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I, Aurora Landman, hereby certify that the document is a true and accurate translation from Japanese (JP) into English of Japanese Examined Patent Application Publication Number H08-7614.

I declare under penalty of perjury that the foregoing is true and correct. Executed on August 14, 2017.

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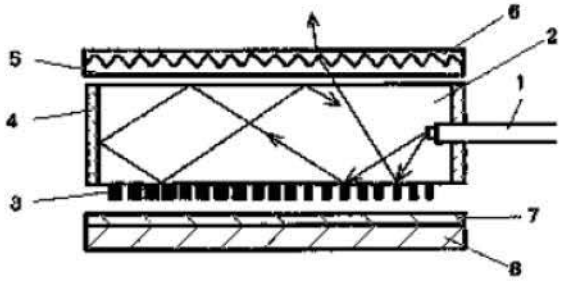
(54) (TITLE OF THE INVENTION) **SHEET-SHAPED LIGHT SOURCE**

(

57) (ABSTRACT)

(PURPOSE) To provide a sheet like light source in which a blue light emitting diode is used and can emit a uniform white light.

(CONSTITUTION) A light emitting diode 1 is optically connected to the terminal surface of a transparent light guide panel 2, in addition to having a light scattering layer 3 coating a white powder which scatters fluorescent light on either of the main surfaces of said light guide panel 2, as well as the provision of a transparent film 6 on the main surface side of the light guide panel 2 of the reflective side and on said light scattering layer 3, and equipping a fluorescent substance emitting fluorescent light by means of light emission excitation of said light emitting diode 1 on this film 6.



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(SCOPE OF PATENT CLAIMS)

(CLAIM 1) A sheet-shaped light source characterized by optically connecting a blue-colored light emitting diode 1 to at least one location of the terminal surface of a transparent light guide panel 2, in addition to having a light scattering layer 3 coating a white powder on either of the main surfaces of said light guide panel 2, and the provision of a transparent film 6 on the main surface side of the light guide panel 2 of the reflective side and on said light scattering layer 3, and equipping a fluorescent substance emitting fluorescent light causing light emission excitation of said blue light emitting diode 1 on the surface of this film 6.

[CLAIM 2] The sheet-shaped light source claimed in claim 1 characterized by the implementation of a minute roughness on the surface contacting the light guide panel of said film.

(DETAILED DESCRIPTION OF THE INVENTION)

[0001]

[TECHNICAL FIELD OF THE INVENTION] The present invention relates to a sheet-shaped light sources employed in backlights of displays, illuminated operating switches and the like, in particular, it relates to sheet-shaped light sources which may be employed to advantage as the backlights for liquid crystal displays.

[0002]

[PRIOR ART] As sheet-shaped light sources for use in the backlights of liquid crystal displays employed in notebook computers, word processors and the like, for example, electroluminescence, and cold cathode tubes are employed. Electroluminescence is a sheet-shaped light source, whereas cold cathode tubes become sheet-shaped light sources when used with a diffusion plate, and currently the color of the emitted light of these backlights are almost all white.

[0003] On the other hand, light emitting diodes (hereafter referred to as LED) are sometimes employed as the light sources for use in backlights. However, when LED are employed to derive a white-colored emitted light, because conventionally the light emission power of blue-colored LED has only a few tens of microwatts, in order to implement white light emission using other red-colored LED, and green-colored LED, there is the big defect that the color variation because of the difficulty of matching the characteristics of each of these colors of LED. Moreover, in order to combine three basic colors of LED, even if they are disposed geometrically in the same locus on the same planar surface, when viewed from a proximal position the backlights using these LED cannot enable a uniform white-colored light source. Therefore, as the sheet-shaped light source of the current white-colored liquid crystal backlights, the reality is that there is a breakout of the use of cold cathode tubes in large-scale screens, and electroluminescence in small scale to medium scale screens, and white-colored light emission backlights employing LED are almost unknown.

[0004] Moreover, as white-colored light emission, or as a monochrome light source, there have been contrivances at color conversion by resin packaging the periphery of a blue-colored LED chip including fluorescence substances in parts thereof, but because the periphery of the chip is affected by light rays with a stronger irradiation strength than sunlight, the deterioration of the fluorescent substance is a problem, and this is particularly noticeable in organic fluorescent dyes. Furthermore, ionic organic dyes cause an electrophoresis resulting from the direct current electrical field proximal to the chip, giving rise to the possibility of variation in the color tone. In addition, the conventional blue-colored LED did not have sufficient output power to cause color changes in the fluorescent substance, and for example, even if the enabled color conversion, it could not be used in practice.

[0005]

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[PROBLEM TO BE SOLVED BY THE INVENTION] Because the present invention was enabled in order to resolve these defects, the object thereof is not only the provision of a sheet-shaped light source enabling white light emission which can be used mainly as a backlight, using LED, but also the provision of a sheet-shaped light source enabling the observation of uniform white light emission, as well as the provision of sheet-shaped light sources enabling light emission in any color other than white light, availing of the superior reliability which is a characteristic of LEDs, which may be employed in all types of operating switches and the like.

[0006]

[MEANS FOR SOLVING THE PROBLEM] The sheet-shaped light source of the present invention is characterized by optically connecting a blue-colored light emitting diode 1 to at least one location of the terminal surface of a transparent light guide panel 2, in addition to having a light scattering layer 3 coating a white powder on either of the main surfaces of said light guide panel 2, and the provision of a transparent film 6 on the main surface side of the light guide panel 2 of the reflective side and on said diffusion layer 3 (hereafter, the main surface of the diffusion layer side is referred to as the second main surface.), and providing a transparent film 6 on the main surface side (hereafter referred to as the first main surface.) of the light guide panel 2 of the opposite side to said diffusion layer 3, and equipping the surface or the interior means of that film 6 with the fluorescent substance emitting fluorescent light excited by means of the light emission of said blue-colored light emitting diode 1.

[0007] Figure 1 is a plan drawing of the light guide panel 2 of the sheet-shaped light source of the present invention as seen from the second main surface side. The light guide panel 2 is comprised of a transparent material such as acrylate, glass and the like, and by providing a blue-colored LED 1 buried in the terminal surface of that light guide panel 2, the light guide panel 2 and the blue-colored LED 1 are optically connected. Now, in the present invention, the optical connection of blue-colored LED 1 and the terminal surface of the light guide panel 2 simply means that the light of the blue-colored LED is inducted from the terminal surface of the light guide panel 2, for example, and of course the blue-colored LED 1 is provided buried therein as illustrated in this figure, and this may be embodied by adhering the blue-colored LED, or by inducting the emitted light of the blue-colored LED into the terminal surface of the light guide panel 2 using optical fiber and the like.

[0008] Next, the diffusion layer 3 diffuses light into the light guide panel 2 using white pigment. In particular said diffusion layer 3 is enabled in a striped shape in figure 1, in order that the surface luminosity of the first main surface side be fixed, the pattern is one in which the surface area of the diffusion layer 3 is caused to be reduced with respect to the unit surface area of the second main surface side as it approaches the LED 1, in addition, the surface area of the terminal means of the second main surface most distal from the LED 1 is slightly less than the maximal surface area. Here, the ■ in figure 1 represents the pattern of the diffusion layer 3. In figure 1, the configuration is one wherein six blue-colored LED are disposed in one terminal surface, but if the light guide panel is square shaped, it goes without saying that LEDs are connected to all of the four terminal surfaces, and the number of LEDs is not particularly limited. In addition, by means of the disposition state of the LED, the coated shape and the coated state of the diffusion layer 3 may be varied appropriately in order to have a uniform sheet shaped light emission as observed from the first main surface side.

[0009]

[OPERATION] Figure 2 is a schematic cross-section drawing of when the sheet-shaped light source of the present invention is embodied, for example, as the backlight of a liquid crystal panel.

This disposes a diffusing reflective layer 7 comprised of, for example, barium titanate, titanium oxide, aluminum oxide, and the like, on the second main surface side of the sheet-shaped light source represented in figure 1, and a reflective panel laminating a base 8 comprised of, for example, aluminum, and a transparent film 6 is provided disposed on the surface of the first main surface side with minute roughness therein, and the fluorescent substance emitting fluorescent light when excited by means of the light emission of a blue-colored LED 1 is coated on to the rough surface of this film 6.

[0010] Firstly, as illustrated by the arrow in figure 2, part of the light emitted from the blue-colored LED 1 is irradiated to the exterior other than to the light guide panel 2 in the vicinity of the chip, but most of the light in the light guide panel 2 reaches the terminal surface of the light guide panel 2 while being repeatedly totally reflected. The light reaching the terminal surface is reflected by the reflective film 4 formed over the entire terminal surface, to enable repeated total reflection. On this occasion, the light is scattered by means of the diffusion layer 3 provided on the second main surface side of the guide panel 2, and part of the diffused light is absorbed by the fluorescent light layer 5 and simultaneously wavelength modified and re-radiated, enabling the observation of light which is a synthesis of these emitted light colors which is observed from the first main surface side of the light guide panel 2. For example, with the sheet-shaped light source providing a fluorescent light layer 5 comprised of an orange colored fluorescent pigment, the color of the light emitted from the blue-colored LED 1 can be observed to become white-colored as a result of the earlier mentioned effect.

[0011] In particular, in this invention, the main emission peak of the emitted light wavelength of one blue-colored LED is shorter than 500 nm, and that light emission output power is greater than 200 μW and more preferably that output power needs to be greater than 300 μW. The reason is that when the emitted light wavelength is greater than 500 nm, the enablement of all the colors is difficult; moreover, when the light emission power is less than 200 μW, for example, there is a tendency for difficulty in enabling a sheet shaped light emission light source with sufficient brightness and uniformity, even when the number of optically connected blue-colored LEDs to the terminal surface of the light guide panel is increased.

[0012] Additionally, in Japanese patent application number H05-318267, the inventors proposed a sheet-shaped light source enabling a uniform white-colored emitted light, by means of the formation of a fluorescent light diffusion layer on the main surface side of a light guide panel of the opposite side to the emitted light observation surface. However, with this method, in respect of the derived sheet-shaped light source, the fluorescent light diffusion layer formed on the light guide panel varying the color tone is peeled, and a fluorescent light diffusion layer must be printed thereto once more to enable the desired color tone. However, with this invention, the fluorescent light layer 5 and the diffusion layer 3 are enabled independently of each other, and because of fluorescent light layer 5 determining the color tone is formed on a film which can be adhered and removed, the color tone can be varied easily by just changing the film forming the fluorescent light layer 5. Moreover, multiple colors may be divided out and emitted simultaneously.

[0013] Moreover, because there is the enablement of roughness in the surface in contact with the first main surface side of the film 6, it is extremely effective in causing diffusion of the emitted light, in addition, the film 6 enables the prevention of the formation of interference fringes stretched across the light guide panel 2.

[0014]

[EMBODIMENTS OF THE INVENTION]

[EMBODIMENT 1] A diffusion layer 3 is formed by screen printing in a striped pattern as illustrated in figure 1 on one surface of an approximately 2 mm thick acrylic sheet. The diffusion layer 3 is formed by printing a white-colored substance comprised of barium titanate dispersed in an acrylic type binder.

[0015] The acrylic sheet whereon the diffusion layer 3 was formed as described above is cut into a desired pattern, and after polishing all the terminal surfaces (cut surfaces) of the acrylic sheet, a light guide panel 2 with a diffusion layer 3 formed thereon is derived by means of forming a reflective layer 4 comprised of aluminum on the polished surfaces.

[0016] Next, a fluorescent light layer 5 is formed on a film 6 having minute roughness formed on the surface thereof. The fluorescent light layer 5 is a coating formed from an acrylic type binder containing a mixture of fluorescent pigments of equal amounts of FA-001 manufactured by Sinloihi Chemicals, which is a red-colored fluorescent pigment and FA-005 which is a green-colored fluorescent pigment manufactured by the same company.

[0017] Holes are provided in six locations of the terminal surfaces of said light guide panel 2, and one each of blue-colored LED 1 comprised of a gallium nitride compound semiconductor having a light emission power of 1200 μW and a light emission wavelength of 480 nm are buried in each hole. Next, the film 6 whereon the fluorescent lights layer 5 is formed as described above is disposed on the emitted light observation surface side, and a reflective panel coating a barium titanate layer 7 is disposed on an aluminium base 8 on the diffusion layer 3 side, and a completely sheet shaped uniform white light emission is derived from the first main surface side when employed as the light source of a backlight. The luminous intensity was 55 cd/m^2.

[0018][EMBODIMENT 2] Almost equal amounts of Lumogen F Yellow-083 manufactured by BASF as a yellow colored fluorescent pigment and-240 manufactured by the same company as an orange colored fluorescent pigment were mixed, and the fluorescent pigments and acrylic resin were dissolved in butyl-carbitol acetate and coated on to a film 6 whereon minute roughness had been imparted. And when a sheet-shaped light source of the present invention was enabled as in embodiment 1 other than the above, and almost uniform sheet shaped light emission was observed. Moreover, when employed as the light source for use in a backlight in the same manner, a completely uniform sheet shaped light emission was observed.

[0019]

[EFFECTS OF THE INVENTION] As described above, the sheet-shaped light source of the present invention employs blue-colored LED, in addition to having a diffusion layer 3 coating white-colored powder onto one of the main surface sides of a light guide panel, in addition to disposing a transparent film 6 coating a fluorescent substance enabling wavelength conversion by means of blue-colored LED on the other main surface side, enabling the embodiment of a sheet-shaped light source by means of a highly reliable LED. Moreover, because the white-colored powder of the diffusion layer 3 has the effect of reflecting and scattering the emitted light of the blue-colored LED, the amount of fluorescent substance employed need only be a small amount. Furthermore, by forming minute surface roughness on film 6, the light diffusion effect is increased, and film 6 enables the prevention of the formation of interference fringes stretched across the light guide panel 2. In addition, fortunately, because there is no direct contact between the LED chip and the fluorescent substance, the deterioration of the fluorescent substance is less, and variation in the color tone of the sheet-shaped light source over long periods does not occur. Moreover, in relation to the color tone, the provision of any color tone including white color is enabled, by means of the types of fluorescent light substances of the fluorescent light layer 5, moreover because the fluorescent light substance is provided on a film, simple changing out of the color tone of the sheet-shaped light source is enabled by just changing the film.

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[0020] On the other hand, as the expectations side of the fluorescent light layer 5, by employing the most preferably used new colored LED with a light emission power of greater than 200 μW, the enablement of a large area bright sheet-shaped light source efficiently converting the wavelength by means of a fluorescent substance is enabled. In this manner, the sheet-shaped light source of the present invention may be employed not only as the light source for use in backlights, it may also be employed in illuminated operating switches employing fluorescent substances.

[BRIEF DESCRIPTION OF THE DRAWINGS]

[Figure 1] A plan view of the light guide panel 2 of the sheet-shaped light source of an embodiment of the present invention when viewed from the diffusion layer 3 side.

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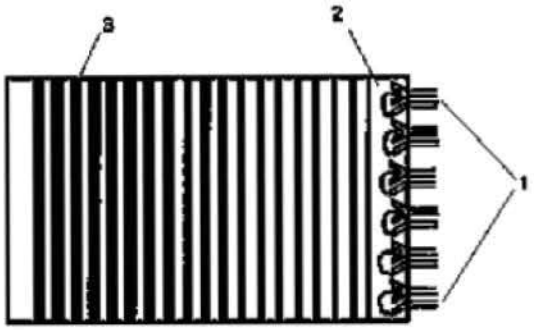
*[Figure 2] A schematic cross-section drawing of a backlight implementing the sheet-shaped light source of an embodiment of the present invention.

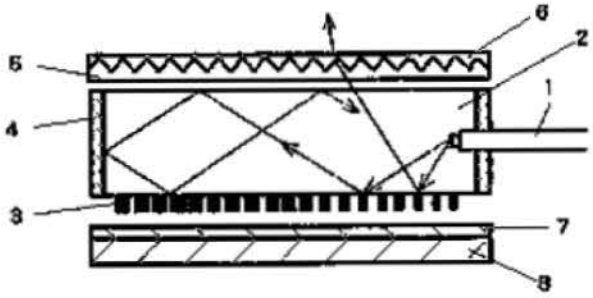
[EXPLANATION OF SYMBOLS]

1 Blue-colored LED
2 Light guide panel
3 Diffusion layer
4 Reflective layer
5 Fluorescent light layer
6 Film
7 Diffusing reflective layer
8 Aluminium base

[Figure 1]



[Figure 2]



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