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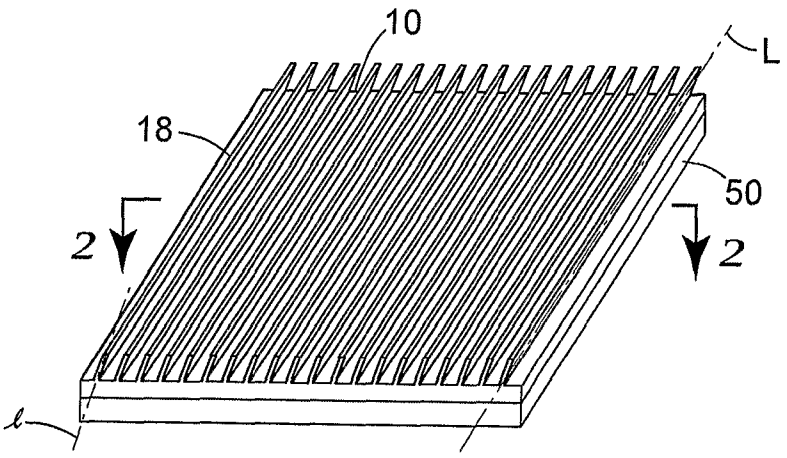

(57) Abstract: A method of making a privacy film includes generally the following steps: providing a polymeric material, depositing the polymeric material onto a microstructured mold comprising a plurality of substantially parallel, elongated channels with specific geometry; inducing the polymeric material to flow into the channels of the microstructured mold; solidifying the polymeric material inside the channels to yield a plurality of light directing elements that are connected with one another via a polymeric base sheet; and separating the privacy film from the microstructured mold.

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METHOD OF MAKING A PRIVACY FILM

Field of Invention

The present invention relates to a privacy film. In particular, the present invention relates to a polymeric based privacy film having a plurality of light directing elements each element being disposed substantially parallel to the next adjacent light directing element, the film being well suited for use with documents.

Background

Products capable of providing privacy for the consumer have increased. For example, it is very common today for most personal computers and automatic teller machines to include a privacy screen allowing the user to view the image on the monitor while simultaneously limiting the view for bystanders, or at least those not in the viewing angle of the screen. Some have used light control films to provide privacy to a user who has documents containing sensitive material. The idea is similar in that the user can view the image on the document but bystanders are limited in viewing the document's content.

The art discloses various light control films that also serve the purpose of providing privacy to the user. However, as document privacy is becoming more and more of a desire for consumers, those skilled in the art seek different solutions to provide this desired feature. Thus, there is a continuing need for new privacy film constructions.

Summary

The present invention provides for a privacy film that can be used with documents to limit the angle at which a viewer can read the information on the document. In particular, when the privacy film is placed in the use orientation such that the viewing angle is coincident with the user's line of sight, the user will be able to see the contents of the documents while others will only have a limited view of the document's content.

In one aspect, the present invention pertains to a privacy film comprising a light transmissive, polymeric base sheet comprising (i) a first polymeric material, the base

sheet having opposing first and second surfaces; and (ii) a plurality of light directing elements comprising a second polymeric material, wherein each element has a base, a height **h**, and a minor axis disposed along the height, wherein the elements protrude from the first surface of the base sheet, and wherein each element is disposed such that the minor axis of one element is substantially parallel to the minor axis of the next adjacent element and the base of one element is not joined with the base of the next adjacent element. In another aspect, the privacy film comprises elongated light directing elements.

In another aspect, the present invention pertains to a method of making a privacy film comprising the steps of (i) providing a polymeric material; (ii) depositing the polymeric material onto a microstructured mold comprising a plurality of substantially parallel, elongated channels, wherein each channel is slanted and is separated from the next channel by a land region, wherein each channel has a base disposed adjacent to and a tip distal from the land region, wherein each channel has a minor axis that runs from the base to the tip; (iii) inducing the polymeric material to flow into the channels of the microstructured mold; (iv) solidifying the polymeric material inside the channels to yield a plurality of light directing elements that are connected with one another via a polymeric base sheet having a first surface from which the light directing elements protrude and an opposing second substantially planar surface; and (iv) separating the privacy film from the microstructured mold.

As used herein, the term "light transmissive" means the ability to transmit visible light. In one embodiment, the light transmissive base sheet has an opacity of 90 or less, as measured using a Lab Scan 6000 Tester with a HuterLab Master Color Data Program, commercially available from Hunter Associates Laboratory, Inc., Reston, VA. With reference to the light directing element, the term "elongated" generally means that the element has a rail-like appearance. The rails can be continuous along the entire length of the privacy film or they can be discontinuous. In one embodiment, the discontinuous light directing elements are discrete bodies having an appearance of a stem, such as, e.g., a stem of a mushroom.

One advantage of the present invention is that it provides the privacy feature with flexible construction that is relatively easy to manufacture. The privacy film can

be quickly attached to the document in a non-permanent manner. Furthermore, the privacy film is durable so that it can be used repeatedly.

In this document, the term "about" is presumed to modify all numerical values.

Brief Description of the Drawings

The invention can be better understood with reference to the following drawings, wherein:

Figure **1** is a perspective view of one exemplary embodiment of a privacy film;

Figure **2** is a cross-sectional view of the privacy film of Figure **1** taken along line **2–2**;

Figure **3** is a cross-sectional view of another exemplary embodiment of a privacy film showing light directing elements with multiple sections;

Figure **4** is a cross-sectional view of another exemplary embodiment of a privacy film showing the tip portions of the light directing elements being covered with a light absorbing coating;

Figure **5** is a cross-sectional view of another exemplary embodiment of a privacy film showing light directing elements at varying cant angles;

Figure **6** is a cross-section view of another exemplary embodiment of a privacy film showing the tip portions of the light directing elements being elongated in a direction parallel to the base layer;

Figure **7** is a perspective of another exemplary embodiment of a privacy film showing a combination of elongated light directing elements; and

Figures **8a** to **8c** are schematic views of an exemplary process that can be used to make the privacy film.

These drawings are not drawn to scale and are intended only for illustrative purposes.

Detailed Description

Figure **1** is a perspective view of one exemplary embodiment of the present invention showing privacy film **10** having elongated light directing elements **18** disposed on substrate **50** that may contain sensitive information. In one embodiment, the privacy film can be attached using a light transmissive adhesive (not shown). The

elements have a major axis **L** and a minor axis *l*. One exemplary substrate is a document bearing confidential information that the document owner wants limited viewing access.

In use the privacy film of the present invention is disposed on the document so that the major axis **L** lies substantially parallel to the image or lines of text on the document. For example, on 8½ by 11 inch paper in portrait orientation where the text lies substantially parallel to the 8½ inch side of the paper, the privacy film would be oriented so that the major axis also lies along the same direction. The privacy film can be disposed on the document temporarily, meaning that the film can be removed from the substrate without damage thereto, or permanently, meaning that removal of the privacy film will most likely cause damage to the document. There exists a variety of means for attaching or disposing the privacy film to the document. For example, an adhesive can be used. The adhesive can be pressure sensitive or hot melt. The adhesive can be a repositionable adhesive, meaning that it can be applied and removed from the substrate multiple times without damage to the substrate and without significant loss in adhesion of the repositionable adhesive. In another application, the privacy film is formed as a pocket, where the privacy film forms a front, a polymeric backing or the privacy film forms a back, and the privacy film and the back are attached on three sides, leaving the fourth, typically top side, open for insertion and removal of a document. Other configurations can be used.

The light directing elements interfere with light transmission thereby providing the privacy feature of the present inventive film. Optically active materials, such as light reflecting and or light absorbing materials, may be included. The light directing elements geometry, spacing, and the optically active materials are discussed below in detail.

In one exemplary embodiment, the heights of the light directing elements are substantially the same on the privacy film. There may be some variation in the elements' heights due to the manufacturing conditions. In another exemplary embodiment, the heights of the elements vary from one region of the privacy film to another region and even from one element to the next adjacent element. By variation in height, it is generally meant that one element will be from 75% to 95% in height of

another element. Figure **3** generally illustrates the embodiment having light reflecting elements with varying heights.

Figure **2** shows a cross-section of the privacy film in Figure **1** taken along line **2–2**. The privacy film includes base sheet **12** having opposing first surface **14** and second surface **16** and demarcation line **13**. Light directing elements **18** protrude from the first surface of the base sheet. While Figure **2** shows that demarcation line **13** is collinear with first surface **14**, the line can be at a different location. Each light directing element has a height **h**, a width **W**, and a center-to-center spacing from one element to the next adjacent element **P**. The height **h** is measured along the minor axis ℓ from the first surface **14** of the base sheet to tip **20**. The width **W** is measured perpendicular to the minor axis.

In one exemplary embodiment the **h** to **P** ratio (**h:P**) is greater than 0.5. In another embodiment, the **h:P** ratio is less than 5. In one embodiment, the width of the light directing element, as measured proximate to the first surface of the base sheet is greater than 25 microns. In another embodiment, the width is less than 750 microns. In the embodiment of Figure **2**, the light directing elements are disposed on the base sheet at a cant angle θ. The cant angle is the angle between first surface **14** and the minor axis of each light directing element. In one embodiment, the cant angle is greater than 15°. In another embodiment, the cant angle is less than 90°. In yet another embodiment, the cant angle ranges from 40° to 85°. In yet another embodiment, the cant angle ranges from 55° to 75°. If desired, adhesive **22** is provided on the second surface of the base sheet, for attachment to a substrate. While the light directing elements of this particular embodiment are substantially uniform in its cross-sectional dimension, there can be a slight draft (i.e., a slight narrowing) to the elements towards tip **20**. Also, as shown in Figure **2**, the placement of two adjacent light directing elements is such that the tip of one element, taken along an imaginary line normal to the first surface of the base sheet (shown as dotted line **N**), lies next to the base (shown as reference letter **b**) of the next element. Other placement configurations can be used, so long as the light directing elements provide the privacy feature and provided that the **h:P** ratio falls within the established range. In this particular embodiment, the light directing element includes either light absorbing materials or light reflecting materials.

Suitable light reflecting materials include, e.g., titanium dioxide, zinc oxide, zinc sulfide, zinc phosphate, calcium carbonate, alumina, silica, antimony oxide, barium sulfate, lithopene (a co-precipitate of barium sulfate and zinc oxide), calcined kaolin, lead carbonate, magnesium oxide, and combinations thereof. Suitable light absorbing materials include, e.g., carbon black, spinel black, rutile black, iron black, and combinations thereof. When a light reflecting material is used, 1 to 50 parts by weight, based on 100 parts by weight total, is added to the polymer resin to form the light directing elements. In some embodiments, 1 to 15 parts by weight is used. In other embodiments, 2 to 10 parts by weight is used. When a light absorbing material is used, 0.1 to 50 parts by weight, based on 100 parts by weight total, is added to the polymer resin to form the light directing elements. In some embodiments 1 to 15 parts by weight of light absorbing material is used. In other embodiments, 1 to 5 parts by weight is used. A combination of light reflecting material and light absorbing material can be used to form an individual light directing element, as further discussed below. In other embodiments, color pigments, fluorescent colors, and glitter can be added to the light directing elements.

Figure **3** shows a cross-sectional view of another embodiment of the invention, where privacy film **100** includes base sheet **112** having opposing first surface **114** and second surface **116**. Light directing elements **118** protrude from the first surface of the base sheet. Demarcation line **113** resides slightly within the light directing element. In this particular embodiment, the light directing element include first portion **119** disposed distal to the first surface of the base sheet, second portion **117** disposed proximate to the first surface, and third portion from the first surface to line **113**. In some embodiments, the composition of the base sheet and the third portion will be similar, and may even be the same. Line **115** demarcates the first portion from the second portion. The first portion includes a light absorbing material and the second portion includes a light reflecting material. The height of the first portion is denoted as ℓ_{119}, and is the distance along the minor axis of the element between line **115** and the tip. The height of the second portion is denoted as ℓ_{117} and is the distance along the minor axis of the element between line **113** and **115**. In one embodiment, the ratio of ℓ_{119} to ℓ_{117} is 3 to 0.1. The placement of two adjacent light directing elements is such that the tip of one element, taken along imaginary line **N** overlaps with the base of the

next adjacent element. While the light directing element of Figure **2** includes a tip that is has substantially straight edges, the tips can be rounded as shown in Figure **3**. Other geometry can be used, so long as the light directing elements interfere with light transmission so as to provide the privacy feature.

Figure **4** shows a cross-sectional view of another embodiment of the present invention where privacy film **200** includes base sheet **212** having opposing first surface **214**, second surface **216**, and demarcation line **213**. Light directing elements **218** protrude from the first surface. At the tips of the light directing elements, light absorbing coating **219** has been applied. The coating may migrate down the sides of the light directing elements. In this particular embodiment, the light directing element could include light reflecting materials. The coating can be applied to the elements using known coating techniques. In one embodiment, the coating is 0.01 to 1.0 mm in dry thickness. In one embodiment, the light absorbing coating is applied to the tips using digital printing methods, such as inkjet printing, color inkjet printing, laser printing, and dye or mass transfer printing or by conventional printing techniques, such as offset lithography, flexography, and gravure. The tips of the elements are receptive to the ink or the dyes used in the printing process.

Figure **5** shows a cross-sectional view of another embodiment of the present invention, where privacy film **300** includes base sheet **312** having opposing first surface **314** and second surface **316**. Light directing elements **318** protrude from the first surface of the base sheet. For ease of understanding, only the cross-sections of five light directing elements are shown. In this particular embodiment, the cant angle of each light directing element differs from the next adjacent element. For example, cant angle θ_1 will be similar to cant angle θ_2. For example, θ_1 may be 90° while θ_1 may be 88°. Thus, these two light directing elements will be substantially parallel to one another. The cant angle for the fifth light directing element, θ_5, however, may be very different than that of the first light directing element. In this figure, if θ_1 is 90°, θ_5 may be 60°, so that the first light directing element will not be considered to be parallel to the fifth light directing element. The magnitude of the varying change in cant angles has been exaggerated in this figure to illustrate the varying cant angles.

Figure **6** shows a cross-sectional view of yet another embodiment of the present invention, where privacy film **400** includes base sheet **412** having opposing first surface

414, second surface **416** and demarcation line **413**. Light directing elements **418** protrude from the first surface. Each light directing element has first portion **419** distal to the first surface of the base sheet and second portion **417** proximate to the first surface. Line **415** demarcates the first portion from the second portion. Line **413** demarcates the second portion from a third portion. The first portion has one-sided extension, similar to an upside down "L". The extensions can all be on the same side, e.g., all left facing or all right facing (as shown in the figure), or they can alternate between left facing and right facing. The extensions can also be randomly oriented to the left or to the right or at any angle between the left and the right side. In other words, if one were to take a top view of the embodiment of Figure **6** so that all that would be seen is first portion **419**, it can be rotated at any of the various angles along a 360° path. In one embodiment, at least one of the first and second portion includes light reflecting materials. In another embodiment, the first portion includes light absorbing materials and the second portion includes light reflecting materials. In yet another embodiment, a combination of different light directing elements, such as, e.g., the elements shown in Figures **2**, **3**, and **6** are used together to form a privacy film.

Figure **1** shows the light directing elements as elongated rails that run continuously along the length of a document. In other embodiments, the elements can include interruptions, either of a specified length to create uniform interruptions, or of a random length to create non-uniform interruptions. Among all the various elements, there could be light directing elements that are continuous over the length of the entire substrate. For example, Figure **7** shows an illustrative privacy film **500** disposed on substrate **550**. The privacy film includes light directing elements **518** having uniform interruptions on the left hand side and non-uniform interruptions on the right hand side. Interspersed in between are light directing elements that are continuous over the entire length of the film.

While the base sheet in all of the embodiments is light transmissive, it may include light reflecting materials. The quantity of light reflecting materials used in the base sheet can, but does not have to, be similar to that used in the light directing elements. The advantage of using similar amounts is that the process of making the privacy film, as further described below, can be simplified to using a single extruder instead of multiple extruders. In the case where substantially the same amount is used,

care should be taken to select a sufficient amount to impart the privacy feature to the film without adversely affecting the readability of the underlying document.

Suitable materials for use in forming the privacy film include thermoplastic polymers and elastomers. Suitable thermoplastic polymers include, e.g., polyolefins such as polypropylene or polyethylene, polystyrene, polycarbonate, polymethyl methacrylate, ethylene vinyl acetate copolymers, acrylate-modified ethylene vinyl acetate polymers, ethylene acrylic acid copolymers, nylon, polyvinylchloride, and engineering polymers such as polyketones or polymethylpentanes. Suitable elastomers include, e.g., natural or synthetic rubber, styrene block copolymers containing isoprene, butadiene, or ethylene (butylene) blocks, metallocene-catalyzed polyolefins, polyurethane, and polydiorganosiloxanes. Mixtures of thermoplastic polymers and elastomers may also be used.

The inventive light directing element can be made in various ways. In a first exemplary method, the privacy film of the present invention can be formed by extruding a polymeric web through a die having an opening cut, for example, by electron discharge machining. The web would include the base sheet and the light directing elements disposed thereon.

The shape of the die opening is designed to generate a web with a desired cross-sectional shape or profile. The web can be quenched after leaving the die opening by pulling it through a quenching material such as water. A wetting agent may be added to the quenching medium to wet the entire surface of the extruded web, including spaces between the light directing elements. The extruded web may be further processed, e.g., by applying a light absorbing coating to the tips of the elements (as shown in Figure **4**) or by cutting the extruded elements and stretching the web to form discontinuous light directing elements.

When the inventive privacy film contains multiple different layers, as when the base sheet and the light directing elements are of different materials or as when the light directing elements contain multiple sections (see, e.g., Figures **3** and **6**), the film can be formed by co extrusion techniques as described, e.g., in PCT application WO 99/17630. The coextrusion technique may involve passing different melt streams from different extruders into a multiple-manifold die or multiple-layer feed block and a film

die. The individual streams merge in the feed block and enter the die as a layered stack that flows out into layered sheets as the material leaves the die.

A second exemplary method of making the privacy film is shown schematically in Figures **8a**, **8b**, and **8c**. In the method depicted in Figure **8a**, polymeric material **801** and microstructured mold **800** are provided. The microstructured mold includes a plurality of elongated, slanted channels **808**, each channel being separated from the next by land region **806**. Each channel has a base **808a** (indicated on one channel in phantom for ease of understanding) disposed adjacent to the land region and a tip **808b** disposed distal to the land region. In this embodiment, the channel may have substantially linear walls with distinct sharp edges at the tip. Each channel includes minor axis *l* that runs from the base to the tip. Each channel is slanted at an angle of greater than 15° and less than 90°. In another embodiment, each channel is slanted at angle of greater than 40° and less than 85°. In yet another embodiment, each channel is slanted at angle of greater than 55° and less than 75°. The angle is formed between the intersection of the minor axis of the channel and a line lying in the plane of the land region. Similar to the light directing element as discussed in Figure **2**, each channel in the mold has a height **h**, as measured its base to its tip along the minor axis. Two adjacent channels have a center-to-center spacing of **P**. In one embodiment, the mold has **h** to **P** ratio of 0.5 to 5.

Two adjacent channels are placed such that, as viewed from an imaginary line normal to the land region, the tip of one channel coincides with the base of the next channel. This feature is similar to that shown in Figure **2**. In an alternative embodiment, two channels are placed such that, as viewed from the imaginary line, the tip of one channel overlaps the base of the next channel. The polymeric material is deposited onto the microstructured mold. Figure **8a** also shows schematically, by use of plunger **804**, that the polymeric material is induced into the channels of the microstructured mold by use of heat and or pressure.

Figure **8b** shows a subsequent step in the process where the polymeric material has flowed into and filled the channels thereby replicating the shape of the channels. The replicated polymeric material solidifies in the mold. The term "solidifies" means generally that the polymeric material cools and hardens sufficiently to allow it to be separated from the mold. In one process, the polymeric material includes light

reflecting material, such as the ones listed above. When used, the light reflecting material constitutes less than 20%, and in some embodiments, less than 5% of the total weight of the polymeric material.

Figure **8c** shows yet another step in the process where the replicated polymeric material has been separated from the mold to yield privacy film **810** having a plurality of distinct light directing elements **818**, each connected to another by a polymeric base sheet **812** having first surface **812a** from which the light directing elements protrude and opposing second substantially planar surface **812b**. The separation step results in substantially no distortion on the light directing elements of the privacy film. That is, when the replicated polymeric material is separated from the mold, each light directing elements of the resulting privacy film is nearly an exact replica of its corresponding channel, so that there would be less than 20% and preferably less than 10% variation in the dimensions of the light directing element as compared to the dimensions of the corresponding channel. Figure **8c** further shows light transmissive adhesive **819** is disposed on the second substantially planar surface of the polymeric base sheet.

The polymeric material can be in the form of a thermoplastic material, such as a thermoplastic film, a molten resin, or a liquid resin. When in the thermoplastic film form, a combination of heat and pressure can be used to induce the polymeric material to flow into the channels. Such a method can be generally described as compression molding and are discussed in publications such as US Patent Nos. 4,244,683 (Rowland) and 4,601,861 (Pricone et al.). In the molten resin state, the heat of the molten resin, along with heating the mold are useful steps in inducing it to flow into the channels. US Patent No. 4,097,634 (Bergh) discloses an exemplary extrusion cast and embossing method. In a liquid resin state, heat and or pressure can be used to induce the polymeric material to flow into the channels. Useful liquid resins are light curable resins, such as an ultraviolet light curable resin. In such a case, the solidifying step will involve exposing the light curable resin to a light source. US Patent Nos. 3,869,346 (Rowland); 4,576,850 (Martens); and 5,183,597 (Lu et al.) disclose exemplary liquid cast and light curing processes. These patents are incorporated by reference in their entirety.

The polymeric material may include at least two layers, i.e., it may be of a multilayer construction. In one embodiment, the polymeric material includes a first

layer that is substantially free of light absorbing and light reflecting materials and a second layer that comprises light absorbing materials, light reflecting materials, or a combination thereof. In such cases, the channels of the microstructured mold contacts the layer containing the light absorbing and/or light reflecting materials.

Example

Example 1

A privacy film, made generally according to Figures **8a** to **8c** as follows. A microstructured tool was made by machining a copper plate to impart channels thereto. Each channel had a height dimension of 19.3 mil (0.5 mm) measured along its minor axis and slanted at an angle of 63.1 degrees. The tip of each channel had a dimension of 3.8 mil. The base of each channel had a dimension of 6.9 mil (0.18 mm), as measured along a line that lies in the same plane as the land region. As measured near the base along a line that is parallel to the tip, the base had a dimension of 5.5 mil (0.14 mm). The land region distance between one edge of a channel to the nearest edge of the next adjacent angle was 4.9 mil (0.12 mm).

A polypropylene film containing 2% by weight of TiO_2 pigment was used as the thermoplastic polymeric film. The polypropylene film was 5 mil (0.13 mm) thick. The film was induced to flow into the channels using a heat press set at 170°C under a pressure of 160 pounds per square inch (psi) for 30 seconds. The compression molded film was cooled to 100°C under the same pressure, after which time it was separated from the mold to yield a privacy film having a plurality of light directing elements connected to one another by a base substrate. A small amount of black ink was applied to the top of the light directing elements.

What is claimed is:

1. A method of making a privacy film comprising the steps of:

providing a polymeric material;

depositing the polymeric material onto a microstructured mold comprising a plurality of substantially parallel, elongated channels, wherein each channel is slanted and is separated from the next channel by a land region, wherein each channel has a base disposed adjacent to and a tip disposed distal to the land region, wherein each channel has a minor axis that runs from the base to the tip;

inducing the polymeric material to flow into the channels of the microstructured mold;

solidifying the polymeric material inside the channels to yield a plurality of light directing elements that are connected with one another via a polymeric base sheet having a first surface from which the light directing elements protrude and an opposing second substantially planar surface; and

separating the privacy film from the microstructured mold.

2. The method of claim 1, wherein the channels of the microstructured mold are tapered at their tips.

3. The method of claim 1, wherein the polymeric material is a thermoplastic polymer.

4. The method of claim 3, wherein the thermoplastic polymer is selected from the group consisting of polypropylene, polyethylene, polystyrene, polycarbonate, polymethyl methacrylate, ethylene vinyl acetate copolymers, acrylate-modified ethylene vinyl acetate polymers, ethylene acrylic acid copolymers, nylon, polyvinylchloride, and combinations thereof.

5. The method of claim 1, wherein the polymeric material comprises a light reflecting material.

6. The method of claim 5, wherein the light reflecting material is selected from the group consisting of titanium dioxide, zinc oxide, zinc sulfide, zinc phosphate, calcium carbonate, alumina, silica, antimony oxide, barium sulfate, lithopene, calcined kaolin, lead carbonate, magnesium oxide, and combinations thereof.

7. The method of claim 6, wherein privacy film comprises less than 20% by weight of the light reflecting material, based on the total weight of the film.

8. The method of claim 1, wherein each channel has a height **h**, which is the distance from its base to its tip along its minor axis, and two adjacent channels have a center-to-center spacing **P**, and wherein the ratio of **h** to **P** is from about 0.5 to 5.

9. The method of claim 1, wherein two adjacent channels are placed such that the tip of one channel, as viewed from an imaginary line normal to the land region, overlaps the base of the adjacent channel.

10. The method of claim 1, wherein the polymeric material is molten resin.

11. The method of claim 10, wherein the inducing step comprises heating the microstructured mold.

12. The method of claim 1, wherein the polymeric material is a liquid resin or a thermoplastic film.

13. The method of claim 12, wherein the inducing step comprises applying heat and pressure to the liquid resin.

14. The method of claim 1, wherein the separating step results in substantially no distortion on the light directing elements of the privacy film.

15. The method of claim 1 further comprising laminating a light transmissive adhesive to the second surface of the polymeric base sheet.

16. The method of claim 1, wherein the light transmissive adhesive is a repositionable pressure sensitive adhesive.

17. The method of claim 1, wherein the channels of the microstructured mold are slanted at an angle greater than about 15° and less than about 90°, the angle being formed between the intersection of the minor axis of the channel and a line lying in the plane of the land region.

18. The method of claim 1, wherein two adjacent channels are placed such that the tip of one channel, as viewed from an imaginary line normal to the land region, is coincident with the base of the adjacent channel.

19. The method of claim 1 further comprising applying a light absorbing coating to a top portion of the light directing elements.

20. The method of claim 1, wherein the polymeric material comprises a light absorbing material.

21. The method of claim 1, wherein the polymeric material comprises light absorbing and light reflecting materials.

22. The method of claim 1, wherein the polymeric material comprises at least two layers, wherein a first layer is substantially free of light absorbing and light reflecting materials, and wherein a second layer comprises light absorbing material, light reflecting materials, or a combination thereof.

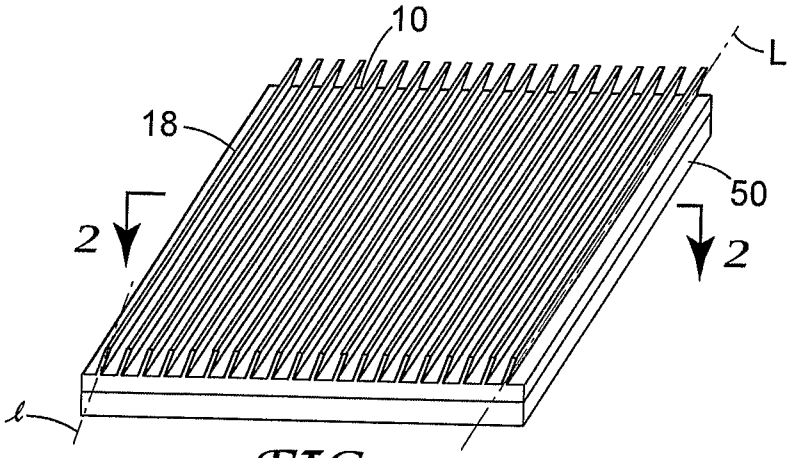

FIG. 1

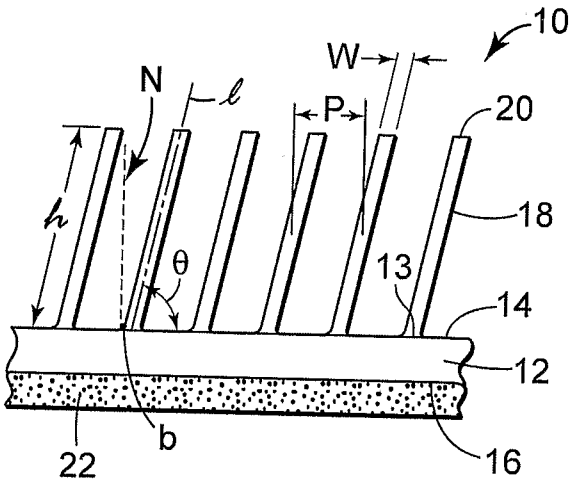

FIG. 2

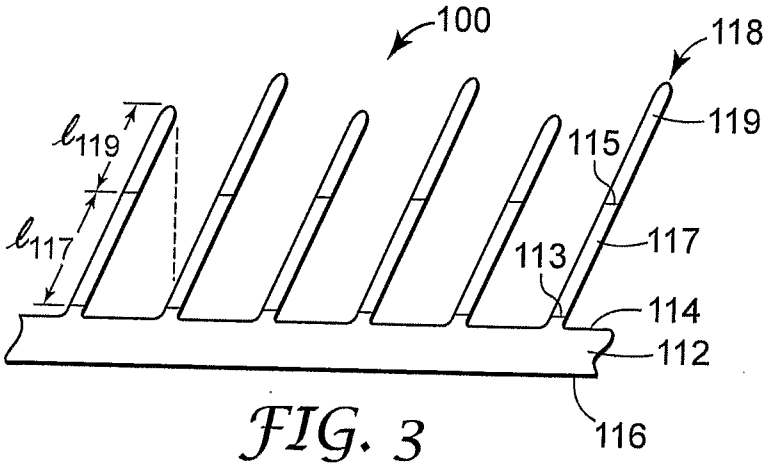

FIG. 3

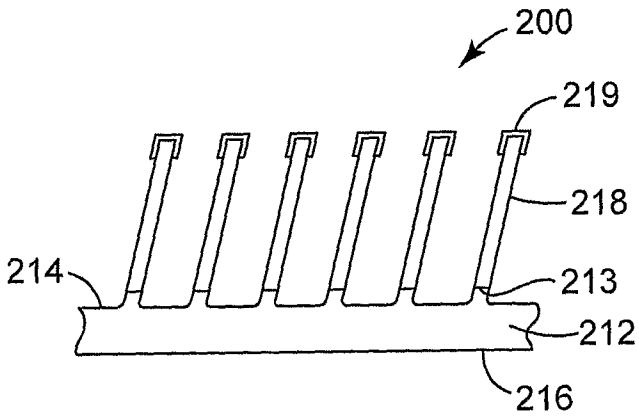
200
219
218
214
213
212
216

FIG. 4

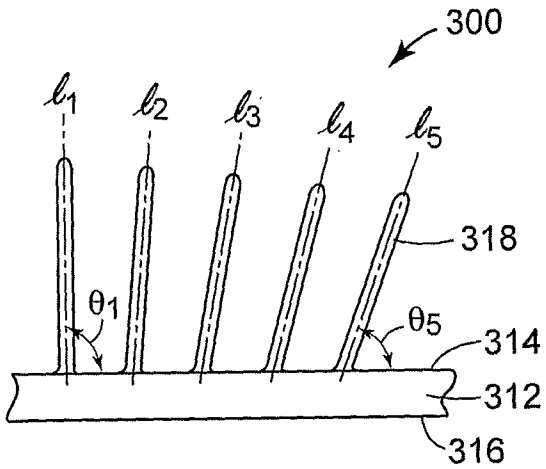
300
ℓ_1
ℓ_2
ℓ_3
ℓ_4
ℓ_5
318
θ_1
θ_5
314
312
316

FIG. 5

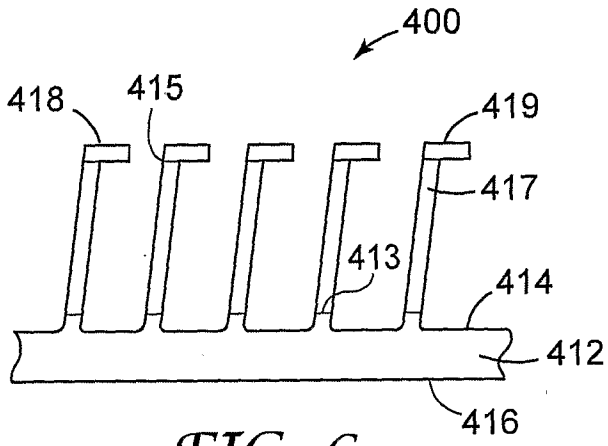

FIG. 6

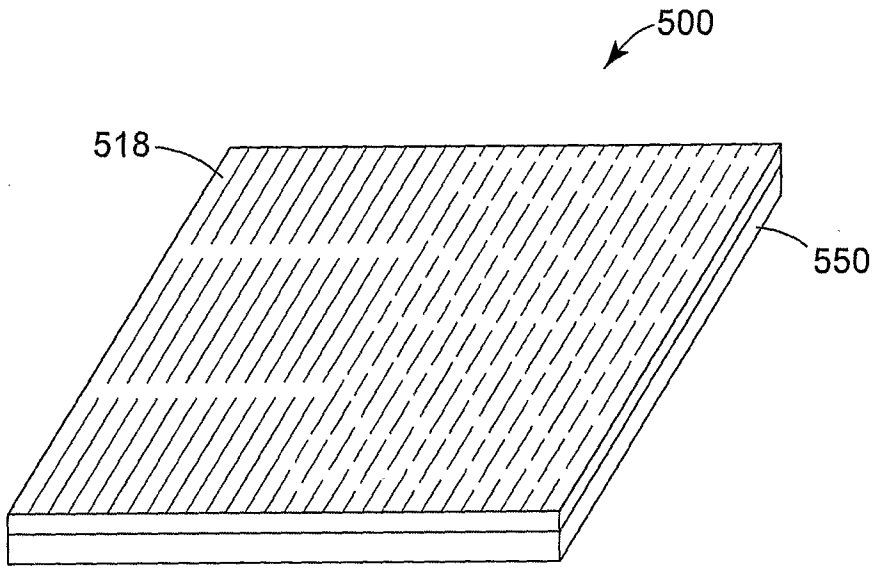

FIG. 7

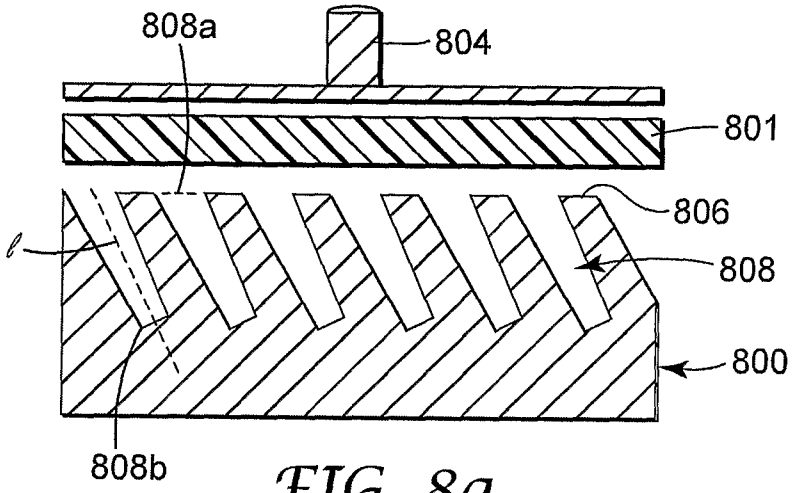

FIG. 8a

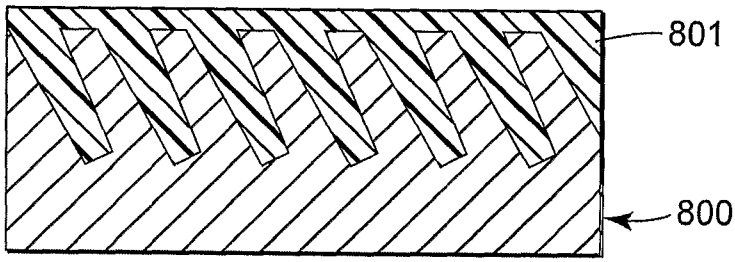

FIG. 8b

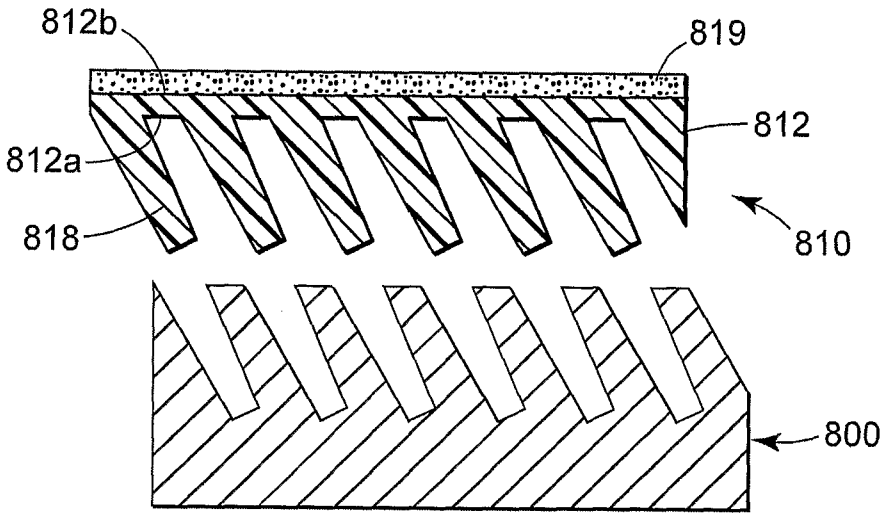

FIG. 8c

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2006/040290

A. CLASSIFICATION OF SUBJECT MATTER

B29C 33/42(2006.01)i, B29C 43/02(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)

IPC8 G02B 5/18, C08F 257/02, B42D 15/10, B44F 1/12

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

Korean Patent and applications for inventions since 1975
Korean Utility models and applications for Utility models since 1975
Japanese Utility models and applications for Utility Models since 1975

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

KIPASS, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	KR 2003-71565 A(CANON KABUSHIKI KAISHA) 03 SEP 2003 See claim 22, See figure 1a-1c	1
A	KR 2005-21016 A(MERCK PATENT GMBH) 04 MAR 2005 See abstract, See claim 1, 10	1
A	JP 2001-219681 A(DAINIPPON PRINTING CO LTD) 14 AUG 2001 See abstract, See figure 3	1

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

☒ See patent family annex.

* Special categories of cited documents:
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
12 MARCH 2007 (12.03.2007)	**13 MARCH 2007 (13.03.2007)**

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Telephone No. 82-42-481-5405

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/US2006/040290

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JP 2001-219681 A	14-08-2001	NONE	