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(71) Applicant: **BAYER MATERIALSCIENCE AG** [DE/DE]; 51368 Leverkusen (DE).

(72) Inventors: **JUNG, Youngsub**; 1001dong 1204ho, 112-34 Wolsan-ro, Gimhae-si, Gyeongsangnam-do 621-250 (KR). **PARK, DaeLim**; 8-13, Yeojwa-ro 63beon-gil, Jinhae-gu, Changwon-si, Gyeongsangnam-do 645-805 (KR). **JUNG, Jongmin**; 101dong 1004ho, 35, Yongjeong-gil 46beon-gil, Dong-eup, Uichang-gu, Changwon-si, Gyeongsangnam-do 641-863 (KR). **JUNG, Soonhun**; 114dong 1404ho, 156, Hwamyeongsindosi-ro, Buk-gu, Busan 616-789 (KR).

(74) Agent: **BIP PATENTS**; c/o Bayer Intellectual Property GmbH, Alfred-Nobel-Str. 10, 40789 Monheim am Rhein (DE).

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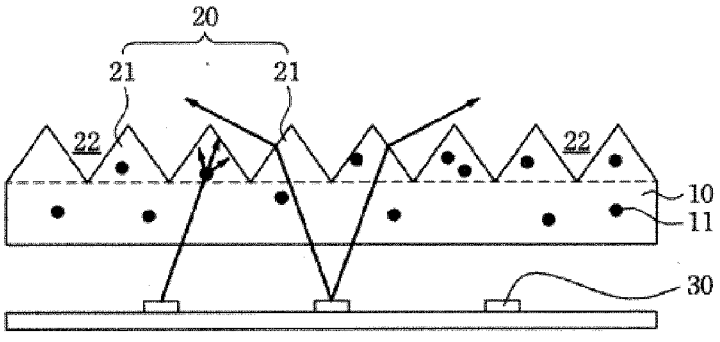
(54) Title: LIGHT DIFFUSION PLATE

【Figure 1】



(57) Abstract: The invention relates to a light diffusion plate. The light diffusion plate according to one embodiment of the invention comprises a core layer formed with a thermoplastic resin containing diffusion agents and having an optical transmission property, and arranged in front of a light source; and a pattern layer configured with patterns formed on the surface of the core layer wherein the core layer is formed with a thickness of 0.5-4.0 mm, and the patterns are formed with a pitch of 0.5-3.0 mm, and a height of 0.1-2.0 mm. Accordingly, it not only obtains the optical feature with the same or more as that of the light diffusion plate according to the prior art, but also reduces the usage of the raw materials by the empty spaces occurring due to the curvature of the patterns constituting the pattern layer, thereby contributing to the weight reduction of the optical apparatuses and drastically reducing the usage of materials.

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LIGHT DIFFUSION PLATE

The invention relates to a light diffusion plate.

A light diffusion plate serves to uniformly diffuse light emitted from light sources such as a backlight unit in a liquid crystal display, a lighting apparatus in a billboard, and a lighting lamp to convert them into a surface light source. Moreover, it is used to protect the light sources, surrounding apparatuses or the like, and becomes a more important optical part as the application of LED light sources with excellent optical efficiency and eco-friendly properties are drastically increased.

Such a light diffusion plate is typically manufactured by mixing a transparent resin and light diffusion particles, that is, diffusion agents within a substance as disclosed in KR2011-0084287 A, and on the other hand, the main trend is a light diffusion plate with a surface consisting of fine shapes in micron such as a lenticular lens, a fresnel lens, a prism, a semi sphere or the like.

Here, there are a lot of efforts for weight reduction of associated parts being used to improve the handling of the optical apparatuses and save production cost thereof. For the light diffusion plate, the weight reduction and the production cost saving are being proceeded by reducing its thickness or using cheap substitute material with a poor material property. However, it is difficult to perform further weight lightening in the light diffusion plate because a preferable feature of the material property closes to its limitation.

That is, for the above light diffusion plate, the approach is done toward improving the diffusion property by controlling an optical transmission rate through concentration control of the diffusion agents and forming fine patterns on the surface of the light diffusion plate, and reducing the thickness of the light diffusion plate so that it reaches its restriction and further improvements thereto aren't easy.

Accordingly, the invention is intended to perform the weight reduction while having an excellent optical transmission property, an excellent light diffusion property and an excellent light stability at the same thickness even in the same material as that of the prior art.

According to one object of the invention, it is intended to provide a light diffusion plate in which patterns of a given size or more are formed on its surface to refract light with the patterns capable of improving the diffusion capability, and empty spaces occurring according to curvature of the patterns to be capable of easily reducing usage of the material.

The object above is achieved by

a light diffusion plate according to the invention is comprised of:

a core layer formed with a thermoplastic resin containing diffusion agents and having an optical transmission property, and arranged in front of a light source; and

a pattern layer configured with patterns being formed on a surface of the core layer;

wherein the core layer is formed with a thickness of 0.5-4.0 mm, and patterns are formed with a pitch of 0.5-3.0 mm, and a height of 0.1-2.0 mm.

"Having an optical transmission property" means that the core layer is made from a transparent thermoplastic resin, wherein "transparent" means that the core layer has a transmittance of at least 90 % measured according to ASTM D1003 (λ = 380 – 780 nm).

Moreover, according to one embodiment of the light diffusion plate of the invention, the light source may be any one of a surface light source lamp, a linear light source lamp, or a point light source lamp.

Moreover, according to one embodiment of the light diffusion plate of the invention, the patterns may be formed with a surface roughness value, Ra (roughness average) of 10 μm or more.

Moreover, according to one embodiment of the light diffusion plate of the invention, the pattern layer may be formed on one side or both sides of the core layer.

Moreover, according to one embodiment of the light diffusion plate of the invention, the patterns may have a one-dimensional shape comprised of a form of lenticular form or a form of prism.

Moreover, according to one embodiment of the light diffusion plate of the invention, the patterns may have a two-dimensional shape comprising a form of semi sphere, a form of pyramid, a form of triangular pyramid, or a form of honeycomb.

Moreover, according to one embodiment of the light diffusion plate of the invention, the patterns may be formed in a raised pattern or an engraved pattern.

Moreover, according to one embodiment of the light diffusion plate of the invention, the patterns may be formed regularly or irregularly.

Moreover, according to one embodiment of the light diffusion plate of the invention, the diffusion agents may be contained in the pattern layer.

Moreover, according to one embodiment of the light diffusion plate of the invention, it further comprises:

a UV blocking layer formed together with the pattern layer or on the other side of the pattern layer.

Those solving measures will be made more clear by the detailed description of the invention below with reference to the accompanying drawing.

Before a specific description is given, terms or words used in the specification and claims don't have to be interpreted in their typical and dictionary definitions, and have to be interpreted in definitions and concepts matched with the technical idea of the invention based on the principle that inventors can appropriately define concepts of terms in order to describe their own inventions with the best method.

According to the invention, the pattern layer consisting of patterns with the pitch of 0.5-3.0 mm and the height of 0.1-2.0 mm is formed on the surface of the core layer with the thickness of 0.5-4.0 mm so that it not only obtains the optical feature with the same as or more than that of the light diffusion plate according to the prior art, but also reduces the usage of the raw materials by the empty spaces occurring due to the curvature of the patterns constituting the pattern layer, thereby contributing to the weight reduction of the optical apparatuses and drastically reducing the usage of materials.

Figures 1 to 9 are perspective views for showing the light diffusion plate according to one embodiment of the invention.

Figure 10 is a schematic view for showing an extrusion molder according to one embodiment of the invention.

The unique viewpoint and specific technical features of the invention will be more clear from particular contents and embodiments below being associated with the accompanying figures. It should be noted that same components may have the same number as much as possible even though they are represented in other figures when it comes to attaching reference numbers to components in each figure.

Hereinafter, the embodiments of the invention will be specifically described with reference to the accompanying figures.

As shown in Figures 1 to 9, the light diffusion plate (1) according to one embodiment of the invention may be provided by forming a pattern layer (20) on the surface of a core layer (10) with the pattern layer (20) consisting of patterns (21) with a pitch of 0.5-3.0 mm and a height of 0.1-2.0 mm, so that it can easily obtain the optical feature and also reduce its weight by empty spaces occurring due to the arrangement of those patterns (21), thereby making it possible to perform the weight reduction and even improve the feature of the light diffusion property according to the forms and sizes of the patterns (21).

The core layer (10) may be formed by using thermoplastic resins with an optical transmission property as a raw material. The thermoplastic resins may comprise a polycarbonate resin, an acrylic based resin, a styrene based resin, a vinyl chloride based resin, an olefin based resin, a cycloolefin based resin, an acrylic-styrene copolymer resin, a polyester based resin or the like.

The pattern layer (20) may consist of patterns (21) that are formed on the surface of the core layer (10) to refract light wherein the patterns (21) may be formed as forms comprising a lenticular form, a prism form or the like, which are typically classified as a one-dimensional shape, and moreover be formed by regularly or irregularly forming a semi sphere form or pyramid form as well as a honeycomb form or triangular pyramid form, which are classified as two-dimensional shapes, thereby the pattern layer (20) being resulted in being configured.

The light diffusion plate (1) comprising the core layer (10) with such a pattern layer (10) thereon may be arranged in front of a light source (30). That is, the light source (30) may be arranged in back of the light diffusion plate (10) to irradiate light, and may be chosen from any one of a typical surface light source lamp, linear light source lamp, or point light lamp.

On the one hand, as mentioned above, for imposing the light diffusion property and reducing the usage of materials to perform the weight reduction, it is preferable for the patterns (21) to have a pitch of about 0.5-3.0 mm and a height (depth) of 0.1-2.0 mm when the patterns (21) are represented for their sizes with the pitch and height (or depth). That is, as the form of the patterns (21) is chosen as the biggest form among forms and sizes not affecting the light uniformity, it can be possible to significantly save on the production cost due to the weight reduction and use of a small amount of material.

Moreover, for irregularly formed patterns (21), it may be difficult to represent the size of the patterns with the pitch and height (depth) so that it is preferable to represent the size with a surface roughness value (Ra). When the Ra is 10 μm or more, the size can be considered as enough to reduce the usage of materials and perform the weight reduction.

Here, because the depth of the patterns (21) may satisfy an instrumental feature when the core layer (10) excluding the pattern layer (20) has to be uniformly kept, the magnitude of the depth must be small when the thickness is thin, and the depth must be higher as the thickness is greater. To this end, it is preferable for the core layer (10) to have a thickness of 0.5-4.0 mm, more preferably 0.8-2.0 mm.

Such a pattern layer (20) may have a form in which it may be formed on one side of the core layer (10) and a gloss form may be applied on the other side of the core layer (10), or a form in which fine embossed shapes may be applied to improve the light diffusion property and the hardness of the surface. Moreover, it can be possible to maximize the effect by providing both sides of the core layer (10) with the pattern layer (20) to impose the optical feature and the weight reduction functions.

Then, when the pattern layer (20) is formed on both sides of the core layer (10), it can be possible to form the same patterns (21) on both sides or different forms of patterns (21). Moreover, all the patterns (21) formed on both sides of the core layer (10) may be a raised pattern or an engraved pattern, and it can expect a mutual complementary effect by arranging the raised pattern on one side and the engraved pattern on the other side.

On the one hand, the core layer (10) may contain diffusion agents (11) for the light diffusion property, and further, the pattern layer (20) may contain the diffusion agents (11). Materials with a refractive index different from that of the thermoplastic resin may be normally used, and organic based and inorganic based particles may be used. Then, the greater the difference of the refractive index of the diffusion agents (11) is, a smaller amount of the diffusion agents (11) may be contained as the size is small, and the less the difference of the refractive index of the diffusion agents (11) is, a relatively larger amount of the diffusion agent (11) may be contained as the size is large.

Accordingly, it can be possible to appropriately control the light transmission property and the light diffusion property depending on the concentration of the diffusion agents (11). But, the agents may not be used if it is possible to obtain adequate diffusion function even with the diffusion effect due to the patterns (21) of the surface depending on a specification and a structural feature applied with the light diffusion plate (1).

Here, because the light diffusion plate (1) is located directly in the light source (30), it must not only be protected by blocking UV lights which can occur according to the kind of light source (30),

but also needs to have a function of being capable of protecting an optical film and a liquid crystal display located in back of the light diffusion plate (1). Therefore, a UV blocking layer (not shown) may be formed together with the patterns (21) or formed on the other side of the pattern layer (20).

Hereinafter, it will specifically describe a manufacturing method of the invention with reference to the accompanying figures.

First, a thermoplastic resin containing the diffusion agents and possibly being molded by extrusion while having the light transmission property may be chosen as a raw material. Moreover, it can be manufactured by using a casting method, an injection molding method or an extrusion molding method.

The casting method, the injection molding method and the extrusion molding method are representative methods for manufacturing the light diffusion plate. When manufacturing the light diffusion plate with the casting method, it is possible to manufacture the plate by forming and transferring preferable patterns on a surface of a casting cast used for the casting. Moreover, when manufacturing the light diffusion plate with the injection molding method, it is possible to manufacture the plate using a pattern mold.

However, the casting method has a limitation with regard to its application because usable materials are limited, and the injection molding method is advantageous for manufacturing small and complicated forms but has a limitation for manufacturing forms such as sheets. Accordingly, the light diffusion plate according to one embodiment of the invention may be manufactured by choosing the extrusion molding method.

As shown in figure 10, the extrusion molding method may be largely divided by an extruding process of conveying, compressing and melting the thermoplastic resins by using a typical extrusion molder (100) to make a sheet form in a T-die attached on an end portion of the molder (100), a calendering process of pressing melted resins from the T-die with a roll having a surface temperature of a glass transition temperature or less to form fine shapes on the surface of the resins and make a certain thickness of sheet, and a cooling process of uniformly cooling the sheet to keep the smoothness.

It is possible to manufacture a multi-layer sheet by using a co-extruder other than a main extruder in the extruding process, and it is possible to impose several functionalities by injecting raw materials added with a UV blocking agent, a charging prevention agent, a diffusion agent or the like or other raw materials into the co-extruder.

Moreover, the major process of forming patterns on the surface of the light diffusion plate may use a pattern roll engraved with a pattern form to be intended to manufacture with the calendering process so that it can manufacture a preferable form of the light diffusion plate.

In the calendering process, three or four rolls may be mainly used. In each roll, it can manufacture the light diffusion plate with preferable forms engraved thereon by transferring glosses, embossing, patterns or the like to the surface of the light diffusion plate with the roll.

[Comparative example]

After forming patterns with the pitch of 0.5-3.0 mm and the depth (or the height) of 0.1-1.4 mm with the form of pyramid uniformly or with the form of semi sphere irregularly on the surface of the core layer with the thickness of 1.5 mm to configure the pattern layer, an optical feature and the level of the weight reduction thereof was compared.

For comparing effects of the size of the patterns to the weight reduction, weights by pattern pitch and pattern height were calculated and compared as listed in [table 1] below. It could be found that the bigger the pattern size is the more the weight-reduction effect continuously is, and when the pattern pitch is 2.0 mm and pattern height is 1.0 mm the weight is lowest, so the weight reduction then amounts to 30% or more compared with a general light diffusion plate without any pattern.

Moreover, a raised pattern is lighter in weight than an engraved pattern. That is because there are more depressed portions than raised portions as protrusions among patterns in the raised pattern. A degree of the weight reduction may depend on the features of the pattern form. Accordingly, it is possible to select the light diffusion plate satisfying all required features if the raised pattern and the engraved pattern are selected and applied according to the optical feature, appearance feature and instrumental feature.

For confirming the actual degree of the weight reduction and the light diffusion plate capability, we manufactured and compared products with the pattern pitch of 2.0 mm and the pattern height of 1.0 mm, [table 2] is a result of measuring and comparing weights of manufactured products, and [table 3] is a result of comparing their optical features.

For manufacturing, a polycarbonate was used as the main raw material, and a silicon based material was applied as the diffusion agent. The manufacturing process was done by using the extruding molder in figure 10. Moreover, during the course of manufacturing, the products had little

difference in their dimensions from a pattern dimension of a roll mold due to a pattern transferring property difference resulting from the thermoplastic resin's original feature, that is, viscoelasticity and a contracting effect in the cooling course, but the products were manufactured with a dimension almost similar to a pattern design dimension.

It could be confirmed that there was almost a 30% weight reduction for both of the raised pattern and the engraved pattern. So, it can be found that the value was close to the theoretical values in [table 1], and it is actually confirmed that such a fact could substantially contribute to the production cost savings and the weight reduction due to a reduction of usage of the raw materials.

Because the bigger the pattern size is the more the weight reduction effect appears in the weight reduction comparison by pattern size, it can be considered to be most advantageous to choose the biggest pattern in a possible level for manufacturing, but an important function in the light diffusion plate, that is, the optical feature, must be considered.

On the one hand, the general light diffusion plate typically used was compared with light diffusion plates according to the invention with regard to the optical features in [table 3]. Products were manufactured with a transmission rate similar to that of the general light diffusion plate, and the optical features with regard to a low transmission rate and a high transmission rate in order to specifically confirm optical feature differences depending on the patterns were compared. It can be found that the color value and brightness value showed almost similar features, and there was an effect of improving the luminance by refracting lights emitted from the light source in the patterns, thereby increasing the brightness.

【Table 1】

Weight reduction comparison by pattern size

	Pattern pitch [mm]	Pattern height (depth) [mm]	Core layer thickness [mm]	Weight [kg]	Weight reduction [%]
General	0	0.0	1.5	1.8	-
Engraved pattern	1.0	0.5	1.0	1.48	15%
Engraved pattern	1.2	0.6	0.9	1.41	18%
Engraved pattern	1.4	0.7	0.8	1.35	21%
Engraved pattern	1.6	0.8	0.7	1.28	25%
Engraved	1.8	0.9	0.6	1.22	28%

pattern					
Engraved	2.0	1.0	0.5	1.15	31%
Raised pattern	1.0	0.5	1.0	1.52	18%
Raised pattern	1.2	0.6	0.9	1.47	22%
Raised pattern	1.4	0.7	0.8	1.41	25%
Raised pattern	1.6	0.8	0.7	1.36	29%
Raised pattern	1.8	0.9	0.6	1.30	32%
Raised pattern	2.0	1.0	0.5	1.25	36%

【Table 2】

Weight comparison of actual manufactured products

	Pattern pitch [mm]	Pattern height (depth) [mm]	Core layer thickness [mm]	Total thickness [mm]	Weight [kg]	Weight reduction [%]
General	0	0.0	1.5	1.55	0.074	-
Engraved pattern	2.0	0.855	0.705	1.56	0.054	27.03
Raised pattern	2.0	1.038	0.682	1.72	0.051	31.08

【Table 3】

Optical feature comparison

	Pattern pitch [mm]	Pattern height [mm]	Transmission rate [%]	Color x	Color y	Brightness
General	0	0	60%	0.2797	0.2818	296.5
Engraved pattern-1	2.0	0.855	58%	0.2808	0.2845	286.7 (-3.31%)
Engraved pattern-2	2.0	0.855	60%	0.2816	0.2841	306.4 (+3.34%)
Engraved pattern-3	2.0	0.855	62%	0.2839	0.2890	298.5 (+0.67%)

While a specific embodiment of the invention is described, it is intended to particularly describe the invention, and the light diffusion plate according to the invention will not be limited thereto, and it should be clear for the persons skilled in the art to change or modify the light diffusion plate within the technical idea of the invention.

【Description of signs】

1-Light diffusion plate
10-Core layer
11-Diffusion agent
20-Pattern layer
21-Patterns
22-Spaces
30-Light source
100-Extruding molder

Claims

1. A light diffusion plate characterized in that it is comprised of:
a core layer formed with a thermoplastic resin containing diffusion agents and having an optical transmission property, and arranged in front of a light source; and
a pattern layer configured with patterns formed on the surface of the core layer;
wherein the core layer is formed with a thickness of 0.5-4.0 mm, and the patterns are formed with a pitch of 0.5-3.0 mm, and a height of 0.1-2.0 mm.

2. A light diffusion plate according to claim 1, characterized in that the light source is any one of a surface light source lamp, a linear light source lamp, and a point light source lamp.

3. A light diffusion plate according to claim 1, characterized in that the patterns are formed with a surface roughness value Ra of 10 μm or more.

4. A light diffusion plate according to claim 1, characterized in that the pattern layer is formed on one side or both sides of the core layer.

5. A light diffusion plate according to claim 1, characterized in that the patterns have a one-dimensional shape comprising a form of lenticular or a form of prism.

6. A light diffusion plate according to claim 1, characterized in that the patterns have a two-dimensional shape comprising a form of semi sphere, a form of pyramid, a form of triangular pyramid or a form of honeycomb.

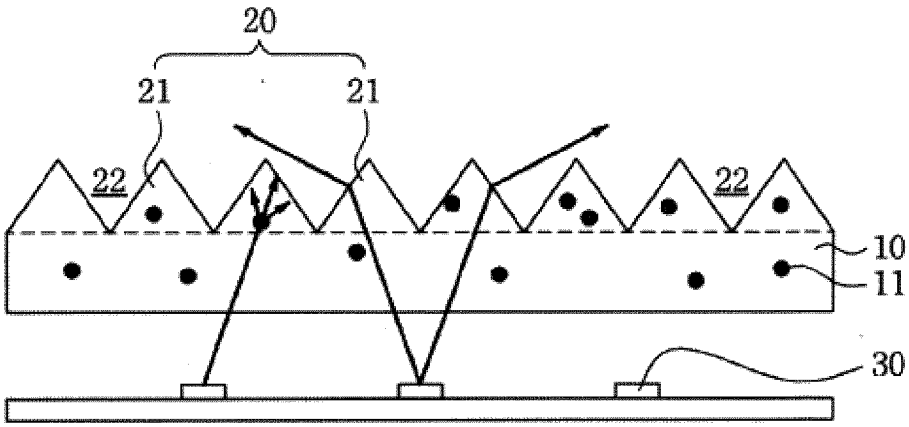
7. A light diffusion plate according to claim 5 or 6, characterized in that the patterns are formed in a raised pattern or an engraved pattern.

8. A light diffusion plate according to claim 7, characterized in that the patterns are formed regularly or irregularly.

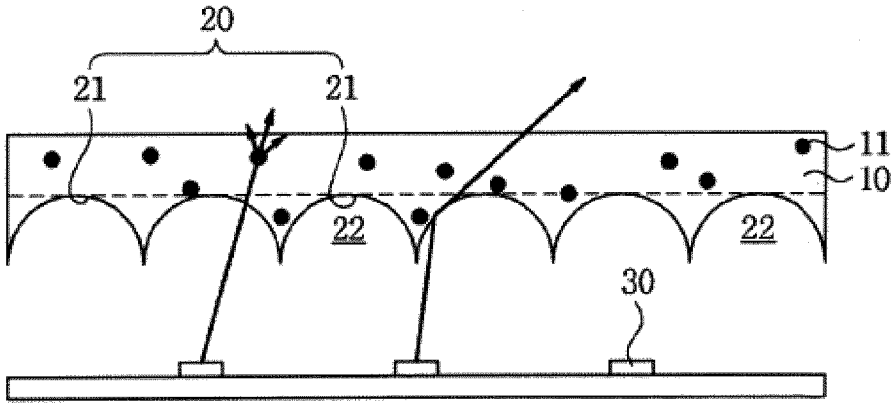
9. A light diffusion plate according to claim 1, characterized in that the diffusion agents are also contained in the pattern layer.

10. A light diffusion plate according to claim 1, characterized in that it further comprises a UV blocking layer formed together with the pattern layer or on the other side of the pattern layer.

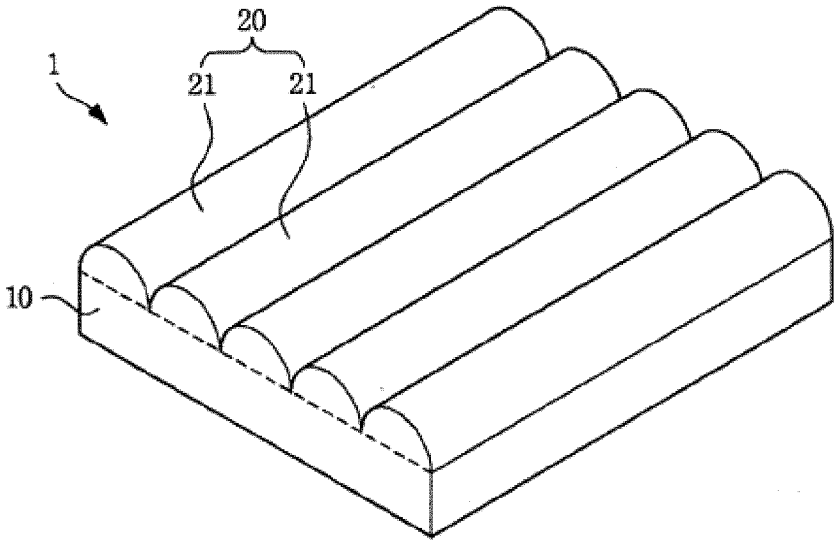
【Figure 1】



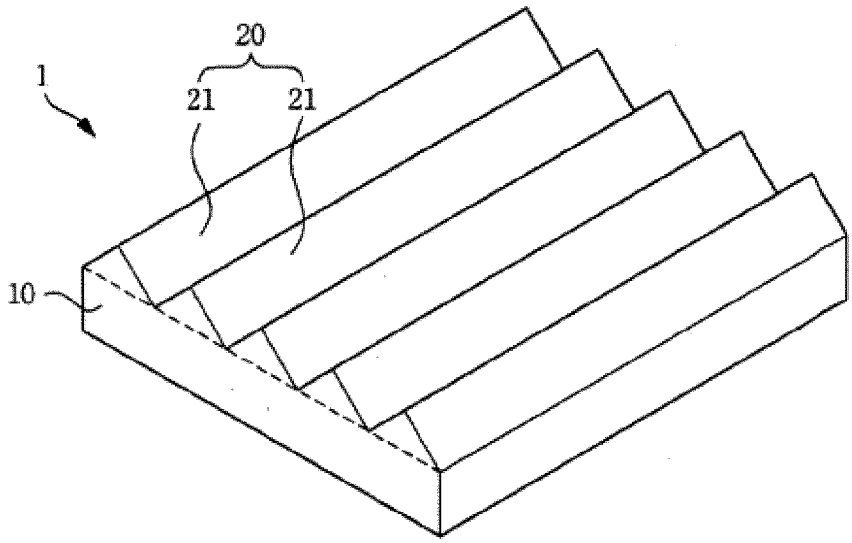
【Figure 2】



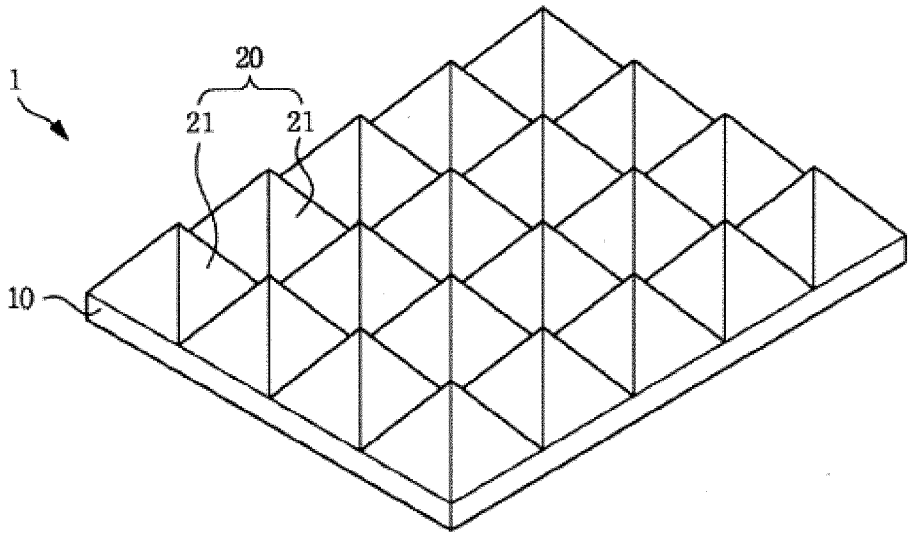
【Figure 3】



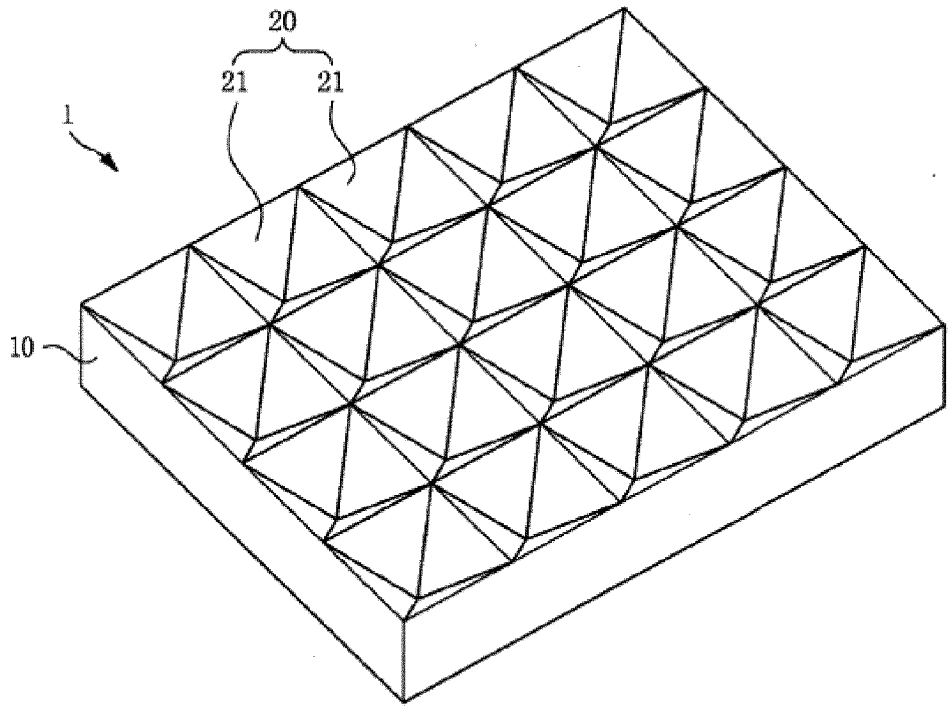
【Figure 4】



【Figure 5】



【Figure 6】



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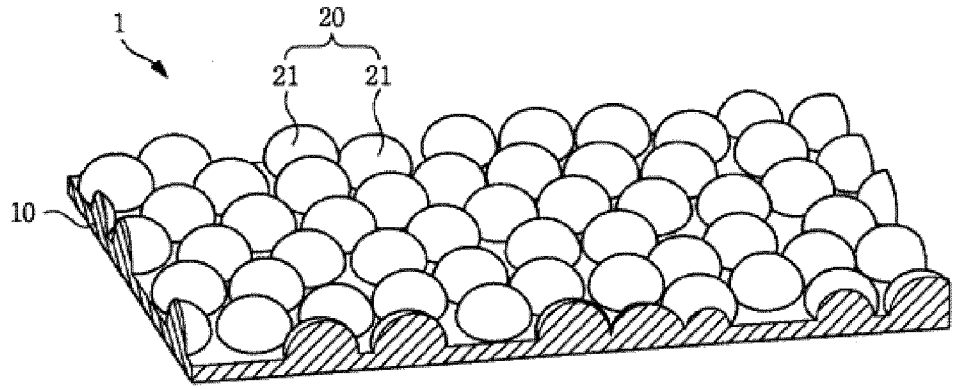
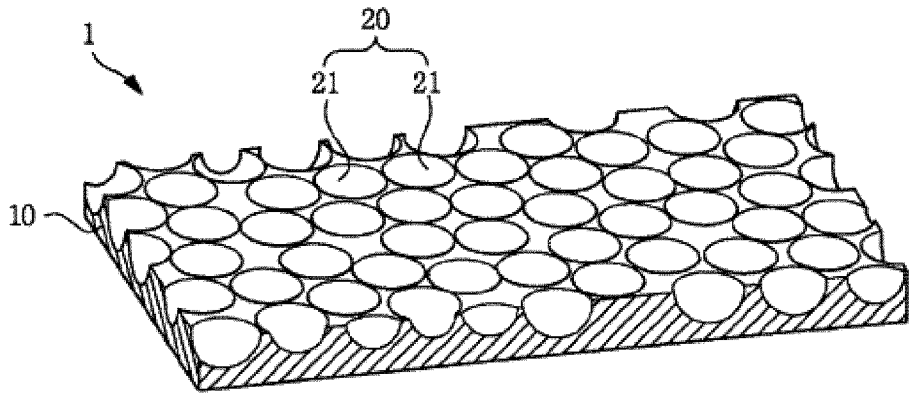
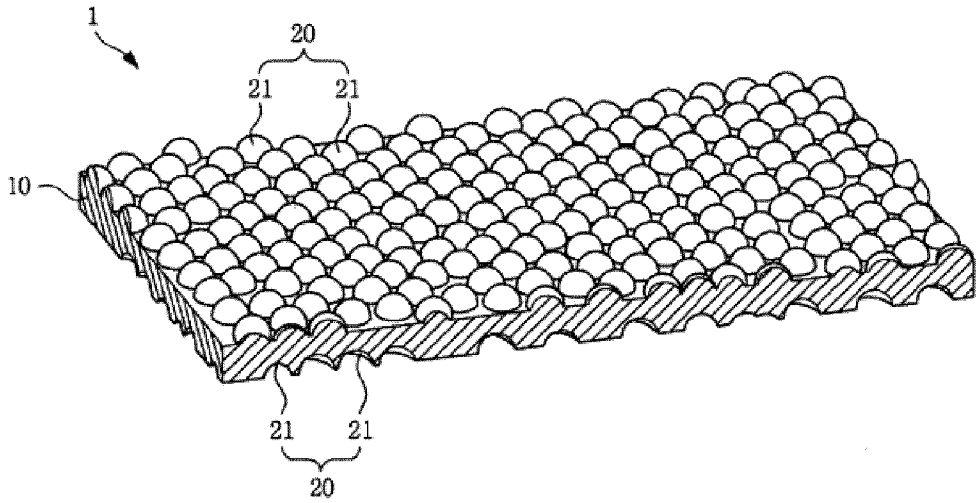


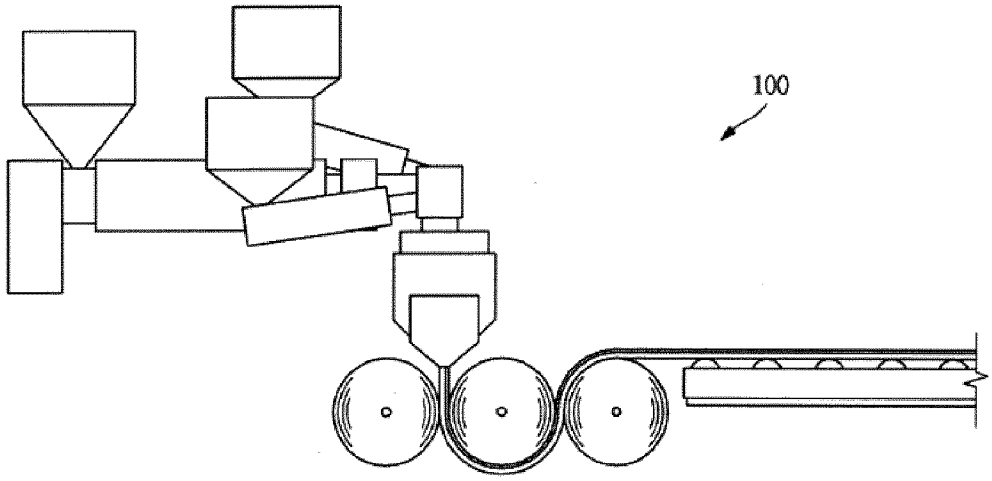
【Figure 8】



【Figure 9】



【Figure 10】



INTERNATIONAL SEARCH REPORT

International application No
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A. CLASSIFICATION OF SUBJECT MATTER
INV. G02B5/02 B29D11/00 F21V8/00
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
G02B B29D

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	US 2011/157690 A1 (CHO TAEHWI [KR] ET AL) 30 June 2011 (2011-06-30) paragraphs [0029], [0030], [0033], [0040] - [0042], [0059], [0065], [0080]; figures 1-4,6,9	1-5,7,8,10 6,9
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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
18 March 2015	26/03/2015

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Blau, Gerd

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2015/050074

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