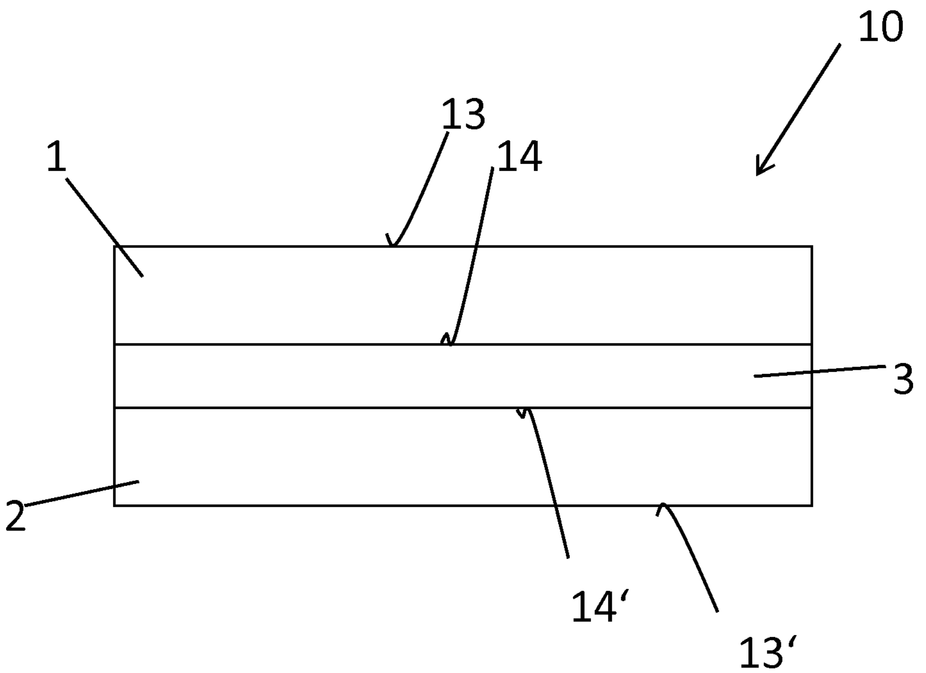


Fig. 2

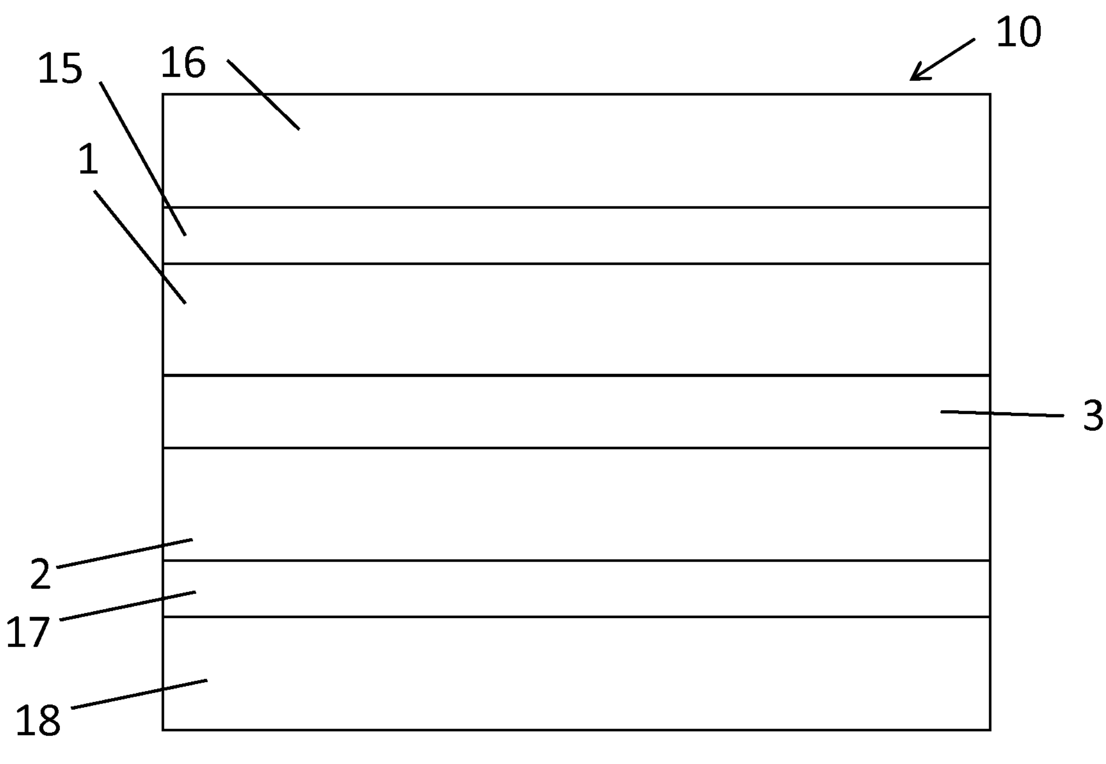


Fig. 3a

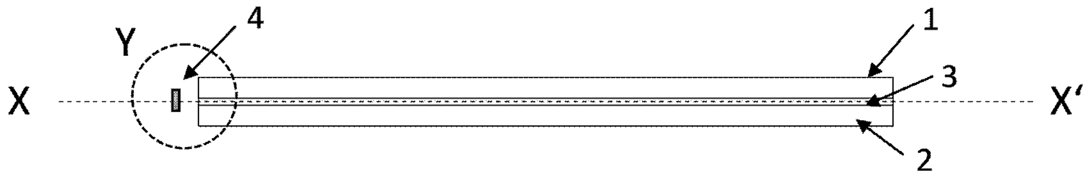


Fig. 3b (X-X')

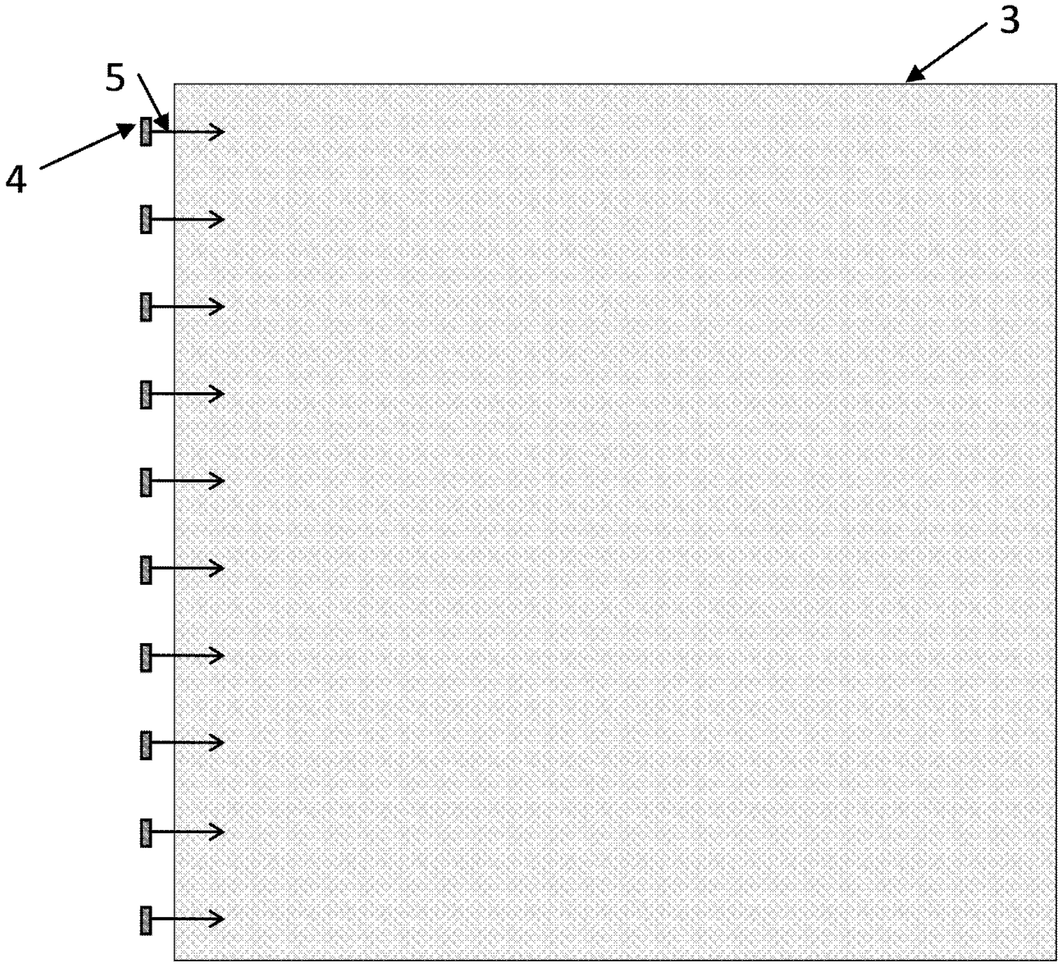


Fig. 3c (Y)

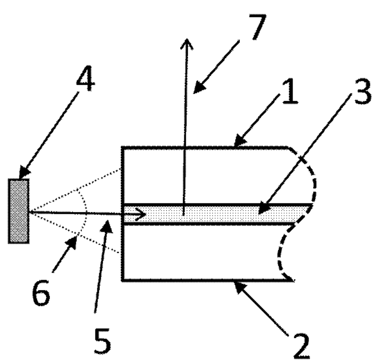


Fig.4a

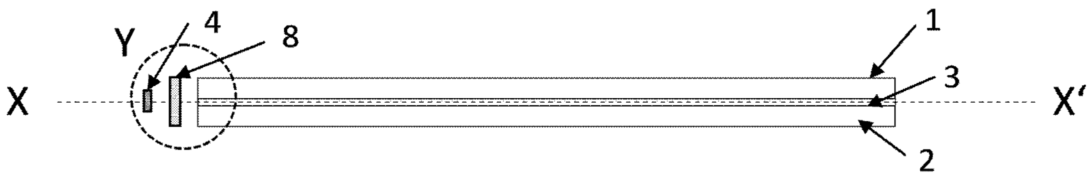


Fig. 4b (X-X')

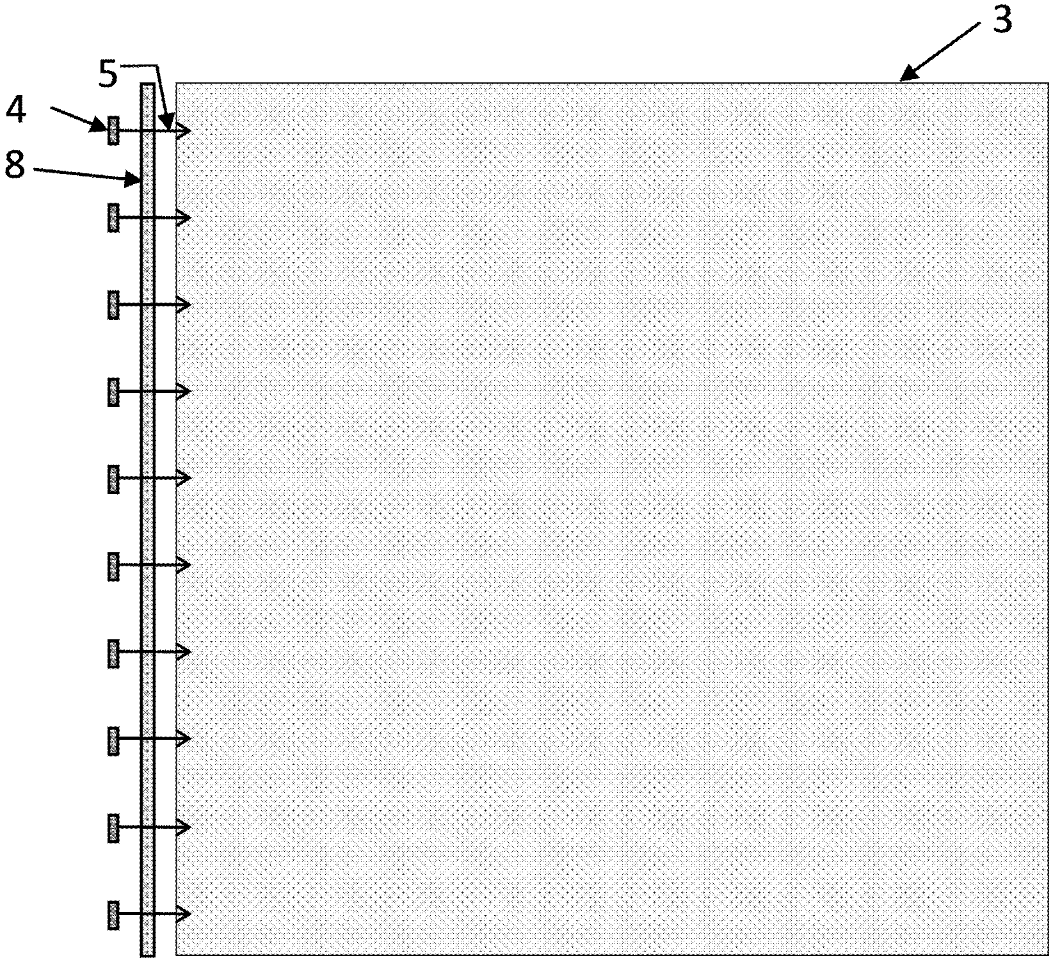


Fig. 4c(Y)

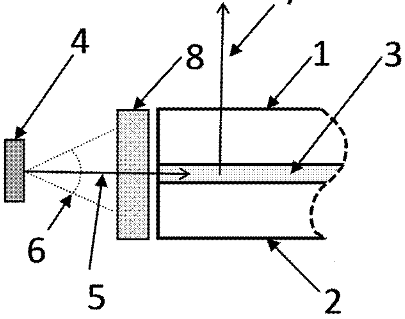


Fig. 5a

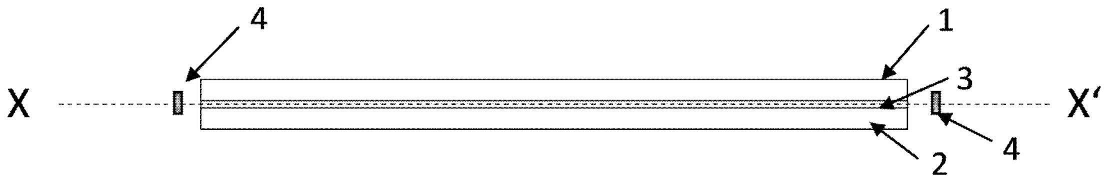


Fig. 5b (X-X')

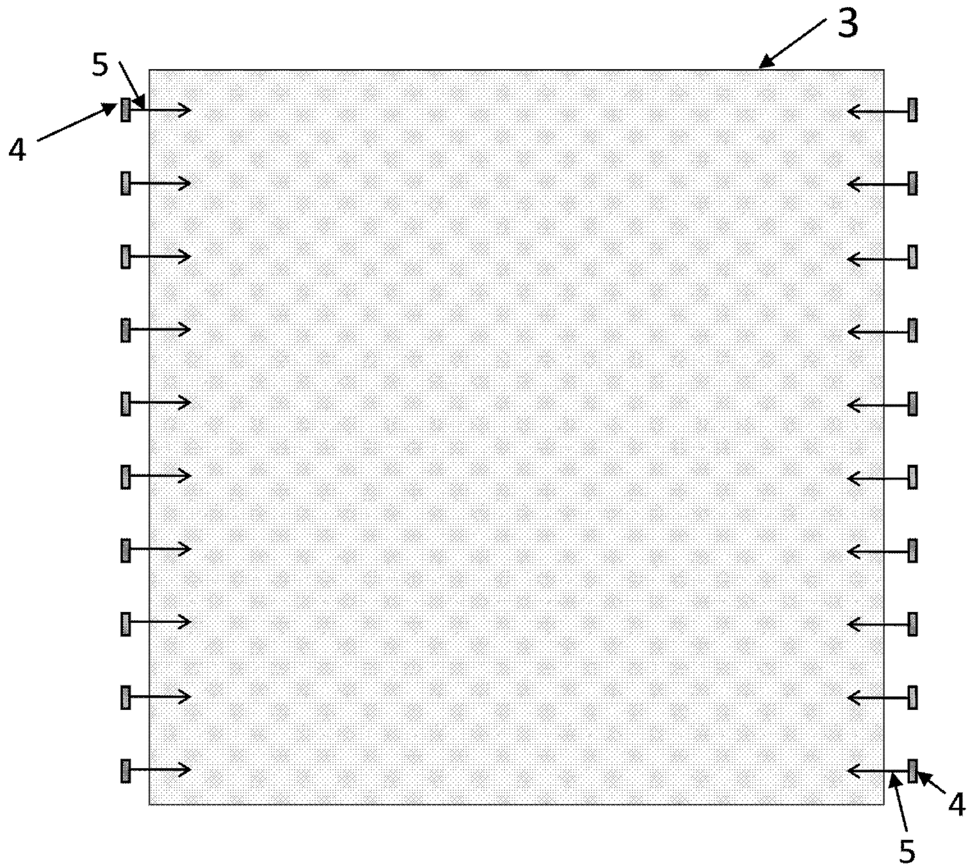


Fig. 6a

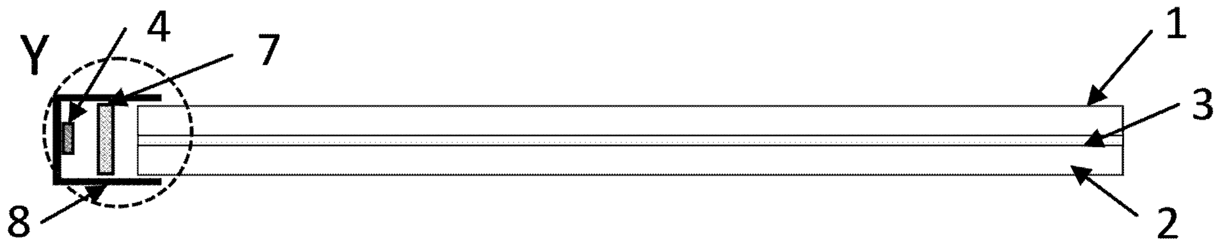


Fig. 6b (Y)

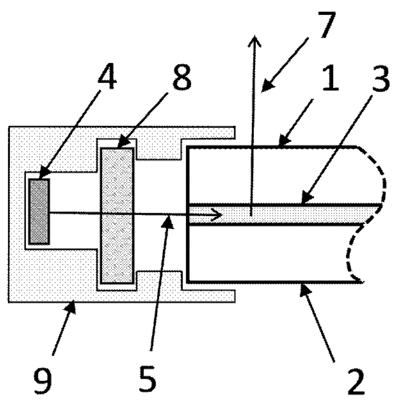
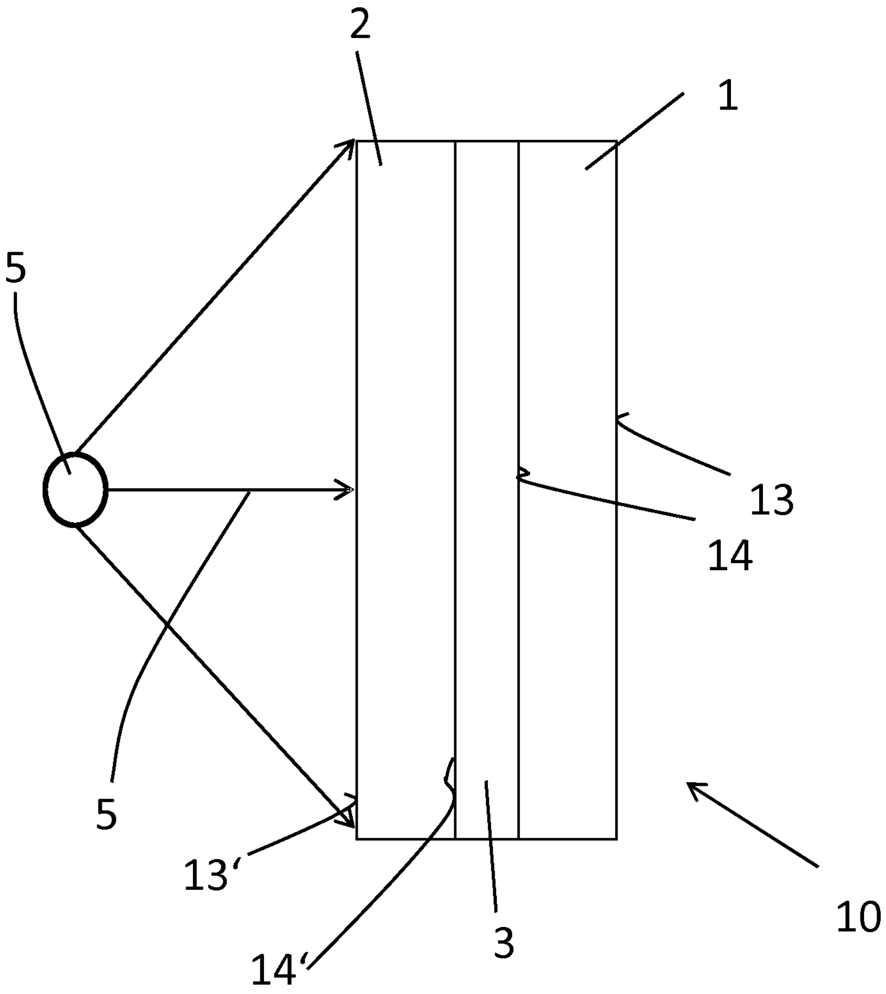


Fig. 7



INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2018/067632

A. CLASSIFICATION OF SUBJECT MATTER
INV. B32B17/10
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B32B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Y	EP 2 110 237 A1 (KURARAY EUROPE GMBH [DE]) 21 October 2009 (2009-10-21) paragraphs [0001], [0013], [0015], [0039], [0040], [0043] - [0045]	1-15
Y	US 2014/076397 A1 (WAGENBLAST GERHARD [DE] ET AL) 20 March 2014 (2014-03-20) paragraphs [0002], [0013], [0032] - [0046], [0088], [0105], [0125]	1-15
A	US 2008/210287 A1 (VOLPP WILLI [DE] ET AL) 4 September 2008 (2008-09-04) paragraph [0129]	1-15

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
27 September 2018	09/10/2018

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Somerville, Fiona

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2018/067632

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