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(54) Title: TRANSPARENT EMISSIVE WINDOW ELEMENT

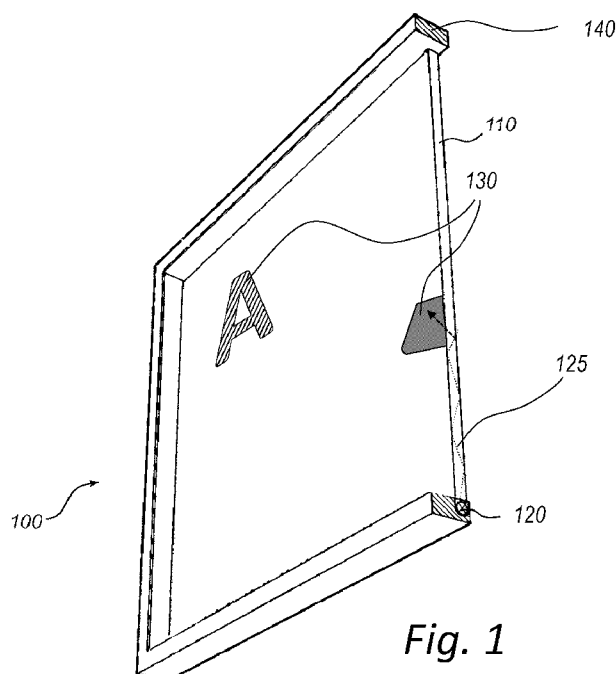


Fig. 1

(57) Abstract: The present invention discloses a transparent emissive window element (100), i.e. a transparent window element capable of emitting light. According to a first aspect of the present invention, the window element (100) comprises a glassy light guide (110) for guiding light emitted from at least one light source (120) by total internal reflection, and outcoupling surface areas (130) which are ion implanted surface layers for coupling the light out of the light guide.

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Description

Transparent Emissive Window Element

Technical Field

[0001] The present invention relates to a window element, and more particularly to a window element capable of emitting light, i.e. a luminous window element. The window element may be arranged in a door frame or a window frame and may be used in various types of buildings like office buildings, commercial buildings, hotels, hospitals and homes. The window element may also be used in an illuminated sign or in a display. The window element may also be used in an automotive glazing, such as for example in the roof of a vehicle. The window element may also be used as a lighting device. The window element may also be part of a hollow glass.

Background Art

[0002] Luminous windows or transparent emissive windows are windows that either are transparent and appear as ordinary windows when turned off or are luminous, i.e. emit light, when turned on. These windows may for instance be used for general lighting or for displaying a sign or logo.

[0003] Generally, a luminous window comprises a transparent polymer material acting as a light guide, which may be lit by means of a light source. The light guide may comprise outcoupling surface areas for extracting the light out of the light guide and, for instance, direct it into a room. As such emissive windows are added to, integrated in or meant to replace existing windows into a building structure or a vehicle, they are exposed to external influences (i.e. the conditions of the surrounding environment). However, a polymer light guide freely exposed to its surroundings is usually vulnerable to scratching and/or contamination (e.g. dust, fingerprints), which may result in a strong and undesired extraction of the light from the light guide at those scratched and/or contaminated locations. Further, polymer materials often have a large temperature expansion coefficient and a hygroscopic nature, which may result in deformation and warping of the light guide when exposed to temperature and moisture fluctuations. Further, polymer materials often have a low fire resistance, which makes the light guide a fire hazard when large surfaces are freely exposed. In

order to circumvent these problems, the light guide is conventionally protected by one or more sheets of glass.

[0004] For example, International patent application WO2006/065049 discloses a luminous window or door comprising a light guide panel in which letters or patterns are engraved by means of micro depressions. A protective glass or protective film is attached to both sides of the light guide panel to protect the surface from damage or defect such as e.g. scratches. Although the light guide panel is protected against external influences by the glass panes, the uniformity of the light emitted from such types of luminous windows (or doors) is still limited, with e.g. darker and lighter areas, which is rather unattractive for an observer. Its construction also requires many different elements and the engraved pattern is easily visible by the naked eye.

[0005] International patent application WO2011/067719 discloses a transparent emissive window element comprising a light guide, a glass pane arranged in proximity to the light guide and outcoupling surface areas for coupling the light out of the light guide that are sandwiched between the light guide. Although this window element provides good light uniformity it is comprises many different elements and is complex to assemble. Furthermore the outcoupling surface areas are easily visible by the naked eye.

Summary of invention

[0006] It is an object of the present invention to alleviate this problem, and to provide a window element providing light outcoupling surface areas that are difficult to see with the naked eye and that contains a minimum of elements.

[0007] According to a first aspect of the invention, this and other objects are achieved by means of a window element comprising a light guide for guiding light emitted from at least one light source by total internal reflection which is a pane of transparent material and outcoupling surface areas arranged in determined areas for coupling the light out of the light guide. The outcoupling surface areas show no visible light scattering or light diffusion and have a haze level of less than 1%, measured according

to standard ASTM D 1003-61. They thus permit an unobstructed view through the substrate in the ion implanted outcoupling areas as well as in the non ion implanted areas.

- [0008] In ion implantation, a gas is ionized in an ion source and accelerated in the direction of a substrate placed in a vacuum environment of less than 10^{-4} mbar.
- [0009] The solution as defined in the first aspect of the present invention is based on the idea that the outcoupling surface areas are formed in the light guide itself, at its surface and just below its surface, instead of being structures that added on top of the light guide's surface. Such a solution is advantageous in that it provides an essentially smooth light guide surface, that is made of glass and therefore does not require additional protective covers. For the purposes of the present specification the term 'pane of transparent material' is used as a common term for glass and other essentially transparent materials such as quartz or sapphire. The outcoupling surface areas of the present invention are obtained with uniform light emission from the window element. The outcoupling surface areas of the present invention have a lower refractive index than the bulk light guide glass and are obtained through ion implantation of determined areas of the light guide and provide uniform light emission from the window element. Ion implantation forms ion implanted surface layers within the light guide which act as outcoupling surface areas.
- [0010] The present invention is advantageous in that a clearer and less distorted view through the window element is provided since there is very low scattering of light that is transmitted through the glass. This light scattering of transmitted light is commonly called haze in the glazing industry. The present invention is also advantageous in that a pane of transparent material such as glass, sapphire or quartz is used as a light guide, thereby providing the light guide with the required mechanical and chemical durability without any additional protective covers, which would otherwise be necessary.

- [0011] In the following, embodiments relating particularly to the window element of the present invention are described. These embodiments may be combined if required.
- [0012] According to an embodiment of the present invention the window element comprises at least one light source, a light guide which is a pane of transparent material and outcoupling surface areas, integrated into determined areas of the pane of transparent material, such that light emitted from the light source is coupled out of the pane of transparent material and directed out of the window element. The light source emits light towards the outcoupling surface areas which direct a part of the light out of the window element. Such a solution is advantageous in that it can provide a uniform light emission from the window element.
- [0013] According to an embodiment, when the surface of the light guide remains essentially smooth in the outcoupling areas.
- [0014] Alternatively, according to yet another embodiment, a material, such as a coating or thin film, having a refractive index higher than that of the material constituting the light guide may be provided on the side opposite the light guide's side that is provided with one or more outcoupling surface areas. This embodiment is advantageous in that it reduces potentially unwanted light leakage from the light guide to side opposite the side in which the outcoupling surface areas are integrated.
- [0015] According to an embodiment, the outcoupling surface areas are arranged in a pattern providing an image (e.g., a logo, a text or a sign) at the surface of the window element when the light source is powered on. In particular, the distribution of the outcoupling surface areas may be locally altered in specific areas to form a (positive or negative) image that becomes visible when the window element is in the on-state, i.e. when the light source is powered on. Such an image may be achieved by locally increasing or decreasing the amount of outcoupled light obtained by the outcoupling surface areas, i.e. by locally increasing or decreasing the amount of light that is extracted from the light guide by the outcoupling surface areas. This is achieved by modifying the parameters of the ion implantation process

parameters used for providing the light guide with outcoupling surface areas.

- [0016] According to an embodiment, the window element may comprise a motion sensor for detecting the distance of a person to the window element. Alternatively, the motion sensor may detect the speed of a person approaching the window element. The light source may then be powered on if the detected distance or the detected speed is below or above, respectively, a predetermined threshold. This embodiment is particularly advantageous in that collision of a person with the window element may be prevented.
- [0017] According to an embodiment, the window element may be integrated into a glazing in particular into a multiple glazing unit such as for example a double glazing or a triple glazing. In the multiple glazing unit any one or more of the glass sheets may be a window element of the present invention. The light coupled out of the light guide may be directed to any side of the multiple glazing, i.e. towards the inside of a building, room, or vehicle or towards the outside.
- [0018] According to an embodiment, the window element of the present invention may be integrated in a spandrel panel.
- [0019] According to an embodiment the window element of the present invention may be used in an appliance such as for example a refrigerator, an oven etc.
- [0020] According to an embodiment of the present invention the window element may be laminated to another substrate, such as to another glass sheet or to another sheet-like material such as for example polymer, wood, concrete or stone. In particular the window element may be laminated to another glass sheet to form a sheet of laminated glazing for use as automotive glazing, for use in buildings, structural glazings, doors or decorative glazings.
- [0021] Further, the window element of the present invention may be lit by means of at least two light sources arranged at two different edges, respectively, of the glassy light guide. In particular, light may be emitted in the window element from at least two light emitting diodes emitting at different wavelengths (or colors). Such embodiments are advantageous in that

gradients in color and intensity across the window element may be achieved.

[0022] The window element of the present invention may be arranged in a window frame or a door frame.

[0023] It is noted that the invention relates to all possible combinations of features recited in the claims.

Brief description of drawings

[0024] This and other aspects of the present invention will now be described in more detail, with reference to the appended drawings showing various exemplifying embodiments of the invention.

[0025] FIG. 1 is a schematic view of a window element according to an exemplifying embodiment of the present invention;

[0026] FIG. 2 is a schematic view of a window element according to another exemplifying embodiment of the present invention;

[0027] FIG. 3 is a schematic view of a window element according to another exemplifying embodiment of the present invention;

[0028] FIG. 4 is a schematic view of a window element according to another exemplifying embodiment of the present invention;

Description of embodiments

[0029] With reference to FIG. 1, a first embodiment of the present invention is described.

[0030] FIG. 1 shows a window element 100 comprising a light guide 110, a light source 120 and outcoupling surface areas 130. The light guide 110 is configured to guide light emitted from at least one light source 150 by total internal reflection. The light is guided within the body of the light guide 110 itself. The outcoupling surface areas 130 are integrated in a surface of the light guide 110 for coupling the light travelling within the light guide out of the light guide. The outcoupling surface areas 130 are ion implanted surface layers in determined areas of the substrate..

[0031] The outcoupling surface areas 130 integrated in a surface of the light guide 110 have the following effect. Light (or photons), represented as a light ray 125 in FIG. 1, emitted from at least one light source 120 arranged at an edge of the light guide 110 travels into the light guide 110 via total

internal reflection, which is a lossless process (assuming negligible absorption in the light guide), until the light ray 125 hits an outcoupling surface area 130. The conditions for total internal reflection are met if the angle of incidence of the light ray at an inner surface of the light guide is larger than a so-called critical angle with respect to the normal of the surface. The critical angle can be calculated based on the refractive indexes of the material constituting the light guide 110 and the material of the medium in contact with the light guide.

- [0032] The phenomenon observed on these outcoupling surface areas obtained by ion implantation is still not fully understood. It may be that the light ray 125 hitting an outcoupling area 130 meets at an angle of incidence for which the conditions of total internal reflection are no longer met because the outcoupling area 130 has a refractive index lower than the refractive index of the light guide bulk. As a result, the light would exit the light guide 110. Thus, the outcoupling surface areas 130 would force the light out of the light guide. A similar effect is however not observed for anti-reflective coatings on glass substrates. It may also be that the ion implantation provides the light guide with scattering elements that result in Rayleigh scattering of the light.
- [0033] The outcoupling surface areas 130 may be integrated into the surface of the light guide by ion implantation for example with ions of H, He, Ne, Ar, Kr, O, or N using an appropriate ion source. By implantation into a certain depth in the light guide, ion implanted surface layers are formed which act as outcoupling surface areas .
- [0034] For the purposes of the present invention, these ion sources, such as for example electron cyclotron resonance (ECR) ion sources, may be used to produce ions from gases such as for example H₂, O₂, N₂, Ar, Kr, He, Ne. Certain ECR ion sources are particular useful for large-scale use as the ion beam they form may have a diameter of at least 5 cm and allow the invention to be performed on substrates having a size of several cm², for example 4 cm² up to one m² or several m², for example up to 3.21 x 6 m². The ions may be extracted from the ion source with an acceleration voltage comprised between 1 kV and 1000 kV, alternatively between 10

kV and 100 kV. The ion dosage is typically comprised between 10^{12} ions/cm² and 10^{18} ions/cm². For the efficient ion implantation in large areas it is necessary to use beams with ion currents of up to 2 mA, 4 mA or even 6 mA, and even up to 20 mA. It is particularly useful when this ion source simultaneously provides a species' single charge ions and multicharge ions for implantation, such as for example N⁺, N²⁺, and N³⁺, or He⁺, and He²⁺. The implantation may be performed in a vacuum chamber at a pressure of 10^{-3} to 10^{-7} mbar, for example 2×10^{-5} mbar to 2×10^{-6} mbar.

- [0035] The light guide may be a pane of transparent material, for example a flat pane of transparent material or a curved or bended pane of transparent material.
- [0036] The light guide may be heat-strengthened, tempered or chemically strengthened.
- [0037] The light guide may be a part of a hollow glass object, such as for example a tube, a bottle, a drinking vessel.
- [0038] The light guide may be enclosed on one or more sides in a frame, for example for hiding the one or more light sources from direct view.
- [0039] The light guide may for instance have a rectangular or hexagonal shape (in fact, any type of shape). The light guide may be made of soda-lime glass, for instance of standard float glass or other types of glass such as for example boro-silicate glass, alumina-silicate glass.
- [0040] The glassy light guide according to this invention may be a glass sheet having the following composition ranges expressed as weight percentage of the total weight of the glass.

SiO ₂	55 - 85%
Al ₂ O ₃	0 - 30%
B ₂ O ₃	0 - 20%
Na ₂ O	0 - 25%
CaO	0 - 20%
MgO	0 - 15%
K ₂ O	0 - 20%
BaO	0 - 20%
Iron total (expressed as Fe ₂ O ₃)	0,002 - 0,1%.

- [0041] The Iron total (expressed as Fe_2O_3) may in particular be in the range from 0.002 to 0.05%, even in the range from 0.002 to 0.03%. This particularly low iron content reduces light absorption in the light guide and thus improves the outcoupling of light.
- [0042] The light-guide may be of quartz or sapphire.
- [0043] The thickness of the light guide may for example be of a thickness in the range from 0.5 mm to 10 mm, in particular from 2 mm to 8 mm.
- [0044] Although only one light source is used in the embodiment described with reference to FIG. 1, it will be appreciated that more than one light source may be used for injected light at one or more of the edges of the light guide 110.
- [0045] With reference to FIG. 2 further embodiments of the present invention are described.
- [0046] In these embodiments, the window element may comprise an additional glass.
- [0047] FIG. 2 shows a cross-section of a window element 200 comprising a glassy light guide 210, two light sources 220 and an outcoupling surface areas 230. The light guide 210 is configured to guide light emitted from both light sources 240 by total internal reflection. The light is guided within the body of the light guide 210 itself. The outcoupling surface area 230 is integrated in a surface of the light guide 210 for coupling the light travelling within the light guide out of the light guide. The outcoupling surface areas 230 are ion implanted surface layers. A second pane 250, for example a pane of transparent material, is arranged at the side of the light guide 210 opposite to the side at which the outcoupling surface areas 230 are arranged. The second pane and the light guide and the space 270 in between may be configured so as to form an insulating glazing or a spandrel. In this case the space 270 may be at least partly filled with an inert gas such as for example Ar or Kr. The second pane and the light guide and the space 270 in between may be configured so as to form a laminated glazing, in this case the space 270 is filled with a laminating interlayer, of materials such as poly-vinyl-butylal (PVB) or ethyl-vinyl-acetate (EVA) traditionally used in the glazing industry for making

laminated glazing. As is well known in the art of glazing, the light guide and second pane need not be flat but can be curved or bended depending on the application.

- [0048] When the second pane is a pane of transparent material all kinds of solar control coatings, insulating coatings or decorative coatings may be applied to any of its surfaces.
- [0049] FIG. 3 shows a cross-section of a window element which is part of a bottle 300 comprising a light guide 310, which is the wall of the bottle, an optional light source 320 is located below the wall of the bottle that comprises an outcoupling an outcoupling surface areas 330. The light guide 310 is configured to guide light emitted from the light sources 340 by total internal reflection. The light is guided within the body of the light guide 310 itself. The outcoupling surface area 330 is integrated in a surface of the light guide bottle wall 310 for coupling the light travelling within the light guide out of the light guide. The outcoupling surface area 330 is an ion implanted surface layer.
- [0050] FIG. 4 shows a cross-section of a curved window element 400 which is an automotive roof glazing. It comprises a light guide 410, which is the inner glass ply, two light sources 420 and an outcoupling surface areas 430. The outcoupling surface areas 430 are ion implanted surface layers. The light guide 410 is configured to guide light emitted from both light sources by total internal reflection. The light is guided within the body of the light guide 410 itself. The outcoupling surface areas 430 are integrated in a surface of the light guide 410 for coupling the light travelling within the light guide out of the light guide. An outer glass ply 450, is laminated to the inner glass ply 410 via a lamination interlayer of PVB or EVA 470. This laminated automotive roof 400 is optionally provided with encapsulation means 460 and may be attached to an automotive roof 480. Light sources 420 are provided to direct light towards the edge of the light guide. In the present exemplary configuration the light sources 420 are placed within the encapsulation means 460, although any other configuration known to the person skilled in the art is not to be excluded.

- [0051] Referring to FIGS. 1 to 4, only a part of the entire surface of the window element is configured to emit light, i.e. outcoupling surface areas are only arranged on part of the face of the light guide, which may be sufficient for certain applications. However, it will be appreciated that the outcoupling surface areas may also be spread over the entire surface of the light guide such that the entire surface of the window element is emissive when the light source is powered on (on-state).
- [0052] Depending on the size and required luminous output of the emissive window element, the electrical power for the light sources (e.g. LEDs) may be provided by a wired connection to the mains supply (via an electrical transformer to provide the appropriate current/voltage) or a battery that can be incorporated in e.g. the window frame. Alternatively, the electrical power may be supplied by solar cells that can be attached onto the window frame or the pane of transparent material itself. The solar cells may be a rather narrow strip of (semi-transparent) thin film applied on the window or door frame or on the edge of the window element, which is advantageous in that it is rather unobtrusive and therefore aesthetically pleasing for an observer. Alternatively, the solar cells may be placed in between a light guide and a second glass ply to which the light guide is laminated.
- [0053] Outcoupling surface areas may be applied on the pane of transparent material near the edges for facilitating the out-coupling of the light.
- [0054] The window element of the present invention may be mounted on a window frame (or door frame), thereby providing windows which, on the one hand, enable entrance of daylight into a room thanks to the transparency of the window in the off-state and, on the other hand, provide functional lighting (or create an atmosphere) during dark periods when the window is in the on-state. If needed, for instance during grey and cloudy days with low levels of daylight in wintertime, the window may be used to enhance the light entering a room by, for example, adjusting the color temperature of the daylight entering the space by turning on the light source. Such windows may also be used as a switchable privacy window

or a window dividing living spaces (in particular when a window with double side emission is used).

- [0055] According to an embodiment, such as that shown in FIG. 2, several light sources may be arranged at the edges of the light guide. In particular, the light sources may be light emitting diodes emitting at different wavelengths such that several colors and mix of colors may be achieved. Separate (or individual) control of the light sources may enable the creation of particular atmosphere on the window element. Using many light-sources enable emission of light at different colors and gradients in color and intensity across the light-guide, which can be used to create an atmosphere resembling for example a sunset or clouds passing by.
- [0056] The light sources may be located in diamond-shaped recessions (holes) in the light guide. The diamond shape ensures that the light of a certain light source is quickly mixed with that of a neighboring light source (that may emit at a different color to make a color-adaptable emissive window). It also ensures a reduced chance that light emitted by a light source is absorbed by another light source. The edges of the light-guide may be equipped with mirrors to reduce loss of light.
- [0057] Further, pre-collimation of the light before entering the light-guide may be advantageous since it facilitates the realization of a predetermined angular distribution of the light coupled out of the light-guide (especially when a narrow distribution is required).
- [0058] The person skilled in the art realizes that the present invention by no means is limited to the preferred embodiments described above. On the contrary, many modifications and variations are possible within the scope of the appended claims.

Example

- [0059] Window elements were prepared from 10 x 10 cm² normal clear soda-lime float glass samples of about 4mm thickness.
- [0060] To form the outcoupling surface areas, ion implantation was performed on the air side of the float glass samples with a ECR ion source Hardion+ from Quertech. N₂ was used as source gas and the ion source provided an ion beam of a mixture of N⁺, N²⁺, and N³⁺. Acceleration voltages for the

ions and ion dosage were set as indicated in the table below. Reflectance of the resulting samples was measured on the implanted side using a D65/2° illuminant.

[0061] For measuring the amount of outcoupled light in the outcoupling areas, one edge of the samples was illuminated with diffused light. As a source for diffused light a 20 inch diameter integrating sphere from Labsphere was used. The integrating sphere was provided with a port to which a 565 nm LED light source was attached. The LED had a power of 979mW at 1000mA. For the measurements 800mA were applied to the LED. The LED had a central wavelength of 565nm and a bandwidth (FWHM) of about 104 nm. A slot for illuminating the sample was provided in the integrating sphere. A photodiode was used for measuring the amount of outcoupled light, the photodiode was a Thorlabs S120C.

[0062]

Table 1

Example	Acceleration voltage [kV]	Dose (ions/cm ²)	Power of outcoupled light (μW)	Reflectance (implanted side, D65/2°)
1	35	5 x 10 ¹⁷	1.18-1.25	5.53
2	35	7.5 x 10 ¹⁶	0.16 - 0.20	4.58
3	20	5 x 10 ¹⁷	0.48-0.52	6.25
C1	None	none	0.06-0.07	8.02
C2	20	7.5 x 10 ¹⁶	0.06-0.08	5.48

[0063] Examples 1 to 3 show increased outcoupling of light. Outcoupling of light increases with the dose and the voltage for these examples. It was also found that light was outcoupled on the side opposite of the implanted areas with outcoupled light power in the same range as on the implanted side.

[0064] Comparative example C1 was not implanted. Comparative example 2 was implanted but did not show increased outcoupling of light, this shows that the outcoupling effect is not only due to the reduction of reflectance obtained by ion implantation.

- [0065] Additional examples 1', 2, and 3' were prepared with the same parameters of ion implantation as examples 1, 2, and 3 respectively. Implantation was performed selectively on a 5 cm x 5 cm square in the centre of the sample by using an 10 cm x 10 cm aluminum mask of 2 mm thickness having a 5 cm x 5 cm square aperture in its centre. In the implanted area, the power of light was in the same range as for examples 1, 2, and 3. In the non-implanted areas, the power of outcoupled light was in the same range as for comparative example C1.
- [0066] It was found that the degree of light outcoupling can be varied by varying the amount of ions and their implantation depth. According to the present invention the ion dosage may be 10^{16} to 10^{20} ions/cm², 5×10^{16} to 10^{19} ions/cm², or 7.5×10^{16} to 10^{18} ions/cm²
- [0067] It was also found that similar results as with the ions of nitrogen in the examples above could be obtained with the ions of H, O, He, Ne, Ar at similar ion dosage and implantation depth. According to the present invention the implantation depth may be at least 14 nm, at least 40 nm, or at least 54 nm. According to the present invention the maximum implantation depth may be at most 750 nm, at most 500 nm, or at most 200 nm
- [0068] The implantation depth is controlled by the acceleration voltage of the ion source.
- [0069] In an embodiment of the present invention the ion dose is in the range from 10^{16} to 10^{20} ions/cm² and the implantation depth is at least 14nm. This minimum implantation depth is obtained for H⁺ with an acceleration voltage in the range from 1 to 50 kV, for O⁺ with an acceleration voltage in the range from 5.5 to 200 kV, for He⁺ with an acceleration voltage in the range from 1.4 to 65 kV, for Ne⁺ with an acceleration voltage in the range from 6.5 to 220 kV, for Ar⁺ with an acceleration voltage in the range from 11 to 450 kV.
- [0070] In another embodiment of the present invention the ion dose is in the range from 5×10^{16} to 10^{19} ions/cm² and the implantation depth is at least 40 nm. This minimum implantation depth is obtained for H⁺ with an acceleration voltage in the range from 2.5 to 35 kV, for O⁺ with an

acceleration voltage in the range from 17 to 160 kV, for He⁺ with an acceleration voltage in the range from 4 to 45 kV, for Ne⁺ with an acceleration voltage in the range from 20 to 180 kV, for Ar⁺ with an acceleration voltage in the range from 37.5 to 350 kV.

[0071] In another embodiment of the present invention the ion dose is in the range from 7.5×10^{16} to 10^{18} ions/cm² and the implantation depth is at least 54 nm. This implantation depth range is obtained for H⁺ with an acceleration voltage in the range from 3.25 to 20 kV, for O⁺ with an acceleration voltage in the range from 22.5 to 110 kV, for He⁺ with an acceleration voltage in the range from 5.5 to 27.5 kV, for Ne⁺ with an acceleration voltage in the range from 27.5 to 130 kV, for Ar⁺ with an acceleration voltage in the range from 50 to 250 kV.

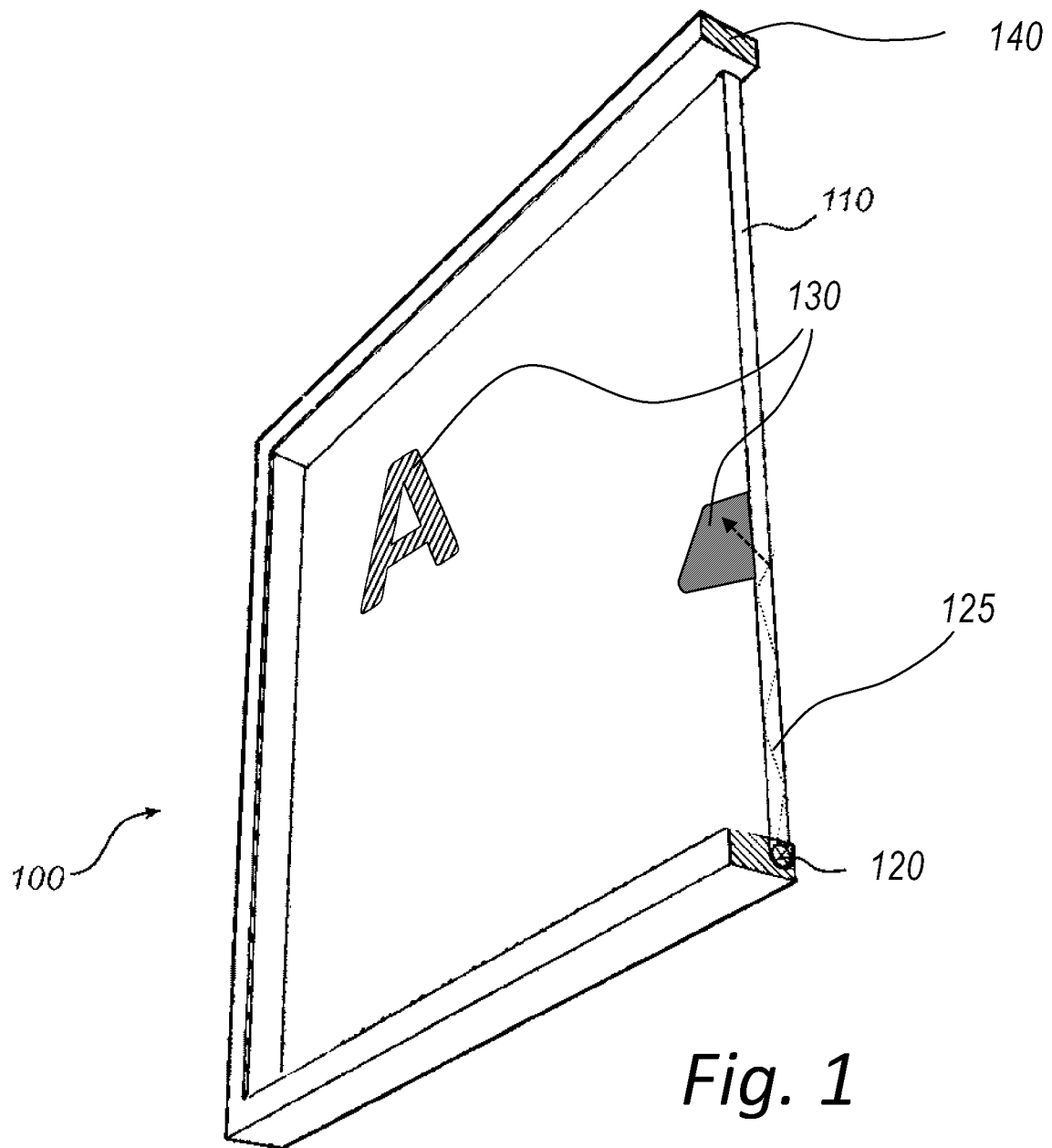
[0072] ECR ion sources providing an ion beam comprising a mixture of single charged ions and multi charged ions are particularly useful as for a certain acceleration voltage, a double charged ion of a certain species, for example N²⁺, will have double the implantation energy of the corresponding single charge ion, N⁺. Thereby greater implantation depths can be reached without having to increase the acceleration voltage. In an embodiment of the present invention the ion beam at least 90% of the ions in the ion beam are made up of the single charge and double charge ions of a species selected from N, O, He, Ne, Ar and the ratio of single charge species and double charge species is at least 55/25. The respective single charge and double charge species are N⁺ and N²⁺, O⁺ and O²⁺, He⁺ and He²⁺, Ne⁺ and Ne²⁺, Ar⁺ and Ar²⁺.

Claims

- Claim 1. A window element (100) comprising:
a light guide (110) for guiding light emitted from at least one light source (120) by total internal reflection, and outcoupling surface areas (130) for coupling the light out of the light guide, wherein the light guide is glass, sapphire, or quartz, and wherein the outcoupling surface areas are ion implanted surface layers.
- Claim 2. A window element according to claim 1, further comprising an additional pane of transparent material arranged at the side of the light guide opposite to the side at which the outcoupling surface areas are arranged, wherein one of a group comprising a layer of inert gas and a laminating interlayer, is sandwiched between said additional pane of transparent material and said light guide.
- Claim 3. A window element according to any preceding claim, wherein the ion implanted surface layers are implanted with ions selected from one or more of H, O, N, He, Ne, Ar.
- Claim 4. A window element according to any preceding claim, wherein the ion implanted surface layers are implanted with a dosage of ions in the range from 10^{16} to 10^{20} ions/cm².
- Claim 5. A window element according to any preceding claim, wherein the implantation depth of the ion implanted surface layers is at least 14nm.
- Claim 6. A window element according to any preceding claim, wherein the light guide is glass selected from soda-lime glass, boro-silicate glass, and alumina-silicate glass
- Claim 7. A window element according to any preceding claim, wherein the light guide is part of a hollow glass object.
- Claim 8. A window element according to any one of the preceding claims, wherein the outcoupling surface areas are arranged in a pattern providing an image (318) at the surface of the window element when said at least one light source is in its on-state.
- Claim 9. A window element according to any one of the preceding claims, wherein the window element is lit by means of at least two light sources arranged at least two different edges, respectively, of the window element.

- Claim 10. A window element according to any one of the preceding claims, wherein light is emitted in the window element from at least two light emitting diodes emitting light at different wavelengths.
- Claim 11. A window element according to any one of the preceding claims, being arranged in a window frame or a door frame.
- Claim 12. A window element according to claim 2 wherein a laminating interlayer selected from PVB and EVA is sandwiched in between the light guide and the additional pane of transparent material.
- Claim 13. Automotive roof glazing comprising a window element according to claim 7.

Drawings



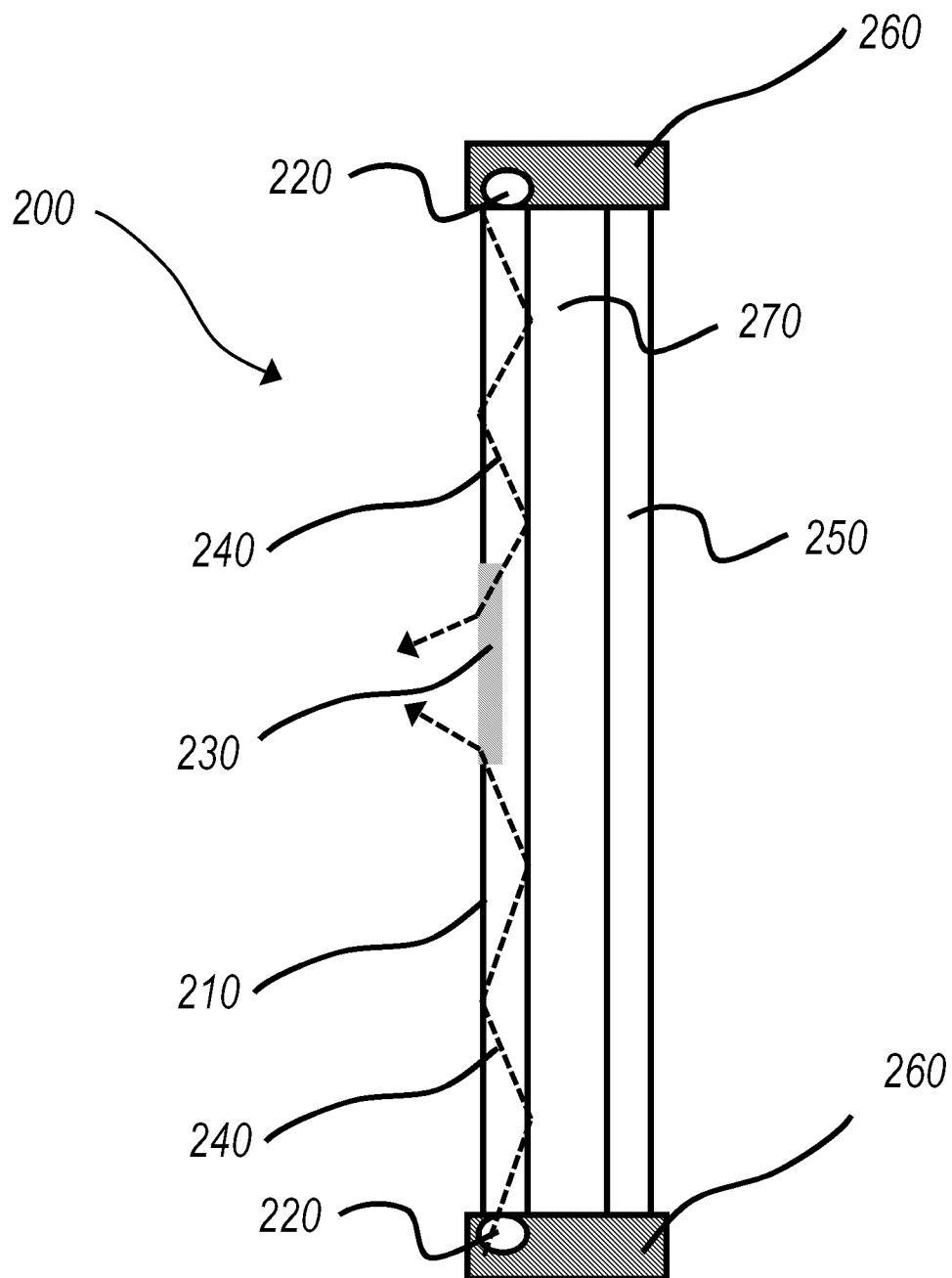


Fig. 2

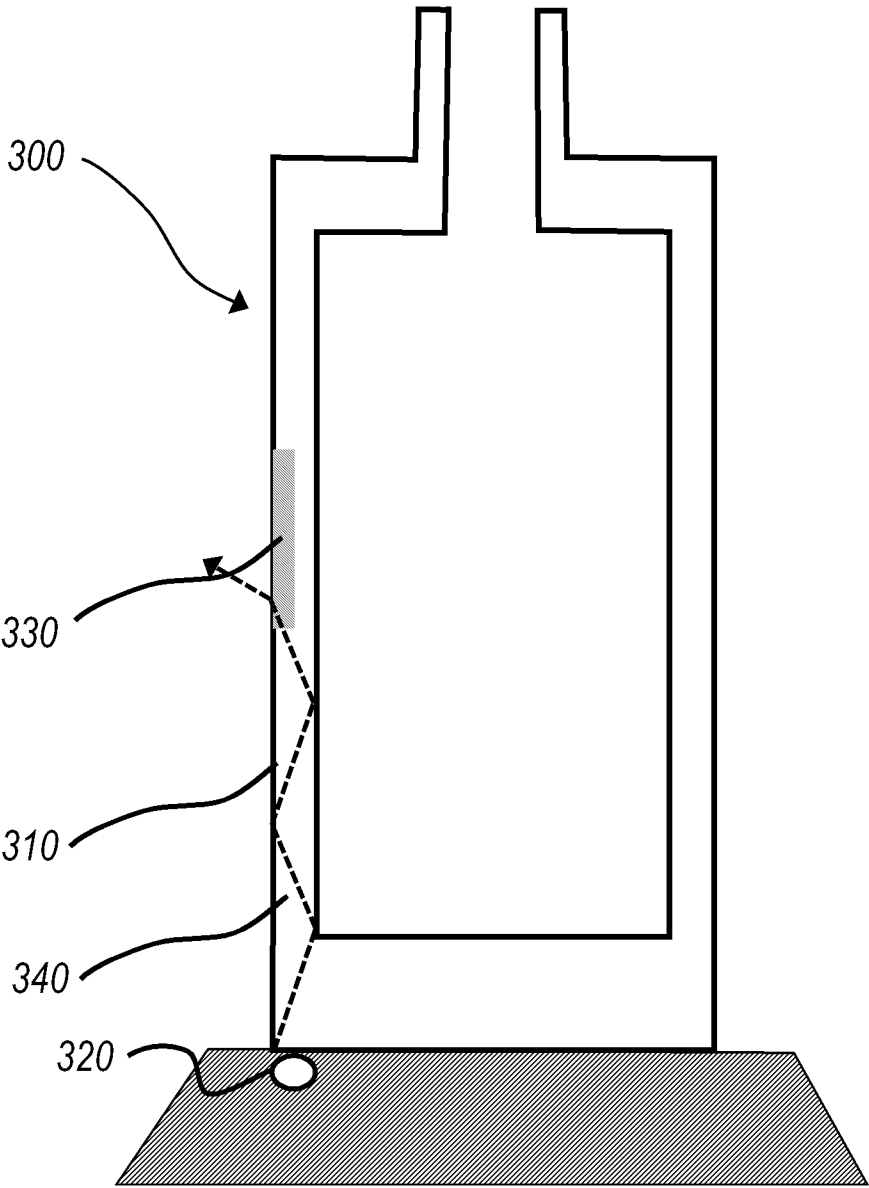


Fig. 3

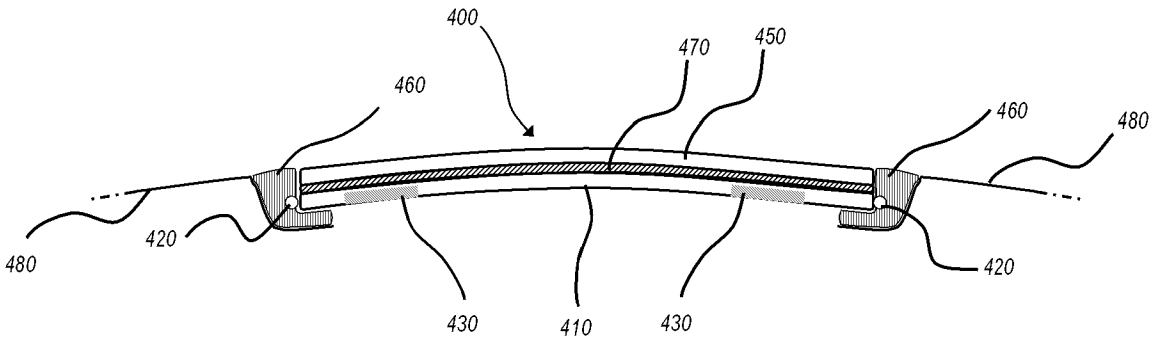


Fig. 4

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2019/052083

A. CLASSIFICATION OF SUBJECT MATTER
INV. F21V8/00
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)
G02B

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

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2015/277023 A1 (ETIENNE MICHAEL [US] ET AL) 1 October 2015 (2015-10-01)	1,6,13
Y	paragraphs [0005], [0041] - [0043], [0055], [0062]; figures 1,2	2-5,7-12
Y	----- WO 2011/067719 A1 (KONINKL PHILIPS ELECTRONICS NV [NL]; KRIJN MARCELLINUS PETRUS CAROLUS) 9 June 2011 (2011-06-09) cited in the application paragraphs [0024], [0058], [0086], [0087]; figures 1,2	2,7-11
Y	----- US 2013/050992 A1 (SCHNEIDER VITOR M [US] ET AL) 28 February 2013 (2013-02-28) paragraphs [0063], [0101], [0105]; figures 1a,11	2,12
	----- -/-	



Further documents are listed in the continuation of Box C.



See patent family annex.

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

19 March 2019

Date of mailing of the international search report

26/03/2019

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INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2019/052083

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2017/334775 A1 (NAVET BENJAMINE [BE] ET AL) 23 November 2017 (2017-11-23) paragraphs [0005], [0014], [0026] -----	3-5

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Information on patent family members

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