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

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
4 May 2006 (04.05.2006)

PCT

(10) International Publication Number
WO 2006/046832 A1

(51) International Patent Classification[7]: G02F 1/1335

(21) International Application Number:
PCT/KR2005/003580

(22) International Filing Date: 26 October 2005 (26.10.2005)

(25) Filing Language: Korean

(26) Publication Language: English

(30) Priority Data:
10-2004-0085552 26 October 2004 (26.10.2004) KR

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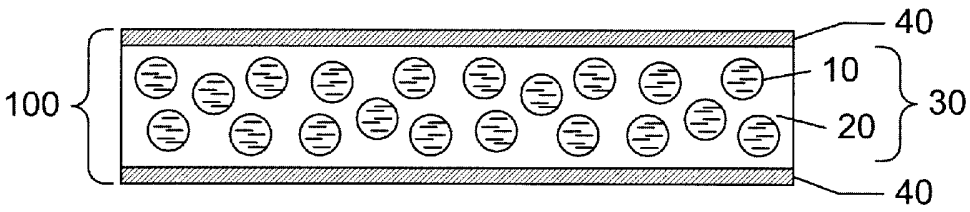
(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KP, KR, KZ, LC, LK,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

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: POLARIZING OPTICAL BODY AND A METHOD FOR MAKING THEREOF



(57) Abstract: The present invention provides a polarizing optical body which has a reduced loss of light due to diffuse reflection, a good efficiency of light transmission, and high reliability on temperature, and which can be easily manufactured, and a method for manufacturing it. For this purpose, the present invention provides a polarizing optical body for polarizing and emitting incident light, the polarizing optical body comprising a polymeric network layer consisting of at least a first and a second media, wherein the first medium is cross-linkable polymeric liquid crystal of which liquid crystal molecules are aligned in a predetermined first axis direction, and the second medium is a light- or thermo- setting resin and particle-like or net-like polymer.

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Description

POLARIZING OPTICAL BODY AND A METHOD FOR MAKING THEREOF

Technical Field

[1] The present invention relates to a polarizing optical body and a method for making thereof, particularly using diffuse transmission effect of light.

[2]

[3] Prior Art Related to the Present Application

[4] Korean Patent No. 10-0424519

[5] Korean Patent No. 10-0409062

Background Art

[6] In the already known Korean Patent No. 10-0424519, a polarizer disposed between a display means which produces images by using polarization and a lighting means is suggested. The polarizer which comprises a first polymeric disperse phase dispersed within a second polymeric continuous phase, and has the difference in refractive indices between the disperse phase and the continuous phase along a first axis, which is sufficiently small for transmitting light in a first polarization state to the display means direction, and the difference in refractive indices between the disperse phase and the continuous phase perpendicular to the first axis and along a second axis, which is sufficiently large for diffuse reflecting light in a second polarization state to the lighting means direction, and wherein the lighting means changes polarization state of a portion of light reflected by the polarizer, thus the light is reoriented to the direction opposite to the polarizer direction, is proposed.

[7] In addition, in the other known Korean Patent No. 10-0409062, with more specifically defining the disclosures of the Korean Patent No. 10-0424519, a combination of a light extractor and a light guide comprising continuous phases, which are polymers, and disperse phases disposed in the continuous phase, wherein the difference of refraction indices of the continuous and disperse phases are at least 0.05 along the first axis and, not more than 0.05 along the second axis perpendicular to the first axis, is disclosed.

[8] However, the above-identified known patents relate to the structure of diffuse reflective polarizers and methods thereof. Herein, the term "diffuse reflection" means the reflection of incident light rays outside the specular cone with a vertex angle of about 16 degrees centered around the specular angle. In the above known patents, in order to increase reflexibility of this diffuse reflection, the difference of refractive indices between the continuous phase and the disperse phase in the first axis direction

are adapted to a large value of at least 0.05. Thus, in the diffuse reflective polarizers manufactured by the above previous patents, the polymeric disperse phase are dispersed and disposed within the polymeric continuous phase, and stretched in the machine direction, so that one of the continuous phase and the disperse phase can have birefringence.

[9] Additionally, since the above known patents mainly use the diffuse reflection, separate reflection means is required. Further, there is a problem that the greater part of the diffuse-reflected light in he diffuse reflective polarizer is scattered or diffused and wander within the device, and finally absorbed and disappeared.

[10] Moreover, the known patents have an another problem that the production processes are very difficult, because birefringence is resulted from stretching synthetic resin. In other words, since the disperse phase becomes an elongated form in its stretch direction by the stretch of materials, the scatter distribution of light is concentrated on a particular direction, on the other hand, it is disadvantageous in certain direction that it looks dark due to lack of scattering.

Disclosure of Invention

Technical Problem

[11] The object of the present invention is to provide polarizing optical bodies which reduce a loss of light by diffuse reflection, which is the problem in the known art, have an improved fill factor and a high reliability on temperature, and are easily produced, and a method for making thereof.

Technical Solution

[12] For the purpose of accomplishing this object, according to the invention, a polarizing optical body for polarizing and emitting incident light is provided, wherein the polarizing optical body includes a polymeric network layer consisting of at least a first and a second media, the first medium is cross-linkable polymeric liquid crystal of which liquid crystal molecules are aligned in a predetermined first axis direction, the second medium is a light- or thermo-setting resin (hereinafter, referred to "setting resin"), and the polarizing optical body is particle-like or net-like polymer. The shape of the particle includes, but is not limited to, a spherical form, an amorphous form, or the like.

[13] The polymeric network layer consisting of the two media has substantially isotropy or homogeneity in its mixed form and distribution. Hence, scatter distribution of light in the polymeric network layer is uniform in substantially all directions, and thus, a phenomenon which it looks dark caused by decrease of transmittance of light in a particular direction can be avoided.

[14] Particularly, refractive indices of the cross-linkable polymeric liquid crystal and the

setting resin are different in a first axis direction which is a predetermined direction on a horizontal plane parallel to the polymeric network layer and substantially the same in a second axis direction perpendicular to the first axis on the horizontal plane. As a result, the polarized light of the direction parallel to the second axis direction moves on in the media without any change, and polarized light of a different direction is refracted in an interface between the cross-linkable polymeric liquid crystal and the setting resin, and simultaneously the direction of polarization is changed. If such procedures are repeated, the direction of polarization of the polarized light of the different direction gradually becomes parallel to the second axis direction.

[15] The present invention uses diffuse transmission phenomenon instead of diffuse reflection as the main mechanism to minimize a loss of light caused by reflection. The term "diffuse transmission" used herein means transmission of incident light rays that are outside a specular cone with a vertex angle of substantially 16 degrees centered around the specular angle. As such, in order to use the diffuse transmission phenomenon as the main mechanism, the degree of diffusion should be adjusted through optimization of external forms of the two media, the mixture distribution, and the difference in refractive indices between the two media to decrease reflection of the incident light. According to results of simulations conducted by the inventor of the present invention, in case the difference between the refractive indices of the two media is substantially 0.04, the number of interfaces between the two media in the thickness direction of the polymeric network layer is substantially 20, and the particle size of the setting resin is substantially 1 □, the diffuse reflection of the polarizing optical body according to the present invention is less than 20% and polarization of which main mechanism is the diffuse transmission is obtained .

[16] In addition, it is easy to manufacture the polarizing optical body of the present invention because birefringence is not attained in a stretching way, but the overall birefringence is formed by alignment of the cross-linkable polymeric liquid crystal in a particular direction by orientation means and a crosslinking reaction caused by light or heat for fixing the the alignment direction. The orientation means are an orientation film, the electric field, the magnetic fields, an oriented polymeric fiber net, or the like.

[17] According to another embodiment of the present invention, the polarizing optical body may further include a protective layer which protects the polymeric network layer from a mechanical impact or abrasion on the outside of the polymeric network layer.

[18] The present invention is advantageous in that it overcomes the problems of the prior arts which are a loss of light and difficulty in manufacturing processes.

Advantageous Effects

[19] According to the present invention, it is possible to provide a polarizing optical

body, which uses diffuse transmission instead of diffuse reflection which has a high loss of light as its main mechanism, to improve efficiency of light transmission and make scatter distribution substantially symmetrical, and which prevents a phenomenon in which it looks dark in a particular direction and can be easily manufactured.

Brief Description of the Drawings

[20] 100: a polarizing optical body

[21] 10: cross-linkable polymeric liquid crystal

[22] 20: setting resin

[23] 30: a polymeric network layer

[24] 40: protective layer(s)

[25] 200: a polarizing optical body

[26] 210: a cross-linkable polymeric liquid crystal layer

[27] 220: setting resin

[28] 230: a polymeric network layer

[29] 240: protective layer(s)

Best Mode for Carrying Out the Invention

[30] With reference to the drawings, polarizing optical bodies according to embodiments of the present invention are illustrated in details in the following.

[31] Fig. 1 is a schematic drawing illustrating the structure of a polarizing optical body 100 in accordance with a first embodiment of the this invention. With referring to Fig. 1, the polarizing optical body 100 of the present invention comprises the polymeric network layer 30 consisting of at least cross-linkable polymeric liquid crystal 10 and the setting resin 20 separately mixed with the polymeric liquid crystal. According to the present embodiment, it is preferred that the polymeric network layer 30 is formed by hardening reaction caused by heat or light, the hardening reaction happening in a state where the setting resin 20 represented by epoxy resin and the cross-linkable polymeric liquid crystal 10 are dissolved in a common solvent such as xylene to be mixed. It should be noted that this procedure may be omitted depending on embodiments since the common solvent such as xylene is used in order for the mixed resin 20 and theliquid crystal 10 to be mixed well and uniformly by decreasing viscosity of the mixed resin 20 and theliquid crystal 10.

[32] If the hardening reaction caused by heat or light happens in a state of the setting resin 20 to the cross-linkable polymeric liquid crystal 10 being mixed in the mass ratio of seven (7) to three (3), the liquid crystal 10 lumps to form particles (droplets) and the liquid crystal particle (droplet) 10 is surrounded by the hardened resin 20 as shown in Fig. 1.

[33] It is preferred that the cross-linkable polymeric liquid crystal 10 leads to cross-

linking reaction by light or heat. It is also preferred that the size of the particle formed of the cross-linkable polymeric liquid crystal 10 is substantially 2 to 100 □ in diameter.

[34] It is preferred that the cross-linkable polymeric liquid crystal 10 and the setting resin 20 are different in their refractive indices in a predetermined first axis direction on a horizontal plane parallel to the surface of the polymeric network layer 30 so that they substantially affect polarization direction of light, and have no difference in their refractive indices in a second axis direction perpendicular to the first axis direction on the horizontal plane so that they do not substantially affect polarization direction of light.

[35] Specifically, according to the present embodiment, in the state of the setting resin 20 and the cross-linkable polymeric liquid crystal 10 being mixed, the setting resin 20 is hardened and then the cross-linkable polymeric liquid crystal 10 is aligned in a pre-determined direction by using orientation means such as the electric field, the magnetic field, and the like, followed by the aligned liquid crystal 10 being hardened, for example, by ultraviolet rays. The alignment direction of the cross-linkable polymeric liquid crystal 10 allows the minor axis direction of the liquid crystal molecules to be parallel to the second axis direction and the major axis direction to be parallel to the first axis direction.

[36] As a result, there is nearly no difference between the refractive indices of the liquid crystal 10 and the setting resin 20 in the minor axis direction of the liquid crystal molecules (i.e., the second axis direction). In the major axis direction of liquid crystal molecules (i.e., the first axis direction), the difference between the refractive indices can be occurred so as to affect the polarization direction of light. Therefore, the polarized light of the second axis direction moves on without substantial change in its polarization direction, and the polarized light of the direction different from the second axis direction is refracted on the interface between the liquid crystal 10 and setting resin 20 to yield change in the polarization direction. As such procedures are repeated, light passing through the polarizing optical body according to the present invention includes polarized light of the direction substantially parallel to the second axis direction.

[37] Here, it should be noted that when the setting resin 20 is hardened by light, light with different wavelengths must be used so that the liquid crystal 10 may not be hardened.

[38] It is preferred that the polymeric network layer 30 has homogeneity or isotropy in its shape and distribution of two media generally. For the purpose of this, the setting resin 20 and the cross-linkable polymeric liquid crystal 10 should be sufficiently blended to be homogeneously mixed, and, after being hardened to form the polymeric network layer 30, no stress or tension should not be applied in a particular direction.

Therefore, in case the polarizing optical body 100 of the present invention is manufactured in the form of film, the moving or winding speed of the film should be maintained uniformly. Further, it is preferred that the cross-linkable polymeric liquid crystal 10 is aligned by the electric field or the magnetic field so that tension may not be applied in a particular direction. It is also preferred that the birefringence of the polymeric network layer 30 is less than 0.01 or zero.

[39] Furthermore, it is preferred that the polymeric network layer 30 further comprises a protective layer 40 on its outside, which protects from a mechanical impact or abrasion.

[40] Next, according to another embodiment of the present invention, it is possible to mix the setting resin with the cross-linkable polymeric liquid crystal at the mixture ratio of about 3 to 7, and, in case of a hardening reaction occurring in this state, the liquid crystal does not form particles (droplets) and the setting resin is hardened between liquid crystal layers in the form of a net. Other particulars are the same as those of the above described embodiment and detailed descriptions on the matters are omitted.

[41] Next, according to an another embodiment of the present invention, as shown in Fig. 2, a polarizing optical body 200 of the present invention includes a polymeric network layer 230 consisting of a cross-linkable polymeric liquid crystal layer 210 and light-refractive particles 220 which are mixed with and distributed in the polymeric liquid crystal layer 210. The light-refractive particles 220 may be selected from polymer particles such as polyethylene particles, polyurethane particles, and the like, or inorganic particles such as silica particles.

[42] According to the present embodiment, the cross-linkable polymeric liquid crystal 210 is mixed with the light-refractive particles 220 is a state of being dissolved in a solvent such as chloroform. Although the shape of the light-refractive particles 220 may be a sphere, a pole, a plate, or the like, these particles 220 should be formed so that they can be distributed throughout the cross-linkable polymeric liquid crystal layer 210 with isotropy or homogeneity substantially. Thus, scatter distribution of light within the polarizing optical body 200 can be uniform in all directions, thereby preventing a phenomenon in which it looks dark in a particular direction.

[43] Specifically, the solution of the cross-linkable polymeric liquid crystal is mixed with the light-refractive particles 220 and sufficiently stirred to be blended well, which allows no stress or tension in a particular direction to be applied. The blend of the light-refractive particles 220 with the cross-linkable polymeric liquid crystal layer 210 is applied on a substrate such as a transparent film, and the solvent is volatilized. Subsequently, the liquid crystal molecules are aligned by applying the electric field, the magnetic fields, or the like, and the liquid crystal layer 210 is hardened, for example,

by irradiation of the aligned liquid crystal layer 210 with ultraviolet rays. The alignment direction of the liquid crystal molecules is the same as described above with reference to Fig. 1.

[44] As a result, it is possible to make hardly any difference exist between the refractive indices of the liquid crystal layer 210 and the light-refractive particles 220 in the minor axis direction of the liquid crystal molecules (i.e., the second axis direction) and a difference exist in the major axis direction of the liquid crystal molecules (i.e., the first axis direction) so as to affect the polarization direction of light.

[45] According to the polarizing optical body 200 of the present invention, since an amount of diffuse transmission of light passing through the body is larger than that of diffuse reflection, a loss of light caused by reflection can be minimized to improve light transmittance. In order to maintain the amount of diffuse reflection to less than 20%, the difference in the refractive indices of the cross-linkable polymeric liquid crystal layer 210 and light-refractive particles 220 is to be substantially 0.04 and the size of the light-refractive particles 220 is to be substantially 1 □ in diameter.

[46] Although the present invention has been described in detail in the above, it is to be understood that such description is solely for the purpose of exemplification of preferred embodiments of the invention rather than limiting the scope of the invention. Therefore, the scope of the invention is defined by technical ideas described in the appended claims not by the described embodiments.

[47]

Industrial Applicability

[48] According to the present invention, it is possible to provide a polarizing optical body, which uses diffuse transmission instead of diffuse reflection which has a high loss of light as its main mechanism, to improve efficiency of light transmission and make scatter distribution substantially symmetrical, and which prevents a phenomenon in which it looks dark in a particular direction and can be easily manufactured.

[49]

[50]

Claims

[1] A polarizing optical body for polarizing and emitting incident light, the polarizing optical body comprising a polymeric network layer consisting of at least a first and a second media, wherein
the first medium is cross-linkable polymeric liquid crystal of which liquid crystal molecules are aligned in a predetermined first axis direction, and
the second medium is a light- or thermo-setting resin, and is particle-like or net-like polymer.

[2] The polarizing optical body as claimed in claim 1, wherein
the refractive indices of the cross-linkable polymeric liquid crystal and the setting resin are different in the first axis direction which is a predetermined direction on a horizontal plane parallel to the polymeric network layer, and
are substantially the same in a second axis direction which is perpendicular to the first axis on the horizontal plane.

[3] The polarizing optical body as claimed in claim 2, wherein the liquid crystal molecules of the cross-linkable polymeric liquid crystal are aligned so that their minor axis direction is parallel to the second axis direction and their major axis direction is parallel to the first axis direction.

[4] The polarizing optical body as claimed in claim 1, wherein
the difference between the refractive indices of the first and the second media is substantially 0.04,
the number of the interfaces between the two media in the thickness direction of the polymeric network layer is substantially 20, and
the particle size of the setting resin is substantially 1 □.

[5] The polarizing optical body as claimed in claim 1 further comprising a protective layer which protects the polymeric network layer from a mechanical impact or abrasion on the outside of the polymeric network layer.

[6] A method for producing a polarizing optical body by polarizing and emitting incident light, comprising the steps of:
mixing light- or thermo-setting resin with cross-linkable polymeric liquid crystal uniformly;
forming a polymeric network layer consisting of the setting resin and the cross-linkable polymeric liquid crystal by a hardening reaction caused by light or heat;
aligning the cross-linkable polymeric liquid crystal molecules in a predetermined direction by using orientation means which applies no stress or tension in a particular direction; and
hardening the cross-linkable polymeric liquid crystal of which the liquid crystal

molecules are aligned.

[7] The method as claimed in claim 6, wherein, in the step of mixing, the setting resin and the cross-linkable polymeric liquid crystal are mixed in the ratio of substantially 7 to 3.

[8] The method as claimed in claim 6, wherein light or heat brings about a crosslinking reaction of the cross-linkable polymeric liquid crystal.

[9] The method as claimed in claim 6, wherein the particle size of the cross-linkable polymeric liquid crystal is substantially 2 to 100 □ in diameter.

[10] The method as claimed in claim 6, wherein
the refractive indices of the cross-linkable polymeric liquid crystal and the setting resin are different in a first axis direction which is a predetermined direction on a horizontal plane parallel to the polymeric network layer, and are substantially the same in a second axis direction perpendicular to the first axis on the horizontal plane.

[11] The method as claimed in claim 10, wherein the cross-linkable polymeric liquid crystal is aligned such that the minor axis direction of the liquid crystal molecules is parallel to the second axis direction and the major axis direction of the liquid crystal molecules is parallel to the first axis direction.

[12] The method as claimed in claim 6, wherein the cross-linkable polymeric liquid crystal is aligned by using the electric field or the magnetic field as the orientation means.

[13] The method as claimed in claim 6, wherein, in the step of mixing, the setting resin and the cross-linkable polymeric liquid crystal are mixed in the ratio of substantially 3 to 7.

[14] A polarizing optical body for polarizing and emitting incident light, the polarizing optical body comprising a polymeric network layer consisting of at least a first and a second media, wherein
the first medium is a cross-linkable polymeric liquid crystal layer of which liquid crystal molecules are aligned in a predetermined first axis direction, and
the second medium is light-refractive particles which are mixed in the polymeric liquid crystal layer to refract the incident light.

[15] The polarizing optical body as claimed in claim 14, wherein the light-refractive particles are selected from the group consisting of polymer particles including polyethylene particles and polyurethane particles and inorganic particles including silica particles.

[16] The polarizing optical body as claimed in claim 14, wherein the refractive indices of the cross-linkable polymeric liquid crystal layer and the light-refractive particles are different in the first axis direction which is a pre-

determined direction on a horizontal plane parallel to the polymeric network layer, and
are substantially the same in the second axis direction perpendicular to the first axis on the horizontal plane.

[17] The polarizing optical body as claimed in claim 16, wherein the cross-linkable polymeric liquid crystal layer is aligned so that the minor axis direction of the liquid crystal molecules is parallel to the second axis direction and the major axis direction of the liquid crystal molecules is parallel to the first axis direction.

[18] The polarizing optical body as claimed in claim 14, wherein
the difference between the refractive indices of the first and the second media is substantially 0.04, and
the size of the light-refractive particles is substantially 1 □.

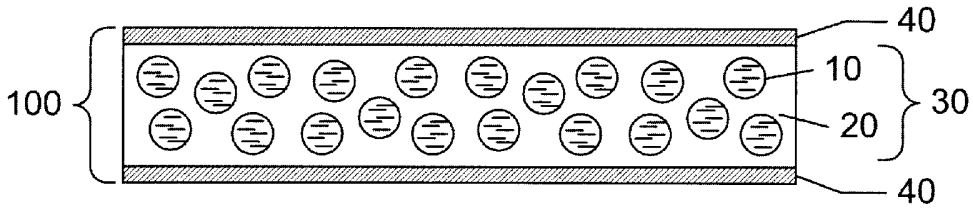
[19] The polarizing optical body as claimed in claim 14 further comprising a protective layer which protects the polymeric network layer from a mechanical impact or abrasion on the outside of the polymeric network layer.

[20] A method for producing a polarizing optical body by polarizing and emitting incident light, comprising the steps of:
mixing light-refractive particles with cross-linkable polymeric liquid crystal which is in a liquid state uniformly;
forming a polymeric network layer consisting of the cross-linkable polymeric liquid crystal layer and the light-refractive particles by applying the mixture of the light-refractive particles of the cross-linkable polymeric liquid crystal layer on a substrate and volatilizing the solvent;
aligning the cross-linkable polymeric liquid crystal molecules in a predetrmined direction by using orientation means which applies no stress or tension in a particular direction; and
hardening the aligned cross-linkable polymeric liquid crystal.

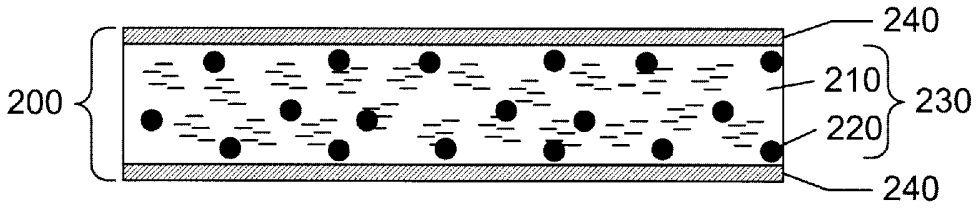
[21] The method as claimed in claim 20, wherein the refractive indices of the cross-linkable polymeric liquid crystal layer and the light-refractive particles are different in the first axis direction which is a predetermined direction on a horizontal plane parallel to the polymeric network layer and
are substantially the same in the second axis direction perpendicular to the first axis on the horizontal plane.

[22] The method as claimed in claim 20, wherein the cross-linkable polymeric liquid crystal layer is aligned so that the minor axis direction of the liquid crystal molecules is parallel to the second axis direction, and the major axis direction of the liquid crystal molecules is parallel to the first axis direction.

[Fig. 1]



[Fig. 2]



INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2005/003580

A. CLASSIFICATION OF SUBJECT MATTER

IPC7 G02F 1/1335

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)
IPC7 G02F, G09F, G09G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean Patents and applications for inventions since 1975
Korean 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)
KIPO DB
search term : polarizer, polymer, resin

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 03/081322 A2 (Fuji Photo Film Co., Ltd.) 02 OCTOBER 2003 See the whole document	1-22
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☐ Further documents are listed in the continuation of Box C. ☒ 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
19 DECEMBER 2005 (19.12.2005)	**21 DECEMBER 2005 (21.12.2005)**
Name and mailing address of the ISA/KR Korean Intellectual Property Office 920 Dunsan-dong, Seo-gu, Daejeon 302-701, Republic of Korea Facsimile No. 82-42-472-7140	Authorized officer LIM, Hyun Suk Telephone No. 82-42-481-8267

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

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
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