(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
26 June 2014 (26.06.2014)

WIPO | PCT

(10) International Publication Number
WO 2014/099486 A1

(51) International Patent Classification:
G02B 5/124 (2006.01) *B32B 3/30* (2006.01)

(21) International Application Number:
PCT/US2013/074095

(22) International Filing Date:
10 December 2013 (10.12.2013)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
61/740,619 21 December 2012 (21.12.2012) US

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

(72) Inventors: **WORRELL, John A.**; 3M Center, Post Office Box 33427, Saint Paul, Minnesota 55133-3427 (US). **RADCLIFFE, Marc D.**; 3M Center, Post Office Box 33427, Saint Paul, Minnesota 55133-3427 (US).

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

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

(54) Title: PHOTOLUMINESCENT RETROREFLECTIVE ARTICLES

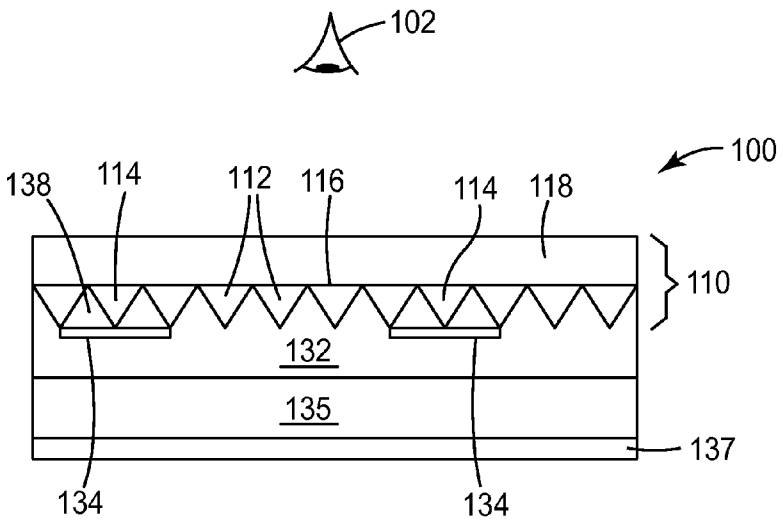


FIG. 1

(57) Abstract: A photoluminescent retroreflective article includes a retroreflective layer including multiple cube corner elements that collectively form a structured surface that is opposite a major surface and a conforming layer having a first region and a second region wherein the second region is in intimate contact with the structured surface and the first region forming a low refractive index layer between the conforming layer and the structured surface of the retroreflective layer. The conforming layer is separated from the structured surface at the first region by a barrier layer. A photoluminescent layer is disposed on the conforming layer.

WO 2014/099486 A1

PHOTOLUMINESCENT RETROREFLECTIVE ARTICLES

Background

[0001] Retroreflective materials are characterized by the ability to redirect light incident on the material back toward the originating light source. This property has led to the widespread use of retroreflective sheeting for a variety of traffic and personal safety uses. Retroreflective sheeting is commonly employed in a variety of articles, for example, road signs, barricades, license plates, pavement markers and marking tape, as well as retroreflective tapes for vehicles and clothing.

[0002] Two known types of retroreflective sheeting are optical element sheeting (e.g., cube corner sheeting) and microsphere-based sheeting. Microsphere-based sheeting, sometimes referred to as "beaded" sheeting, employs a multitude of microspheres typically at least partially embedded in a binder layer and having associated specular or diffuse reflecting materials (e.g., pigment particles, metal flakes or vapor coats, etc.) to retroreflect incident light. Cube corner retroreflective sheeting, sometimes referred to as “prismatic” sheeting, typically comprises a thin transparent layer having a substantially planar first surface and a second structured surface comprising a plurality of geometric structures, some or all of which include three reflective faces configured as a cube corner element.

[0003] A cube corner element can include three mutually perpendicular optical faces that intersect at a single apex. Generally, light that is incident on a corner cube element from a light source is totally internally reflected from each of the three perpendicular cube corner optical faces and is redirected back toward the light source.

[0004] Luminescent dyes and pigments are utilized in the preparation of signs and other articles where visibility in dark conditions is required. Chemiluminescent and/or photoluminescent materials may be used. The luminous material may be attached to exits, stairways, fire extinguishers, and so on to guide a person in the event of a power failure. While this is effective immediately after loss of power occurs, the luminescence of such materials decreases rapidly and may be substantially gone in a relatively short time. These photoluminescent films are known and are commercially used to provide signage that warns, cautions, and provides other messages conveying safety information. Frequently, these films are combined with an adhesive to form a

photoluminescent tape. Sometimes also characterized as "Glow-in-the-Dark", "luminous", or "luminescent", these films or tapes are based on materials that absorb photons and emit visible light

[0005] There is a need to provide a signage article that combines the properties of retroreflectivity and luminescence. An article having such properties would be highly visible when there is a light source available to impinge upon its surface in a "front-lit" condition and would also be visible in conditions of complete or near-complete darkness.

Summary

[0006] The present disclosure relates to photoluminescent retroreflective articles. In particular, the present disclosure relates to photoluminescent retroreflective articles where the retroreflective elements do not substantially interfere with the charging and emission of the photoluminescent element.

[0007] In a first aspect of the disclosure, a photoluminescent retroreflective article includes a photoluminescent retroreflective article including a retroreflective layer having multiple cube corner elements that collectively form a structured surface that is opposite a major surface and a conforming layer having a first region and a second region wherein the second region is in intimate contact with the structured surface and the first region forming a low refractive index layer between the conforming layer and the structured surface of the retroreflective layer and the conforming layer is separated from the structured surface at the first region by a barrier layer. A photoluminescent layer is disposed on the conforming layer and the conforming layer separates the photoluminescent layer and the retroreflective layer.

[0008] In one or more embodiments, the conforming layer transmits excitation light to the photoluminescent layer and the conforming layer transmits emission light from the photoluminescent layer. In one or more embodiments, the barrier layer transmits excitation light to the photoluminescent layer and the barrier layer transmits emission light from the photoluminescent layer. In one or more embodiments, the low refractive index layer includes air. In one or more embodiments, the conforming layer includes a pressure sensitive adhesive. In one or more embodiments, a light reflective layer is disposed on the photoluminescent layer. The photoluminescent layer separates the light reflective layer from the conforming layer. In

one or more embodiments, an adhesive layer is disposed on the light reflective layer. The light reflective layer separating the adhesive layer from the photoluminescent layer. In one or more embodiments, a releasable liner is disposed on the adhesive layer. In one or more embodiments, the conforming layer is index matched to the retroreflective layer.

[0009] In a second aspect of the disclosure, a method of forming a photoluminescent retroreflective article, includes providing a retroreflective layer including multiple cube corner elements that collectively form a structured surface and disposing one or more discontinuous barrier layers adjacent to the structured surface. Then the method includes placing a conforming layer adjacent to the one or more discontinuous barrier layers and structured surface and positioning a photoluminescent layer on the conforming layer so that the conforming layer separates the photoluminescent layer from the structured surface.

[0010] In one or more embodiments the method includes transmitting excitation light through the conforming layer layers to excite the photoluminescent layer. In one or more embodiments the method includes transmitting photoluminescent layer emission light through the conforming layer and structured surface. In one or more embodiments the method includes transmitting excitation light through the discontinuous barrier layers to excite the photoluminescent layer. In one or more embodiments the method includes comprising transmitting photoluminescent layer emission light through the discontinuous barrier layers and structured surface and conforming layer. In one or more embodiments the disposing step forms and maintains a low refractive index layer between the structured surface and the conforming layer. In one or more embodiments the low refractive index layer includes air. In one or more embodiments the method includes forming or printing the one or more discontinuous barrier layers onto the conforming layer.

[0011] These and various other features and advantages will be apparent from a reading of the following detailed description.

Brief Description of Drawings

[0012] The disclosure may be more completely understood in consideration of the following detailed description of various embodiments of the disclosure in connection with the accompanying drawings, in which:

[0013] FIG. 1 is a schematic side view of an exemplary embodiment of a photoluminescent retroreflective article.

[0014] The figures are not necessarily to scale. Like numbers used in the figures refer to like components. However, it will be understood that the use of a number to refer to a component in a given figure is not intended to limit the component in another figure labeled with the same number.

Detailed Description

[0015] In the following description, reference is made to the accompanying set of drawings that form a part hereof and in which are shown by way of illustration several specific embodiments. It is to be understood that other embodiments are contemplated and may be made without departing from the scope or spirit of the present disclosure. The following detailed description, therefore, is not to be taken in a limiting sense.

[0016] Unless otherwise indicated, all numbers expressing feature sizes, amounts, and physical properties used in the specification and claims are to be understood as being modified in all instances by the term "about." Accordingly, unless indicated to the contrary, the numerical parameters set forth in the foregoing specification and attached claims are approximations that can vary depending upon the desired properties sought to be obtained by those skilled in the art utilizing the teachings disclosed herein.

[0017] As used in this specification and the appended claims, the singular forms "a", "an", and "the" encompass embodiments having plural referents, unless the content clearly dictates otherwise. As used in this specification and the appended claims, the term "or" is generally employed in its sense including "and/or" unless the content clearly dictates otherwise.

[0018] Spatially related terms, including but not limited to, "lower," "upper," "beneath," "below," "above," and "on top," if used herein, are utilized for ease of description to describe spatial relationships of an element(s) to another. Such spatially related terms encompass different orientations of the device in use or operation in addition to the particular orientations depicted in the figures and described herein. For example, if a cell depicted in the figures is turned over or flipped over, portions previously described as below or beneath other elements would then be above those other elements.

[0019] As used herein, when an element, component or layer for example is described as forming a "coincident interface" with, or being "on", "connected to," "coupled with", "in contact with", "separating" or "adjacent" another element, component or layer, it can be directly on, directly connected to, directly coupled with, in direct contact with, or intervening elements, components or layers may be on, connected, coupled or in contact with or separating the particular element, component or layer, for example. When an element, component or layer for example is referred to as being "directly on," "directly connected to," "directly coupled with," or "directly in contact with" another element, there are no intervening elements, components or layers for example.

[0020] The present disclosure relates to photoluminescent retroreflective articles. In particular, the present disclosure relates to photoluminescent retroreflective articles where the retroreflective elements do not substantially interfere with the charging and emission of the photoluminescent element. While the present disclosure is not so limited, an appreciation of various aspects of the disclosure will be gained through a discussion of the examples provided below.

[0021] **FIG. 1** is schematic side view of an exemplary embodiment of a photoluminescent retroreflective article **100** that faces viewer **102**. Photoluminescent retroreflective article **100** includes a retroreflective layer **110** including multiple cube corner elements **112** that collectively form a structured surface **114** opposite a major surface **116**. The specific photoluminescent retroreflective article **100** shown in **FIG. 1** includes an overlay layer **118** (also referred to as a top film), but those of skill will appreciate that some embodiments do not include an overlay layer. One or more barrier layers **134** are positioned between retroreflective layer **110** and conforming layer **132**. Barrier layers **134** form a physical "barrier" between cube corner elements **112** and conforming layer **132**. Barrier layers **134** are discrete and discontinuous elements. Barrier layer **134** can directly contact or be spaced apart from or can push slightly into the tips of cube corner elements **112**. A photoluminescent layer **135** is disposed on the conforming layer **132**. The conforming layer **132** separates one or both of barrier layer **134** and cube corner elements **112** from the photoluminescent layer **135.** Barrier layer **134** can directly contact or be spaced apart from the photoluminescent layer **135**.

[0022] In general, any material that prevents the conforming layer material from contacting cube corner elements **112** or flowing or creeping into low refractive index area **138** can be used to form the barrier layer. The portions of structured surface **112** that are adjacent to low refractive index area **138**, which is created, in part, by barrier layers **134**, are typically retroreflective. Exemplary materials for use in barrier layer **134** include resins, polymeric materials, dyes, inks (including color-shifting inks), vinyl, inorganic materials, UV-curable polymers, multi-layer optical films (including, for example, color-shifting multi-layer optical films), pigments, particles, and beads. The size and spacing of the one or more barrier layers can be varied. In many embodiments, the barrier layer **134** can be formed of any material that transmits excitation light to the photoluminescent layer **135** and transmits emission light from the photoluminescent layer **135.**

[0023] In some embodiments, the barrier layers may form a pattern on the retroreflective sheeting. In some embodiments, one may wish to reduce the visibility of the pattern on the sheeting. This can be accomplished, for example, by using barrier layers that are relatively small and difficult to resolve at a specific distance. In general, any desired pattern can be generated by combinations of the described techniques, including, for example, indicia such as letters, words, alphanumerics, symbols, graphics, logos, or pictures. The patterns can also be continuous, discontinuous, monotonic, dotted, serpentine, any smoothly varying function, stripes, varying in the machine direction, the transverse direction, or both; the pattern can form an image, logo, or text, and the pattern can include patterned coatings and/or perforations. The pattern can include, for example, an irregular pattern, a regular pattern, a grid, words, graphics, images lines, and intersecting zones that form cells.

[0024] A low refractive index area **138** is positioned between (1) one or both of barrier layer **134** and conforming layer **132** and (2) cube corner elements **112**. The low refractive index area **138** facilitates total internal reflection such that light that is incident on cube corner elements **112** adjacent to a low refractive index area **138** is retroreflected. A light ray incident on a cube corner element **112** that is adjacent to low refractive index layer **138** is retroreflected back to viewer **102**. For this reason, an area of retroreflective article **100** that includes low refractive index layer **138** can be referred to as an optically active area. In contrast, an area of retroreflective article **100** that does not include low refractive index layer **138** can be referred to

as an optically inactive area because it does not substantially retroreflect incident light. As used herein, the term "optically inactive area" refers to an area that is at least 50% less optically active (e.g., retroreflective) than an optically active area. In some embodiments, the optically inactive area is at least 40% less optically active, or at least 30% less optically active, or at least 20% less optically active, or at least 10% less optically active, or at least at least 5% less optically active than an optically active area.

[0025] Low refractive index layer **138** includes a material that has a refractive index that is less than about 1.30, less than about 1.25, less than about 1.2, less than about 1.15, less than about 1.10, or less than about 1.05. In general, any material that prevents the conforming layer material from contacting cube corner elements **112** or flowing or creeping into low refractive index area **138** can be used as the low refractive index material. In some embodiments, barrier layer **134** has sufficient structural integrity to prevent conforming layer **132** from flowing into a low refractive index area **138**. In such embodiments, low refractive index area may include, for example, a gas (e.g., air, nitrogen, argon, and the like). In other embodiments, low refractive index area includes a solid or liquid substance that can flow into or be pressed into or onto cube corner elements **112**. Exemplary materials include, for example, ultra-low index coatings (those described in PCT Patent Application No. PCT/US2010/031290), and other highly porous materials.

[0026] The portions of conforming layer **132** that are adjacent to or in contact or direct contact with cube corner elements **112** form optically inactive (e.g., non-retroreflective) areas or cells. The conforming layer **132** can be formed of any material that transmits excitation light to the photoluminescent layer **135** and transmits emission light from the photoluminescent layer **135.** In many embodiments, a light reflective layer **137** is disposed on the photoluminescent layer **135**. The photoluminescent layer **135** can separate the light reflective layer **137** from the conforming layer **132**. In many embodiments, the light reflective layer **137** has a white color. In these embodiments, the photoluminescent layer **135** can have adhesive properties to adhere to the light reflective layer **137** or a separate adhesive layer (not shown) can adhere the light reflective layer **137** to the photoluminescent layer **135.** In some embodiments an pressure sensitive adhesive layer (not shown) on an exterior surface of the light reflective layer **137** and an optional release liner (not shown) can be disposed on the pressure sensitive adhesive layer to

protect the pressure sensitive adhesive layer until the photoluminescent retroreflective article **100** is prepared for mounting to a substrate.

[0027] In some embodiments, conforming layer **132** is an adhesive. Exemplary adhesives include those described in PCT Patent Application No. PCT/US2010/031290. Where the conforming layer is an adhesive, the conforming layer may assist in holding the entire photoluminescent retroreflective construction together and/or the viscoelastic nature of barrier layers **134** may prevent wetting of cube tips or surfaces either initially during fabrication of the photoluminescent retroreflective article or over time.

[0028] In some embodiments, conforming layer **132** is a pressure sensitive adhesive. The PSTC (pressure sensitive tape council) definition of a pressure sensitive adhesive is an adhesive that is permanently tacky at room temperature which adheres to a variety of surfaces with light pressure (finger pressure) with no phase change (liquid to solid). While most adhesives (e.g., hot melt adhesives) require both heat and pressure to conform, pressure sensitive adhesives typically only require pressure to conform. Exemplary pressure sensitive adhesives include those described in U.S. Patent No. 6,677,030. Barrier layers **134** may also prevent the pressure sensitive adhesive from wetting out the cube corner sheeting.

[0029] The conforming layer **132** can be formed in a variety of ways including but not limited to the following exemplary methods. In one exemplary embodiment, the material(s) forming the barrier layer is printed onto the conforming layer and/or the cube corner elements. The method of printing can be a non-contact method such as, for example, printing using an inkjet printer. The method of printing can be a contact printing method such as, for example, flexographic printing. In another exemplary embodiment, the material(s) forming the barrier layer is printed onto a flat release surface using, for example, an inkjet or screen printing method, and are then subsequently transferred from the flat release surface onto the conforming layer and/or cube corner elements. In another exemplary embodiment, the material(s) forming the barrier layer are flood coated onto a microstructured surface. The barrier layer material is subsequently transferred from the microstructured surface to the conforming layer by, for example, lamination. The structured surface is removed after lamination to provide a conforming layer with barrier layers that is laminated to a retroreflective layer to make the retroreflective article. The

retroreflective article can then be adhesively bonded to the photoluminescent layer **135** to form the photoluminescent retroreflective article **100.**

[0030] The photoluminescent layer **135** can be formed of any useful luminescent material. The photoluminescent layer **135** can be prepared using any of the known photoluminescent materials known in the art. This layer may itself be a multi-layered construction consisting of a luminescent layer and a carrier layer. The carrier layer, generally a thermoplastic material such as vinyl, is covered with a layer to prevent migration of the luminescent material into the carrier layer. This layer can be made of any suitable material, such as acrylic or methacrylic type resins. The luminescent layer, which may be a vinyl or other suitable thermoplastic having photoluminescent particles dispersed therein, can be positioned or adhesively disposed on the layer. Any of the known photoluminescent materials can be incorporated into this photoluminescent layer **135**. Photoluminescent film is commercially available from 3M Company (3M) as 3M™ Photoluminescent Film 6900 HPPL that provides luminosity that lasts for an extended time after photon excitation in the film ends.

[0031] All references mentioned herein are incorporated by reference.

[0032] Those having skill in the art will appreciate that many changes may be made to the details of the above-described embodiments and implementations without departing from the underlying principles thereof. Further, various modifications and alterations of the present invention will become apparent to those skilled in the art without departing from the spirit and scope of the invention. The scope of the present application should, therefore, be determined only by the following claims.

[0033] Thus, embodiments of the PHOTOLUMINESCENT RETROREFLECTIVE ARTICLES are disclosed. The implementations described above and other implementations are within the scope of the following claims. One skilled in the art will appreciate that the present disclosure can be practiced with embodiments other than those disclosed. The disclosed embodiments are presented for purposes of illustration and not limitation, and the present disclosure is limited only by the claims that follow.

What is claimed is:

1. A photoluminescent retroreflective article, comprising:

a retroreflective layer including multiple cube corner elements that collectively form a structured surface that is opposite a major surface;

a conforming layer having a first region and a second region wherein the second region is in intimate contact with the structured surface and the first region forming a low refractive index layer between the conforming layer and the structured surface of the retroreflective layer and the conforming layer is separated from the structured surface at the first region by a barrier layer;

a photoluminescent layer disposed on the conforming layer, the conforming layer separating the photoluminescent layer and the retroreflective layer.

2. The photoluminescent retroreflective article of claim 1, wherein the conforming layer transmits excitation light to the photoluminescent layer and the conforming layer transmits emission light from the photoluminescent layer.

3. The photoluminescent retroreflective article of claims 1 to 2, wherein the barrier layer transmits excitation light to the photoluminescent layer and the barrier layer transmits emission light from the photoluminescent layer.

4. The photoluminescent retroreflective article of claims 1 to 3, wherein the low refractive index layer includes air.

5. The photoluminescent retroreflective article of claims 1 to 4, wherein the conforming layer comprises a pressure sensitive adhesive.

6. The photoluminescent retroreflective article of claims 1 to 5, further comprising a light reflective layer disposed on the photoluminescent layer, the photoluminescent layer separating the light reflective layer from the conforming layer.

7. The photoluminescent retroreflective article of claim 6, further comprising an adhesive layer disposed on the light reflective layer, the light reflective layer separating the adhesive layer from the photoluminescent layer.

8. The photoluminescent retroreflective article of claim 7, further comprising a releasable liner disposed on the adhesive layer.

9. The photoluminescent retroreflective article of claims 1 to 8, wherein the conforming layer is index matched to the retroreflective layer.

10. A method of forming a photoluminescent retroreflective article, comprising:
providing a retroreflective layer comprising multiple cube corner elements that collectively form a structured surface;
disposing one or more discontinuous barrier layers adjacent to the structured surface;
placing a conforming layer adjacent to the one or more discontinuous barrier layers and structured surface; and
positioning a photoluminescent layer to the conforming layer so that the conforming layer separates the photoluminescent layer from the structured surface.

11. The method of claim 10, further comprising transmitting excitation light through the conforming layer layers to excite the photoluminescent layer.

12. The method of claims 10 to 11, further comprising transmitting photoluminescent layer emission light through the conforming layer and structured surface.

13. The method of claims 10 to 12, further comprising transmitting excitation light through the discontinuous barrier layers to excite the photoluminescent layer.

14. The method of claims 10 to 13, further comprising transmitting photoluminescent layer emission light through the discontinuous barrier layers and structured surface and conforming layer.

15. The method of claims 10 to 14, wherein the disposing step forms and maintains a low refractive index layer between the structured surface and the conforming layer.

16. The method of claim 15, wherein the low refractive index layer includes air.

17. The method of claims 10 to 16, wherein the disposing step includes forming or printing the one or more discontinuous barrier layers onto the conforming layer.

5

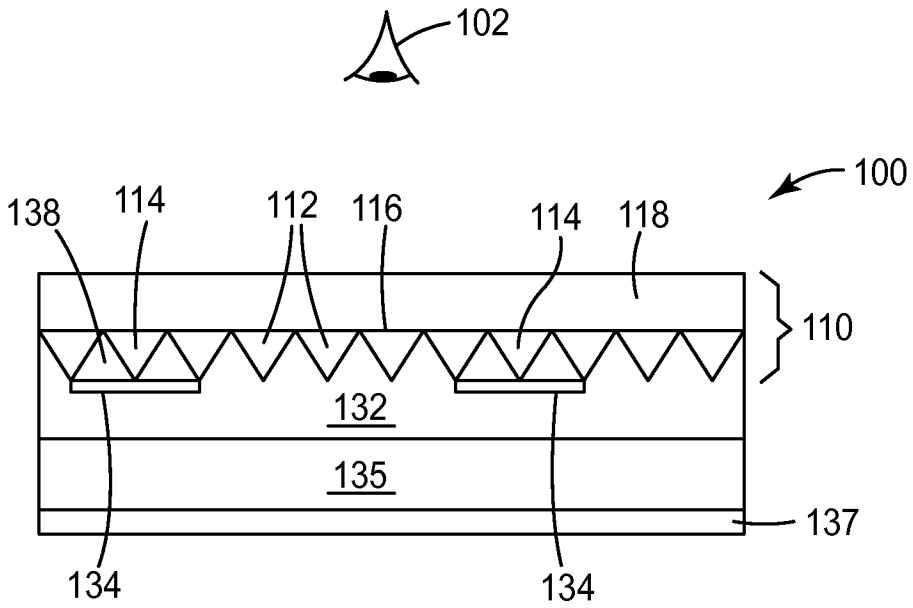


FIG. 1

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2013/074095

A. CLASSIFICATION OF SUBJECT MATTER
INV. G02B5/124 B32B3/30
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 B32B

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	WO 98/58281 A1 (MINNESOTA MINING & MFG [US]) 23 December 1998 (1998-12-23) figure 1 page 13, line 14 - page 14, line 20; figure 2 page 7, line 5 - line 22 page 13, line 6 - line 11 page 21, line 19 - line 33 -----	1-4,6-8, 10-17 5,9
Y A	WO 2011/129833 A1 (3M INNOVATIVE PROPERTIES CO [US]; SMITH KENNETH L [US]; FREE MICHAEL B) 20 October 2011 (2011-10-20) paragraph [0006]; figure 1A -----	5 17
	-/--	

[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 application or patent 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
21 February 2014	04/03/2014

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	Linke, Felix

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

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2013/074095

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5 743 981 A (LU SHIH-LAI [TW]) 28 April 1998 (1998-04-28)	9
A	column 6, line 63 - column 7, line 2 figure 1	17

A	WO 2008/029128 A2 (RUE DE INT LTD [GB]; COMMANDER LAWRENCE GEORGE [GB]; EASTELL CHRISTOPH) 13 March 2008 (2008-03-13) page 36, line 10 - line 30; figure 22 page 24, line 6 - line 11	1-17

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2013/074095

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9858281 A1	23-12-1998	AT 302957 T	15-09-2005
		AU 727741 B2	21-12-2000
		AU 7969998 A	04-01-1999
		BR 9810034 A	19-09-2000
		CA 2292537 A1	23-12-1998
		CN 1264473 A	23-08-2000
		DE 69831331 D1	29-09-2005
		DE 69831331 T2	08-06-2006
		EP 0990178 A1	05-04-2000
		ES 2245483 T3	01-01-2006
		JP H1115415 A	22-01-1999
		NO 996259 A	16-12-1999
		NZ 501313 A	29-06-2001
		RU 2204154 C2	10-05-2003
		US 6166856 A	26-12-2000
		WO 9858281 A1	23-12-1998
WO 2011129833 A1	20-10-2011	CN 102858528 A	02-01-2013
		EP 2558290 A1	20-02-2013
		JP 2013524294 A	17-06-2013
		KR 20130067272 A	21-06-2013
		US 2013135731 A1	30-05-2013
		WO 2011129833 A1	20-10-2011
US 5743981 A	28-04-1998	AU 689327 B2	26-03-1998
		AU 3637395 A	31-05-1996
		BR 9509569 A	16-09-1997
		CA 2203645 A1	17-05-1996
		CN 1162289 A	15-10-1997
		DE 69508607 D1	29-04-1999
		DE 69508607 T2	29-07-1999
		EP 0790896 A1	27-08-1997
		JP H10508549 A	25-08-1998
		US 5591527 A	07-01-1997
		US 5743981 A	28-04-1998
		WO 9614215 A1	17-05-1996
WO 2008029128 A2	13-03-2008	NONE	