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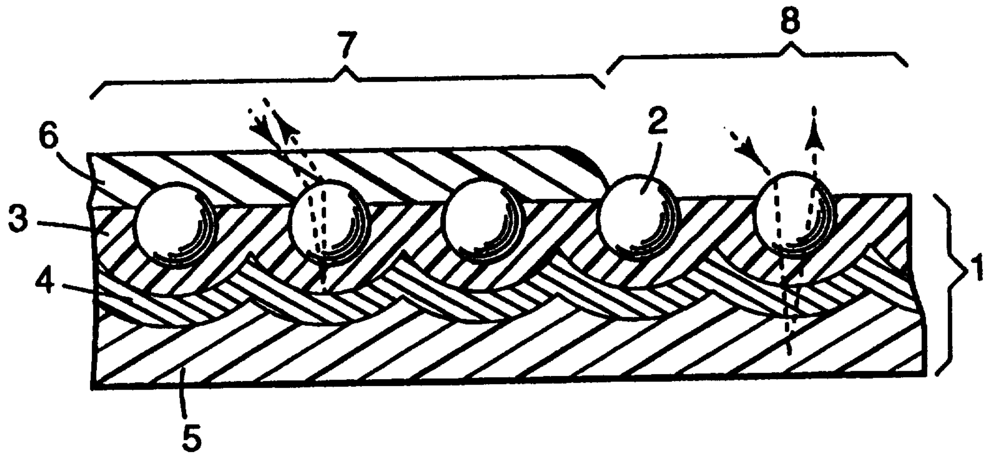

(57) Abstract

The present invention refers to a multilayer film, comprising a substrate bearing essentially a monolayer of retroreflective elements, said substrate bearing a front surface and a rear surface, and a transparent layer overlying said front surface of said substrate, wherein said transparent layer includes means for providing patterned differential retroreflectivity.

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Multilayer Film with Differential Retroreflectivity

Technical Field

The invention concerns a multilayer film having retroreflective characteristics which vary in a pattern of areas of greater retroreflectivity and lesser retroreflectivity. The film can be used as a component of known retroreflective products such as security laminates and provides a method of marking retroreflective materials so that their authenticity can be verified.

Background of the Invention

Retroreflective sheeting has been known for many years and is described, for example, in U.S. Patent Numbers 2,407,680 (Palmquist et al), 4,626,127 (May), 4,511,210 (Tung et al), 4,569,920 (Tung et al), 4, 367,857 (Tung et al) and 4,664,966 (Bailey). Such sheeting is commonly used for safety or advertising purposes, and generally wherever it is desired to draw attention to a surface when light impinges upon the surface from the direction of the viewer. Retroreflective sheeting and films have also become popular elements for incorporation into security laminates in recent years, partially because reflective sheeting is difficult to manufacture, thus rendering laminates made with it especially difficult to counterfeit. Security laminates comprising retroreflective sheeting are described in co-pending European patent application EP 96107988.6 (Weber), for example.

A widely used feature in security laminate construction is providing one or more of the elements with additional marking, commonly called a verification marking, which provides an additional level of security. A verification marking can be customized to indicate not only that the components are authentic, but that the overall security laminate is authentic and comes from a controlled source of distribution.

Known verification markings include specific patterns of print enclosed between different layers of a security laminate such as those described in U.S. Patent Numbers 4,121,003 and 4,721,638. Such patterns printed with colored inks are visible under normal illumination.

A verification marking can also be provided in a security laminate by incorporating a layer of transparent polymeric film bearing a holographic feature.

It is also known that retroreflective films can be provided with verification markings created by selective alteration of the reflective layer, as disclosed in U.S. Patent No. 4,714,656 (Bradshaw et al.). This method has the advantage that it is difficult to duplicate and that the marking can be viewed or read only under retroreflective viewing conditions. Some drawbacks are present, however, in that the reflective layer must be modified at the manufacturing level, rendering this process less amenable to small batch, customized verification marking suited to small to medium sized customers.

Verification markings are also known where a patterned transparent layer generates differential retroreflectivity which is visible only under retroreflective viewing conditions. These verification markings are described in U.S. Patent Numbers 3,801,183, 4,630,891, 5,080,463 and 5,169,707. In these materials, a patterned transparent layer is present behind the space coat underlying the monolayer of glass beads. The rear surface is defined as the surface of the monolayer of glass beads which is in closest proximity to the reflective layer. An aluminum reflective layer is then applied over the patterned transparent layer. Though these systems generate some differential retroreflectivity, they have the disadvantage that the patterned transparent layer must be applied as an intermediate step in the basic manufacture of reflective sheeting. Thus this method lends itself less readily to small-batch customer-specific verification marking. Also, because the result is a relatively minor change in retroreflectivity, it can be difficult for an observer to ascertain the pattern.

Thus it is desirable to provide a new retroreflective sheeting comprising both retroreflective and verification properties, which bears a verification marking, is relatively simple to create, does not require intervention in basic manufacturing sequences, enlarges the pool of materials accessible to a person skilled in the art, and is more easily verified than conventional materials.

Summary of the Invention

The invention concerns a multilayer film, comprising a substrate bearing essentially a monolayer of retroreflective elements, said substrate having a front surface and a rear surface, and a transparent layer overlying said front surface of said substrate, wherein the transparent layer includes means for providing patterned differential retroreflectivity. The invention also concerns a security laminate comprising the multilayer film and the use of the multilayer film as a verification marking in retroreflective security laminates.

Brief Description of the Drawings

The present invention is described in reference to the following drawings, in which:

Figure 1 is a cross-sectional view of a first embodiment of the multilayer film of the present invention;

Figure 2 is a cross-sectional view of a second embodiment of the multilayer film of the present invention; and

Figure 3 is a cross-sectional view of a third embodiment of the multilayer film of the present invention.

Detailed Description of the Invention

The invention concerns a multilayer film, comprising a substrate bearing essentially a monolayer of retroreflective elements, said substrate having a front surface and a rear surface, and a transparent layer overlying said front surface of said substrate, wherein the transparent layer includes means for providing patterned differential retroreflectivity.

The substrate can be selected from any of the known materials where retroreflective elements have been partially or fully embedded in a supporting matrix to which they adhere. The front surface of the substrate is defined as the surface which is viewed by the observer and the surface through which incident light first passes. The substrate can be prepared using several known methods. The basic method is disclosed within U.S. Patent Numbers 2,407,680 (Palmquist et al), 4,626,127 (May), 4,511,210 (Tung et al), 4,569,920 (Tung et al), 4, 367,857 (Tung et al) and 4,664,966 (Bailey), among others. These documents describe basic techniques for manufacturing substrates bearing monolayers of glass beads, and also describe fully finished retroreflective sheeting, bearing at least one additional continuous top layer, which do not exhibit differential retroreflectivity.

One such substrate bearing essentially a monolayer of reflective elements is available commercially from the Minnesota Mining and Manufacturing Company (3M Company) of St. Paul, Minnesota, USA under the name FAVS as 3M® Scotchlite® FAVS sheeting VP 5500E. This material comprises essentially a monolayer of glass beads in a transparent polymeric matrix, where no additional transparent layers are superimposed upon the glass beads. A reflective layer comprising an aluminum vapor coat is also present on the rear surface of the substrate bearing the monolayer of beads.

In the present invention, retroreflective elements are present essentially as a monolayer. "Essentially a monolayer of retroreflective elements" is defined for the purposes of this application as any arrangement of retroreflective elements which presents a roughly planar array of such elements. Certain manufacturing processes, described in the references mentioned above, generate monolayers of elements, where elements are spaced more regularly and are more uniformly embedded (either partially or fully) in a matrix. Other manufacturing processes result in materials where the spatial arrangement of the elements within the plane may be less regular. Each of these materials is suitable for practicing the present invention.

Completely finished retroreflective sheeting products traditionally comprise an additional coating or additional layers applied in a continuous fashion on top of the layer of retroreflective elements, so that all elements are covered in a nearly uniform manner and relatively uniform thickness with a material of uniform refractive index, thus producing a multilayer film with uniform retroreflectivity and uniform brightness. Such additional transparent layers or coatings are known, particularly for use over monolayers of glass beads in conjunction with a reflective layer, for formation of enclosed lens retroreflective sheeting and are described in U.S. Patent Numbers 2,407,680 (Palmquist et al), 4,626,127 (May), 4,511,210 (Tung et al), 4,569,920 (Tung et al), 4, 367,857 (Tung et al) and 4,664,966 (Bailey). Transparent top coats are traditionally present for the purpose of at least partially providing a surrounding medium for the bead which has the appropriate refractive index for completing the known physical and optical requirements for a high quality retroreflective sheeting, the principles of which are described more fully in "Guide to the Properties and Uses of Retroreflectors at Night", Publication CIE No. 72 (1987) of the International

Commission on Illumination, P. O. Box 169, Vienna 1033, Austria. Such top coats also allow retroreflectivity when the sheeting is wet.

Retroreflective elements useful for the present invention comprise glass beads of specific sizes and refractive index well known to the industry, although other retroreflective elements capable of exhibiting lens-like behavior are not excluded.

Whereas conventional retroreflective sheetings do not exhibit a modulation in the level of retroreflectivity, the multilayer films of the present invention exhibit differential retroreflectivity. A multilayer film having differential retroreflectivity is defined as one where certain areas of the multilayer film have substantially greater retroreflectivity as compared to other areas. Preferably there is sufficient difference in the retroreflectivity that this difference can be perceived by the otherwise unaided eye with the aid of a hand-held viewer which simulates retroreflective viewing conditions. Hand-held viewers are commercially available from 3M Company of St. Paul, Minnesota, USA.

The difference in retroreflectivity can be quantitatively expressed by measuring the retroreflectivity of both the area having greater retroreflectivity and the area having lesser retroreflectivity and then comparing the two in a relationship known as the contrast ratio. The difference in retroreflectivity or contrast ratio is defined as the retroreflectivity of the more highly reflective areas (in $cd \cdot lux^{-1} \cdot m^{-2}$) divided by the retroreflectivity of the less reflective areas (in $cd \cdot lux^{-1} \cdot m^{-2}$) as measured by the method described below under Test Methods. Even though any difference perceivable by the naked eye is useful in providing verification markings, the contrast ratio is preferably at least 1.5, more preferably at least 2.0 and especially preferably in the range of 1.5 to 5.0.

Materials suitable for use as the transparent layer in the present invention can be selected from a group comprising transparent polymers. Especially preferred are transparent polymers which are at least slightly flexible in the form of a thin layer or sheet. Some degree of flexibility is required so that the multilayer film of the present invention can be handled during manufacture, rolled upon itself for transportation and utilized on converting equipment without breaking or cracking of the transparent layer. Breaking or cracking of the transparent layer would cause unsightly defects in the appearance of the finished multilayer film and reduce mechanical stability of the overall construction.

Transparent polymeric materials suitable for use as the transparent layer include polyurethanes, polyacrylates, polyesters and polyamides as well as other polymers known for their optical clarity, stability and flexibility as polymeric films. Preferred polymeric materials for use as the transparent layer are polyurethanes and polyacrylates.

The thickness of the transparent layer can be any thickness which is capable of generating a substantial increase in retroreflectivity. A transparent layer having a thickness of only 0.7 microns was found to have already increased the retroreflectivity of a monolayer of glass beads on a substrate by a factor of almost three. The thickness of the transparent layer is chosen according to the refractive index of the transparent layer and techniques which can be used to apply it and can easily be varied and optimized by a person skilled in the art. The thickness of the transparent layer is preferably at least 0.2 microns, preferably at least 0.5 microns, with the most preferable thickness in the range of 5-50 microns.

In a first embodiment of the present invention, areas of greater and lesser retroreflectivity, respectively, are generated by applying a transparent layer on top of the monolayer of retroreflective elements in a patterned fashion. A "pattern" as used in regard to the present invention is any array of coated and uncoated areas which constitutes less than a full surface coating of the transparent layer on top or the total area of retroreflective elements. Included under the definition of "patterned fashion" are coated areas in a pattern of discrete discontinuous geometrical forms such as circles, squares, triangles, as well as continuous networks or grids where uncoated areas have been left at regular intervals. It is preferred that the coated and uncoated areas are present in a repetitive and symmetrical pattern, but a random distribution of spots, for example or an irregular or non-repetitive network or pattern is also within the scope of the present invention. In an especially preferred embodiment, the pattern represents a customer-specific graphic, such as a logo or a seal or mark of a regulatory authority, such as the eagle commonly used by the Federal Republic of Germany, for example.

The patterned transparent layer is preferably be applied in such an amount that at least 2 per cent and less than 98 per cent of the total surface area of the monolayer of retroreflective elements is covered. More preferred is 10 to 90 per cent coverage. Especially preferred is 40-60 per cent coverage.

The patterned transparent layer must also be physically applied to the surface of the monolayer of retroreflective elements using such a method that a pattern of differential retroreflectivity is generated. In order to achieve significant difference in retroreflectivity , the transparent layer must be applied at least partially in such fashion such that it conforms closely to the surface of the substrate bearing the monolayer of retroreflective elements. This can be accomplished by any one of several common techniques.

The transparent layer may be applied by pattern-coating or printing a solution or emulsion of the preferred polymeric material onto the surface of the reflective elements from solution, followed by evaporation of the liquid medium (organic solvent or water). Common techniques for pattern-coating of solvent-based or water-based polymers include gravure printing, tampon printing, flexographic printing and screen printing, among others.

The transparent layer can also be applied by pattern hot melt coating techniques where the transparent layer is applied to the substrate bearing the monolayer of retroreflective elements in the molten form, in a pattern of stripes, for example, allowing the transparent layer form in intimate contact with the surface of the layer of retroreflective elements.

The transparent layer can also be applied by heat lamination of a preformed transparent layer. To provide a discontinuous pattern of spots, for example, the transparent material can be coated and dried first on a release liner and then transferred to the layer of reflective elements using a hot lamination process wherein lamination variables such as time, temperature and pressure have been selected so as to provide good contact between the transparent layer and the reflective elements.

Alternatively, a preformed grid or net of hot-melt adhesive can be heat laminated directly to the layer of reflective elements, with or without the use of an intermediate release liner, thus generating an interconnected grid of coated areas with intermittent uncoated areas.

Figure 1 shows a schematic drawing of the first embodiment of a multilayer film having differential retroreflectivity. In Figure 1, a substrate coated with essentially a monolayer of retroreflective elements is shown as 1. Retroreflective elements (2) are shown as glass beads embedded in a polymeric matrix (3). A reflective layer (4) is shown, as well as an optional supportive backing (5). The transparent layer (6) overlying the front surface of the retroreflective elements (2) is present in some areas (7) and absent in others (8). The front surface is defined as the surface which is viewed by the observer and the surface through which incident light first passes.

In areas where the transparent layer is present and intimately bonded to the surface of the substrate bearing the monolayer of glass beads, areas of greater retroreflectivity (7) are created. In areas where the transparent layer is absent, areas of lesser retroreflectivity (8) are observed.

As shown in Figure 1, in areas of greater retroreflectivity (7), a ray of incident light passes through the transparent layer and through the glass bead, focusing on the reflective layer. There it is reflected back out through the bead and transparent layer, exiting the multilayer film at very nearly the same angle at which it entered.

In areas of lesser retroreflectivity (8), where the transparent layer is absent, a ray of incident light is not focused correctly on the reflective layer, because the focal point is beneath the reflective layer. Thus a greater portion of the light impinging upon the area (8) is not reflected back in the direction of the viewer, but rather is at least partially scattered or diffracted at angles greater than incoming light.

It is well known that the optics and physics of retroreflection depend on an optical element which focuses incident light onto a reflective layer at such a point that the reflected light follows the approximate path of the incident light. The point at which the incident light beam is focused is a function of the shape of the optical element (such as a glass bead), and the refractive indices of the both the optical element and the medium which surrounds the optical element. If these parameters are selected such that the incident light is focused on the reflective layer, a high degree of retroreflectivity is achieved. If one or more of these parameters is altered sufficiently, then the incident light beam is not focused on the reflective layer and a lesser degree of retroreflectivity is present.

A detailed description of the principles which govern the behavior of retroreflective materials is given in "Guide to the Properties and Uses of Retroreflectors at Night", Publication CIE No. 72 (1987) of the International Commission on Illumination, P. O. Box 169, Vienna 1033, Austria.

It is believed that in areas of greater retroreflectivity (7), the refractive index of the transparent layer is such that a greater amount of the incident light is focused on the reflective layer, whereas in areas of lesser retroreflectivity (8), where air is present as the surrounding medium of the reflector, a lesser amount of the incident light is focused on the reflective layer. Thus it is speculated that areas of greater and lesser retroreflectivity are generated in a controlled fashion by providing the transparent layer (6) as a surrounding medium for the beads in some areas and providing air as a surrounding medium for the beads in other areas.

A second embodiment of the present invention is one where a complete transparent layer with 100% surface coverage of the retroreflective elements is present. In this case, the transparent layer is present in all areas, but intimately bonded to the surface of the retroreflective elements only in selected areas, thus providing differential retroreflectivity.

The second embodiment of the invention, created using this process, is shown schematically in Figure 2. Areas of greater and lesser retroreflectivity, respectively, are again indicated as (7) and (8). Air spaces (9) are present in areas where the transparent layer (6) is not in intimate contact with the surface of the monolayer of retroreflective elements.

This second embodiment of the invention requires superimposing a full-surface transparent layer over the monolayer of retroreflective elements and then heat-sealing the transparent layer into intimate contact with the surface of the retroreflective elements only in certain areas. This patterned lamination or patterned heat-sealing can be performed, for example, using a heated roll which has a pattern of elevated and depressed areas such as those found on a waffle iron, for example. In this embodiment, the transparent layer is present above the retroreflective elements across the entire surface area of the monolayer of retroreflective elements, but is only intimately bonded to it in selected areas corresponding to the protrusions on the lamination roll. Areas of greater retroreflectivity (7) are present where the transparent layer is intimately bonded and areas of lesser retroreflectivity (8) are created where the transparent layer and retroreflective elements have not been bonded at all or where bonding is insufficient to form good contact with the surface of the retroreflective elements.

It is believed that the second embodiment of the invention gives rise to differential retroreflectivity by substantially the same mechanism as the first embodiment. In areas where the transparent layer (6) is not bonded intimately to the surface of the substrate bearing a monolayer of beads, a layer of air (9) is present which acts as the functional medium for the reflector.

In a third embodiment of the present invention, the retroreflective elements are covered with a complete transparent layer which closely conforms to the monolayer of retroreflective elements. In this embodiment, however, the transparent layer comprises alternating segments, for example, of two or more transparent polymers having differing refractive indices. This embodiment can be prepared by first pattern coating a first transparent material and then pattern coating a second transparent material in areas left uncoated by the first material.

In a fourth embodiment of the present invention, a single transparent material is employed, but with a thickness which varies in a pattern.

The various embodiments and the methods of preparation are presented by way of example only. The person skilled in the art can easily find other embodiments employing the general principles outlined above. According to this principle, areas of differential retroreflectivity are obtained by providing a pattern of segments exhibiting differing focal points.

The multilayer film of the present invention optionally comprises other layers which act to provide other features to the overall final product constructions. Other optional layers include other transparent polymeric overlay films or top coats, backings, verification markings, primers, release coatings, damageable layers and adhesives, including pressure-sensitive adhesives and heat-activated adhesives.

A particularly preferred optional layer is a transparent holographic film such as those available from Crown Royal Leaf, Inc. of Peterson, New Jersey, USA (polymethylmethacrylate-based structured layer, a high-index zinc sulfide reflector and a thin adhesive layer). Such transparent films bearing holographic features can be heat-laminated on top of the patterned transparent layer to provide additional verification marking in a security laminate, for example, if desired. Laminates comprising such transparent holographic films are described in co-pending EP 96108129.6 (Weber).

Examples of other layers mentioned are described, for example, in WO 96/02048 (Bischof et al), co-pending application EP 95202069.1 (Kuester et al), and co-pending application EP 96108129.6 (Weber et al).

Care must be taken, however, with heat lamination of further layers when the second embodiment of the invention has been selected. Heat lamination conditions for application of further layers should be selected so that the unbonded areas (8) of the transparent layer (as shown in Figure 2) are not forced into intimate contact with the surface of the monolayer of retroreflective elements. This must be prevented or the desired differential retroreflectivity can be inadvertently reduced or lost entirely.

The multilayer film according to the present invention can also be used for the preparation of security laminate. Security laminates additionally comprise at least one internal damageable layer as is described in, for example, in WO 96/02048 (Bischof et al), co-pending application EP 95202069.1 (Kuester et al), and co-pending application EP 96107988.6 (Weber et al).

The present invention also encompasses the use of a multilayer film comprising a substrate bearing essentially a monolayer of retroreflective elements, said substrate having a front surface and a rear surface, and a transparent layer overlying said front surface of said substrate, wherein the transparent layer includes means for providing patterned differential retroreflectivity, as a verification marking in retroreflective security laminates.

In yet another embodiment, illustrated in Figure 3, a substantially uniform monolayer of glass beads 2a may be retained in an overlying bead bond coat 3a and an underlying space coat 3b (or a slurry coat that performs both functions), beneath which is provided a vapor-coated reflective layer 4a that approximately conforms to the hemispherical shape of the beads 2a. This core sheeting is believed to have a brightness in the range of up to 15 cpl. When a patterned transparent layer 6a is provided over the core sheeting just described, the greater thickness provides greater brightness; believed to be in the range of from 30-100 cpl. Thus, by providing a patterned transparent area, differential retroreflectivity can be provided in accordance with the present invention.

The following test methods and examples serve to illustrate the invention, but should not be seen as limiting the scope of the invention in any manner.

Test Methods

Coefficient of Retroreflection

Retroreflectivity of reflective sheeting was measured using DIN 67520 (Part 1) or ASTM E 810-81 using an entrance angle of 0.33° and an observation angle of 5.0°. Retroreflectivity measurements were repeated three times for each sample and recorded in units of $cd \cdot lux^{-1} \cdot m^{-2}$.

All quantitative retroreflectivity measurements were made on retroreflective sheeting having full coatings of a transparent layer. Quantitative measurement of retroreflectivity of a small area of a pattern-coated material is difficult.

Thickness of transparent layer

The thickness of the transparent layer overlying the monolayer of retroreflective elements was measured by a subtraction process. The thickness of the combined layer of retroreflective elements and the substrate was measured using an electronic caliper measurement device available commercially from Gockel and Co. GmbH, Munich, Germany as Model 51D2. Then a coating was applied and the thickness of the multilayer film was measured again using the same apparatus. The thickness of the coating was calculated by subtracting the original thickness from the final thickness.

Materials

1. Retroreflective sheeting, available from 3M Company of St. Paul, Minnesota, USA as 3M® Scotchlite® FAVS sheeting VP 5500E, comprising essentially a monolayer of glass beads bonded to a polymeric film substrate where no additional transparent layers or coating have been applied over the glass beads.

2. Transparent holographic transfer film, available from Crown Royal Leaf, Inc. of Peterson, New Jersey, USA (polymethylmethacrylate-based structured layer, a high-index zinc sulfide reflector and a thin adhesive layer). The holographic film has a thickness of approximately 3-4 microns.

3. Materials used to generate differential retroreflectivity:

3a Polyurethane dispersion, available as NeoRez R960 from Zeneca Resins, Frankfurt am Main, Germany.

3b Polyurethane dispersion, available as NeoRez 9630 from Zeneca.

3c Polyurethane dispersion, available as NeoRez 9621 from Zeneca.

3d Polyurethane dispersion, available as Neotac 560 from Zeneca.

3e Acrylic dispersion, available as Neocryl A45 from Zeneca.

3f Carbodiimide solution, available as Ucarlink from Union Carbide.

3g Polymeric net comprising approx. 1 mm x 5 mm bars of hot melt adhesive arranged in a diamond-like pattern available as Texiron™ 116/20 polyamide hot melt adhesive film from Protechnic Company, Cernay, France. The net had a weight of 20 g m^{-2} and the thickness of the adhesive bars was estimated to be approximately 100 microns.

Examples

Comparative Example 1

Retroreflectivity measurements were made on retroreflective sheeting available from 3M Company of St. Paul, Minnesota, USA as 3M® Scotchlite® FAVS sheeting VP5500 E. This material has no additional transparent layer overlying the glass beads.

The average of three measurements gave a retroreflectivity of 12.3 $\cdot$ $lux^{-1} \cdot m^{-2}$

Comparative Example 2.

A 50:50 weight:weight mixture of a first polyurethane dispersion, available as NeoRez R960 from Zeneca (denoted as 3a), and a second polyurethane dispersion, available as NeoRez 9630 from Zeneca (denoted as 3b), was prepared and coated in a continuous and unbroken fashion onto retroreflective sheeting using gravure coating. The water-borne coating was dried at 80° for 1 min. in a forced air oven. The thickness of the dried coating was 2-3 microns.

Retroreflectivity measurements resulted in an average value of 24.2 cd $\cdot$ $lux^{-1} \cdot m^{-2}$

Example 1

Retroreflective sheeting was pattern-coated with the waterborne polyurethane mixture described in Comparative Example 2, using gravure coating to generate a transparent coating having checkerboard pattern with squares of approximately 10 mm. Areas coated with transparent polyurethane had a thickness of approximately 2-3 microns and were adjacent to areas where no coating was present.

The material produced in the above manner was viewed with a handheld light source simulating retroreflective viewing conditions. The checkerboard pattern was clearly visible as a pattern of lighter and darker areas, corresponding to areas of greater and lesser retroreflectivity.

Based on measurements of continuous coatings, the contrast ratio of this pattern-coated sheeting was estimated to be: light / dark = 24.2 cd $\cdot$ lux^{-1} $\cdot$ m^{-2} / 12.3 cd $\cdot$ lux^{-1} $\cdot$ m^{-2} = 2.0.

Comparative Example 3

A transparent holographic film (denoted as 2 under Materials) was heat laminated onto retroreflective sheeting (denoted as 1 above) so as to provide 100% coverage of the surface. Heat lamination was performed using heat lamination equipment commercially available from Sallmetall (Raalte, The Netherlands) at a pressure of 2 bar with a temperature of 140° C at a lamination speed of 5 cm/min.. No intermediate pattern coating was present.

The resulting laminated was viewed with a handheld viewer commercially available form 3M Company of St. Paul, Minnesota, USA, and no pattern of light and dark areas was visible. Retroreflectivity measurements resulted in a value of 10.2 cd $\cdot$ lux^{-1} $\cdot$ m^{-2}.

Example 2

Example 1 was repeated and then a thin transparent holographic film was heat laminated on top of the pattern coating of transparent polyurethane which had been applied to the retroreflective sheeting. Lamination was performed using conditions described in Comparative Example 3.

Samples were evaluated for retroreflectivity by viewing with a handheld viewer as described in Example 1. The checkerboard was clearly visible as a pattern of lighter and darker areas, corresponding to areas of greater and lesser retroreflectivity.

Based on measurements of continuous coatings generated in the Comparative Examples, the contrast ratio of this pattern-coated sheeting was: light/dark = $34.1\ cd \cdot lux^{-1} \cdot m^{-2} / 10.2\ cd \cdot lux^{-1} \cdot m^{-2} = 3.3$.

Examples 3-10

Example 1 was repeated with the exception that the polymeric solution applied in a pattern coating was varied. All solutions or dispersions were coated with a gravure roll in a checkerboard pattern with squares of 10 mm and resulted in transparent pattern coatings having an approximate dry thickness of .2-3 microns. Upon viewing with a retroreflective viewer, a distinct checkerboard pattern of brighter and darker areas was visible. Chemical composition of the pattern-coatings is summarized in Table 1.

Table 1

Example	Comp. of pattern coating (parts)	Thick. of coated areas (microns)
3	3a (50), 3e (50)	2-3
4	3a (97.5), 3f (2.5)	2-3
5	3a (95), 3f (5)	2-3
6	3b (50), 3e (50)	2-3
7	3c (50), 3e (50)	2-3
8	3c (70), 3e (30)	2-3
9	3d (50), 3e (50)	2-3
10	3d (70), 3e (30)	2-3

Comparative Examples 4-9

Continuous coatings of varying thickness were applied to cover 100% of the surface of the retroreflective sheeting denoted as 1 and dried in a forced air oven. Comparative Examples 4-7 were dried for 1 minute at 80° C. and Comparative Example 8 was dried for 5 minute at 80° because of its substantial thickness. Retroreflectivity was then measured and compared to the retroreflectivity of an uncoated sample of retroreflective sheeting (denoted as 1). A contrast ratio was calculated as that which would be expected from materials having pattern coating at the thicknesses indicated in Table 2. The uncoated retroreflective sheeting had a retroreflectivity of 20.4 cd · lux^{-1} · m^{-2}.

These examples show that the operable thickness of the transparent layer extends down into the submicron range as measured by the technique described under Test Methods.

Table 2

Comp. Example	Composition of coating (parts)	Thickness (microns)	Coating wt., (g m^{-2})	Retroreflectivity (cd · lux^{-1} m^{-2})	Contrast ratio*
C4	3a (50), 3b (50)	0.7	4.4	55.8	2.7
C5	3a (50), 3b (50)	1.7	5.0	65.9	3.2
C6	3a (50), 3b (50)	5.3	10.1	79.0	3.9
C7	3a (50), 3b (50)	8.5	14.5	71.0	3.5
C8	3a (50), 3b (50)	36.5	42.8	75.1	3.7

* A calculated contrast ratio based on retroreflectivity measurements made on uncoated reflective sheeting and full surface coated reflective sheeting, respectively. Quantitative retroreflectivity is difficult to measure on surfaces having small-patterned structures.

Example 11

Retroreflective sheeting was coated with a pattern of a regular array of circular spots approximately 3 cm in diameter using a tampon-printing process. This discontinuous transparent layer was created by applying the same solution as described in Comparative Examples 4-8.

When observed with a hand-held viewer, a bright pattern of circular spots was clearly visible.

Example 12

A three layer laminate was prepared by first superimposing a net (denoted as 3g), comprising approx. 1 mm x 5 mm bars of hot melt adhesive arranged in a diamond-like pattern (available as Texiron™ 116/20 polyamide hot melt adhesive film from Protechnic Company, Cernay, France), on top of glass bead retroreflective sheeting (denoted 1 under Materials). Then a layer of transparent holographic film (denoted as 2 under Materials) was superimposed upon the net. The three-layer construction was then heat-laminated using a commercially available heat laminator (Sallmetall) at a temperature of 130° C, a pressure of 2 bar and a speed of 5 cm/min.

The resulting construction, representing a transparent layer comprising a continuous network bearing holes, was viewed with a retroreflective viewer. A clear and distinct bright pattern corresponding to the geometrical pattern of the net was visible.

Claims

1. Multilayer film, comprising:

a) a substrate bearing essentially a monolayer of retroreflective elements, said substrate having a front surface and a rear surface; and

b) a transparent layer overlying said front surface of said substrate, wherein said transparent layer includes means for providing patterned differential retroreflectivity.

2. Multilayer film according to claim 1, wherein said transparent layer is patterned.

3. Multilayer film according to claim 1, wherein said transparent layer covers said substrate completely and exhibits areas of more intimate bonding and areas of less intimate bonding between said transparent layer and said substrate.

4. Multilayer film according to claim 1 wherein said retroreflective elements are glass beads.

5. Multilayer film according to claim 1 where said transparent layer is polymeric film.

6. Multilayer film according to claim 1 where said transparent layer has a thickness of at least 0.5 microns.

7. Multilayer film according to claim 1 comprising at least one additional optionally non-continuous layer on top of said transparent layer, including polymeric films, verification markings, primers, release coatings, damageable layers and adhesives.

8. Multilayer film according to claim 5, where said additional layer is a transparent holographic film or a damageable layer.

9. Multilayer film according to claim 1 wherein the contrast ratio is greater than 1.5.

10. The multilayer film according to claim 1, in combination with a document for use as a security laminate.

11. Multilayer film according to claim 1, wherein the film comprises an exposed lens construction having a patterned area disposed between the retroreflective elements and a cover sheet.

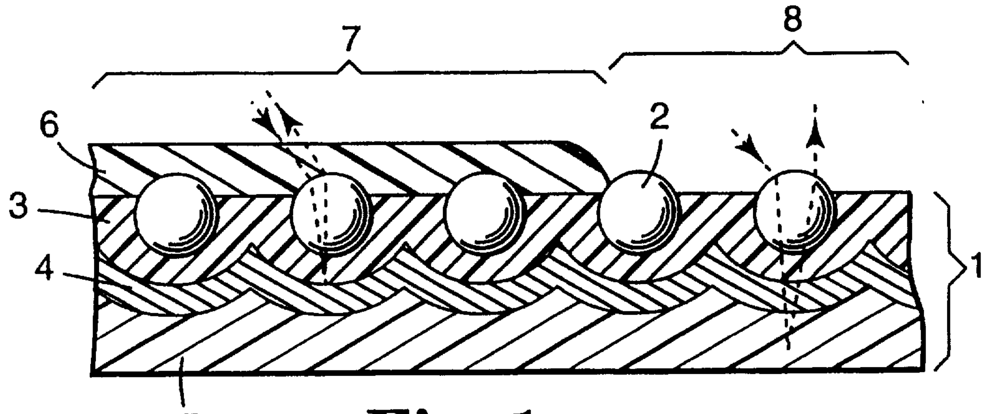

Fig. 1

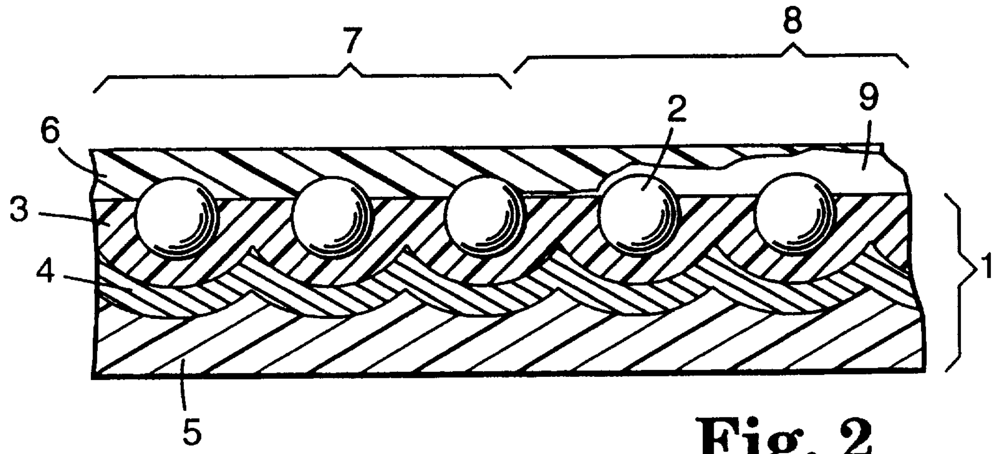

Fig. 2

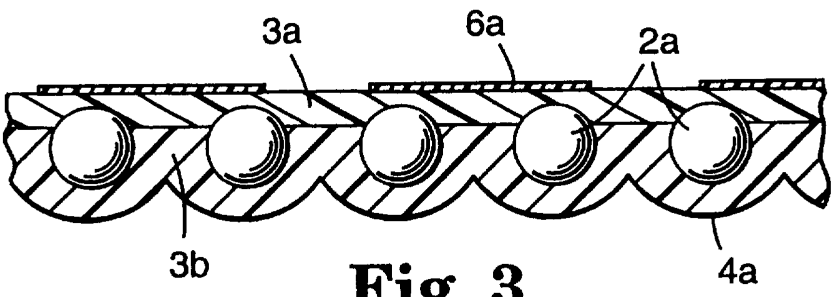

Fig. 3

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 97/12438

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 G02B5/128

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)
IPC 6 G02B

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3 877 786 A (BOORAS PETER J ET AL) 15 April 1975 see column 5, line 51 - column 6, line 9 see column 6, line 33 - column 7, line 48; figure 5 ---	1,2,4,5, 7
X	US 3 176 420 A (HOWARD C ALVERSON) 6 April 1965 see column 1, line 64 - column 5, line 4; figures 1,2 ---	1,2,4,5, 8,11
A	US 2 407 680 A (P V PALMQUIST) 17 September 1946 cited in the application see column 10, line 41 - column 11, line 75; figure 2 --- -/--	1-8

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

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
31 October 1997	07/11/1997

Name and mailing address of the ISA	Authorized officer
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INTERNATIONAL SEARCH REPORT

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
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A	US 5 306 520 A (YOU CHING C) 26 April 1994 see column 1, line 16 - column 2, line 49; figures 1-11 ---	1-11
A	WO 96 02048 A (MINNESOTA MINING & MFG) 25 January 1996 see page 13, line 28 - page 14, line 15; figure 8; example 17 ---	1-11
A	WO 94 25666 A (MINNESOTA MINING & MFG) 10 November 1994 see page 11, line 12 - page 16, line 16; figures 2-5 -----	1-11

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