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(71) Applicant *(for all designated States except US)*: **3M INNOVATIVE PROPERTIES COMPANY** [US/US]; 3M Center, Post Office Box 33427, Saint Paul, MN 55133-3427 (US).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: **KROPP, Karl M.**, [US/US]; 3M Center, Post Office Box 33427, Saint Paul, MN 55133-3427 (US). **WEAVER, Billy L.**, [US/US]; 3M Center, Post Office Box 33427, Saint Paul, MN 55133-3427 (US). **WHEATLEY, John A.**, [US/US]; 3M Center, Post Office Box 33427, Saint Paul, MN 55133-3427 (US).

(74) Agents: **KNECHT, Harold C., III**, et al.; 3M Center Office of Intellectual Property Counsel, Post Office Box 33427, Saint Paul, MN 55133-3427 (US).

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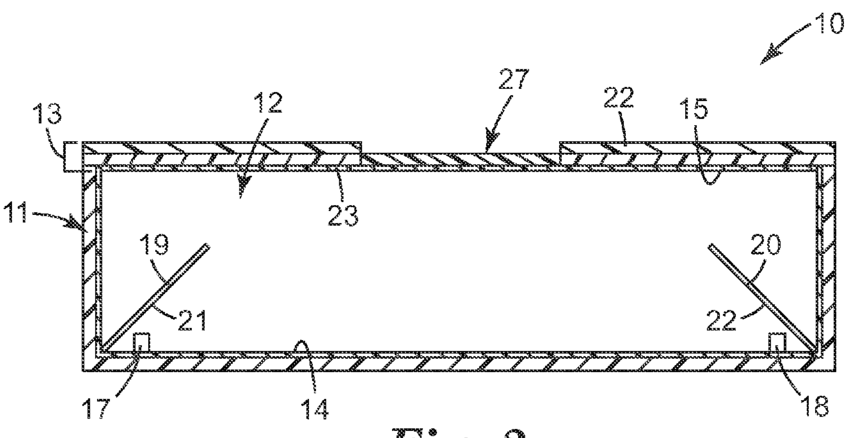

Fig. 2

(57) **Abstract**: Articles and lighting assemblies (10) that include a non-transmissive substrate (22) having first and second, generally opposed major surfaces, a film having first and second generally opposed major surfaces, the film is at least one of semi-specularly reflective or specularly reflective and has an on-axis average reflectivity emitted of at least 98% of any polarization and a partially reflective film having first and second generally opposed major surfaces. Light assemblies described herein are useful as functional or decorative elements, for example, in displays, signs, and vehicles (e.g., automobile, trucks, etc.). Useful embodiments of light assemblies described herein for vehicles include automobile and truck (vehicle) lighting, dash lighting, instrument cluster lighting, door sill lighting, dome lighting, and under cabinet lighting.

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LIGHTING ASSEMBLY

Background

[0001] Light emitting diodes ("LEDs") (also sometimes referred to as "solid state lamps") are well known in the art. Known LEDs include those having Lambertian light emission pattern and having a light emission collimated to a range from 20° to 30° in at least one direction (e.g., the thickness direction of an enclosure, as well as in a cone). One limitation of lighting with LEDs is providing uniform illumination over an output surface. The ratio between the size of the LED die and illuminated area typically ranges from several 100 to several 1,000 to 1, to even more than 10000 to 1 (i.e., size of the lighted area vs. the size of the LED die). One technique for trying to obtain more uniform lighting from LEDs is to utilize numerous, relatively closely spaced LEDs, which is an approach that is inefficient from both a cost standpoint having to use numerous LEDS, as well as the sensitivity of these systems to drift or failure of an individual LED.

[0002] LEDs are used in a variety of applications. Distributing light from LEDs is a common need shared by signs, displays, and liquid crystal displays. Here, a light distribution enclosure is placed behind an element which can be a colored panel, a graphic, or an LCD panel. Often, the goal is to achieve uniform illumination in a thin form factor, and with the fewest possible light sources.

[0003] LEDs have been used to light vehicle sill plates, but tend to lack desired efficiency, brightness, and uniformity. Current lighted sill plate designs can use multiple LEDs directly coupled to a light distribution assembly. Generally this is a sheet of clear plastic, but it could also be a bundle of plastic optical fibers. Typically these approaches lack lighting uniformity, sufficient brightness, or both.

[0004] One approach to try to provide a more efficient distribution of light is to use multiple LEDs directly attached to the edge of a light guide. Use of light guides can add significant weight to a system.

Summary

[0005] In one aspect, the present disclosure describes an article comprising:

a non-transmissive (in some embodiments, opaque) substrate having first and second, generally opposed major surfaces,

a film having first and second generally opposed major surfaces, the film is at least one of semi-specularly reflective or specularly reflective and has an on-axis average reflectivity of at least 98% (in some embodiments, is at least 98.5% or more) of any polarization; and a partially reflective film having first and second generally opposed major surfaces. In some embodiments, for example, the non-transmissive substrate, the film having an on-axis average reflectivity of at least 98% (in some embodiments, at least 98.5% or more) of any polarization, and the partially reflective film are in that order. In some embodiments, for example, the non-transmissive substrate, and the film having an on-axis average reflectivity of at least 98% (in some embodiments, at least 98.5% or more) of any polarization are in that order.

[0006] It is understood herein that all the reflectivity values encompass all visible light reflected into a hemisphere (i.e., such values include semi-specular, specular, and diffuse reflections). It is understood that an element can be one or several optical elements which collectively function as the partial reflector or diffusive element. The term "transmissive" as used herein means at least 50% (optionally, at least 60%, 70%, 75%, 80%, 85%, or even at least 90%) of the photons for at least one wavelength in the of light (e.g., in the visible spectrum) striking the area/film/element/etc. are transmitted through and exit the area/film/element/etc., as applicable.

[0007] In some embodiments of articles described herein, the first and second major surfaces of both the non-transmissive substrate and the film having an on-axis average reflectivity of at least 98% (in some embodiments, at least 98.5% or more) of any polarization comprises an aligned discontinuous area(s) (i.e., one, two, three, four, five, or more discontinuous area(s)) of at least 1 mm^2 (in some embodiments, at least 2 mm^2, 3 mm^2, 4 mm^2, 5 mm^2, 10 mm^2, 100 mm^2, 1000 mm^2, or even at least 10,000 mm^2, or more).

[0008] "Aligned discontinuous area" as used herein refers to an area overlapping discontinuous areas. For example, the non-transmissive substrate may have a discontinuous area of 12 mm^2, and the specularly reflective film may have a discontinuous area of 8 mm^2, where 7 mm^2 of the discontinuous area of the film having an on-axis average reflectivity of at least 98% (in some embodiments, at least 98.5% or more) of any polarization overlaps with the 12 mm^2 of discontinuous area of the non-transmissive substrate. In this case, the aligned discontinuous area is 5 mm^2.

[0009] The article is useful, for example, to make, and as a part of, a lighting assembly (e.g., a top of a lighted enclosure) such as described herein.

[0010] In another aspect, the present disclosure describes an lighting assembly comprising:

an enclosure having an interior surface and a first transmissive area, the interior surface comprising a first surface area region and a second surface area region generally opposite the first surface area region, wherein the first transmissive area is within second surface area region, wherein the interior surface is at least one of semi-specularly reflective or specularly reflective and has an on-axis average reflectivity of at least 98% (in some embodiments, at least 98.5% or more) of any polarization, wherein the second surface area region of the enclosure is a film having a first major surface that is at least one of semi-specularly reflective or specularly reflective and has an on-axis average reflectivity of at least 98% (in some embodiments, at least 98.5% or more) of any polarization, and a second, generally opposed major surface affixed to a first major surface a non-transmissive substrate, wherein the non-transmissive substrate has a second major surface, generally opposed to the first major surface of the non-transmissive substrate, and wherein the first and second major surfaces of both the non-transmissive substrate and the film of the second major surface of the enclosure comprises an aligned discontinuous area(s) (i.e., one, two, three, four, five, or more discontinuous area(s)) of at least 1 mm^2 (in some embodiments, at least 2 mm^2, 3 mm^2, 4 mm^2, 5 mm^2, 10 mm^2, 100 mm^2, 1000 mm^2, or even at least 10,000 mm^2, or more);

a partially reflective film positioned in the enclosure opposite the first surface area region; and

a first light source member disposed to emit light into the enclosure over a limited angular distribution, wherein the first light source member is between the first surface area region and the partially reflective film. In some embodiments, the lighting assembly further comprises additional transmissive areas (i.e., two, three, four, five, six, seven, eight, nine, ten, or more) within the second surface area region.

[0011] In another aspect, the present disclosure describes an lighting assembly comprising:

an enclosure having an interior surface and a first transmissive area, the interior surface comprising a first surface area region and a second surface area region generally opposite the first surface area region, wherein the first transmissive area is within second surface area region, wherein the interior surface is at least one of semi-specularly reflective or specularly reflective and has an on-axis average reflectivity of at least 98% (in some embodiments, at least 98.5% or more) of any polarization, wherein the second surface area region of the enclosure has a generally opposed major surface facing a first major surface of a non-transmissive substrate, wherein the non-transmissive substrate has a second major surface, generally opposed to the first major surface of the non-transmissive substrate, and wherein the first and second major surfaces of both the non-transmissive substrate and the second surface area region of the enclosure, including the generally opposed major surface thereof, comprises an aligned discontinuous area(s) (i.e., one, two, three, four, five, or more discontinuous area(s)) of at least 1 mm^2 (in some embodiments, at least 2 mm^2, 3 mm^2, 4 mm^2, 5 mm^2, 10 mm^2, 100 mm^2, 1000 mm^2, or even at least 10,000 mm^2, or more);

a partially reflective film positioned in the enclosure opposite the first surface area region; and

a first light source member disposed to emit light into the enclosure over a limited angular distribution, wherein the first light source member is between the first surface area region and the partially reflective film. In some embodiments, the lighting assembly further comprises additional transmissive areas (i.e., two, three, four, five, six, seven, eight, nine, ten, or more) within the second surface area region.

[0012] In some embodiments, and typically desirably, the light emitting diode(s), when energized have a uniform lumens output.

[0013] Light assemblies described herein are useful as functional or decorative elements, for example, in displays, signs, and vehicles (e.g., automobile, trucks, etc.). Useful embodiments of light assemblies described herein for vehicles include automobile and truck (vehicle) lighting, dash lighting, instrument cluster lighting, door sill lighting, dome lighting, and under cabinet lighting.

Brief Description of the Drawings

[0014] FIG. 1 is a cross-sectional view of an exemplary article described here.

[0015] FIG. 2 is a cross-sectional view of an exemplary lighting assembly described here.

[0016] FIGS. 3-5 are schematic side views of backlights containing a hollow recycling enclosure, comparing the effects of specular, Lambertian, and semi-specular reflectors.

Detailed Description

[0017] Referring to FIG. 1, article 1 has non-transmissive substrate 2, film 3 that is at least one of specular reflective or semi-specular reflective, partially reflective film 4, optional aligned discontinuous area 5, and optional tinted transmissive element 6. Alternatively, for example, tinted element 6 could be, for example, before non-transmissive substrate 2, between substrate 2 and film 3, or between film 3 and partially reflective film 4.

[0018] Referring to FIG. 2, exemplary lighting assembly 10 has an enclosure 11 having interior surface 12 and first transmissive area 13, non-transmissive substrate 22, partially reflective film 23, and aligned discontinuous area 27. Interior surface12 includes first surface area region 14 and second surface area region 15. First and (optional) second light emitting diodes 17, 18 each having a light emission cone in a range from 20° to 30° are positioned generally opposite each other within enclosure 11. First asymmetric reflective film 19 positioned over the light emission cone of first light emitting diode 17. Optional second asymmetric reflective film 20 positioned over the light emission cone of optional second light emitting diode 18.

[0019] The enclosure can be made of any of a variety of materials, including plastic, metal, wood, etc. The shape of the enclosure may be any of a variety of shapes including generally rectangular and triangular (including with squared off edges (internal and/or external), as well as those with oblong or rounded edges (internal and/or external)), as well as elliptical, and other Euclidean geometrical shapes.

[0020] Desirable length to width ratios of the enclosure are, for example, in a range from 10:1 to 40:1 (in some embodiments, 15:1 to 40:1, 20:1 to 40:1, 25:1 to 40:1, or even 30:1 to 40:1). Desirable length to height (i.e., first surface area region to generally opposed, second surface area region) ratios of the enclosure are, for example, in a range from 20:1 to 150:1 (in some embodiments, in a range from 50:1 to 100:1).

[0021] Exemplary light sources include at least one of an incandescent light, a light emitting diode, or an arc discharge lamp. Such light source(s) are well known and available in the art. Suitable light emitting diodes are known in the art, and are commercially available. Such light emitting diodes include those having Lambertian light emission pattern. In some embodiments, the LED may be used with a wedge-shaped reflector so that light may be emitted into the enclosure with a restricted or partially collimated angular distribution. Further, in some embodiments, light sources that at least partially collimate the emitted light may be preferred. Such light sources can include lenses, extractors, shaped encapsulants, or combinations thereof of optical elements to provide a desired output into the enclosure. Further, the light source can include injection optics that partially collimate or confine light initially injected into the enclosure to propagate in directions close to a transverse plane (the transverse plane being parallel to the output area of the light source) (e.g., an injection beam having an average deviation angle from the transverse plane in a range from 0° to 45°, or 0° to 30°, or even 0° to 15°).

[0022] LEDs are available in a variety of power usage ratings, including those ranging from less than 0.1 watt to 5 watts (e.g., power usage ratings up to 0.1, 0.25, 0.5, 0.75, 1, 1.25, 1.5, 1.75, 2, 2.5, 3, 4, or even up to 5 watts) per LED. LEDs are available in colors ranging from violet (about 410 nm) to deep red (about 700 nm). Basic colors of LEDs are blue, green, red and amber, although other colors, such as white, are also available. Ultraviolet LEDs can also be used. These can be used, for example, with a down converting phosphor to convert their emitted light to visible light.

[0023] Light from a light source (e.g., a light emitting diode) can be introduced into the enclosure in a variety of ways. For example, a light source (e.g., an LED (chip)) itself can be placed inside the enclosure. A lens connected to a light source (e.g., an LED) can protrude into the enclosure even though the light source itself is outside the enclosure. In some cases, a light source (e.g., LED) can be located a meter away or more and have its light transported to the enclosure by, for example, a light fiber system. Light fiber systems use total internal reflection to propagate light from the injection end of the fiber to an exit point. The exit end of the fiber can be inserted into the enclosure, and optionally used with collimation technique (e.g., lenses or an external collimating wedge). Techniques of transporting light in a solid medium include low absorption solids (e.g., low loss glass fiber or acrylic fiber). It is often preferable to use a lower refractive index cladding surrounding the glass or acrylic core. The low index cladding prevents or reduces accidental light leakage that may occur from scratching, or objects physically touching the core. Further, for example, it is possible to use a hollow technique for light transport rather than solid. In this case a cavity comprised of a low-loss omnidirectional specular, or semi-specular mirror can be used. Light, preferably collimated, is injected into one end of this transport cavity, and by multiple reflections is transported to an extraction point which may be, in the case of a tube, the opposite end. The extraction end of this transport system can be positioned proximate the enclosure so as to introduce light into the enclosure.

[0024] The light emitting diodes are typically placed in and/or light from a light source is introduced into, the first surface area region and/or one of the sides (typically a narrow side).

[0025] Typically, the light source(s) is positioned, and/or light from the light source diodes is introduced into the enclosure, with respect to an interior surface, within a range from 0.5 cm to 2.5 cm (in some embodiments, 0.75 cm to 1.5 cm) and/or, with respect to the first surface area region, within 50 (in some embodiments, 25) percent of the distance between the first and second surface area regions.

[0026] In one exemplary embodiment, the light source member(s) disposed to emit light into the enclosure over a limited angular distribution comprises a light emitting diode(s) having a light emission collimated to a range from 20° to 30° in at least one direction positioned to be closer to the first surface area region than to the second surface area region, wherein when light is emitted from the first light emitting diode, the light is reflected multiple times by the interior surface to provide diffuse light and a asymmetric reflective film(s) positioned over the light emission cone of the light emitting diode(s) (respectively).

[0027] A “specular” reflector, sometimes referred to as a mirror, performs according to the optical rule that “the angle of incidence equals the angle of reflection.” This is seen in the hollow enclosure 816 of FIG. 3. There, the front and back reflectors, 812, 814 are both specular. A small portion of an initially launched oblique light ray 850 is transmitted through the front reflector 812, but the remainder is reflected at an equal angle to the back reflector 814, and reflected again at an equal angle to the front reflector 812, and so on as illustrated. This arrangement provides maximum lateral transport of the light across the enclosure 816, since the recycled ray is unimpeded in its lateral transit of the enclosure 816. However, no angular mixing occurs in the enclosure, since there is no mechanism to convert light propagating at a given incidence angle to other incidence angles.

[0028] A “Lambertian” reflector, on the other hand, redirects light rays equally in all directions. This is seen in the hollow enclosure 916 of FIG. 4, where the front and back reflectors 912, 914 are both Lambertian. The same initially launched oblique light ray 950 is immediately scattered in all directions by the front reflector 912, most of the scattered light being reflected back into the enclosure 916 but some being transmitted through the front reflector 912. Some of the reflected light travels “forward” (generally to the right as seen in the figure), but an equal amount travels “backward” (generally to the left). By forward scattering, we refer to the lateral or in-plane (in a plane parallel to the scattering surface in question) propagation components of the reflected light. When repeated, this process greatly diminishes the forward directed component of a light ray after several reflections. The beam is rapidly dispersed, producing minimal lateral transport.

[0029] A “semi-specular” reflector provides a balance of specular and diffusive properties. In the hollow enclosure 1016 of FIG. 5, the front reflector 1012 is purely specular but the back reflector 1014 is semi-specular. The reflected portion of the same initially launched oblique light ray 1050 strikes the back reflector 1018, and is substantially forward-scattered in a controlled amount. The reflected cone of light is then partially transmitted but mostly reflected (specularly) back to the back reflector 1014, all while still propagating to a great extent in the “forward” direction. For an enclosure to be semi-specular, a semi-specular element can even be placed any wherein in the enclosure where light impinges on the surface of the semi-specular element. For example, a semi-specular element may be placed on the inner surface of the first or second surface area region or as a separate element in between the regions.

[0030] Specularly reflective surfaces having an on-axis average reflectivity of at least 98% for visible light emitted by the light source(s) of any polarization can be provided, for example, by a film(s) such as those described in U.S. Pat. Nos. 5,882,774 (Jonza et al.) and 6,641,880 (Deyak et al.), the disclosures of which are incorporate herein by reference; additional details regarding such films can also be found in said patents. Embodiments of such films are marketed by 3M Company, St. Paul, MN, under the trade designation “VIKUITI ENHANCED SPECULAR REFLECTOR FILM.” Other suitable reflective materials include those marketed by Alanod Aluminum-Veredlung GmbH & Co., Ennepetal, Germany, under the trade designation “MIRO-2 ANODIZED ALUMINUM FILM”).

[0031] Semi-specular reflective surfaces can be provided, for example, by (1) a partial transmitting specular reflector plus a high reflectance diffuse reflector; (2) a partial Lambertian diffuser covering a high reflectance specular reflector; (3) a forward scattering diffuser plus a high reflectance specular reflector; or (4) a corrugated high reflectance specular reflector. Additional details regarding semi-specular reflective materials, can be found, for example, in PCT Application No. US2008/864115 (Attorney Docket No. 63032WO003), the disclosure of which is incorporated herein by reference.

[0032] Exemplary non-transmissive substrates include metal (e.g., aluminum or steel) sheets and polymeric (e.g., plastic (e.g., acrylic, polycarbonate, polycvinychloride, rubbers, and foams), including carbon filled plastic) sheets.

[0033] A partial reflector (element) is an optical element or a collection of optical elements which reflect at least 30% of incident light while transmitting the remainder, minus absorption losses. Exemplary partially reflective elements include foams, polarizing and non-polarizing multilayer optical films, microreplictated structures (e.g. brightness enhancement films (“BEF”)), polarized and non-polarized blends, wire grid polarizers, partially transmissive metals such as silver or nickel, metal/dielectric stacks such as silver and indium tin oxide, and asymmetric optical films. Asymmetric optical films are also appropriate as partial reflectors. “Asymmetric optical films” as used herein refer to a multilayer optical film (MOF) reflective polarizer that includes a multilayer construction (e.g., coextruded polymer microlayers that have been oriented under suitable conditions to produce desired refractive index relationships and desired reflectivity characteristics) having a very high reflectivity for normally incident light in the block polarization state and a lower but still substantial reflectivity (e.g., 25% to 90%) for normally incident light in the pass polarization state. Suitable asymmetric reflective films are further described, for example, in U.S. Pat. No. 6,924,014 (Ouderkirk et al.) and U.S. Patent Application having Serial No. 60/939,084, filed May 20, 2007 (Attorney Docket No. 63031US002), and PCT Patent Application No. US2008/064133 (Attorney Docket No. 63274WO004), the disclosures of which are incorporated herein by reference. Also useful as partial reflectors are perforated partial reflectors or mirrors (e.g., perforating specularly reflective films having an on-axis average reflectivity of at least 98% of any polarization such as described above (e.g., that marketed by 3M Company under the trade designation “VIKUITI ENHANCED SPECULAR REFLECTOR FILM”). Crossed polarizers can be used as partial reflectors; the angle of crossing can be used to adjust the ratio of transmission to reflection. Also, polymers filled with inorganic particulates such as titanium dioxide (TiO_2) can be used.

[0034] Films for constructing lighting assemblies described herein may be supported, for example, by a transmissive substrate. Suitable transmissive substrates can include optical films, sheets, or plates. Suitable materials include glass, transmissive engineering thermoplastics (e.g., polycarbonate, polystyrene, acrylic, styrene acrylonitrile, cyclo olefin polymer (“COP”; available from Zeon Chemicals L.P., Louisville, KY), polyethylene terephthalate, polyethylene 2,6-naphthalate, and fluoropolymers).

[0035] In some embodiments, lighting assembly described herein, the first and second surface area regions are parallel, while in others, the first and second surface area regions are non-parallel. This can be used, for example, to control the uniformity of light output, as disclosed in U.S. Patent Application having Serial No. 61/030,767, filed February 22, 2008, the disclosure of which is incorporated herein by reference.

[0036] Optionally, articles and light assemblies described herein further comprising additional transmissive and discontinuous areas (e.g., one two, three, four, five, six, seven, eight, nine, ten, or more additional transmissive and discontinuous areas(s) within the second surface area region. Optionally, the transmissive area(s) are in the shape of, or otherwise include, both alphanumerics and trademark indicia. The transmissive and discontinuous areas can be made of any material suitable for the particular light assembly desired, which may include acrylic, polycarbonate, plastics, and glass, as well as a material described below for the transmissive element.

[0037] Optionally, lighting assembly described herein further comprising a tinted transmissive element(s) (e.g., a film(s)) having a major surface parallel to a major surface of the non-transmissive substrate and may be present or between any major surface opposite the first surface area region. Alternatively, or in addition, a tinted transmissive element (e.g., a film) can be placed inside the enclosure, including parallel and/or perpendicular to a major surface of the non-transmissive substrate. Suitable films are known in the art and include tinted (e.g., dyed or pigmented) films and color shifting films. Transmissive tinted and color shifting films are available, for example, from 3M Company under the trade designation “SCOTCHCAL 3630” in about 60 different colors.

[0038] “Color shifting film” as used herein refers to a film comprising alternating layers of at least a first and second layer type, wherein the first layer type comprises a strain hardening polymer (e.g., a polyester), wherein the film has at least one transmission band and one reflection band in the visible region of the spectrum, the transmission band having an average transmission of at least 70%, and wherein at least one of said transmission band and reflection band varies at normal incidence by less than about 25 nm over a square inch. Optionally, the film comprises alternating polymeric layers of at least a first and a second layer type, wherein the film has at least one transmission band and at least one reflection band in the visible region of the spectrum, and wherein at least one of the transmission band and reflection band has a band edge that varies at normal incidence by no more than 8 nm over a distance of at least 2 inches along each of two orthogonal axes in the plane of the film. Optionally, at least one of the transmission band and the reflection band has a bandwidth at normal incidence that varies by no more than 2 nm over a surface area of at least 10 cm^2. Optionally, the film has exactly one transmission band in the visible region of the spectrum. Optionally, the film has exactly one reflection band in the visible region of the spectrum. Color shifting films can be made, for example, as described in U.S. Pat. No. 6,531,230 (Weber et al.), the disclosure of which is incorporate herein by reference; additional details regarding such films can also be found in said patent.

[0039] Films typically have a major surface covered with adhesive. Suitable adhesives are well known in the art (e.g., pressure sensitive adhesives) will generally be found on one surface of the film (continuous or portions depending on the embodiment involved) and allows the film to be attached to another surface.

[0040] Suitable light assembly configurations can be designed and assembled using known techniques by one skilled in the art after reviewing the instant disclosure.

[0041] Light assemblies described herein are useful as functional or decorative elements, for example, in displays, signs, and vehicles (e.g., automobile, trucks, etc.). Useful embodiments of light assemblies described herein for vehicles include automobile and truck (vehicle) lighting, dash lighting, instrument cluster lighting, door sill lighting, dome lighting, and under cabinet lighting.

[0042] In some embodiments, lighting assembly described herein comprise at least one (in some embodiments, at least two, three, or more) subdividing reflective element to provide at least a first and second, divided zones. In some embodiments, the at least the first and second, divided the zones are independently controlled (e.g., via optical sensors and feedback controls known in the art). For example, it is possible to have two of more hollow cavities adjacent, for example by using a reflective subdivider running lengthwise along the direction of light propagation. Each cavity would have at least one light source. Such a divider limits or prevents light from one cavity entering the adjacent cavity and thus enables independent control of each zone. Such functionality would be useful in segmented auto tail lights, or in zoned LED LCD TV backlights.

[0043] In both zoned and non-zoned systems of described herein, it is advantageous to use a light sensor and feedback circuitry. One or more light sensors can be placed in or external to the optical enclosure to sense the intensity of light and provide signal to a control circuit to adjust light output of the source. Appropriate brightness sensors include those manufactured by Texas Advanced Optoelectronic Solutions, Plano TX.

[0044] Optionally, at least two (in some embodiments, at least three, four, five, or more) lighting assembly described herein are placed adjacent one another.

[0045] Advantages and embodiments of this invention are further illustrated by the following examples, but the particular materials and amounts thereof recited in these examples, as well as other conditions and details, should not be construed to unduly limit this invention. All parts and percentages are by weight unless otherwise indicated.

Example

[0046] A lighting assembly as generally shown in the FIG. 1 was constructed as follows. A 39.4 cm (15.5 inches) long, 4.5 cm (1.8 inch) wide, 6 mm (0.25 inch) deep (high) tray was made from 0.1 cm (0.04 inch) sheet metal. An adhesive backed film having a specular reflectance least 98.5% (available from 3M Company, St. Paul, MN, under the trade designation "VIKUITI ENHANCED SPECULAR REFLECTIVE FILM") was tightly fitted and applied to the bottom of the tray.

[0047] An adhesive backed film having a specular reflectance of 98.5% ("VIKUITI ENHANCED SPECULAR REFLECTIVE FILM") was also tightly fitted and applied to the perpendicular (interior) sides of the tray.

[0048] Two T1 LEDs (obtained from Kingbright Corporation, City of Industry, CA, under the trade designation "T1 LED" (white)) each having a light emission collimated to a cone of about 26° were positioned one on each end of the bottom of the tray, each from 1.3 cm (0.5 inch) and centered between the width of the tray. The LEDs, wired in parallel (but could also be wired in series).

[0049] Asymmetric reflective film (0.05 mm (2 mils) thick; see U.S. Patent Application having Serial No. 60/939,084, filed May 20, 2007 (Attorney Docket No. 63031US002), the disclosure of which is incorporated herein by reference) were cut to provide two 4.5 cm (1.8 inch) by 4.5 cm (1.8 inch) pieces which were used to cover the LEDS as generally shown in the Figure (see 19, 20). The cut pieces of asymmetric reflective film were secured to the bottom of the tray about 0.5 cm behind the respective light emitting diodes by a conventional pressure sensitive adhesive and were at an angle of about 45° relative to the first surface area region (14).

[0050] A 0.24 cm (0.1 inch) thick piece of clear acrylic sheet was cut to 39.4 cm (15.5 inches) by 4.5 cm (1.8 inch) and a piece of 0.05 mm (2 mils) thick asymmetric reflective film (see U.S. Patent Application having Serial No. 60/939,084, filed May 20, 2007 (Attorney Docket No. 63031US002), the disclosure of which is incorporated herein by reference) having the same dimensions was attached secured to the top of the clear acrylic sheet. The resulting composite article was used to cover the tray, wherein the exposed major surface of the asymmetric reflective film was toward the outside of the tray.

[0051] A cover plate having slightly longer and wider dimensions than the tray was also made from 0.1 cm (0.04 inch) thick sheet metal to fit tightly on the top of the tray. An adhesive backed film having a reflectance of at least 90% (available from 3M Company under the trade designation "LIGHT ENHANCEMENY FILM") was tightly fitted and applied to the interior major surface of the cover plate. A decorative design was then milled through the major surfaces of the cover plate (and film). The cover plate was placed over the tray.

Various Possible Embodiments

1. An article comprising:

a non-transmissive substrate having first and second, generally opposed major surfaces,

a film having first and second generally opposed major surfaces, the film is at least one of semi-specularly reflective or specularly reflective and has an on-axis average reflectivity of at least 98% of any polarization; and

a partially reflective film having first and second generally opposed major surfaces.

2. The article according to embodimentembodiment 1, wherein the film having an on-axis average reflectivity of at least 98% of any polarization is semi-specularly reflective.

3. The article according to embodimentembodiment 1, wherein the film having an on-axis average reflectivity of at least 98% transmissive of any polarization is specularly reflective.

4. The article according to any one of embodimentembodiments 1 to 3, wherein the non-transmissive substrate, the film having an on-axis average reflectivity of at least 98% of any polarization, and the partially reflective film are in that order.

5. The article according to any one of embodimentembodiments 1 to 3, wherein the partially reflective film, the non-transmissive substrate, and the film having an on-axis average reflectivity of at least 98% of any polarization are in that order.

6. The article according to any preceding embodimentembodiment, wherein the film having an on-axis average reflectivity of at least 98.5% of any polarization.

7. The article according to any preceding embodimentembodiment, wherein the first and second major surfaces of both the non-transmissive substrate and the film having an on-axis average reflectivity of at least 98% of any polarization comprises an aligned discontinuous area of at least 1 mm^2.

8. The article according to any one of embodimentembodiments 1 to 6, wherein the first and second major surfaces of both the non-transmissive substrate and the film having an on-axis average reflectivity of at least 98% of any polarization comprises an aligned discontinuous area of at least 2 mm^2.

9. The article according to any one of embodimentembodiments 1 to 6, wherein the first and second major surfaces of both the non-transmissive substrate and the film having an on-axis average reflectivity of at least 98% of any polarization comprises an aligned discontinuous area of at least 3 mm^2.

10. The article according to any one of embodimentembodiments 1 to 6, wherein the first and second major surfaces of both the non-transmissive substrate and the film having an on-axis average reflectivity of at least 98% of any polarization comprises an aligned discontinuous area of at least 4 mm^2.

11. The article according to any one of embodimentembodiments 1 to 6, wherein the first and second major surfaces of both the non-transmissive substrate and the film having an on-axis average reflectivity of at least 98% of any polarization comprises an aligned discontinuous area of at least 5 mm^2.

12. The article according to any one of embodimentembodiments 1 to 6, wherein the first and second major surfaces of both the non-transmissive substrate and the film having an on-axis average reflectivity of at least 98% of any polarization comprises an aligned discontinuous area of at least 10 mm^2.

13. The article according to any one of embodimentembodiments 1 to 6, wherein the first and second major surfaces of both the non-transmissive substrate and the film having an on-axis average reflectivity of at least 98% of any polarization comprises an aligned discontinuous area of at least 100 mm^2.

14. The article according to any one of embodimentembodiments 1 to 6, wherein the first and second major surfaces of both the non-transmissive substrate and the film having an on-axis average reflectivity of at least 98% of any polarization comprises an aligned discontinuous area of at least 1000 mm^2.

15. The article according to any one of embodimentembodiments 1 to 6, wherein the first and second major surfaces of both the non-transmissive substrate and the film having an on-axis average reflectivity of at least 98% of any polarization comprises an aligned discontinuous area of at least 10,000 mm^2.

16. The article according to any preceding embodimentembodiment, wherein the aligned discontinuous area is in the shape of at least one alphanumeric.

17. The article according to any preceding embodimentembodiment, wherein the aligned discontinuous area is in the shape of at least one trademark indicia.

18. The article according to any preceding embodimentembodiment, wherein the first and second major surfaces of both the non-transmissive substrate and the film having an on-axis average reflectivity of at least 98% of any polarization comprise two aligned discontinuous areas of at least 1 mm^2.

19. The article according to any preceding embodiment, wherein the first and second major surfaces of both the non-transmissive substrate and the film having an on-axis average reflectivity of at least 98% of any polarization comprise three aligned discontinuous areas of at least 1 mm^2.

20. The article according to any one of embodiments 1 to 19 further comprising a tinted transmissive element having a major surface parallel to a major surface of the non-transmissive substrate.

21. A lighting assembly comprising:

an enclosure having an interior surface and a first transmissive area, the interior surface comprising a first surface area region and a second surface area region generally opposite the first surface area region, wherein the first transmissive area is within second surface area region, wherein the interior surface is at least one of semi-specularly reflective or specularly reflective and has an on-axis average reflectivity of at least 98% of any polarization, wherein the second surface area region of the enclosure is a film having a first major surface that is at least one of semi-specularly reflective or specularly reflective and has an on-axis average reflectivity of at least 98% of any polarization, and a second, generally opposed major surface affixed to a first major surface a non-transmissive substrate, wherein the non-transmissive substrate has a second major surface, generally opposed to the first major surface of the non-transmissive substrate, and wherein the first and second major surfaces of both the non-transmissive substrate and the film of the second major surface of the enclosure comprises an aligned discontinuous area of at least 1 mm^2;

a partially reflective film positioned in the enclosure opposite the first surface area region; and

a first light source member disposed to emit light into the enclosure over a limited angular distribution, wherein the first light source is between the first surface area region and the partially reflective film.

22. The article according to embodiment 21, wherein the film having an on-axis average reflectivity of at least 98% of any polarization is semi-specularly reflective.

23. The article according to embodiment 21, wherein the film having an on-axis average reflectivity of at least 98% of any polarization is specularly reflective.

24. The lighting assembly according to any one of embodiments 21 to 23, wherein the film having an on-axis average reflectivity of at least 98.5% of any polarization.

25. The lighting assembly according to any one of embodiments 21 to 24, wherein the first light source member disposed to emit light into the enclosure over a limited angular distribution comprises a first light emitting diode having a light emission collimated to a range from 20° to 30° in at least one direction positioned to be closer to the first surface area region than to the second surface area region, wherein when light is emitted from the first light emitting diode, the light is reflected multiple times by the interior surface to provide diffuse light and a first asymmetric reflective film positioned over the light emission cone of the first light emitting diode.

26. The lighting assembly according to any one of embodiments 21 to 24, wherein the light source includes at least one of an incandescent light, a light emitting diode, or an arc discharge lamp.

27. The lighting assembly according to any one of embodiments 21 to 26, wherein the first and second major surfaces of both the non-transmissive substrate and the film having an on-axis average reflectivity of at least 98% of any polarization comprises an aligned discontinuous area of at least 2 mm^2.

28. The lighting assembly according to any one of embodiments 21 to 26, wherein the first and second major surfaces of both the non-transmissive substrate and the film having an on-axis average reflectivity of at least 98% of any polarization comprises an aligned discontinuous area of at least 3 mm^2.

29. The lighting assembly according to any one of embodiments 21 to 26, wherein the first and second major surfaces of both the non-transmissive substrate and the film having an on-axis average reflectivity of at least 98% of any polarization comprises an aligned discontinuous area of at least 4 mm^2.

30. The lighting assembly according to any one of embodiments 21 to 26, wherein the first and second major surfaces of both the non-transmissive substrate and the film having an on-axis average reflectivity of at least 98% of any polarization comprises an aligned discontinuous area of at least 5 mm^2.

31. The lighting assembly according to any one of embodiments 21 to 26, wherein the first and second major surfaces of both the non-transmissive substrate and the film having an on-axis average reflectivity of at least 98% of any polarization comprises an aligned discontinuous area of at least 10 mm^2.

32. The lighting assembly according to any one of embodiments 21 to 26, wherein the first and second major surfaces of both the non-transmissive substrate and the film having an on-axis average reflectivity of at least 98% of any polarization comprises an aligned discontinuous area of at least 100 mm^2.

33. The lighting assembly according to any one of embodiments 21 to 26, wherein the first and second major surfaces of both the non-transmissive substrate and the film having an on-axis average reflectivity of at least 98% of any polarization comprises an aligned discontinuous area of at least 1000 mm^2.

34. The lighting assembly according to any one of embodiments 21 to 26, wherein the first and second major surfaces of both the non-transmissive substrate and the film having an on-axis average reflectivity of at least 98% of any polarization comprises an aligned discontinuous area of at least 10,000 mm^2.

35. The lighting assembly according to any one of embodiments 21 to 34, wherein the aligned discontinuous area is in the shape of at least one alphanumeric.

36. The lighting assembly according to any one of embodiments 21 to 35, wherein the aligned discontinuous area is in the shape of at least one trademark indicia.

37. The lighting assembly according to any one of embodiments 21 to 36, wherein the first and second major surfaces of both the non-transmissive substrate and the film having an on-axis average reflectivity of at least 98% of any polarization comprise two aligned discontinuous areas of at least 1 mm^2.

38. The lighting assembly according to any one of embodiments 21 to 37, wherein the interior surface area is semi-specularly reflective.

39. The lighting assembly according to any one of embodiments 21 to 37, wherein the interior surface area is specularly reflective.

40. The lighting assembly according to any one of embodiments 21 to 37, wherein the on-axis average reflectivity of the interior surface is provided by at least one film.

41. The light assembly according to any one of embodiments 21 to 40, wherein the enclosure is generally rectangular in shape.

42. The light assembly according to any one of embodiments 21 to 41, wherein the first transmissive area is in the shape of at least one alphanumeric.

43. The light assembly according to any one of embodiments 21 to 42, wherein the first transmissive area is in the shape of at least one trademark indicia.

44. The light assembly according to any one of embodiments 21 to 43, further comprising additional transmissive areas within the second surface area region.

45. The light assembly according to embodiment 44, wherein the transmissive areas are in the shape of alphanumerics.

46. The light assembly according to embodiment 44, wherein the transmissive areas include both alphanumerics and trademark indicia.

47. The lighting assembly according to any one of embodiments 21 to 46 having a length, wherein the first light emitting diode is positioned, with respect to an interior surface, within a range from 0.5 cm to 2.5 cm.

48. The lighting assembly according to any one of embodiments 21 to 47 having a distance between the first and second surface area regions, wherein the first light emitting diode is positioned, with respect to the first surface area region, within 50 percent of the distance between the first and second surface area regions.

49. The lighting assembly according to any one of embodiments 21 to 48 further comprising a tinted transmissive element having a major surface parallel to a major surface of the non-transmissive substrate.

50. The lighting assembly according to any one of embodiments 21 to 49 having at least one subdividing reflective element to provide at least a first divided zone and a second divided zone.

51. The light assembly of embodiment 50 where at least the first divided zone and the second divided zone are independently controlled.

52. The lighting assembly according to any one of embodiments 21 to 51 having at least one optical sensors and feedback control.

53. The lighting assembly according to any one of embodiments 21 to 52, wherein the first and second surface area regions are parallel.

54. The lighting assembly according to any one of embodiments 21 to 52, wherein the first and second surface area regions are non-parallel.

55. At least two lighting assembly according to any one of embodiments 21 to 54 placed adjacent one another.

56. The lighting assembly according to any one of embodiments 21 to 55 that is a door sill lighting assembly.

57. A vehicle comprising the lighting assembly according to any one of embodiments 21 to 56.

58. A lighting assembly comprising:

an enclosure having an interior surface and a first transmissive area, the interior surface comprising a first surface area region and a second surface area region generally opposite the first surface area region, wherein the first transmissive area is within second surface area region, wherein the interior surface is at least one of semi-specularly reflective or specularly reflective and has an on-axis average reflectivity of at least 98% of any polarization, wherein the second surface area region of the enclosure has a generally opposed major surface facing a first major surface of a non-transmissive substrate, wherein the non-transmissive substrate has a second major surface, generally opposed to the first major surface of the non-transmissive substrate, and wherein the first and second major surfaces of both the non-transmissive substrate and the second surface area region of the enclosure, including the generally opposed major surface thereof, comprises an aligned discontinuous area of at least 1 mm^2;

a partially reflective film positioned in the enclosure opposite the first surface area region; and

a first light source member disposed to emit light into the enclosure over a limited angular distribution, wherein the first light source is between the first surface area region and the partially reflective film.

59. The lighting assembly according to embodiment 58, wherein the interior surface is semi-specularly reflective.

60. The lighting assembly according to embodiment 58, wherein the interior surface is specularly reflective.

61. The lighting assembly according to any one of embodiments 58 to 60, wherein the interior surface is at least 98.5% of any polarization.

62. The lighting assembly according to any one of embodiments 58 to 61, wherein the first light source member disposed to emit light into the enclosure over a limited angular distribution comprises a first light emitting diode having a light emission collimated to a range from 20° to 30° in at least one direction positioned to be closer to the first surface area region than to the second surface area region, wherein when light is emitted from the first light emitting diode, the light is reflected multiple times by the interior surface to provide diffuse light and a first asymmetric reflective film positioned over the light emission cone of the first light emitting diode.

63. The lighting assembly according to any one of embodiments 58 to 61, wherein the light source includes at least one of an incandescent light, a light emitting diode, or an arc discharge lamp.

64. The lighting assembly according to any one of embodiments 58 to 63, wherein the first and second major surfaces of both the non-transmissive substrate and the

second surface area region of the enclosure, including the generally opposed major surface thereof, comprises an aligned discontinuous area of at least 2 mm^2.

65. The lighting assembly according to any one of embodiments 58 to 63, wherein the first and second major surfaces of both the non-transmissive substrate and the second surface area region of the enclosure, including the generally opposed major surface thereof, comprises an aligned discontinuous area of at least 3 mm^2.

66. The lighting assembly according to any one of embodiments 58 to 63, wherein the first and second major surfaces of both the non-transmissive substrate and the second surface area region of the enclosure, including the generally opposed major surface thereof, comprises an aligned discontinuous area of at least 4 mm^2.

67. The lighting assembly according to any one of embodiments 58 to 63, wherein the first and second major surfaces of both the non-transmissive substrate and the second surface area region of the enclosure, including the generally opposed major surface thereof, comprises an aligned discontinuous area of at least 5 mm^2.

68. The lighting assembly according to any one of embodiments 58 to 63, wherein the first and second major surfaces of both the non-transmissive substrate and the second surface area region of the enclosure, including the generally opposed major surface thereof, comprises an aligned discontinuous area of at least 10 mm^2.

69. The lighting assembly according to any one of embodiments 58 to 63, wherein the first and second major surfaces of both the non-transmissive substrate and the second surface area region of the enclosure, including the generally opposed major surface thereof, comprises an aligned discontinuous area of at least 100 mm^2.

70. The lighting assembly according to any one of embodiments 58 to 63, wherein the first and second major surfaces of both the non-transmissive substrate and the second surface area region of the enclosure, including the generally opposed major surface thereof, comprises an aligned discontinuous area of at least 1000 mm^2.

71. The lighting assembly according to any one of embodiments 58 to 63, wherein the first and second major surfaces of both the non-transmissive substrate and the second surface area region of the enclosure, including the generally opposed major surface thereof, comprises an aligned discontinuous area of at least 10,000 mm^2.

72. The lighting assembly according to any one of embodiments 58 to 71, wherein the aligned discontinuous area is in the shape of at least one alphanumeric.

73. The lighting assembly according to any one of embodiments 58 to 72, wherein the aligned discontinuous area is in the shape of at least one trademark indicia.

74. The lighting assembly according to any one of embodiments 58 to 73 wherein the first and second major surfaces of both the non-transmissive substrate and the second surface area region of the enclosure, including the generally opposed major surface thereof, comprise two aligned discontinuous areas of at least 1 mm^2.

75. The lighting assembly according to any one of embodiments 58 to 74, wherein the specular reflectance of the interior surface is provided by at least one film.

76. The light assembly according to any one of embodiments 58 to 75, wherein the enclosure is generally rectangular in shape.

77. The light assembly according to any one of embodiments 58 to 76, wherein the first transmissive area is in the shape of at least one alphanumeric.

78. The light assembly according to any one of embodiments 58 to 77, wherein the first transmissive area is in the shape of at least one trademark indicia.

79. The light assembly according to any one of embodiments 58 to 78 further comprising additional transmissive areas within the second surface area region.

80. The light assembly according to embodiment 79, wherein the transmissive areas are in the shape of alphanumerics.

81. The light assembly according to embodiment 79, wherein the transmissive areas include both alphanumerics and trademark indicia.

82. The lighting assembly according to any one of embodiments 58 to 81 having a length, wherein the first light emitting diode is positioned, with respect to an interior surface, within a range from 0.5 cm to 2.5 cm.

83. The lighting assembly according to any one of embodiments 58 to 82 having a distance between the first and second surface area regions, wherein the first light emitting diode is positioned, with respect to the first surface area region, within 50 percent of the distance between the first and second surface area regions.

84. The lighting assembly according to any one of embodiments 58 to 83 further comprising a tinted transmissive element having a major surface parallel to a major surface of the non-transmissive substrate.

85. The lighting assembly according to any one of embodiments 58 to 84 having at least one subdividing reflective element to provide at least a first and second, divided zones.

86. The light assembly of embodiment 85 where at least the first and second, divided the zones are independently controlled.

87. The lighting assembly according to any one of embodiments 58 to 86 having at least one optical sensors and feedback control.

88. The lighting assembly according to any one of embodiments 58 to 87, wherein the first and second surface area regions are parallel.

89. The lighting assembly according to any one of embodiments 58 to 87, wherein the first and second surface area regions are non-parallel.

90. At least two lighting assembly according to any one of embodiments 58 to 89 placed adjacent one another.

91. The lighting assembly according to any one of embodiments 58 to 90 that is a door sill lighting assembly.

92. A vehicle comprising the lighting assembly according to any one of embodiments 58 to 91.

[0052] Foreseeable modifications and alterations of this invention will be apparent to those skilled in the art without departing from the scope and spirit of this invention. This invention should not be restricted to the embodiments that are set forth in this application for illustrative purposes.

What is claimed is:

1. An article comprising:

a non-transmissive substrate having first and second, generally opposed major surfaces,

a film having first and second generally opposed major surfaces, the film is at least one of semi-specularly reflective or specularly reflective and has an on-axis average reflectivity of at least 98% of any polarization; and

a partially reflective film having first and second generally opposed major surfaces.

2. A lighting assembly comprising:

an enclosure having an interior surface and a first transmissive area, the interior surface comprising a first surface area region and a second surface area region generally opposite the first surface area region, wherein the first transmissive area is within second surface area region, wherein the interior surface is at least one of semi-specularly reflective or specularly reflective and has an on-axis average reflectivity of at least 98% of any polarization, wherein the second surface area region of the enclosure is a film having a first major surface that is at least one of semi-specularly reflective or specularly reflective and has an on-axis average reflectivity of at least 98% of any polarization, and a second, generally opposed major surface affixed to a first major surface a non-transmissive substrate, wherein the non-transmissive substrate has a second major surface, generally opposed to the first major surface of the non-transmissive substrate, and wherein the first and second major surfaces of both the non-transmissive substrate and the film of the second major surface of the enclosure comprises an aligned discontinuous area of at least 1 mm^2;

a partially reflective film positioned in the enclosure opposite the first surface area region; and

a first light source member disposed to emit light into the enclosure over a limited angular distribution, wherein the first light source is between the first surface area region and the partially reflective film.

3. A lighting assembly comprising:

an enclosure having an interior surface and a first transmissive area, the interior surface comprising a first surface area region and a second surface area region generally opposite the first surface area region, wherein the first transmissive area is within second surface area region, wherein the interior surface is at least one of semi-specularly reflective or specularly reflective and has an on-axis average reflectivity of at least 98% of any polarization, wherein the second surface area region of the enclosure has a generally opposed major surface facing a first major surface of a non-transmissive substrate, wherein the non-transmissive substrate has a second major surface, generally opposed to the first major surface of the non-transmissive substrate, and wherein the first and second major surfaces of both the non-transmissive substrate and the second surface area region of the enclosure, including the generally opposed major surface thereof, comprises an aligned discontinuous area of at least 1 mm^2;

a partially reflective film positioned in the enclosure opposite the first surface area region; and

a first light source member disposed to emit light into the enclosure over a limited angular distribution, wherein the first light source is between the first surface area region and the partially reflective film.

4. The lighting assembly according to claim 2, wherein the first and second major surfaces of both the non-transmissive substrate and the film having an on-axis average reflectivity of at least 98% of any polarization comprises an aligned discontinuous area of at least 2 mm^2 or two aligned discontinuous areas of at least 1 mm^2.

5. The article according to claim 2 or 3, wherein the interior surface is semi-specularly reflective or specularly reflective.

6. The lighting assembly according to any one of claims 2 to 5, wherein the first light source member disposed to emit light into the enclosure over a limited angular distribution comprises a first light emitting diode having a light emission collimated to a range from 20° to 30° in at least one direction positioned to be closer to the first surface area region than to the second surface area region, wherein when light is emitted from the

first light emitting diode, the light is reflected multiple times by the interior surface to provide diffuse light and a first asymmetric reflective film positioned over the light emission cone of the first light emitting diode.

7. The lighting assembly according to any one of claims 2 to 5, wherein the first and second major surfaces of both the non-transmissive substrate and the second surface area region of the enclosure, including the generally opposed major surface thereof, comprises an aligned discontinuous area of at least 2 mm^2 or two aligned discontinuous areas of at least 1 mm^2.

8. The lighting assembly according to any one of claims 2 to 7, wherein the aligned discontinuous area is in a shape of indicia.

9. The light assembly according to any one of claims 2 to 8, wherein each transmissive area is in a shape of indicia.

10. The lighting assembly according to any one of claims 2 to 9 having a length, wherein the first light emitting diode is positioned, with respect to an interior surface, within a range from 0.5 cm to 2.5 cm.

11. The lighting assembly according to any one of claims 2 to 10 having a distance between the first and second surface area regions, wherein the first light emitting diode is positioned, with respect to the first surface area region, within 50 percent of the distance between the first and second surface area regions.

12. The lighting assembly according to any one of claims 2 to 11 having at least one subdividing reflective element to provide at least a first and second, divided zones.

13. The lighting assembly according to any one of claims 2 to 12, wherein the first and second surface area regions are non-parallel.

14. The lighting assembly according to any one of claims 2 to 13 that is a door sill lighting assembly.

15. A vehicle comprising the lighting assembly according to any one of claims 2 to 14.

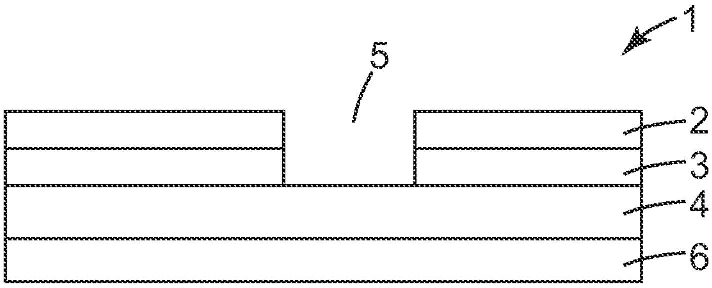

Fig. 1

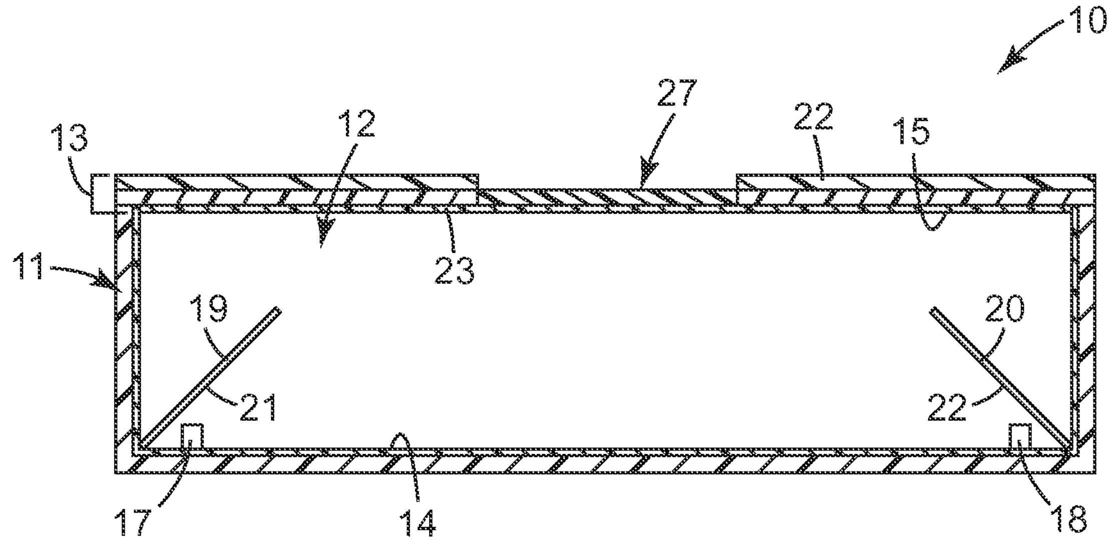

Fig. 2

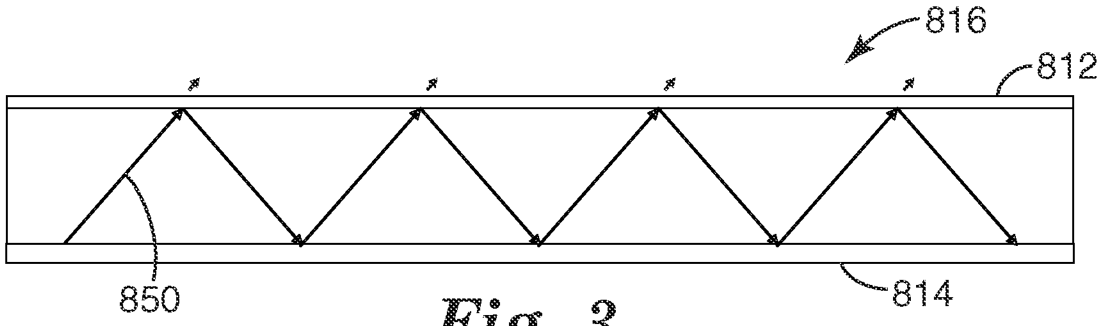

Fig. 3

Fig. 4

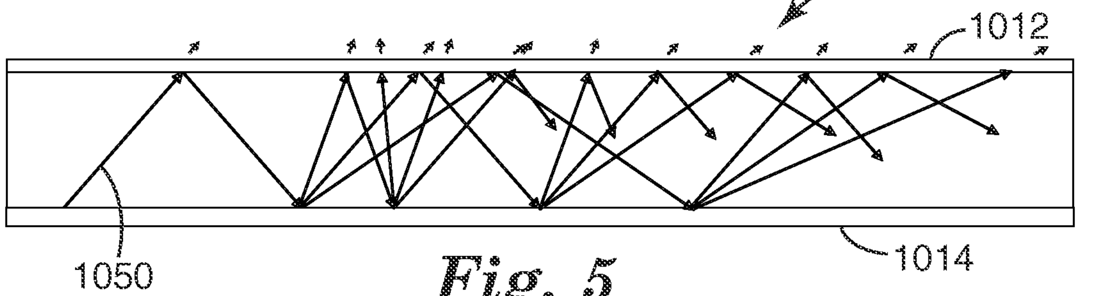

Fig. 5

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2009/069808

A. CLASSIFICATION OF SUBJECT MATTER
INV. G02B5/02 G09F13/04 G09F13/06

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 G09F

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 practical, 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	EP 1 014 160 A1 (SEIKO EPSON CORP [JP]) 28 June 2000 (2000-06-28)	1
A	paragraph [0076] figure 10	2-3
X	WO 2008/144656 A2 (3M INNOVATIVE PROPERTIES CO [US]; WEBER MICHAEL F [US]; HEBRINK TIMOTH) 27 November 2008 (2008-11-27)	1
A	page 18, line 16 - line 25 page 19, line 7 - page 20, line 21 page 46, line 5 - page 47, line 27 figure 2	2-3

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"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
8 March 2010	12/03/2010

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	Cosnard, Denis

Form PCT/ISA/210 (second sheet) (April 2005)

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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