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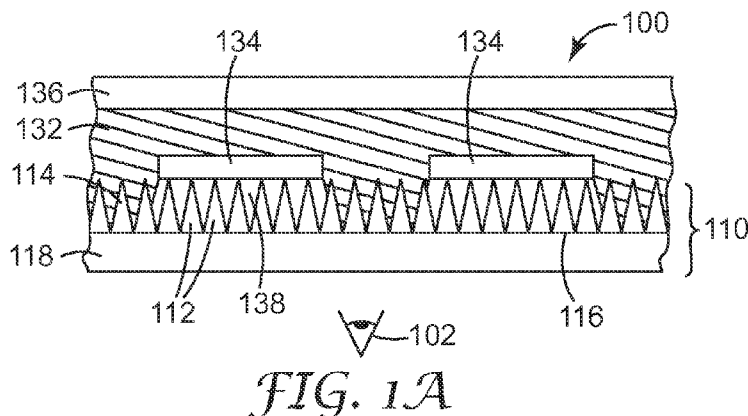
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(54) Title: RETROREFLECTIVE ARTICLES INCLUDING A SECURITY MARK



(57) Abstract: The present disclosure relates to prismatic retroreflective articles that includes a security mark and to methods of making such articles.

**RETROREFLECTIVE ARTICLES INCLUDING A SECURITY MARK****BACKGROUND**

- [01] 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.
- [02] 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.
- [03] 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. Presence of, for example, dirt, water, and adhesive on the optical faces can prevent total internal reflection (TIR) and lead to a reduction in the retroreflected light intensity.
- [04] Security marks are used to indicate that an article is authentic. Security marks have been used on beaded retroreflective sheeting. For example, U.S. Patent No. 4,688,894 describes a security mark for use on beaded retroreflective sheeting having the ability to be optically variable based on viewing angle. U.S. Patent No. 7,995,278 describes a security mark for use on beaded retroreflective sheeting that appears to float or sink along the article sheeting surface.

**BRIEF SUMMARY**

- [05] The inventors of the present application recognized a need for security marks capable of use on prismatic retroreflective sheeting. The present disclosure relates to prismatic retroreflective articles that includes a security mark and to methods of making such articles.
- [06] In one illustrative embodiment, a retroreflective article includes a retroreflective layer including multiple cube corner elements that collectively form a structured surface; one or more barrier layers positioned

adjacent to the structured surface; and a conforming layer positioned adjacent to the one or more barrier layers; wherein one or more of the layers in combination form a security mark having a first portion including a first characteristic and a second portion including a second characteristic, wherein the characteristic is one of color and infra-red absorbency. For purposes of clarity, the one or more barrier layers have a characteristic that varies from a characteristic in one of (1) the areas not including the one or more barrier layers or (2) another barrier layer. Exemplary characteristics include, for example, color and infrared absorbency.

- [07] In some embodiments, at least some of the first and second portions overlap. In some embodiments, the first and second portions do not overlap. In some embodiments, the barrier layers are applied to the conforming layer. In some embodiments, the barrier layers are applied to at least a portion of the structured surface. In some embodiments, the one or more barrier layers cover less than 100% of the structured surface. In some embodiments, the structured surface that is adjacent to the one or more barrier layers is optically active and the portion of the structured surface not adjacent to the one or more barrier layers is not optically active. In some embodiments, the conforming layer is an adhesive. In some embodiments, the adhesive is optically opaque. In some embodiments, the security mark can be distinguished from the background by a viewer in both ambient light and in retroreflection. In some embodiments, the security mark can be distinguished from the background by a viewer in ambient light, but not in retroreflection.
- [08] In another illustrative embodiment, a method of forming a retroreflective article includes providing a retroreflective layer including multiple cube corner elements that collectively form a structured surface; positioning one or more barrier layers adjacent to the structured surface to form a security mark having a first portion including a first characteristic and a second portion including a second characteristic, wherein the characteristic is one of color and infra-red absorbency; positioning a conforming layer adjacent to the one or more barrier layers; and laminating the layers.
- [09] In some embodiments, the method further includes forming a pattern of the one or more barrier layers on the conforming layer before the laminating step. In some embodiments, the method further includes forming a pattern on one or more of the barrier layers before the laminating step. In some embodiments, the method further includes patterning the one or more barrier layers onto the conforming layer before the laminating step to form a security mark void; and patterning another barrier layer into the security mark void, wherein the barrier layer and the security mark do not substantially overlap. In some embodiments, the one or more barrier layers are formed by curing a polymer-containing layer before the laminating step. In some embodiments, the one or more barrier layers are printed onto the conforming layer. In some embodiments, the laminating step encapsulates air between the structured surface and the one or more barrier layers. In some embodiments, the security mark can be distinguished from the background by a viewer in both ambient light and in retroreflection. In some embodiment, the security mark can be

distinguished from the background by a viewer in ambient light, but not in retroreflection. In some embodiments, the confirming layer is an adhesive. In some embodiments, the adhesive is a pressure sensitive adhesive. In some embodiments, the adhesive is optically opaque. In some embodiments, the security mark exhibits variable retroreflectivity.

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

### **BRIEF DESCRIPTION OF THE DRAWINGS**

- [11] The disclosure may be more completely understood in view of the following detailed description of various embodiments of the disclosure in connection with the accompanying drawings, in which:
- [12] **FIGS. 1A and 1B** are schematic side views of one exemplary embodiment of a retroreflective article.
- [13] **FIG. 2** is schematic drawing of one exemplary intermediary step that can be used in forming a retroreflective article.
- [14] **FIG. 3** is schematic drawing of one exemplary intermediary step that can be used in forming a retroreflective article.
- [15] **FIG. 4** is a photograph from a front view of an illustrative retroreflective article with security markings.
- [16] **FIG. 5** is a schematic side view of another exemplary embodiment of a retroreflective article.
- [17] **FIG. 6** is a schematic side view of another exemplary embodiment of a retroreflective article.
- [18] The figures are not 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**

- [19] 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.
- [20] The present disclosure relates to prismatic retroreflective articles that includes a security mark and to methods of making such articles. The term “security mark” refers to an element on or in a retroreflective

film that can be used to authenticate the article. The security marks of the present application can be continuous or discontinuous.

- [21] **FIGS. 1A and 1B** are schematic side views of one exemplary embodiment of a retroreflective article **100** that faces a viewer **102**. 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 optical elements can be full cubes, truncated cubes, or preferred geometry (PG) cubes as described in, for example, U.S. Patent No. 7,422,334, incorporated herein by reference. The specific retroreflective layer **110** shown in **FIGS. 1A and 1B** 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 layer **134** can directly contact or be spaced apart from or can push slightly into the tips of cube corner elements **112**. Barrier layers **134** have a characteristic that varies from a characteristic in one of (1) the areas not including barrier layers **134** or (2) another barrier layer **134**. Exemplary characteristics include, for example, color and infrared absorbency.
- [22] 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. 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 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. 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.
- [23] 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. As is shown in **FIG. 1B**, a light ray **150** 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.

- [24] 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 gels.
- [25] The portions of conforming layer **132** that are adjacent to or in contact with cube corner elements **112** form non-optically active (*e.g.*, non-retroreflective) areas or cells. In some embodiments, conforming layer **132** is optically opaque. In some embodiments conforming layer **132** has a white color.
- [26] 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 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 retroreflective article or over time.
- [27] 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.
- [28] In some embodiments, conforming layer **132** includes a sealing film **136** that assists in holding the construction together. Some sealing films require heat and pressure to conform.
- [29] In one exemplary embodiment, one or more barrier layers are printed in a first region (*e.g.*, a background region) with one (or more) first colors, and one or more barrier layers are printed in a second region (*e.g.*,

a security mark region) with one or more second colors. The first and second regions combine to create a security mark. In this embodiment, the security mark is defined by the color differential between the first region and the second region.

- [30] In some exemplary embodiments, the security mark is visible in ambient light (the visible spectrum) and “disappears” in retroreflection. This could be done, for example, by making a security mark with colored areas that have the same size, shape, and/or spacing as the background but at least one color that is different from the background color. In ambient light, the different colors make the mark apparent. However, because the color of the areas including barrier material(s) does not affect the appearance of the film in retroreflected light, the mark looks effectively the same as the background.
- [31] In some embodiments, the security mark is visible in retroreflection and is not substantially visible in ambient light. This could be done, for example, by creating an image area having a higher percentage coverage of conforming material than adjacent areas, and in the same image area, using a pigment to adjust the conforming layer to have a lower cap-Y (*i.e.*, grayer appearance) than the adjacent conforming material. The result is that both areas appear the same color in diffuse light. The image area appears less reflective in retroreflection. Alternatively, this could be done by, for example, using barriers layers having dissimilar colors that do not have a high degree of contrast between the colors.
- [32] Retroreflective layer **110** of **FIGS. 1A and 1B** is shown as including overlay layer **118** and no land layer or land portion. The term “land layer” as used in the present application refers to a continuous layer of material coextensive with the cube corner elements and composed of the same material. Those of skill in the art will appreciate that retroreflective layer **110** can include a land layer or land portion. A construction without a land layer may be desirable for flexible embodiments.
- [33] In some embodiments, one or more barrier layers are printed on a film that is later positioned adjacent to the structured surface of the retroreflective layer.
- [34] One implementation of these embodiments is schematically shown in **FIG. 2**. **FIG. 2** shows one method of making at least some of the retroreflective articles of the present disclosure involves placing barrier layer material **134** onto a pressure sensitive adhesive material **132** and then laminating the resulting pressure sensitive adhesive layer **130** to a retroreflective layer **110**. The pressure sensitive adhesive layer **130** 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 are printed onto the pressure sensitive adhesive. 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 are 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 pressure sensitive adhesive. 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 pressure sensitive adhesive by, for example, lamination. The structured surface is removed after lamination to provide a pressure sensitive adhesive with barrier layers that is laminated to a retroreflective layer to make the retroreflective article. The retroreflective article may then, optionally, be adhesively bonded to a substrate (*e.g.*, an aluminum substrate) to form, for example, a license plate or signage.

- [35] In some embodiments, one or more barrier layers are applied (*e.g.*, printed) on the cube corner elements and a film layer is later placed on top of the barrier layers and cube corner elements. One implementation of these embodiments is schematically shown in **FIG. 3**.
- [36] **FIG. 4** is a front view of an illustrative retroreflective article **100** with two separate security markings **134**. The retroreflective article **100** shown has a white, opaque, retroreflective background and black or gray security markings **134**. Under ambient light, the security markings **134** appear black or gray and under retroreflection the security markings **134** appear brighter than the surrounding background.
- [37] **FIGS. 5 and 6** are a schematic side view of another exemplary embodiment of a retroreflective article **101**. This embodiment is similar to **FIGS. 1A and 1B** except that multiple barrier layers **134** and **135** are shown. The barrier layers in **FIG. 5** are overlapping, and the barrier layers in **FIG. 6** are not substantially overlapping. Those of skill in the art will appreciate that in some embodiments, the barrier layers partially overlap.
- [38] With specific reference to the embodiment shown in **FIG. 5**, the different barrier layers **134** and **135** can have the same or similar physical properties or can have different physical properties. In some embodiments, barrier layers **134** and **135** do not have the same color. In some embodiments, barrier layer **134** is clear or colorless while barrier layer **135** has a color and/or is opaque. In some embodiments, barrier layer **134** and conforming layer **132** have the same color (*e.g.*, white). Barrier layer **135** can have a color that is different than either or both of pressure sensitive adhesive layer **132** and barrier layer **134**.
- [39] With specific reference to the embodiment shown in **FIG. 6**, this security marking can be formed by, for example, first patterning (*e.g.*, printing) barrier layer **134** onto the conforming layer **132** where the barrier layer **135** defines a security mark void and then patterning barrier layer **135** into the security mark void. Thus, barrier layer **134** and barrier layer **135** are not overlapping.
- [40] In some embodiments, the security mark changes appearance to a viewer as the viewer changes their point of view. For example, as the observation angle and/or entrance angle changes, the appearance of the security mark changes.
- [41] In some embodiments, the conforming layer conforms less than completely in the optically inactive areas. The optical effect of this is that the optically inactive areas may be partially or somewhat optically active (*e.g.*, retroreflective). In other words, the retroreflectivity or lack thereof can be varied in both the



optically inactive and optically active areas. The conformance of the conforming layer can be modified to create this optical effect.

- [42] Some embodiments of the security marks described in the present application do not interfere with reading of the license plate characters. This means that the security mark does not interfere with reading of the license plate alphanumerics in at least one light spectrum, *e.g.*, visible, infra-red, retroreflection. In some embodiments, the security feature(s) on a license plates can be read by optical character recognition cameras without confusion between the alphanumeric characters that form the license plate number and the security marks.
- [43] Some embodiments of the security marks described in the present application increase or decrease the retroreflectivity of certain areas of the security mark relative to the background area. By comparison, prior art security marks on beaded sheeting could only decrease the retroreflectivity. Increasing or decreasing the retroreflectivity of certain areas of the security mark can be done, for example, by varying the dimensions and/or percent optically active area of repeating units in a pattern of barrier layers.
- [44] Some embodiments of the security marks described in the present application increase or decrease the whiteness or CAP-Y of certain areas of the security mark relative to the background area. Increasing or decreasing the whiteness or CAP-Y of certain areas of the security mark can be done, for example, by varying the dimensions and/or percent optically active area of repeating units in a pattern of barrier layers. Alternatively or additionally, the barrier material can be white, which could, in some embodiments, increase the CAP-Y of the security mark in comparison with the background area.
- [45] All references mentioned herein are incorporated by reference.
- [46] 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.
- [47] 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.
- [48] 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.

- [49] Embodiments of the present disclosure are disclosed. The disclosed embodiments are presented for purposes of illustration and not limitation. 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. 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 present disclosure. The scope of the present application should, therefore, be determined only by the following claims.

What is claimed is:

1. A retroreflective article, comprising:  
a retroreflective layer including multiple cube corner elements that collectively form a structured surface;  
one or more barrier layers positioned adjacent to the structured surface; and  
a conforming layer positioned adjacent to the one or more barrier layers;  
wherein one or more of the layers in combination form a security mark having a first portion including a first characteristic and a second portion including a second characteristic, wherein the characteristic is one of color and infra-red absorbency.
2. The retroreflective article of claim 1, wherein at least some of the first and second portions overlap.
3. The retroreflective article of claim 1, wherein the first and second portions do not overlap.
4. The retroreflective article of any of the preceding claims, wherein one or more of the barrier layers are applied to the conforming layer.
5. The retroreflective article of any of the preceding claims, wherein one or more of the barrier layers are applied to at least a portion of the structured surface.
6. The retroreflective article of any of the preceding claims, wherein the one or more barrier layers cover less than 100% of the structured surface.
7. The retroreflective article of claim 6, wherein the portion of the structured surface adjacent to the one or more barrier layers is optically active and the portion of the structured surface not adjacent to the one or more barrier layers is not optically active.
8. The retroreflective article of any of the preceding claims, wherein the conforming layer is an adhesive.
9. The retroreflective article of claim 8, wherein the adhesive is optically opaque.
10. The retroreflective article of any of the preceding claims, wherein the security mark can be distinguished from the background by a viewer in both ambient light and in retroreflection.

11. The retroreflective article of claims 1-9, wherein the security mark can be distinguished from the background by a viewer in ambient light, but not in retroreflection.
12. A method of forming a retroreflective article, comprising:
  - providing a retroreflective layer including multiple cube corner elements that collectively form a structured surface;
  - positioning one or more barrier layers adjacent to the structured surface to form a security mark having a first portion including a first characteristic and a second portion including a second characteristic, wherein the characteristic is one of color and infra-red absorbcency;
  - positioning a conforming layer adjacent to the one or more barrier layers; and
  - laminating the layers.
13. The method of claim 12, further comprising:
  - forming a pattern of the one or more barrier layers on the conforming layer before the laminating step.
14. The method of claims 12, further comprising:
  - forming a pattern on one or more of the barrier layers before the laminating step.
15. The method of claims 12, further comprising:
  - patterning the one or more barrier layers onto the conforming layer before the laminating step to form a security mark void; and
  - patterning another barrier layer into the security mark void, wherein the barrier layer and the security mark do not substantially overlap.
16. The method of claims 12 to 15, wherein the one or more barrier layers is formed by curing a polymer-containing layer before the laminating step.
17. The method of claims 12 to 16, wherein the one or more barrier layers is printed onto the conforming layer.
18. The method of claims 12 to 17, wherein the laminating step encapsulates air between the structured surface and the one or more barrier layers.

19. The retroreflective article of claims 12-18, wherein the security mark can be distinguished from the background by a viewer in both ambient light and in retroreflection.
20. The retroreflective article of claims 12-18, wherein the security mark can be distinguished from the background by a viewer in ambient light, but not in retroreflection.
21. The method of claims 12-20, wherein the confirming layer is an adhesive.
22. The method of claims 12-21, wherein the adhesive is a pressure sensitive adhesive.
23. The method of claims 12-22, wherein the adhesive is optically opaque.
24. The method of claims 12-23, wherein the security mark exhibits variable retroreflectivity.
25. The retroreflective article of any of claims 1-11, wherein the one or more barrier layers have a characteristic that varies from a characteristic in one of (1) the areas not including the one or more barrier layers or (2) another barrier layer.
26. The method of any of claims 12-24, wherein the one or more barrier layers have a characteristic that varies from a characteristic in one of (1) the areas not including the one or more barrier layers or (2) another barrier layer.

1/3

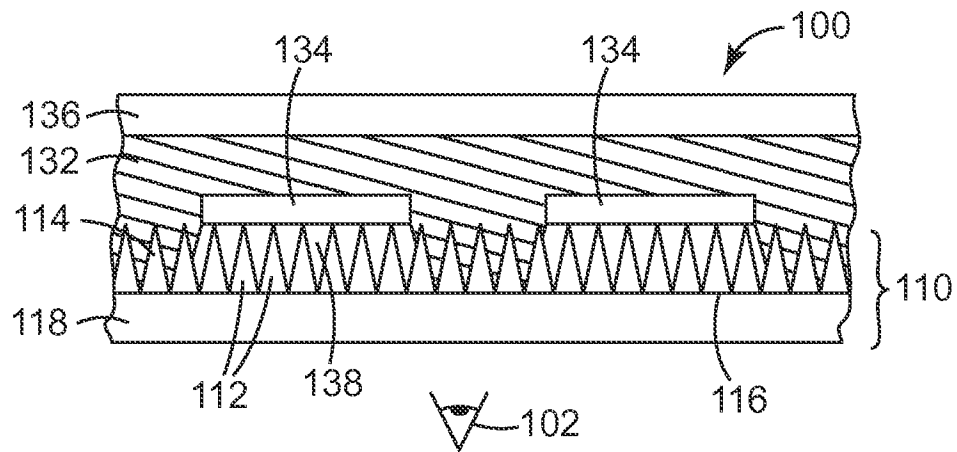


FIG. 1A

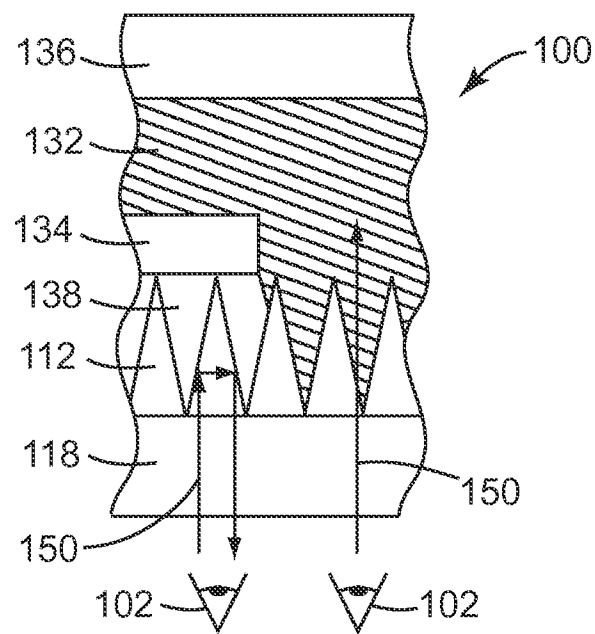


FIG. 1B

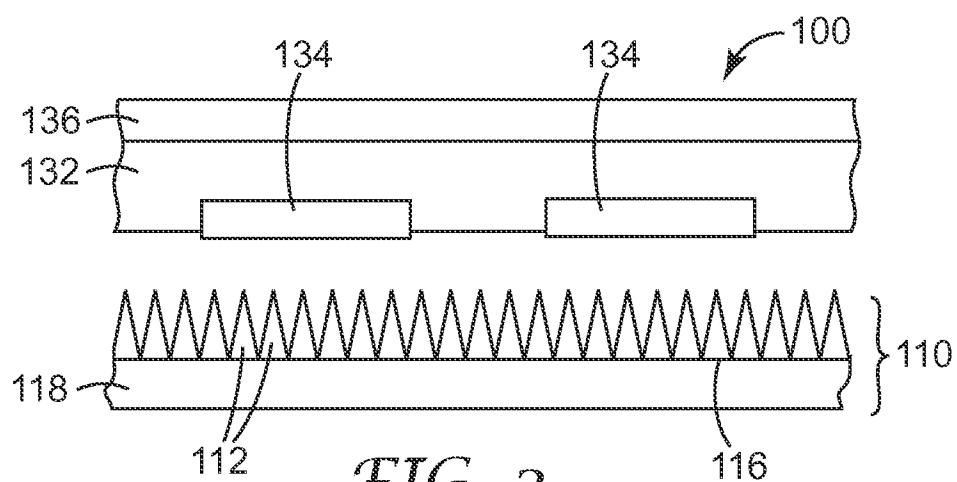
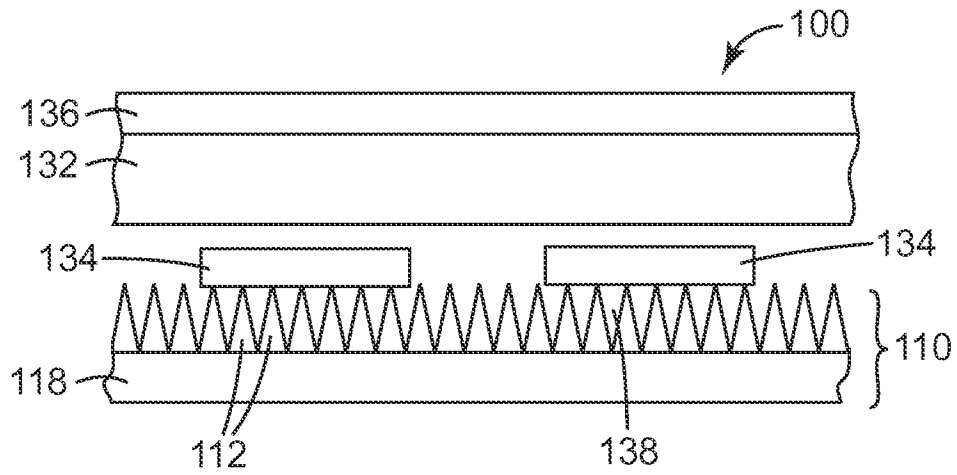
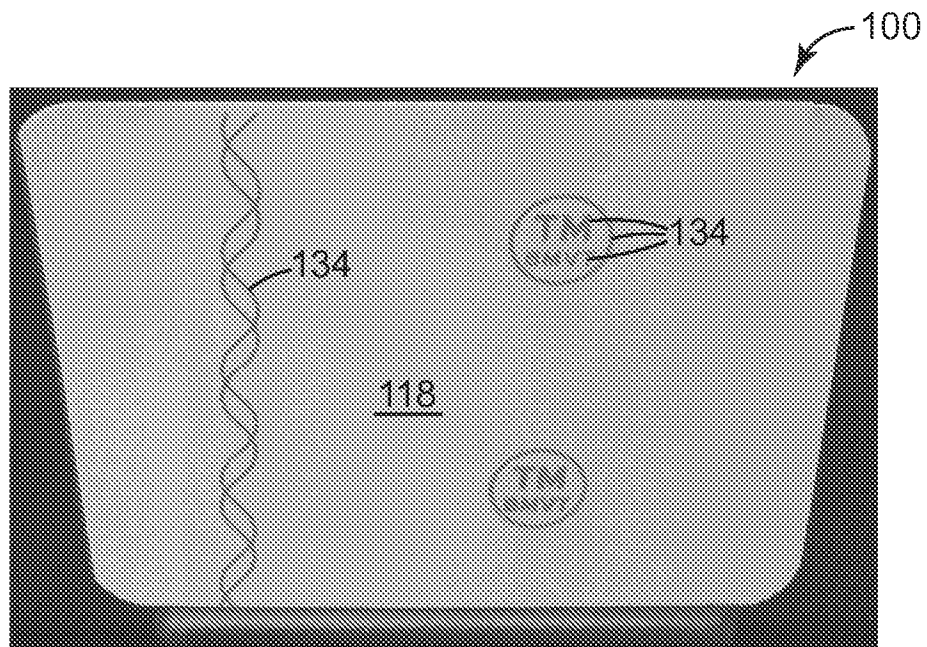


FIG. 2

*FIG. 3**FIG. 4*

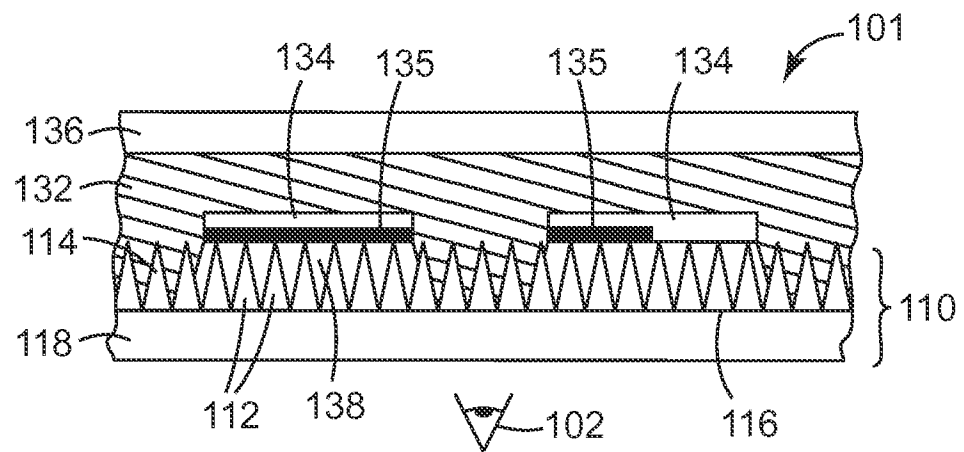


FIG. 5

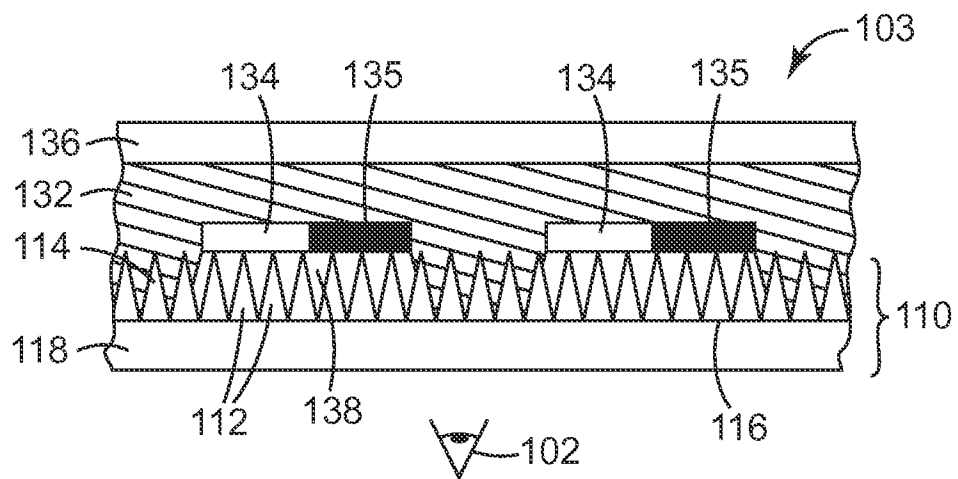


FIG. 6



**A. CLASSIFICATION OF SUBJECT MATTER****G02B 5/08(2006.01)i, G06K 9/18(2006.01)i, G06K 7/10(2006.01)i**

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 5/08; G02B 5/124; G06K 9/20; B32B 3/00; B32B 9/04; G06K 9/00; G02B 5/122

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

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

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

eKOMPASS(KIPO internal) &amp; keywords: retroreflective sheet, barrier, adhesive, infra-red absorber, color

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5591527 A (LU) 07 January 1997 See abstract, columns 7, 12-13, 16 and figures 2, 4.	1-4, 12-15
Y	EP 0416742 A2 (MINNESOTA MINING AND MANUFACTURING COMPANY) 13 March 1991 See abstract, claims 3, 5 and figure 1B.	1-4, 12-15
A	US 6568817 B1 (MIMURA et al.) 27 May 2003 See abstract, column 7, lines 1-55 and figure 3.	1-4, 12-15
A	KR 10-2008-0023345 A (AVERY DENNISON CORP.) 13 March 2008 See abstract, claim 1 and figures 2C, 2D.	1-4, 12-15
A	US 5614286 A (BACON, JR. et al.) 25 March 1997 See abstract, column 11, line 24 - column 13, line 32 and figure 1.	1-4, 12-15



Further documents are listed in the continuation of Box C.



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 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

"&amp;" document member of the same patent family

Date of the actual completion of the international search

26 FEBRUARY 2013 (26.02.2013)

Date of mailing of the international search report

**27 FEBRUARY 2013 (27.02.2013)**

Name and mailing address of the ISA/KR



Facsimile No. 82-42-472-7140

Authorized officer

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Telephone No. 82-42-481-8405



**INTERNATIONAL SEARCH REPORT**

Information on patent family members

International application No.

**PCT/US2012/056267**

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 05591527A A	07.01.1997	CN 1058665 C	22.11.2000
		CN 1162289 A	15.10.1997
		CN 1162289 C0	15.10.1997
		EP 0790896 A1	21.01.1998
		EP 0790896 B1	24.03.1999
		JP 10-508549 A	25.08.1998
		KR 10-1997-0706972 A	01.12.1997
		US 05743981 A	28.04.1998
		WO 96-14215 A1	17.05.1996
EP 0416742 A2	13.03.1991	AU 5871090 A	07.02.1991
		AU 633599 B2	04.02.1993
		CA 2020380 A1	04.02.1991
		EP 0416742 A3	30.12.1992
		IE 902400 A1	13.02.1991
		JP 03-075996 A	29.03.1991
		KR 10-1991-0005192 A	30.03.1991
US 6568817 B1	27.05.2003	AT 349717 T	15.01.2007
		AT 474240 T	15.07.2010
		AT 499621 T	15.03.2011
		CA 2372421 A1	18.10.2001
		CA 2372421 C	18.05.2010
		CN 1188714 C0	09.02.2005
		CN 1366620 A0	28.08.2002
		DE 60125484 D1	08.02.2007
		DE 60125484 T2	21.06.2007
		DE 60142594 D1	26.08.2010
		DE 60144126 D1	07.04.2011
		EP 1193511 A1	03.04.2002
		EP 1193511 A4	24.08.2005
		EP 1193511 B1	27.12.2006
		EP 1746444 A2	24.01.2007
		EP 1746444 A3	24.10.2007
		EP 1746444 B1	14.07.2010
		EP 2157457 A1	24.02.2010
		EP 2157457 B1	23.02.2011
		ES 2274875 T3	01.06.2007
		ES 2349680 T3	10.01.2011
		ES 2361287 T3	15.06.2011
		JP 2001-290013 A	19.10.2001
		JP 4063472 B2	19.03.2008
		WO 01-77721 A1	18.10.2001
KR 10-2008-0023345 A	13.03.2008	AU 2006-259705 A1	28.12.2006
		AU 2006-259705 A2	28.12.2006
		CN 101198889 A0	11.06.2008
		CN 101198889 B	21.09.2011
		EP 1891469 A1	27.02.2008

**INTERNATIONAL SEARCH REPORT**International application No.  
**PCT/US2012/056267****Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)**

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☒ Claims Nos.: 7, 9  
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:  
Claims 7, 9 have been drafted as dependent claims on multiple dependent claims, thereby rendering the claims unclear.
3. ☒ Claims Nos.: 5-6, 8, 10-11, 16-26  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

**Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)**

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

**Remark on Protest**

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

**INTERNATIONAL SEARCH REPORT**

Information on patent family members

International application No.

**PCT/US2012/056267**

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 05614286 A	25.03.1997	US 2008-0212181 A1	04.09.2008
		US 8177374 B2	15.05.2012
		WO 2006-138129 A1	28.12.2006
US 05614286 A	25.03.1997	CA 2172272 C	27.12.2005
		CA 2172636 C	24.01.2006
		CA 2173232 A1	27.04.1995
		CA 2173232 C	28.12.2004
		CN 1040694 C	11.11.1998
		CN 1041962 C	03.02.1999
		CN 1052794 C	24.05.2000
		CN 1133093 A	09.10.1996
		CN 1133093 C0	08.10.1996
		CN 1133635 A	16.10.1996
		CN 1133635 C0	15.10.1996
		CN 1133636 A	16.10.1996
		CN 1133636 C0	15.10.1996
		EP 0724731 A1	07.08.1996
		EP 0724731 A1	18.03.1998
		EP 0724731 B1	26.01.2000
		EP 0724734 A1	08.11.2000
		EP 0724734 B1	11.07.2001
		EP 0724737 A1	07.08.1996
		EP 0724737 B1	22.07.1998
		EP 1074860 A2	07.02.2001
		EP 1074860 A3	28.07.2010
		JP 09-504620 A	06.05.1997
		JP 09-504622 A	06.05.1997
		JP 09-504624 A	06.05.1997
		JP 3590062 B2	17.11.2004
		JP 3623506 B2	23.02.2005
		JP 3623507 B2	23.02.2005
		KR 10-0437958 B1	25.08.2004
		US 05450235 A	12.09.1995
		US 05632946 A	27.05.1997
		US 05691846 A	25.11.1997
		US 05988820 A	23.11.1999
		US 2001-0040731 A1	15.11.2001
		US 2001-0053026 A1	20.12.2001
		US 2002-0126382 A1	12.09.2002
		US 2007-0014011 A1	18.01.2007
		US 6318867 B1	20.11.2001
		US 6350035 B1	26.02.2002
		US 6508559 B2	21.01.2003
		US 7185993 B2	06.03.2007
		US 7568807 B2	04.08.2009
		WO 95-11464 A3	10.08.1995
		WO 95-11466 A1	27.04.1995
		WO 95-11468 A1	27.04.1995