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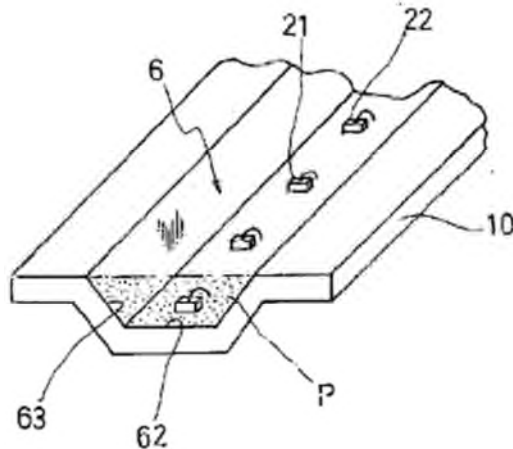
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(54) Name of Invention LED line
light source

(57) Abstract

Means of Resolution

Linear recession 6 is formed in aluminum base plate 10 by a process such as drawing. Recession 6 has a flat-shaped bottom part 62, with tapered sidewalls used as reflective surfaces 63 connecting thereto. LEDs 21, 22 are arranged in a row along bottom part 62, and opposing reflective surfaces 63 provide a conical reflective surface with respect to LEDs 21, 22. By forming reflective surfaces along both sides of the LED array line, it is possible to bring forward light reflected from the side of each LED, and thereby to limit drops in light output immediately above places where no LED is present.



Scope of Claim for Patent

Claim 1

An LED line light source, wherein a multiplicity of LEDs is arranged in a row along a wiring base plate, and a reflective surface reflecting light output from the sides of each LED towards the front of the wiring base plate is formed along both sides of the line of arrangement of said LEDs.

Claim 2

An LED line light source, wherein a linear recession is formed in a wiring baseplate, a multiplicity of LEDs is arranged in a row along said recession, and the side walls of said recession form reflective surfaces reflecting light emitted from the side surfaces of each LED towards the front of the wiring base plate.

Claim 3

An LED line light source according to Claim 1 or Claim 2, wherein the wiring base plate is a resistive metal.

Claim 4

An LED line light source according to any of Claims 1 through 3, wherein the LEDs and reflective surface parts are sealed in plastic resin.

Detailed Description of the Invention

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Field of Industry to which the Invention Belongs

The present invention relates to an LED line light source appropriate for a facsimile or scanner light source etc.

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Prior Art

In general, known linear light sources are, LED linear light sources configured with a multiplicity of LEDs arrayed in a line along a wiring base plate 1 of glass epoxy etc., as shown in Figure 1. An LED linear light source for a facsimile or scanner uses a configuration wherein said multiplicity of LEDs are not of the same type, but normally an alternating arrangement of two different types of LED 21, 22 emitting different types of light. The upper surface electrode and glass epoxy wiring base plate of each LED respectively are electrically connected by gold wire 3, and on the surface thereof, plastic resin 4 is coated for the purpose of protecting gold wire 3 and LEDs 21, 22. Also, lenses 5 are placed in front of glass epoxy wiring base plate 1, in order to

concentrate light radiated from the LEDs and obtain designated light distribution characteristics.

0003

Problem to be Resolved by the Concept

However in the aforementioned LED linear light source, if light output from the linear light source is measured when lighting only one type of LED 21, light output tends to be high in areas immediately above parts where LEDs 21 are mount, but light output tends to be low in areas where an LED 21 is not mounted immediately below. In other words, when the light output is measured, it has wave-shaped characteristics as shown in Figure 2. In order to smooth such wave-shape characteristics, the spacing between placement of LEDs 21 may be made narrower, but there are limits to such higher density because two types of LED 21, 22 are arranged alternately.

0004

If the difference in light output is significant at places where an LED is not present, then if used as a light source for a device such as a facsimile or scanner, problems of increased color mottling or poor resolution arise. The purpose of the present invention is to provide an LED linear light source capable of removing such mottling in light output to the extent possible.

0005

Means of Resolving the Problem

In the composition of an LED linear light source according to the present invention, a multiplicity of LEDs is arranged in a row along a wiring base plate, and a reflective surface reflecting light output from the sides of each LED towards the front of the wiring base plate is formed along both sides of the line of arrangement of said LEDs.

0006

Also, in the composition of the aforementioned formed shape of the reflective surface, preferably a linear recession is formed in a wiring baseplate, a multiplicity of LEDs is arranged in a row along said recession, and the side walls of said recession form reflective surfaces reflecting light emitted from the side surfaces of each LED towards the front of the wiring base plate.

0007

In addition, in a preferred form of composition, the wiring base plate is a resistive metal, and the LEDs and reflective surface parts are sealed in plastic resin.

0008

Operation

In an LED linear light source according to the aforementioned prior art configuration, only light from the upper surface of LEDs is fully utilized, with the result that extreme differences in light output may arise between parts where LEDs are present, and parts where they are not present. Therefore, by placing reflective surfaces along both sides of the LED array line it is possible to bring light emitted from the side surfaces of each LED

towards the front, and thus to prevent drops in light output immediately above places where no LEDs are present.

0009

Also, by placing a linear shaped recession in the wiring base plate itself, and placing a multiplicity of LED's in a line along the bottom part thereof, configuring the side walls of the recession to serve as the aforementioned reflective surface, it is not necessary to have separate constituent parts of a reflective surface, thus enabling reduction in the number of components. In this case preferably an insulative metal base plate is used as the base plate, and thus the aforementioned recession can be formed relatively easily by a process such as extrusion.

0010

In addition, by sealing the LEDs and reflective surface areas in plastic resin, diffusion of light emitted inside the reflective mechanism occurs, and thereby it is possible to smooth the light obtained from the front of the base plate.

0011

Preferred Embodiments of the Invention

Next we describe preferred embodiments of the present invention, with reference to the Drawings. Figure 3 is an oblique view showing one example of a LED linear light source according to the present invention. In this preferred embodiment, two types of LED 21, 22 of different light emission wavelengths are placed alternately along a single line on the surface of wiring base plate 1 of glass epoxy etc., and reflectors 6a, 6b are placed along the two sides of the line of the array of LEDs 21, 22. These reflectors 6a, 6b have tapered reflective surface 61, and by placing these in pairs opposite each other enclosing the line of the LED array, a cone-shaped reflective surface is provided for each LED 21, 22.

0012

Figure 4 shows another preferred embodiment of the present invention, and in this preferred embodiment an insulative metal base plate 10 such as an aluminum base wiring plate is used as the base plate, and a case is shown wherein linear recession 6 is formed in said base plate by a method such as extrusion. In recession 6, bottom part 62 is made as a flat surface, and the side wall surfaces along side are made as tapered reflective surfaces 63. LED's 21, 22 are placed in a linear array in said bottom part 62, and said opposing reflective surfaces 63 provide a cone-shaped reflective surface with respect to LEDs 21, 22. Also, cavities in recession 60 are filled with plastic resin P of silicone resin etc., sealing LEDs 21, 22 and reflective surfaces 63.

0013

Next we describe the reflective mechanism in further detail with reference to Figure 5. First, if width W of the plane of placement of the multiple LEDs, in other words the width in the cross-sectional direction of bottom part 62 of recession 6, is size W1 of the LED chips 2 that are used, then preferably $0.05\text{mm} + W1 \leq W \leq 1\text{mm} + W1$, and more preferably $0.1\text{mm} + W1 \sim 0.5\text{mm} + W1$. If the width of the plane of placement is too narrow, then variability in the die bonding positions of LED chips 2 may cause LED

chips 2 to come into contact with reflecting surface 63, so that LED chips 2 become damaged. And if the width is too wide, the effect of the reflection function will be diminished and the light emitted laterally from LED chips 2 will not be able to be used effectively.

0014

Angle θ of rise of reflective surface 63 is preferably $20^\circ \leq \theta \leq 90^\circ$, and more preferably $30^\circ \leq \theta \leq 75^\circ$. If angle θ of rise of the reflective surface is smaller than 20° , light emitted laterally from the side surface of the LEDs will become significantly difficult to use effectively, and if the angle of the reflective surface exceeds 90° it will become impossible to obtain light at the forward surface.

0015

Also, as for depth T of recession 6, if we let T1 be the height of LED chip 2, then preferably $-0.05\text{mm} + T1 \leq T \leq 5\text{mm} + T1$, and more preferably $0.1\text{mm} + T1 < T < 1\text{mm} + T1$. If depth T of recession 6 is too low in comparison with height T1 of LED chips 2, then as described above, it will become impossible to use light emitted laterally. And if depth T of recession 6 is more than 5mm greater than height T1 of LED chips 2, then the reliability of wire bonding will be reduced.

0016

The material of plastic sealing resin P filling the cavity of recession 6 is a transparent resin and preferably the index of refraction n of the resin is not less than $n=1.2$, and more preferably not less than $n=1.4$. Such a resin may be, for example, epoxy resin, silicone resin, polycarbonate resin, or alkali resin, etc.

0017

Also, reflective surface 63 should preferably have reflective processing applied to the surface, and should preferably be a coating process etc. with a material having an index of reflection of not less than 0.2 such as gold, silver, aluminum, chrome, etc. Note also that depending on the use of an LED linear light source according to the present invention, it is also possible to use the reflection at the interface between sealing resin P and the air, and in this case the aforementioned coating processing etc. is not specifically necessary.

0018

Preferred Sample Embodiments

As an LED linear light source according to the present invention, an LED linear light source was prepared according to the structure shown in Figure 4. An aluminum base insulative wiring base plate 10 was used as the wiring base plate, and linear recession 6 was formed with reflective surface 63 having an angle of rise of 45° , bottom part 62 a width of 0.6mm, and recession 6 a depth of 0.4mm. On top of bottom part 62 of base plate 10 were placed alternately, DH type AlGaAs/AlGaAs red LEDs 21 (chip size 0.32mm square, chip height 0.15mm) and homojunction type GaAs infrared LEDs 22 (chip size 0.32mm, chip height 0.23mm). The number of LEDs 21, 22 was 30 each, and the placement pitch between adjacent LEDs was 1.5mm respectively. Also, LEDs 21, 22

where checked beforehand for light output value, and those used had a light output variability of not greater than $\pm 10\%$ with respect to each other. In addition, the surface of reflective surfaces 63 was coated with solder resist, and the cavity of recession 6 was sealed with silicone resin P to produce the LED linear light source.

0019

Comparison Embodiments

For the purpose of comparison with the LED linear light source prepared as described above, an LED linear light source as shown in Figure 1 was prepared by placing the same two types of LEDs 21, 22 as in the aforementioned preferred embodiment, alternatively on a glass epoxy wiring base plate 1. Similarly, the number of LEDs was 30 each, the placement pitch was 1.5mm, and the LEDs used had a light output variability of not greater than $\pm 10\%$ with respect to each other. In addition, a silicone resin was bonded over each LED 21, 22 as well as the bonding wires for protection.

0020

The variability of light was measured for each LED linear light source prepared according to the preferred embodiment and comparison embodiment. Measurements were made using a C6386 photosensor amplifier (manufactured by Hamamatsu Photonics) with a 1.5mm diameter slit mounted on the end of an optical fiber. The measurement position was placed at 10mm above the LED linear light source, and measurements of light output were taken at intervals of every 1.5mm. The measurement procedure was first, to light only the red light emitting LEDs 21 at a current value of 10mA per LED and measure light output from one end of the base plate to the other end, then to light only the other red light emitting LEDs 22 at a current value of 10mA per LED and measure light output in the same way.

0021

The results of the measurements described above are shown in Figure 6 for the LED linear light source according to the preferred embodiment, and in Figure 7 for the LED linear light source according to the comparison embodiment. As shown in the drawings, in comparison embodiment B, optical output is high directly above a lighted LED however optical output becomes lower in other parts, and it can also be confirmed that optical output varies greatly over a 1.5mm pitch. In the preferred embodiment, however, optical output between parts directly above a lighted LED and other parts has virtually disappeared, and thus it was confirmed that by means of the present invention it is possible to provide a LED linear light source with low variability in optical output.

0022

Incidentally, in regard to LED linear light sources in the preferred and comparison embodiments, if the variability in light output value over an effective illumination distance within 84mm is expressed by the formula $\text{light output variation} = (\text{maximum light output} - \text{minimum light output}) / (\text{maximum light output} + \text{minimum light output})$, then the variability of light output when red LEDs 21 are lit in LED linear light source according to the preferred embodiment was 7.7%, and the same variability for infrared

LEDs 22 was 4.4%, compared to 12.5% for red LEDs 21 and 12.7% for infrared LEDs 22 in an LED linear light source according to the comparison embodiment.

0023

The aforementioned preferred embodiment was described in terms of GaAs and AlGaAs type red and infrared LEDs, however the present invention may of course apply not only these but also InGaAlP, GaP, GaAsP, or InGaN type LEDs etc. as well, and it also goes without saying that the present invention may also be applied to cases not alternating two types of LED but placing one type of LED in a linear form.

0024

Effect of the Invention

By means of an LED linear light source according to the present invention as described above, it is possible to reduce to very low levels variability in light output between areas directly above and not directly above the LED array. As a result it is possible to achieve a linear light source with extremely stable longitudinal light output, obtaining superior results without color patches or deterioration in resolution when used as a light source for a facsimile or scanner.

Simplified Description of Drawings

Figure 1 is a cross sectional view showing an LED linear light source according to prior art,

Figure 2 is a graph showing distribution of light output in an LED linear light source according to prior art,

Figure 3 is an oblique view showing one example of an LED linear light source according to the present invention,

Figure 4 is an oblique view showing another example of an LED linear light source according to the present invention,

Figure 5 is a descriptive diagram of the reflective mechanism part in an LED linear light source according to the present invention,

Figure 6 is a graph showing a distribution of light output in the preferred embodiment of the present invention, and

Figure 7 is a graph showing a distribution of light output in the comparison embodiment.

Explanation of Symbols

1, 10...	wiring base plate
21, 22...	LED
6a, 6b...	reflector
6...	recession
61, 63...	reflective surface
62...	bottom of recession
P...	sealing resin

Figure 1

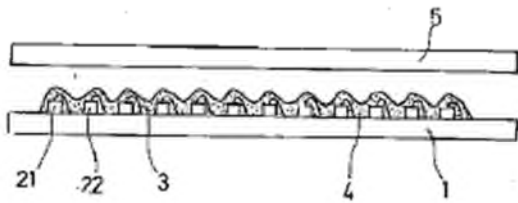


Figure 2

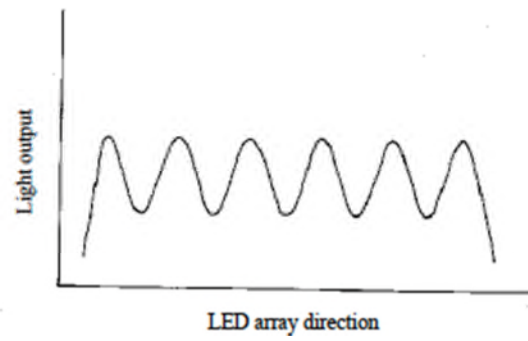


Figure 3

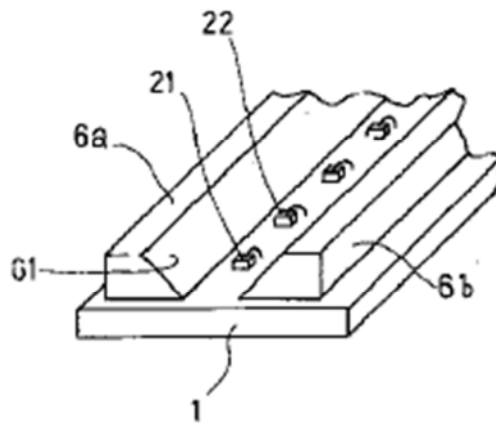


Figure 4

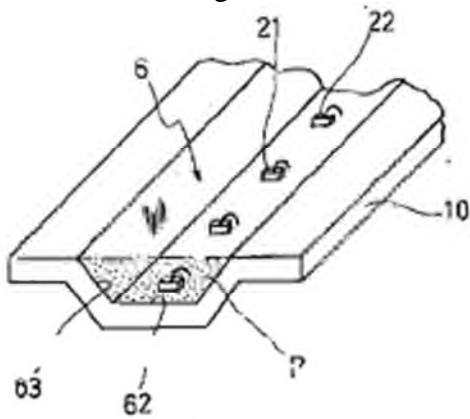


Figure 5

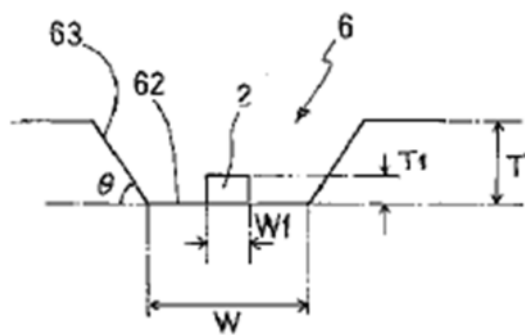


Figure 6

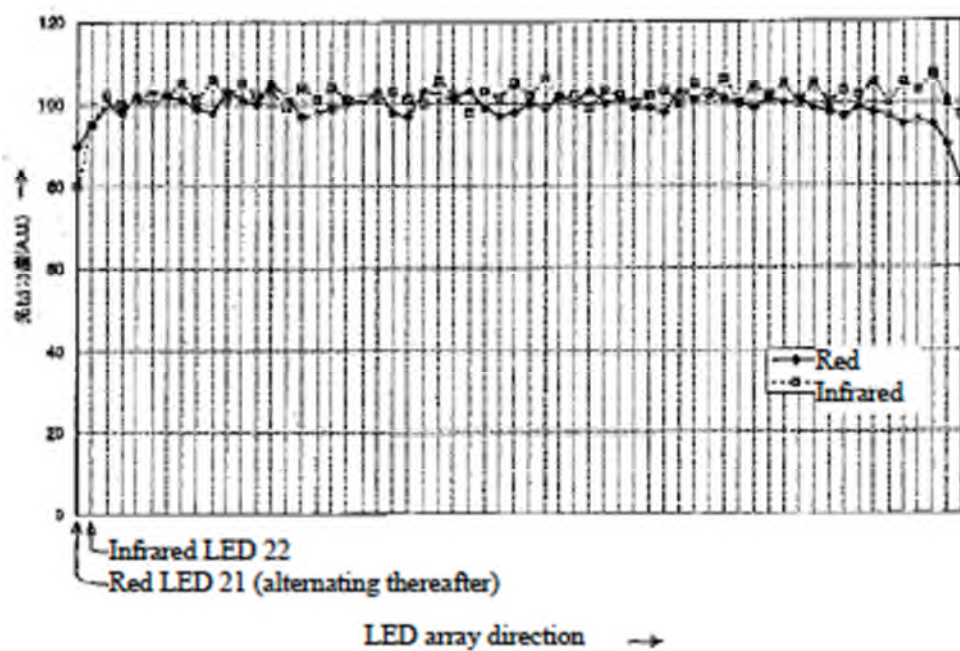


Figure 7

