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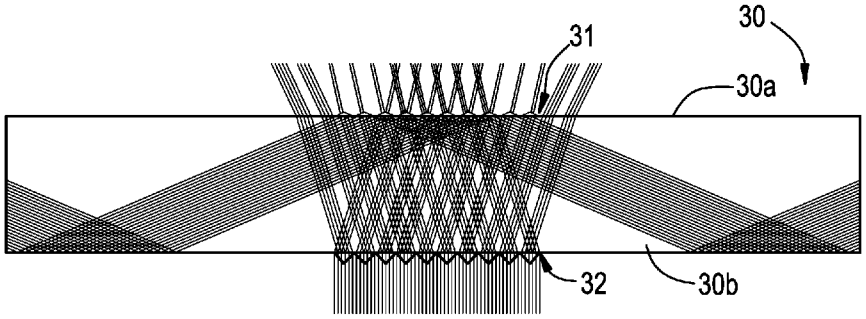
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(54) **Title:** BACKLIGHT UNIT HAVING A LIGHT GUIDE PLATE

FIG. 2



(57) **Abstract:** A backlight (100) comprising a plurality of light sources (5) and a patterned light guide plate (30) having a first pattern of microstructures (33) on a top surface or a bottom surface to extract light from the plurality of light sources, a second pattern of microstructures (32) on the bottom surface, and a third pattern of microstructures (31) on the top surface near or above the light sources. The plurality of light sources (5) are located directly behind the patterned light guide plate (30), and dominant rays of the plurality of light sources (5) are transmitted by the second pattern and reflected by the third pattern (31) such that more than 60% of the dominant rays travels laterally in the patterned light guide plate (30) due to total internal reflection.

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BACKLIGHT UNIT HAVING A LIGHT GUIDE PLATE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of priority under 35 U.S.C. § 119 of U.S. Provisional Application Serial No. 62/549,576 filed on August 24, 2017 and U.S. Provisional Application Serial No. 62/649,210 filed on March 28, 2018, the contents of each of which are relied upon and incorporated herein by reference in their entireties.

FIELD OF THE DISCLOSURE

[0002] The disclosure relates generally to light guide assemblies and display or lighting devices comprising such assemblies, and more particularly to glass light guide plates comprising at least one optical manipulation feature.

BACKGROUND

[0003] Liquid crystal displays (LCDs) are light valve-based displays in which the display panel comprises an array of individually addressable light valves typically using a pair of polarizers and an electrically controlled liquid crystal layer. A back light unit (BLU) is required to produce an emissive image from the LCD. Due to high efficiency and small size of state-of-the-art light emitting diodes (LED), almost all modern BLUs are using LEDs. BLUs come in two varieties. Edge-lit BLUs comprise a linear LED array edge-coupled to a light guide plate (LGP) that emits light from its surface. Direct-lit BLUs comprise a 2D array of LEDs directly behind the LCD panel. Edge-lit BLUs are typically thinner than direct-lit BLUs. However, direct-lit BLUs have an important advantage – they can enable improved dynamic contrast by employing a feature known as 2D local dimming, where LEDs in dark regions of the screen can be turned off.

[0004] There is still a need to develop a thin and efficient back light design having the 2D local dimming capability and also allowing for a simplified display assembly

SUMMARY

[0005] The disclosure relates, in various embodiments, to a backlight comprising a plurality of light sources and a patterned light guide plate having a first pattern of microstructures on a top surface or a bottom surface to extract light from the plurality of light sources, a second pattern of microstructures on the bottom surface, and a third pattern of microstructures on the top surface near or above the light sources, wherein the plurality of light sources are located directly behind the patterned light guide plate, and wherein dominant rays of the plurality of light sources are transmitted by the second pattern and reflected by the third pattern such that more than 60% of the dominant rays travels laterally in the patterned light guide plate due to total internal reflection. In some embodiments, the second pattern and the third pattern of microstructures on the patterned light guide plate are circular in shape. In some embodiments, the second pattern of microstructures on the patterned light guide plate has a base angle between 25 and 65 degrees. In some embodiments, the third pattern of microstructures on the patterned light guide plate has a base angle between 15 and 65 degrees. In some embodiments, the second pattern of microstructures on the patterned light guide plate has a base angle between 35 and 55 degrees. In some embodiments, the third pattern of microstructures on the patterned light guide plate has a base angle between 20 and 50 degrees. In some embodiments, the third pattern of microstructures is larger than the second pattern of microstructures. In some embodiments, some microstructures in the third pattern have different angles and/or some microstructures in the third pattern have different pitches. In some embodiments, the patterned light guide plate comprises glass or a polymer. The thickness of the patterned light guide plate can be between 0.1 mm and 2 mm. In some embodiments, the backlight further comprises a diffuser plate, a quantum dot film, a prismatic film, or a reflective polarizer. In some embodiments, the backlight further comprises a patterned reflector having a first area and a second area, the first area being more reflective than the second area, and the second area being more transmissive than the first area. In some embodiments, the backlight further comprises a bottom reflector. In some embodiments, the patterned light guide plate has a first pattern of microstructures on both the top and bottom surfaces.

[0006] In other embodiments, the disclosure relates to a backlight comprising a plurality of light sources and a patterned light guide plate having a first pattern of microstructures on a top surface or a bottom surfaces to extract light from the plurality of light sources, and a second pattern of microstructures on the bottom surface near or above the plurality of light sources to redirect the light away from the plurality of light sources and reduce the absorption of the light by the plurality of light sources, wherein the plurality of light sources are located directly behind the patterned light guide plate, and wherein the first pattern of microstructures have a base angle in the range between 25 and 65 degrees. In some embodiments, the patterned light guide plate further comprises a third pattern of microstructures on the top surface near or above the light sources to further redirect the light away from the plurality of light sources and to reduce the absorption of the light by the plurality of light sources, and wherein the third pattern of microstructures has a base angle in the range between 15 and 65 degrees. In some embodiments, the backlight further comprises a bottom reflector. In some embodiments, the patterned light guide plate has a first pattern of microstructures on both the top and bottom surfaces.

[0007] The backlight of some embodiments can be a thin direct-lit BLU with improved light efficiency over the prior art thin backlight that has a patterned reflective film.

[0008] Improved light efficiency of exemplary embodiments can be achieved with a glass light guide plate that is placed above the LEDs. At least a portion of the light from the LEDs is spread laterally in the glass light guide plate by the total internal reflection. This is made possible by the first pattern and the second pattern of microstructures on the patterned light guide plate.

[0009] In some embodiments, the backlight can be assembled simply by stacking its constituent parts on top of one another and does not require very precise alignment or gluing the parts together.

[0010] Additional features and advantages of the disclosure will be set forth in the detailed description which follows, and in part will be readily apparent to those skilled in the art from that description or recognized by practicing the methods as described herein, including the detailed description which follows, the claims, as well as the appended drawings.

[0011] It is to be understood that both the foregoing general description and the following detailed description present various embodiments of the disclosure, and are intended to provide an overview or framework for understanding the nature and character of the claims. The accompanying drawings are included to provide a further understanding of the disclosure, and are incorporated into and constitute a part of this specification. The drawings illustrate various embodiments of the disclosure and together with the description serve to explain the principles and operations of the disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] The following detailed description can be further understood when read in conjunction with the following drawings, in which:

[0013] Figure 1A is a side view of a portion of an exemplary backlight comprising a light guide plate;

[0014] Figure 1B is a side view of a microstrucrure on one surface of the light guide plate shown in Figure 1A;

[0015] Figure 1C is a bottom view of the first pattern on the bottom surface (left panel) and a top view of the second pattern on the top surface (right panel);

[0016] Figure 2 is a side view of another example of a light guide plate that can be used in an exemplary backlight;

[0017] Figure 3 is a side view of another example of a light guide plate that can be used in an exemplary backlight;

[0018] Figure 4 is a side view of another example of a light guide plate that can be used in an exemplary backlight;

[0019] Figure 5 is a side view of a portion of an exemplary backlight comprising a light guide plate and a patterned reflector;

[0020] Figure 6 is a backlight design including a patterned reflector but without a light guide;

[0021] Figure 7 is a side view of an exemplary display including a backlight, optical films, and display panel; and

[0022] Figures 8A to 8D are exemplary backlights according to some embodiments.

DETAILED DESCRIPTION

[0023] Disclosed herein are backlight assemblies comprising a plurality of discrete light sources, a bottom reflector, a patterned glass light guide plate that has a first pattern of microstructures on its bottom surface and a second pattern of microstructures on its top surface near or above the discrete light sources, and a third pattern of microstructures on its top or bottom (or both) surfaces away from the discrete light sources to extract light, and a patterned reflector having a first area and a second area, the first area being more reflective than the second area, and the second area being more transmissive than the first area. These discrete light sources can be located directly behind the patterned glass light guide plate, a first portion of the light output of the discrete light sources is coupled into the patterned glass light guide plate by the first pattern and the second pattern on the patterned glass light guide plate, travels laterally in the patterned glass light guide plate due to the total internal reflection, and is extracted out by the third pattern of microstructures, and a second portion of the light output of the discrete light sources travels laterally between the bottom reflector and the patterned reflector due to multiple reflections at the reflective surfaces of the bottom reflector and the patterned reflector.

[0024] Disclosed herein are also backlight assemblies comprising a plurality of discrete light sources, a bottom reflector, and a patterned light guide plate that has a first pattern of microstructures on its top or bottom (or both) surfaces and away from the discrete light sources to extract light, and has a second pattern of microstructures on its bottom surface near or above the discrete light sources to redirect the light away from the discrete light source and reduce the absorption of the light by the discrete light source. These discrete light sources can be located directly behind the patterned light guide plate, and the first pattern of microstructures has a base angle in the range of 25 and 65 degrees.

[0025] Various embodiments of the disclosure will now be discussed with reference to the figures appended herewith, which illustrate exemplary embodiments

and aspects of light guide assemblies. The following general description is intended to provide an overview of the claimed devices, and various aspects will be more specifically discussed throughout the disclosure with reference to the non-limiting depicted embodiments, these embodiments being interchangeable with one another within the context of the disclosure.

[0026] One exemplary embodiment of a backlight 100 is shown in Figure 1A and includes certain features required for functioning of the backlight. The exemplary backlight 100 comprises a patterned light guide plate (LGP) 30, a plurality of discrete light sources 5 (only one is shown for simplicity purposes), and a bottom reflector 10. The patterned light guide plate 30 can include a first pattern of microstructures 33 on its top surface 30a or bottom surface 30b or both top and bottom surfaces 30a, 30b. The first pattern of microstructures 33 can be positioned distal the discrete light sources 5 to extract light. The patterned LGP 30 can also comprise a second pattern of microstructures 32 on its bottom surface 30b and a third pattern of microstructures 31 on its top surface 30a near or above one or more of the discrete light sources 5.

[0027] With reference to Figures 1B and 1C, a second pattern of microstructures 32 can comprise a plurality of first circular prisms. In some embodiments, the first prisms can have an apex angle 33a of 90° and can have a first base angle 33b and a second base angle 33c of 45° and 45°, respectively. In other embodiments, the third pattern of microstructures 31 can comprise a plurality of second circular prisms. With continued reference to Figure 1A, in some embodiments the second prisms can have an apex angle of 130°, and a first and second base angles of 25° and 25°, respectively. In additional embodiments, both the first and second prisms have the same pitch, and the pitch can be any suitable length. In further embodiments, the pitch can vary between 5 μm and 500 μm. In the example, the pitch is 100 μm, and the thickness of the light guide plate 30 is 0.66 mm, but such examples should not limit the scope of the claims appended herewith. Of course, the geometries described herein are exemplary only and should not limit the scope of the claims appended herewith (including the apex angle, the first base angle, the second base angle, and the pitch) as, for example, the geometries of the first and second prisms can be selected such that more than 60% of the dominant

rays of the light sources are redirected into the light guide plate at an angle that is greater than the total internal reflection angle. Such rays can then travel in a light guide plate without loss until extracted by the third pattern of the microstructures.

[0028] The dominant rays of a typical light source located behind an exemplary light guide plate travel in the normal direction of the light guide plate. The dominant rays have the maximum intensity, while non-dominant rays have lower intensity than dominant rays. Thus, dominant rays contribute most to the overall optical efficiency of an exemplary backlight. Any choice of the first and second prisms can increase the chance of experiencing the total internal reflection for some rays, while decreasing the chance of experiencing the total internal reflection for other rays. Therefore a desired choice of the first and second prisms should increase the chance of experiencing the total internal reflection for dominant rays. In some embodiments, the first prisms and the second prisms can be registered so that the dominant rays are firstly transmitted by the first prisms on the bottom surface and subsequently reflected by the second prisms on the top surface. In further embodiments, a small portion of the dominant rays can be transmitted through the second prisms on the top surface.

[0029] Figure 1C shows a bottom view of the second pattern of microstructures 32 on the bottom surface 30b (left panel) and a top view of the third pattern of microstructures 31 on the top surface 30a (right panel). Both Figure 1A and Figure 1C illustrate, in some embodiments, that the third pattern of microstructures 31 can be larger than the second pattern of microstructures 32.

[0030] It can be advantageous for some embodiments to have the third pattern of microstructures 31 larger in size than the second pattern of microstructures 32. For example, in some embodiments a patterned light guide plate 30, as shown in Figure 2, can be identical to that as shown in Figure 1A except that the third pattern of microstructures 31 and the second pattern of microsturctures 32 have substantially the same size. In this non-limiting embodiment, mmore than 60% of the dominant rays of the light sources are redirected into the light guide plate at an angle that is greater than the total internal reflection angle. Some dominant rays refracted by the second pattern of microstructures 32 on the bottom surface 30b do not meet the third pattern of microstructures 31 on the top surface 30a. Therefore they are not reflected into the light guide plate 30. The patterned light guide plate 30

shown in Figure 2 still functions, however, to couple the dominant rays of the light sources into the light guide plate 30, though it is not as efficient as the patterned light guide plate 30 with a larger third pattern of microstructures 31 as shown in Figure 1A.

[0031] To capture more rays into an exemlary light guide plate and therefore enable more efficient spreading of light from the concentrated sources laterally, in the plane of the backlight, it can be advantageous to vary the geometry of exemplary microstructure patterns as a function of radius from the center of the pattern, as described in additional embodiments below.

[0032] For example, another exemplary embodiment of a light guide plate 30 is illustrated in Figure 3. With reference to Figure 3, this embodiment is identical to that shown in Figure 1A except that the two rightmost prisms 35, 36 of the third pattern of microstructures 31 in Figure 3 have different first and second base angles. In this particular embodiment, the first and second base angles are depicted to be 25° and 50°, respectively. Other prisms of the third pattern of microstructures 31 in Figure 3 can have the same first and second base angles of 25°, as depicted. but such examples should not limit the scope of the claims appended herewith. Of course, these angles and geometries described with reference to Figure 3 are exemplary only and should not limit the scope of the claims appended herewith as, for example, the base angles of these microstructures can be selected such that more than 60% of the dominant rays of the light sources are redirected into the light guide plate at an angle that is greater than the total internal reflection angle.

[0033] By way of further example, another exemplary embodiment of a light guide plate 30 is illustrated in Figure 4. With reference to Figure 4, this embodiment is identical to that shown in Figure 1A except that the rightmost prism 36 of the third pattern of microstructures 31 in Figure 4 has a different pitch than the other prisms in the third pattern of microstructures 31. In this particular example, the pitch of the rightmost prism 36 is 140 μm, larger than the depicted pitch of the other prisms at 100 μm. In such an embodiment, more dominant rays of the light sources can be reflected into the light guide plate 30 and undergo total internal reflection. Of course, these pitches and geometries described with reference to Figure 4 are exemplary only and should not limit the scope of the claims appended herewith as,

for example, the pitch of these prisms can be selected such that more than 60% of the dominant rays of the light sources are redirected into the light guide plate at an angle that is greater than the total internal reflection angle.

[0034] In the embodiment of an exemplary backlight shown in Figure 1A, for an LED source with Lambertian output radiation pattern and second and third microstructures 31, 32 designed according to the guidelines described above, some of the LED output can be captured by the light guide plate 30 and spread in a plane defined by the respective backlight by propagating in the light guide plate 30. Some of the LED output can be transmitted through the light guide plate 30. This might create “hot spots” – areas with higher brightness apparent to the observer positioned at normal direction to the backlight plane, i.e., the typical position of a user of the display where the backlight is employed. In conventional direct lit backlights, this can be remedied by positioning a strong optical diffuser some distance away from LED sources, such that the hot spots are “washed out”. Doing so, however, necessarily makes the backlight relatively thick. Thus, in some embodiments, a patterned reflector with radially varying reflectivity can be advantageously used.

[0035] An exemplary backlight 120 is shown in Figure 5 having the light guide plate 30 shown in Figure 1A with a patterned reflector 20 over the patterned light guide plate 30. In some embodiments, the patterned reflector 20 may be separated from the light guide plate 30 by an air gap 21 or may be monolithically integrated with the light guide plate 30 (not shown), e.g., a patterned reflective coating on the top surface of the light guide plate.

[0036] In some embodiments, an exemplary patterned reflector 20 can have a more reflective area 20a and a more transparent area 20b. The more transparent area 20b can vary in size in the horizontal direction x-axis and can be registered with light sources 5. The size and density of the transparent areas can be designed to homogenize the spatial luminance distribution in certain embodiments. Exemplary backlights can also comprise one or more optical films, such as a quantum dot film for improving color gamut, a prismatic film (such as so called brightness enhancement film or BEF) to control the angular distribution, and/or a reflective polarizing film 10 for recycling the light with a polarization that would otherwise be absorbed by a rear polarizer of an LCD panel.

[0037] As a result, in an exemplary backlight 120 a first portion of light can travel laterally in the patterned glass light guide plate 30 due to the total internal reflection and extracted out by the pattern of light extractors. Depending on the nature and design of the light extractors (e.g., areas of the surface coated with highly scattering paint, laser damaged areas, micro-optic features such as prisms or lenses formed on the glass surface out of plastic or another glass, or other light extractors known in the art), the light can be extracted toward the patterned reflector, or toward the bottom reflector, or in both directions. The second portion of the light travels laterally between the bottom reflector and the patterned reflector due to multiple reflections at the reflective surfaces of the bottom reflector and the patterned reflector.

[0038] In conventional direct lit backlights, the spacing between a plane defined by light sources (e.g., LEDs) and a plane defined by an optical diffuser (conventionally used to "wash out" hot spots corresponding to individual light sources and provide area-uniform illumination to the display panel) is commonly called "optical distance" or OD. In conventional backlights, OD is typically 25-30 mm or even larger. With the use of an exemplary patterned light guide plate and a patterned reflector, the optical distance OD can be nearly as small as the thickness of the light guide plate (with an addition of the thickness of first and second microstructures, the thickness of the patterned reflector, and air gaps between them). Thicknesses of exemplary glass light guide plates can range from 0.1 mm to 2 mm, 0.1 mm to 1 mm, and 0.1 mm to 0.7 mm.

[0039] Figure 7 shows a side view of another exemplary backlight 120 (described above) further comprising a diffuser plate 121, a quantum dot film 122, a prismatic film 123, and a reflective polarizer 124. Figure 7 also illustrates that the backlight 120 can be used in combination with a display panel such as an LCD panel 125.

[0040] Figures 8A – 8D are graphs which provide comparisons between a first backlight design and a second backlight design with and without an exemplary light guide plate having second and third microstructure patterns. With reference to Figures 8A – 8D, two backlight designs are compared, each design having 3 x 3 zones, each zone having a size of 100 mm x 100 mm. Each backlight comprises a

bottom reflector having a Lambertian emission angular distribution, a Lambertian reflectance of 98% and absorbance of 2%, an LED with a diameter of 1 mm having a Lambertian reflectance of 60% and absorbance of 40%, and a patterned reflector designed to provide uniform brightness over the respective backlight area having four different properties: Figure 8A: a specular reflectance of 98% and absorbance of 2%; Figure 8B: a specular reflectance of 92% and absorbance of 8%; Figure 8C: a Lambertian reflectance of 98% and absorbance of 2%; and Figure 8D: a Lambertian reflectance of 92% and absorbance of 8%. The first backlight design (with LGP) also comprises a patterned glass light guide plate located between the LED and the patterned reflector. The light guide plate in this first design has a refractive index of 1.5 and has a thickness d varying between 0.1 mm and 0.9 mm. The light guide plate has an internal transmission of 98.567% over 1000 mm at 550 nm, has a second pattern of microstructures in which the first and second base angles of the respective prisms are 45°, and has a third pattern of microstructures in which the first and second base angles of the respective prisms are 25°. The second backlight design (without LGP) has no glass light guide plate (see, e.g., Figure 6). Rather and as shown in Figure 6, the second backlight design has an air gap 21 of the same thickness as the glass light guide plate for the first backlight design.

[0041] With reference to Figures 8A – 8D, only the LED in the center zone is turned on. As can be observed, in all of the four cases, light power efficiency (defined as the ratio between the light power that is not absorbed by the LED, the bottom reflector, the patterned reflector, or the light guide, and the total light power emitted from the LED) in the second backlight design without the glass light guide plate is quite low and decreases with reduced thicknesses d. Light power efficiency in the first backlight design with the glass light guide plate is noticeably higher, by almost a factor of 3x in certain instances (see, e.g., Figure 8C), and peaks at a light guide plate thickness d of about 0.7 mm.

[0042] Tables 1 and 2 below provide a comparison between backlight designs with different base angles in the second and third patterns of microstructures. With reference to these tables, various backlight designs are compared each design comprising 3 x 3 zones, each zone having a size of 100 mm x 100 mm, and each backlight design comprising a bottom reflector having a

Lambertian reflectance of 98% and absorbance of 2%, an LED with a diameter of 1 mm having a Lambertian emission angular distribution, a Lambertian reflectance of 60%, and absorbance of 40%, a patterned reflector designed to provide uniform brightness over the backlight area having a Lambertian reflectance of 92% and absorbance of 8%.

[0043] With reference to Table 1, light power efficiency, as defined above, vs. the base angle α_B of the prisms of the second pattern of microstructures on the bottom surface and the base angle α_T of the prisms of the third pattern of microstructures on the top surface of the light guide plate are examined. Since the light power efficiency depends on the reflectance of the bottom reflector, the reflectance of the patterned reflector, and other factors, it is also important to examine the relative light power efficiency to understand the impact of the base angles α_B, α_T of the prisms on the bottom and top surfaces of the light guide. Table 2 shows the relative light power efficiency at various base angles α_B, α_T, with the relative light power efficiency being 100% when the base angle α_B on the bottom surface is 45°, and the base angle α_T on the top surface is 25°.

Table 1

Light Power Efficiency		Base angle of the prisms on the top surface							
		0	5	15	25	35	45	55	65
Base angle of the prisms on the bottom surface	0	20.1%	21.6%	26.3%	30.9%	31.1%	31.0%	30.5%	28.9%
	5	22.9%	24.0%	28.4%	33.0%	33.2%	33.1%	32.8%	31.0%
	15	30.2%	31.1%	34.2%	38.3%	38.7%	38.8%	38.4%	37.0%
	25	37.4%	38.3%	40.8%	43.6%	43.8%	44.3%	43.8%	42.9%
	35	42.1%	43.0%	45.3%	47.4%	47.2%	47.6%	47.2%	46.5%
	45	44.4%	45.3%	47.8%	49.4%	48.5%	48.7%	48.4%	48.2%
	55	44.2%	45.1%	47.8%	49.5%	48.7%	49.0%	48.6%	48.2%
	65	42.3%	43.2%	46.0%	48.7%	48.5%	48.9%	48.2%	47.3%

Table 2

Relative Light Power Efficiency		Base angle of the prisms on the top surface							
		0	5	15	25	35	45	55	65
Base angle of the prisms on the bottom surface	0	41%	44%	53%	63%	63%	63%	62%	58%
	5	46%	49%	58%	67%	67%	67%	66%	63%
	15	61%	63%	69%	78%	78%	78%	78%	75%
	25	76%	78%	83%	88%	89%	90%	89%	87%

	35	85%	87%	92%	96%	96%	96%	96%	94%
	45	90%	92%	97%	100%	98%	99%	98%	97%
	55	89%	91%	97%	100%	99%	99%	98%	98%
	65	86%	87%	93%	99%	98%	99%	97%	96%

[0044] With reference to Table 2, it can be observed that the base angle of the prisms in the second pattern of microstructures on the bottom surface in the range of 25 degrees to 65 degrees may be preferable, and that the base angle of the prisms in the third pattern of microstructures on the top surface in the range of 15 degrees to 65 degrees may be preferable. In other embodiments, the base angle of the prisms of the second pattern of microstructures on the bottom surface may be in the range of 35 degrees and 55 degrees, and the base angle of the prisms of the third pattern of microstructures on the top surface may be in the range of 20 degrees and 50 degrees.

[0045] A few comparative examples can also be observed in Table 2. In embodiments having no prisms on the bottom and top surface: α_B=0°, α_T=0°, and relative light power efficiency = 41%. In embodiments having no prisms on the bottom surface: α_B=0°, α_T=5 to 65°, and relative light power efficiency ≤ 63%. In embodiments having no prisms on the top surface and prisms having small base angles: α_B=5 to 15°, α_T=0°, and relative light power efficiency ≤ 61%. In embodiments having a light guide plate with prisms on the bottom surface with a base angle in the ranges described above and no prisms the on top surface: α_B=45°, α_T=0°, and relative light power efficiency = 90%. In embodiments having a light guide plate with prisms on the bottom surface with a base angle in the ranges described above and prisms on the top surface with a base angle in the ranges describe above: α_B=25°, α_T=45°, and relative light power efficiency = 90%. In embodiments having a light guide plate with prisms on the bottom surface with a base angle in the ranges described above and prisms on the top surface with a base angle in the ranges described above: α_B=45°, α_T=25°, and relative light power efficiency = 100%.

[0046] Exemplary light guide plates can comprise a glass substrate with any desired size and/or shape as appropriate to produce a desired light distribution.

The major surfaces of the glass substrate may, in certain embodiments, be planar or substantially planar and/or parallel. The first and second major surfaces may also, in various embodiments, have a radius of curvature along at least one axis. The glass substrate may comprise four edges, or may comprise more than four edges, e.g. a multi-sided polygon. In other embodiments, the glass substrate may comprise less than four edges, e.g., a triangle. By way of a non-limiting example, the glass substrate may comprise a rectangular, square, or rhomboid sheet having four edges, although other shapes and configurations are intended to fall within the scope of the disclosure including those having one or more curvilinear portions or edges.

[0047] In certain embodiments, the glass substrate may have a thickness of less than or equal to about 3 mm, for example, ranging from about 0.1 mm to about 2.5 mm, from about 0.3 mm to about 2 mm, from about 0.5 mm to about 1.5 mm, or from about 0.7 mm to about 1 mm, including all ranges and subranges therebetween. The glass substrate can comprise any material known in the art for use in display devices, including aluminosilicate, alkali-aluminosilicate, borosilicate, alkali-borosilicate, aluminoborosilicate, alkali-aluminoborosilicate, soda lime, or other suitable glasses.

[0048] Some non-limiting glass compositions can include between about 50 mol % to about 90 mol% SiO_2, between 0 mol% to about 20 mol% Al_2O_3, between 0 mol% to about 20 mol% B_2O_3, between 0 mol% to about 20 mol% P_2O_5, and between 0 mol% to about 25 mol% R_xO, wherein R is any one or more of Li, Na, K, Rb, Cs and x is 2, or Zn, Mg, Ca, Sr or Ba and x is 1. In some embodiments, $R_xO - Al_2O_3 > 0$; $0 < R_xO - Al_2O_3 < 15$; x = 2 and $R_2O - Al_2O_3 < 15$; $R_2O - Al_2O_3 < 2$; x=2 and $R_2O - Al_2O_3 - MgO > -15$; $0 < (R_xO - Al_2O_3) < 25$, $-11 < (R_2O - Al_2O_3) < 11$, and $-15 < (R_2O - Al_2O_3 - MgO) < 11$; and/or $-1 < (R_2O - Al_2O_3) < 2$ and $-6 < (R_2O - Al_2O_3 - MgO) < 1$. In some embodiments, the glass comprises less than 1 ppm each of Co, Ni, and Cr. In some embodiments, the concentration of Fe is < about 50 ppm, < about 20 ppm, or < about 10 ppm. In other embodiments, Fe + 30Cr + 35Ni < about 60 ppm, Fe + 30Cr + 35Ni < about 40 ppm, Fe + 30Cr + 35Ni < about 20 ppm, or Fe + 30Cr + 35Ni < about 10 ppm. In other embodiments, the glass comprises between about 60 mol % to about 80 mol% SiO_2, between about 0.1 mol% to about 15 mol% Al_2O_3, 0 mol% to about 12 mol% B_2O_3, and about 0.1 mol% to about 15 mol% R_2O

and about 0.1 mol% to about 15 mol% RO, wherein R is any one or more of Li, Na, K, Rb, Cs and x is 2, or Zn, Mg, Ca, Sr or Ba and x is 1.

[0049] In other embodiments, the glass composition can comprise between about 65.79 mol % to about 78.17 mol% SiO_2, between about 2.94 mol% to about 12.12 mol% Al_2O_3, between about 0 mol% to about 11.16 mol% B_2O_3, between about 0 mol% to about 2.06 mol% Li_2O, between about 3.52 mol% to about 13.25 mol% Na_2O, between about 0 mol% to about 4.83 mol% K_2O, between about 0 mol% to about 3.01 mol% ZnO, between about 0 mol% to about 8.72 mol% MgO, between about 0 mol% to about 4.24 mol% CaO, between about 0 mol% to about 6.17 mol% SrO, between about 0 mol% to about 4.3 mol% BaO, and between about 0.07 mol% to about 0.11 mol% SnO_2.

[0050] In additional embodiments, the glass composition can comprise glass having an R_xO/Al_2O_3 ratio between 0.95 and 3.23, wherein R is any one or more of Li, Na, K, Rb, Cs and x is 2. In further embodiments, the glass may comprise an R_xO/Al_2O_3 ratio between 1.18 and 5.68, wherein R is any one or more of Li, Na, K, Rb, Cs and x is 2, or Zn, Mg, Ca, Sr or Ba and x is 1. In yet further embodiments, the glass can comprise an $R_xO - Al_2O_3 - MgO$ between -4.25 and 4.0, wherein R is any one or more of Li, Na, K, Rb, Cs and x is 2. In still further embodiments, the glass may comprise between about 66 mol % to about 78 mol% SiO_2, between about 4 mol% to about 11 mol% Al_2O_3, between about 4 mol% to about 11 mol% B_2O_3, between about 0 mol% to about 2 mol% Li_2O, between about 4 mol% to about 12 mol% Na_2O, between about 0 mol% to about 2 mol% K_2O, between about 0 mol% to about 2 mol% ZnO, between about 0 mol% to about 5 mol% MgO, between about 0 mol% to about 2 mol% CaO, between about 0 mol% to about 5 mol% SrO, between about 0 mol% to about 2 mol% BaO, and between about 0 mol% to about 2 mol% SnO_2.

[0051] In additional embodiments, the glass composition can comprise a glass material including between about 72 mol % to about 80 mol% SiO_2, between about 3 mol% to about 7 mol% Al_2O_3, between about 0 mol% to about 2 mol% B_2O_3, between about 0 mol% to about 2 mol% Li_2O, between about 6 mol% to about 15 mol% Na_2O, between about 0 mol% to about 2 mol% K_2O, between about 0 mol% to about 2 mol% ZnO, between about 2 mol% to about 10 mol% MgO, between about 0 mol% to about 2 mol% CaO, between about 0 mol% to about 2 mol% SrO, between

about 0 mol% to about 2 mol% BaO, and between about 0 mol% to about 2 mol% SnO_2. In certain embodiments, the glass can comprise between about 60 mol % to about 80 mol% SiO_2, between about 0 mol% to about 15 mol% Al_2O_3, between about 0 mol% to about 15 mol% B_2O_3, and about 2 mol% to about 50 mol% R_xO, wherein R is any one or more of Li, Na, K, Rb, Cs and x is 2, or Zn, Mg, Ca, Sr or Ba and x is 1, and wherein Fe + 30Cr + 35Ni < about 60 ppm.

[0052] In some embodiments, the glass substrate can comprise a color shift Δy less than 0.05, such as ranging from about -0.005 to about 0.05, or ranging from about 0.005 to about 0.015 (e.g., about -0.005, -0.004, -0.003, -0.002, -0.001, 0, 0.001, 0.002, 0.003, 0.004, 0.005, 0.006, 0.007, 0.008, 0.009, 0.010, 0.011, 0.012, 0.013, 0.014, 0.015, 0.02, 0.03, 0.04, or 0.05). In other embodiments, the glass substrate can comprise a color shift less than 0.008. Color shift may be characterized by measuring variation in the x and y chromaticity coordinates of the extracted light along the length L of an LGP illuminated by standard white LED(s) such as the Nichia NFSW157D-E using the CIE 1931 standard for color measurements. The nominal color point of the LED(s) is chosen to be y=0.28 and x=0.29. For glass LGPs the color shift Δy can be reported as $\Delta y = y(L_2)-y(L_1)$ where L_2 and L_1 are Z positions along the panel or substrate direction away from the source launch and where $L_2-L_1=0.5$ meters. Exemplary glass LGPs have $\Delta y < 0.05$, $\Delta y < 0.01$, $\Delta y< 0.005$, $\Delta y < 0.003$, or $\Delta y < 0.001$. If the LGP has no light extraction features it may be characterized by adding a small area of light extraction features at each measurement point L_1 and L_2.

[0053] According to certain embodiments, the glass substrate can have a light attenuation α_1 (e.g., due to absorption and/or scattering losses) of less than about 4 dB/m, such as less than about 3 dB/m, less than about 2 dB/m, less than about 1 dB/m, less than about 0.5 dB/m, less than about 0.2 dB/m, or even less, e.g., ranging from about 0.2 dB/m to about 4 dB/m, for wavelengths ranging from about 420-750 nm. Attenuation may be characterized by measuring light transmission $T_L(\lambda)$ of an input source through a transparent substrate of length L and normalizing this transmission by the source spectrum $T_0(\lambda)$. In units of dB/m the attenuation is given by $\alpha(\lambda) = -10/L*\log_{10}(T_L(\lambda)/T_L(\lambda))$ where L is the length in meters and $T_L(\lambda)$ and $T_L(\lambda)$ are measured in radiometric units.

[0054] The glass substrate may, in some embodiments, comprise glass that is chemically strengthened, e.g., by ion exchange. During the ion exchange process, ions within a glass sheet at or near the surface of the glass sheet may be exchanged for larger metal ions, for example, from a salt bath. The incorporation of the larger ions into the glass can strengthen the sheet by creating a compressive stress in a near surface region. A corresponding tensile stress can be induced within a central region of the glass sheet to balance the compressive stress.

[0055] Ion exchange may be carried out, for example, by immersing the glass in a molten salt bath for a predetermined period of time. Exemplary salt baths include, but are not limited to, KNO_3, $LiNO_3$, $NaNO_3$, $RbNO_3$, and combinations thereof. The temperature of the molten salt bath and treatment time period can vary. It is within the ability of one skilled in the art to determine the time and temperature according to the desired application. By way of a non-limiting example, the temperature of the molten salt bath may range from about 400ºC to about 800ºC, such as from about 400ºC to about 500ºC, and the predetermined time period may range from about 4 to about 24 hours, such as from about 4 hours to about 10 hours, although other temperature and time combinations are envisioned. By way of a non-limiting example, the glass can be submerged in a KNO_3 bath, for example, at about 450ºC for about 6 hours to obtain a K-enriched layer which imparts a surface compressive stress.

[0056] In some embodiments, an exemplary transparent material or substrate can comprise less than 1 ppm each of Co, Ni, and Cr. In some embodiments, the concentration of Fe is < about 50 ppm, < about 20 ppm, or < about 10 ppm. In other embodiments, Fe + 30Cr + 35Ni < about 60 ppm, Fe + 30Cr + 35Ni < about 40 ppm, Fe + 30Cr + 35Ni < about 20 ppm, or Fe + 30Cr + 35Ni < about 10 ppm. According to additional embodiments, an exemplary transparent material can comprise a color shift $\Delta y < 0.015$ or, in some embodiments, a color shift < 0.008.

[0057] As noted above, exemplary light guide assemblies and backlights disclosed herein can comprise at least one optical manipulation feature designed to direct light in a forward direction, e.g., toward the viewer. For instance, the optical manipulation feature may increase the amount of light transmitted by a light guide assembly in a direction normal or substantially normal to the light emitting surface of

the glass substrate. The relative refractive indices of the prismatic layer n_P, modifying layer(s) n_M and/or $n_{M'}$, and glass substrate n_G can similarly be engineered to promote the normal or substantially normal direction of light rays transmitted by the light guide assembly. The use of inorganic or inorganic-organic materials to replace one or more organic (e.g., polymeric) layers in the backlight stack may provide opportunities to create layers of varying refractive index, which may allow for a greater degree of light manipulation within the backlight stack.

[0058] The light guide assemblies disclosed herein may be used in various display devices including, but not limited to, LCDs. The optical components of an exemplary LCD may further comprise one or more diffusing, reflecting, prismatic, and/or polarizing films, a thin film transistor (TFT) array, a liquid crystal layer, and/or one or more color filters, to name a few components. The light guide assemblies disclosed herein may also be used in various illuminating devices, such as luminaires or solid state lighting devices.

[0059] It will be appreciated that the various disclosed embodiments may involve particular features, elements or steps that are described in connection with that particular embodiment. It will also be appreciated that a particular feature, element or step, although described in relation to one particular embodiment, may be interchanged or combined with alternate embodiments in various non-illustrated combinations or permutations.

[0060] It is also to be understood that, as used herein the terms “the,” “a,” or “an,” mean “at least one,” and should not be limited to “only one” unless explicitly indicated to the contrary. Thus, for example, reference to “a light source” includes examples having two or more such light sources unless the context clearly indicates otherwise. Likewise, a “plurality” or an “array” is intended to denote “more than one.” As such, a “plurality of light extraction features” includes two or more such features, such as three or more such features, etc., and an “array of microstructures” includes two or more such microstructures, such as three or more such microstructures, and so on.

[0061] Ranges can be expressed herein as from “about” one particular value, and/or to “about” another particular value. When such a range is expressed, examples include from the one particular value and/or to the other particular value.

Similarly, when values are expressed as approximations, by use of the antecedent "about," it will be understood that the particular value forms another aspect. It will be further understood that the endpoints of each of the ranges are significant both in relation to the other endpoint, and independently of the other endpoint.

[0062] The terms "substantial," "substantially," and variations thereof as used herein are intended to note that a described feature is equal or approximately equal to a value or description. For example, a "substantially planar" surface is intended to denote a surface that is planar or approximately planar. Moreover, as defined above, "substantially similar" is intended to denote that two values are equal or approximately equal. In some embodiments, "substantially similar" may denote values within about 10% of each other, such as within about 5% of each other, or within about 2% of each other.

[0063] Unless otherwise expressly stated, it is in no way intended that any method set forth herein be construed as requiring that its steps be performed in a specific order. Accordingly, where a method claim does not actually recite an order to be followed by its steps or it is not otherwise specifically stated in the claims or descriptions that the steps are to be limited to a specific order, it is no way intended that any particular order be inferred.

[0064] While various features, elements or steps of particular embodiments may be disclosed using the transitional phrase "comprising," it is to be understood that alternative embodiments, including those that may be described using the transitional phrases "consisting" or "consisting essentially of," are implied. Thus, for example, implied alternative embodiments to an assembly that comprises A+B+C include embodiments where an assembly consists of A+B+C and embodiments where an assembly consists essentially of A+B+C.

[0065] It will be apparent to those skilled in the art that various modifications and variations can be made to the present disclosure without departing from the spirit and scope of the disclosure. Since modifications combinations, sub-combinations and variations of the disclosed embodiments incorporating the spirit and substance of the disclosure may occur to persons skilled in the art, the disclosure should be construed to include everything within the scope of the appended claims and their equivalents.

WHAT IS CLAIMED IS:

1. A backlight comprising:

a plurality of light sources; and

a patterned light guide plate having a first pattern of microstructures on a top surface or a bottom surface to extract light from the plurality of light sources, a second pattern of microstructures on the bottom surface, and a third pattern of microstructures on the top surface near or above the light sources,

wherein the plurality of light sources are located directly behind the patterned light guide plate, and

wherein dominant rays of the plurality of light sources are transmitted by the second pattern and reflected by the third pattern such that more than 60% of the dominant rays travels laterally in the patterned light guide plate due to total internal reflection.

2. The backlight of claim 1, wherein the second pattern and the third pattern of microstructures on the patterned light guide plate are circular in shape.

3. The backlight of claim 1, wherein the second pattern of microstructures on the patterned light guide plate has a base angle between 25 and 65 degrees.

4. The backlight of claim 1, wherein the third pattern of microstructures on the patterned light guide plate has a base angle between 15 and 65 degrees.

5. The backlight of claim 3, wherein the second pattern of microstructures on the patterned light guide plate has a base angle between 35 and 55 degrees.

6. The backlight of claim 1, wherein the third pattern of microstructures on the patterned light guide plate has a base angle between 20 and 50 degrees.

7. The backlight of claim 1, wherein the third pattern of microstructures is larger than the second pattern of microstructures.

8. The backlight of claim 1, wherein some microstructures in the third pattern have different angles.

9. The backlight of claim 1, wherein some microstructures in the third pattern have different pitches.

10. The backlight of claim 1, wherein the patterned light guide plate comprises glass or a polymer.

11. The backlight of claim 1, wherein the thickness of the patterned light guide plate is between 0.1 mm and 2 mm.

12. The backlight of claim 1 further comprising a diffuser plate, a quantum dot film, a prismatic film, or a reflective polarizer.

13. The backlight of claim 1 further comprising a patterned reflector having a first area and a second area, the first area being more reflective than the second area, and the second area being more transmissive than the first area.

14. The backlight of claim 1 further comprising a bottom reflector.

15. The backlight of claim 1 wherein the patterned light guide plate has a first pattern of microstructures on both the top and bottom surfaces.

16. A backlight comprising:

a plurality of light sources; and

a patterned light guide plate having a first pattern of microstructures on a top surface or a bottom surfaces to extract light from the plurality of light sources, and a second pattern of microstructures on the bottom surface near or above the plurality

of light sources to redirect the light away from the plurality of light sources and reduce the absorption of the light by the plurality of light sources;

wherein the plurality of light sources are located directly behind the patterned light guide plate, and

wherein the first pattern of microstructures have a base angle in the range between 25 and 65 degrees.

17. The backlight of claim 16, wherein the patterned light guide plate further comprises a third pattern of microstructures on the top surface near or above the light sources to further redirect the light away from the plurality of light sources and to reduce the absorption of the light by the plurality of light sources, and

wherein the third pattern of microstructures has a base angle in the range between 15 and 65 degrees.

18. The backlight of claim 16 further comprising a bottom reflector.

19. The backlight of claim 16 wherein the patterned light guide plate has a first pattern of microstructures on both the top and bottom surfaces.

FIG. 1A

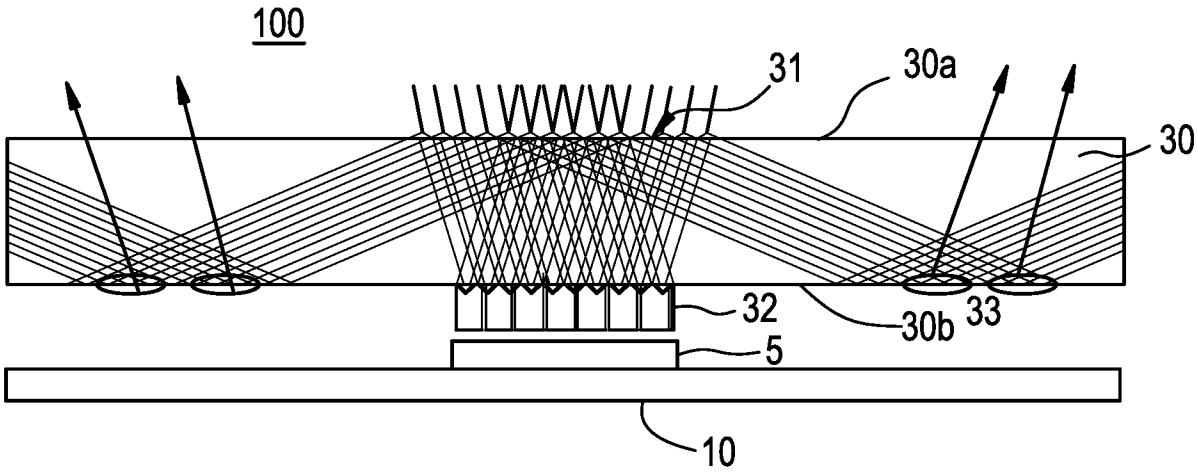


FIG. 1B

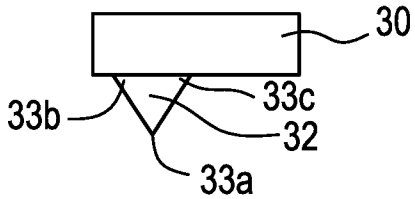


FIG. 1C

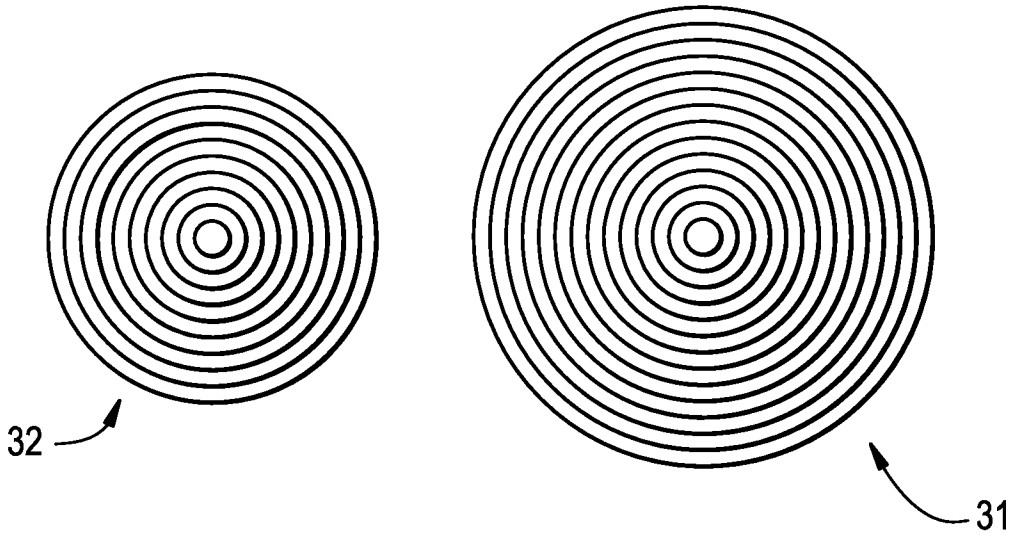


FIG. 2

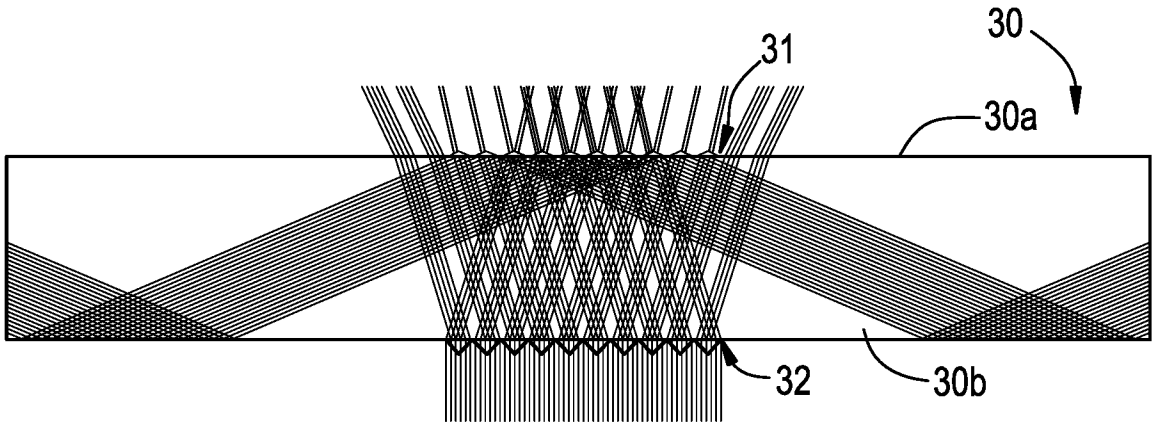


FIG. 3

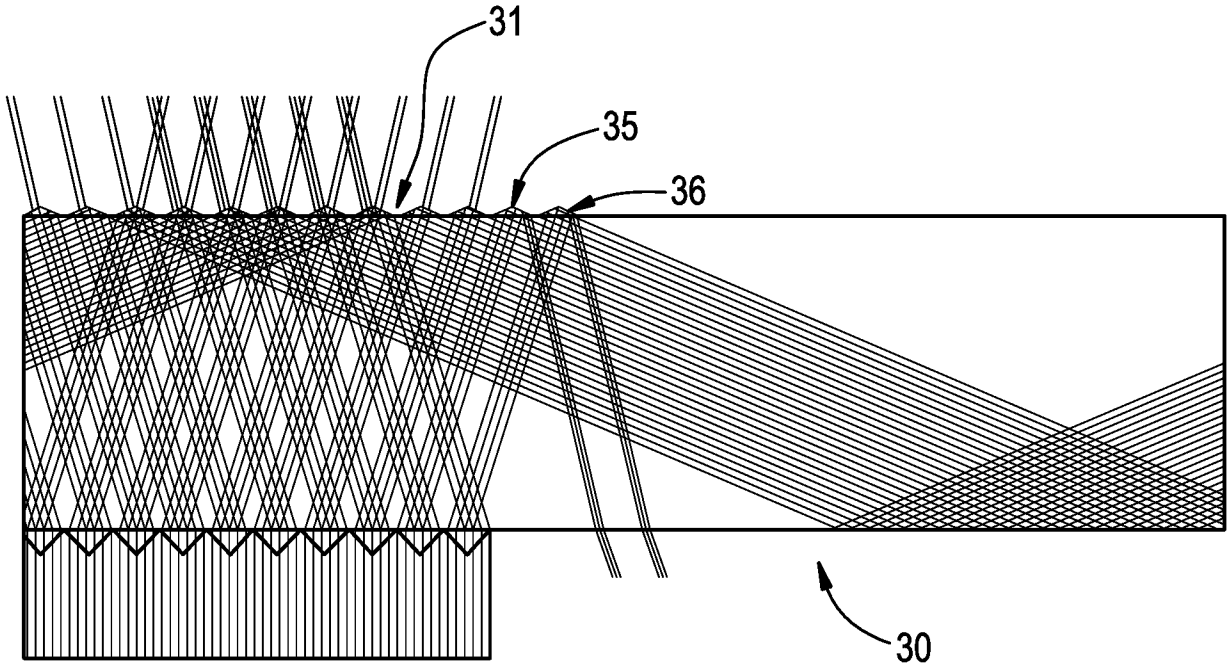


FIG. 4

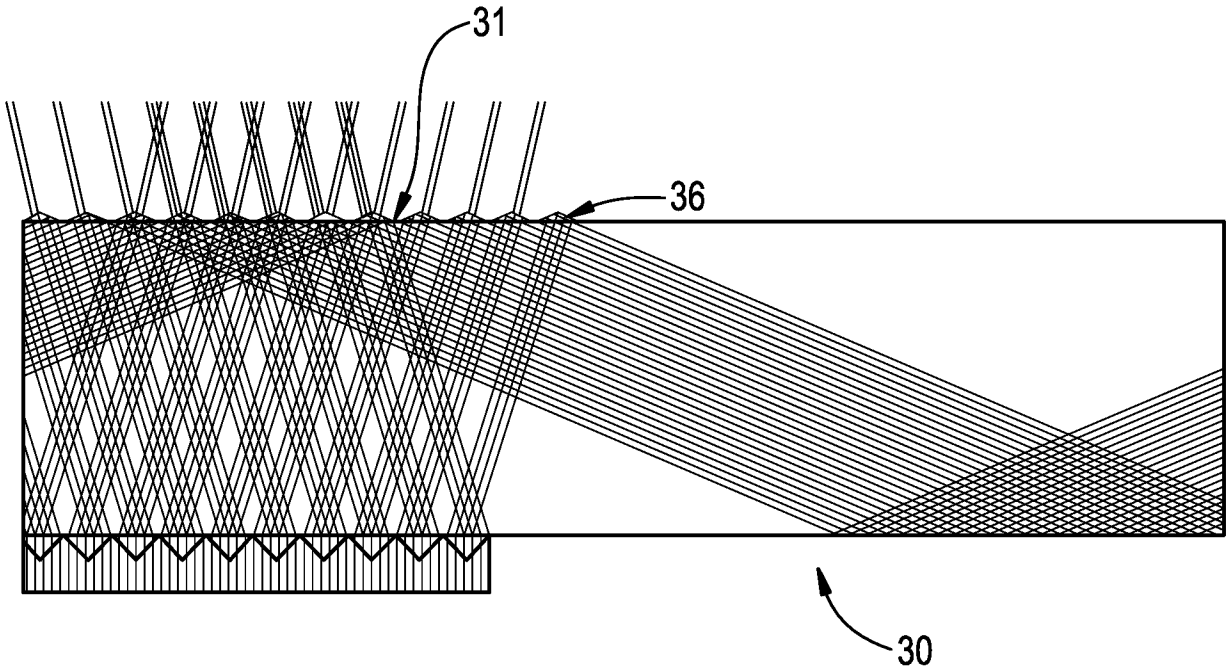


FIG. 5

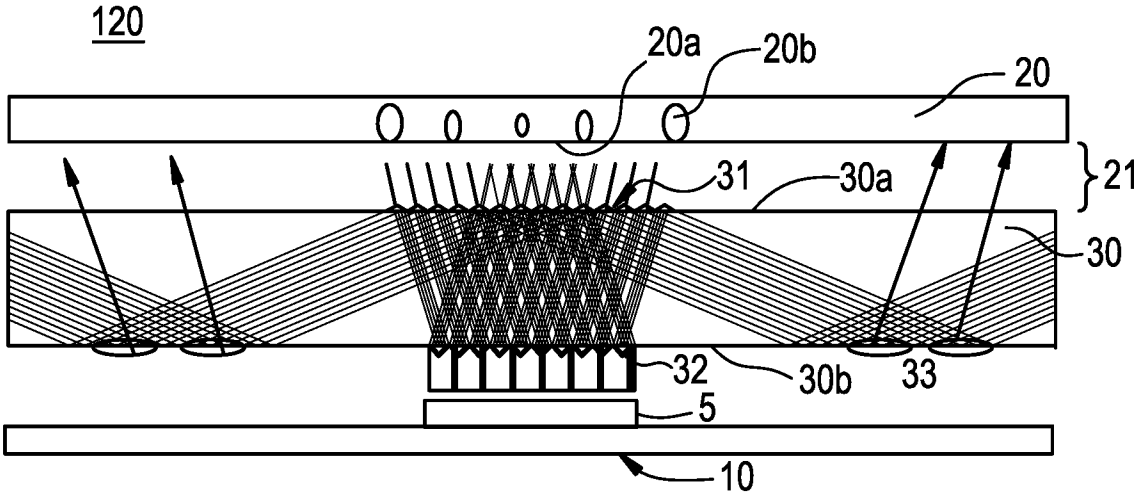


FIG. 6

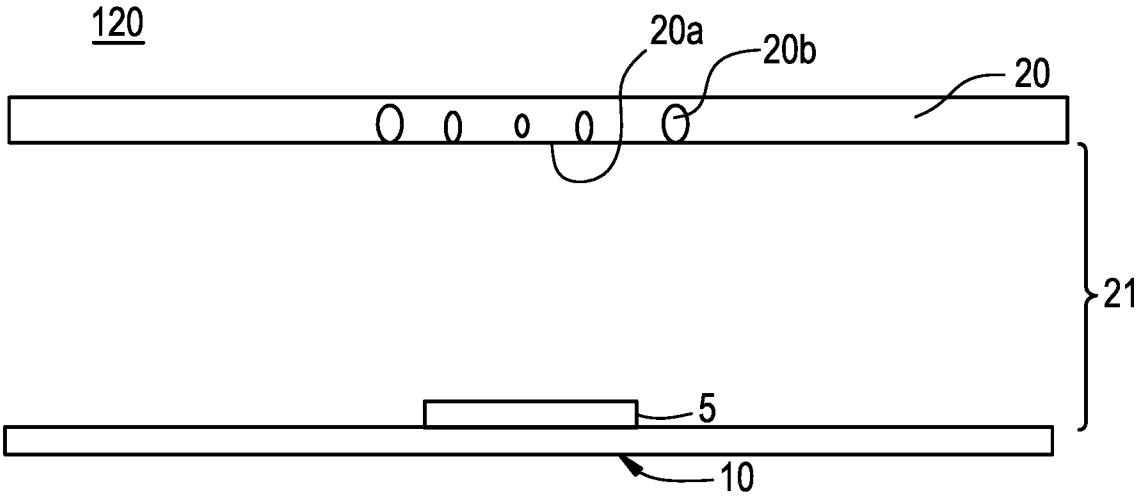


FIG. 7

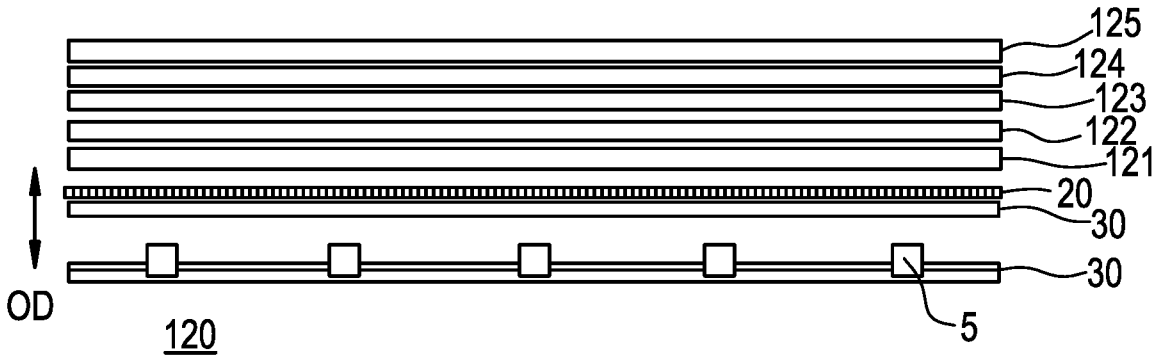


FIG. 8A

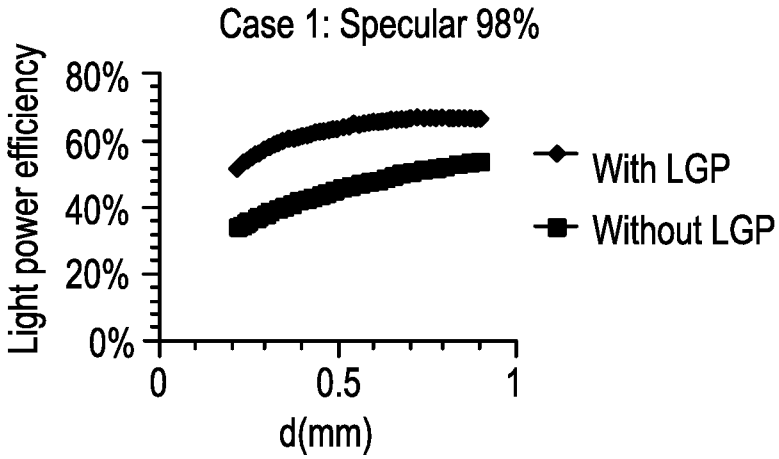


FIG. 8B

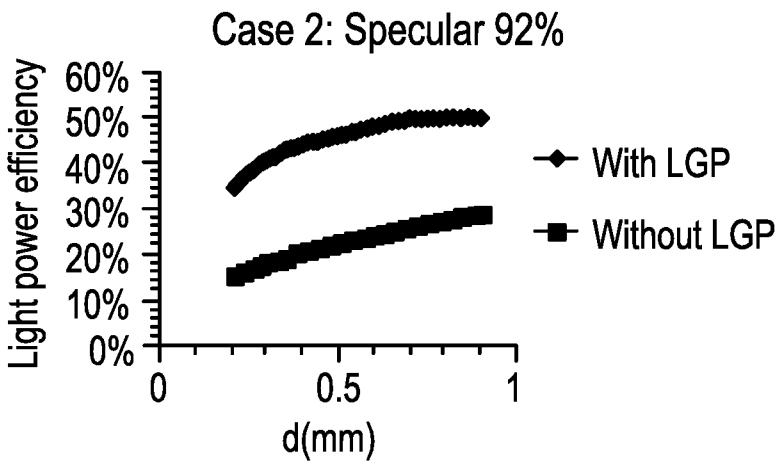


FIG. 8C

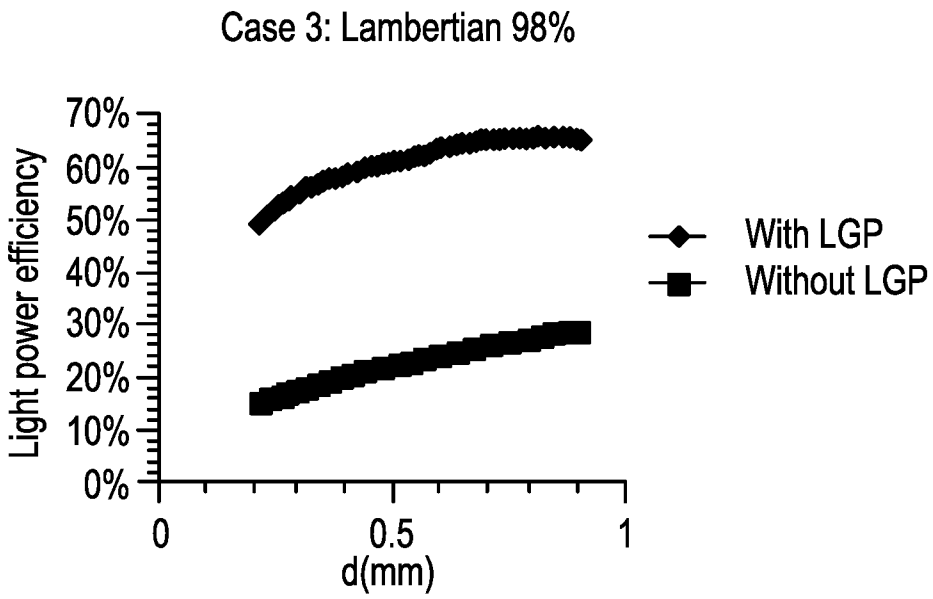
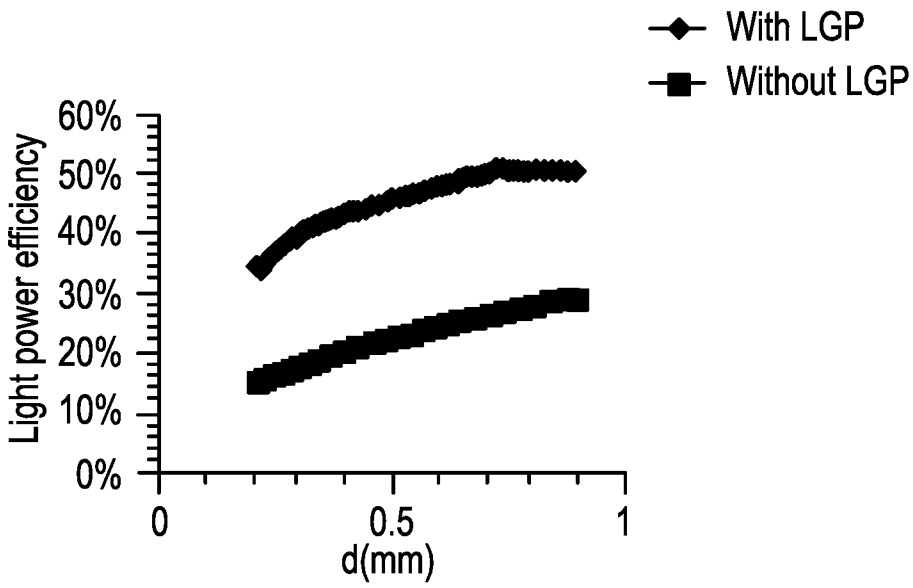

Case 3: Lambertian 98%
70%
60%
50%
40%
30%
20%
10%
0%
Light power efficiency
0
0.5
1
d(mm)
With LGP
Without LGP

FIG. 8D


Case 4: Lambertian 92%
With LGP
Without LGP
60%
50%
40%
30%
20%
10%
0%
Light power efficiency
0
0.5
1
d(mm)

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2018/047635

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, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2012/064007 A1 (LG INNOTEK CO LTD [KR]; KIM JONG SUN [KR]; PARK SANG JUN [KR]; AHN KYO) 18 May 2012 (2012-05-18)	1,3-19
Y	abstract paragraphs [0039], [0040], [0043] figures 2,4f	2

X	WO 2010/058625 A1 (SHARP KK [JP]; SHIMIZU TAKAHARU) 27 May 2010 (2010-05-27)	1,3-10, 15-17,19
Y	abstract	2
A	figure 2	11-14,18

X	US 2012/013811 A1 (SHIMIZU TAKAHARU [JP]) 19 January 2012 (2012-01-19)	1,2,16
A	abstract figures 5,7,8 paragraphs [0054] - [0046]	3-15, 17-19

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

☒ See patent family annex.

* Special categories of cited documents :

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"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	Date of mailing of the international search report
31 October 2018	07/11/2018

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	Menck, Alexander

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2018/047635

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2012064007 A1	18-05-2012	CN 103299236 A	11-09-2013
		EP 2638428 A1	18-09-2013
		JP 5931895 B2	08-06-2016
		JP 2013542575 A	21-11-2013
		TW 201234089 A	16-08-2012
		US 2013223096 A1	29-08-2013
		WO 2012064007 A1	18-05-2012
WO 2010058625 A1	27-05-2010	CN 102216672 A	12-10-2011
		US 2011194034 A1	11-08-2011
		WO 2010058625 A1	27-05-2010
US 2012013811 A1	19-01-2012	JP 5179651 B2	10-04-2013
		JP WO2010113361 A1	04-10-2012
		KR 20110134439 A	14-12-2011
		US 2012013811 A1	19-01-2012
		WO 2010113361 A1	07-10-2010