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LED lamp

Abstract

An LED lamp A includes a plurality of LED modules **2** each including an LED chip **21**, and a support member **1** including a support surface **1***a* on which the LED modules **2** are mounted. The LED modules **2** include a plurality of kinds of LED modules, or a first through a third LED modules **2**A, **2**B and **2**C different from each other in directivity characteristics that represent light intensity distribution with respect to light emission directions. This arrangement ensures that the entire surrounding area can be illuminated with sufficient brightness.

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References Cited

U.S. PATENT DOCUMENTS

Patent No.	Issued Date	Patentee Name	U.S. Cl.	CPC
6250774	12/2000	Begemann et al.	N/A	N/A
6376902	12/2001	Arndt	257/432	H10H 20/8585
6975011	12/2004	Arndt	257/E31.118	H10H 20/856
7066626	12/2005	Omata	362/257	H10H 20/8506
7311423	12/2006	Frecska et al.	N/A	N/A
7635915	12/2008	Xie	257/E23.06	H10H 20/8585
7756413	12/2009	Matsui	N/A	N/A
7868345	12/2010	Mori et al.	N/A	N/A
7997770	12/2010	Meurer	N/A	N/A
8029159	12/2010	Chen	N/A	N/A
8164102	12/2011	Furukawa	257/E33.059	H01L 25/0753
8330362	12/2011	Lin	N/A	N/A
8360599	12/2012	Ivey et al.	N/A	N/A
8362605	12/2012	Xie	257/692	H10H 20/857

8368112	12/2012	Chan	257/89	H10H 20/857
8901823	12/2013	Scapa	N/A	N/A
9711491	12/2016	Marutani	N/A	H10H 20/857
10230036	12/2018	Yoon	N/A	H10H 20/831
10340433	12/2018	Lee et al.	N/A	N/A
2001/0017568	12/2000	Kasa et al.	N/A	N/A
2002/0060526	12/2001	Timmermans et al.	N/A	N/A
2002/0190262	12/2001	Nitta	257/E33.059	H01L 25/167
2003/0080341	12/2002	Sakano	257/E33.059	B29C 67/08
2005/0133808	12/2004	Uraya et al.	N/A	N/A
2005/0156187	12/2004	Isokawa	257/E23.07	H01L 23/49838
2006/0049477	12/2005	Arndt	257/432	H10H 20/857
2006/0203493	12/2005	Brower	362/342	F21V 11/02
2006/0205237	12/2005	Kodama et al.	N/A	N/A
2006/0208268	12/2005	Ueno et al.	N/A	N/A
2006/0268555	12/2005	Kelly	362/341	F21L 14/023
2007/0030676	12/2006	Ichihara	257/E33.059	F21K 9/00
2007/0064425	12/2006	Frecska	362/253	F21S 4/28
2007/0181900	12/2006	Sato et al.	N/A	N/A
2007/0200127	12/2006	Andrews	N/A	N/A
2007/0201225	12/2006	Holder	257/E33.073	F21V 5/04
2007/0252250	12/2006	Hui	257/672	H10H 20/857
2008/0062689	12/2007	Villard	N/A	N/A
2008/0094837	12/2007	Dobbins et al.	N/A	N/A
2008/0117355	12/2007	Mori	N/A	N/A
2008/0186714	12/2007	Nagayama	362/308	H10H 20/8506
2008/0217640	12/2007	Suzuki	N/A	N/A
2008/0237627	12/2007	Kobayakawa	257/E33.058	H10H 20/857
2008/0258168	12/2007	Loh	257/E33.001	H10H 20/852
2008/0283862	12/2007	Fujii	N/A	N/A
2008/0296590	12/2007	Ng	438/28	H10H 20/8506
2009/0045422	12/2008	Kato et al.	N/A	N/A
2009/0072251	12/2008	Chan	257/E33.059	H01L 25/0753
2009/0140271	12/2008	Sah	N/A	N/A
2009/0323330	12/2008	Gordin et al.	N/A	N/A
2010/0214780	12/2009	Villard	362/249.02	F21V 19/02
2010/0284195	12/2009	Liu	362/373	F21V 23/008
2011/0042124	12/2010	Matsui et al.	N/A	N/A

2011/0216537	12/2010	Holder	362/311.01	F21V 31/005
2011/0255276	12/2010	Coward	362/217.02	F21V 14/02
2011/0303936	12/2010	Wu	438/27	H10H 20/857
2012/0049203	12/2011	Mondada et al.	N/A	N/A
2012/0104426	12/2011	Chan et al.	N/A	N/A
2012/0126260	12/2011	Hussell et al.	N/A	N/A
2013/0003370	12/2012	Watanabe	362/244	F21S 8/086
2013/0069089	12/2012	Hussel et al.	N/A	N/A
2013/0135853	12/2012	Lin	385/39	G02B 6/002
2013/0258668	12/2012	Dellian et al.	N/A	N/A
2014/0151731	12/2013	Tran	N/A	N/A
2014/0256072	12/2013	Loh	438/28	H10H 20/8506
2015/0014838	12/2014	Yap	N/A	N/A

FOREIGN PATENT DOCUMENTS

Patent No.	**Application Date**	**Country**	**CPC**
201081165	12/2007	CN	N/A
63-95261	12/1987	JP	N/A
4-92660	12/1990	JP	N/A
6-54103	12/1993	JP	N/A
H10294495	12/1997	JP	N/A
11-17228	12/1998	JP	N/A
11-306811	12/1998	JP	N/A
2002033517	12/2001	JP	N/A
2002-197901	12/2001	JP	N/A
2003051618	12/2002	JP	N/A
2004-109407	12/2003	JP	N/A
2005-159263	12/2004	JP	N/A
3707024	12/2004	JP	N/A
2008-258094	12/2007	JP	N/A
3145640	12/2007	JP	N/A
2008251937	12/2007	JP	H01L 23/49541
3148527	12/2008	JP	N/A
2009252375	12/2008	JP	N/A
4482193	12/2009	JP	H01R 13/6315
20070006733	12/2006	KR	N/A
20080066635	12/2007	KR	N/A
20080088891	12/2007	KR	N/A
100866586	12/2007	KR	N/A
20090044789	12/2008	KR	N/A
WO-2009049824	12/2008	WO	F21K 9/00
WO-2009142449	12/2008	WO	F21K 9/00
WO-2010117210	12/2009	WO	F21K 9/00

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Background/Summary

TECHNICAL FIELD

(1) The present invention relates to an LED lamp that uses a light emitting diode (hereinafter referred to as “LED”) as the light source.

BACKGROUND ART

(2) FIG. **63** shows an example of conventional LED lamp (see Patent Document 1, for example). The LED lamp X shown in the figure includes a plate-like substrate **91**, a plurality of LED modules **92** mounted on the substrate **91**, a heat dissipation member **95** attached to the substrate **91**, a case **93** accommodating the substrate **91**, and terminals **94**. The substrate **91** is provided with a wiring pattern, not shown, connected to the LED modules **92** and the terminal **94**. The LED lamp X is structured such that the LED modules **92** can be turned on when the terminals **94** are fitted into inlet ports of a socket of a general-use fluorescent lighting fixture.

(3) The general-use fluorescent lighting fixture herein refers to lighting fixtures widely used for interior lighting as the main application, and more specifically, lighting fixtures which use, for example in Japan, a commercial power supply (e.g. AC 100 v) and to which a JIS C7617 straight-tube fluorescent lamp or a JIS C7618 circular fluorescent lamp can be attached. (Hereinafter, such a general-use fluorescent lighting fixture is simply referred to as a “lighting fixture”.)

(4) When the LED lamp X is attached to a lighting fixture on e.g. an indoor ceiling, the main light emission direction of the LED modules **92** is oriented downward. When the LED modules **92** are turned on, most part of the light emitted from the LED modules **92** is directed in the main light emission direction of the LED modules **92**. Thus, sufficient brightness cannot be obtained at the surrounding area of the LED lamp X, especially near the sides of the LED lamp X.

(5) As compared with this, general-use fluorescent lamps can emit light from almost the entire surface of the case, so that the surrounding area of the lighting fixture is uniformly illuminated to obtain sufficient brightness. Thus, as compared with general-use fluorescent lamps, the LED lamp X has a disadvantage that sufficient brightness cannot be obtained especially near the sides of the lamp.

(6) Patent Document 1: JP-U-H06-54103

SUMMARY OF THE INVENTION

Problems to be Solved by the Invention

(7) The present invention has been proposed under the circumstances described above. It is therefore an object of the present invention to provide an LED lamp that can illuminate the surrounding area with sufficient brightness.

Means for Solving the Problem

(8) According to the present invention, there is provided an LED lamp comprising a plurality of LED modules each including an LED chip and a support member including a support surface on which the LED modules are mounted. The LED modules comprise a plurality of kinds of LED modules different from each other in directivity characteristics that represent light intensity distribution with respect to a light emission direction.

(9) In a preferred embodiment of the present invention, the plurality of LED modules include a first LED module arranged adjacent to the center of the support surface. The directivity characteristics of the first LED module are such that light intensity in the normal direction of the support surface is relatively high, as compared with other LED modules.

(10) In a preferred embodiment of the present invention, the first LED module includes a reflector that surrounds the LED chip and that is open in the normal direction.

(11) In a preferred embodiment of the present invention, the first LED module further includes a sealing resin that seals the LED chip. The sealing resin is filled in a space surrounded by the reflector.
(12) In a preferred embodiment of the present invention, the dimension of the first LED module in the normal direction of the support surface of the support member is smaller than a dimension of the first LED module in the in-plane direction of the support surface.
(13) In a preferred embodiment of the present invention, the first LED module includes a substrate on which the LED chip is mounted, and the substrate is provided with a mount terminal on a surface thereof opposite from a surface on which the LED chip is mounted.
(14) In a preferred embodiment of the present invention, the plurality of LED modules include a second LED module arranged adjacent to an edge of the support surface. The directivity characteristics of the second LED module are such that light intensity in an outward direction within the plane of the support surface is relatively high, as compared with other LED modules.
(15) In a preferred embodiment of the present invention, the second LED module includes a reflector that surrounds the LED chip and that is open in the outward direction within the plane of the support surface.
(16) In a preferred embodiment of the present invention, the second LED module further includes a sealing resin that seals the LED chip. the sealing resin is filled in a space surrounded by the reflector.
(17) In a preferred embodiment of the present invention, the second LED module includes a substrate on which the LED chip is mounted. The second LED module is mounted on the support member, with a side surface of the substrate facing the support surface of the support member.
(18) In a preferred embodiment of the present invention, a dimension of the second LED module in an in-plane direction of the support member is larger than the dimension of the second LED module in the normal direction of the support member.
(19) In a preferred embodiment of the present invention, the plurality of LED modules further include a third LED module arranged between the first LED module and the second LED module. The directivity characteristics of the third LED module are such that the light intensity distribution with respect to the light emission direction is relatively uniform, as compared with the first and the second LED modules.
(20) In a preferred embodiment of the present invention, the third LED module includes a substrate on which the LED chip is mounted, and the substrate is provided with amount terminal on a surface thereof opposite from the surface on which the LED chip is mounted.
(21) In a preferred embodiment of the present invention, the third LED module includes a sealing resin that seals the LED chip. The sealing resin is exposed in both of the normal direction of the support surface and the in-plane direction of the support surface.
(22) In a preferred embodiment of the present invention, the support surface has an elongated shape. A plurality of first LED modules are arranged in the longitudinal direction of the support surface adjacent to the center of the support surface. A plurality of second LED modules are arranged along edges of the support surface that are spaced from each other in the width direction. A plurality of third LED modules are arranged in the longitudinal direction at each of the regions between the first LED modules and the second LED modules.
(23) In a preferred embodiment of the present invention, the LED lamp further comprises a case that accommodates the first through the third LED modules and the support member and allows light emitted from the first through the third LED modules to pass through while diffusing the light.
(24) In a preferred embodiment of the present invention, the case is cylindrical.
(25) In a preferred embodiment of the present invention, the support member comprises an insulating substrate, and the LED lamp further comprises a heat dissipation member attached to the insulating substrate at a portion opposite from the support surface.
(26) In a preferred embodiment of the present invention, the case is formed with a projecting piece

that projects inward and supports the substrate.
(27) In a preferred embodiment of the present invention, the projecting piece is in engagement with the heat dissipation member.
(28) Other features and advantages of the present invention will become more apparent from the detailed description given below with reference to the accompanying drawings.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
(1) FIG. **1** is a perspective view showing an example of LED lamp according to the present invention;
(2) FIG. **2** is a schematic sectional view taken along liens II-II in FIG. **1**;
(3) FIG. **3** is a top view of a first LED module;
(4) FIG. **4** is a schematic sectional view taken along lines IV-IV in FIG. **3**;
(5) FIG. **5** is a bottom view of the first LED module;
(6) FIG. **6** shows directivity characteristics of the first LED module;
(7) FIG. **7** is a side view of a second LED module;
(8) FIG. **8** is a schematic sectional view taken along lines VIII-VIII in FIG. **7**;
(9) FIG. **9** shows the second LED module mounted on a support substrate;
(10) FIG. **10** shows directivity characteristics of the second LED module;
(11) FIG. **11** is a side view showing a variation of the second LED module;
(12) FIG. **12** is a schematic sectional view taken along lines XII-XII in FIG. **11**;
(13) FIG. **13** shows directivity characteristics of a variation of the second LED module;
(14) FIG. **14** is a top view of a third LED module;
(15) FIG. **15** is a schematic sectional view taken along lines XV-XV in FIG. **14**;
(16) FIG. **16** is a bottom view of the third LED module;
(17) FIG. **17** shows directivity characteristics of the third LED module;
(18) FIG. **18** is a view for explaining advantages of the LED lamp;
(19) FIG. **19** shows a variation of the LED lamp;
(20) FIG. **20** is a schematic view showing the outer configuration of a variation of the first LED module;
(21) FIG. **21** shows directivity characteristics of the first LED module shown in FIG. **20**;
(22) FIG. **22** is a schematic view showing the outer configuration of a variation of the first LED module;
(23) FIG. **23** shows directivity characteristics of the first LED module shown in FIG. **22**;
(24) FIG. **24** is a schematic view showing the outer configuration of a variation of the first LED module;
(25) FIG. **25** shows directivity characteristics of the first LED module shown in FIG. **24**, designed to emit red light and green light;
(26) FIG. **26** shows directivity characteristics of the first LED module shown in FIG. **24**, designed to emit blue light and red light;
(27) FIG. **27** is a schematic view showing the outer configuration of a variation of the first LED module;
(28) FIG. **28** shows directivity characteristics of the first LED module shown in FIG. **27**;
(29) FIG. **29** is a schematic view showing the outer configuration of a variation of the first LED module;
(30) FIG. **30** shows directivity characteristics of the first LED module shown in FIG. **29**;
(31) FIG. **31** is a schematic view showing the outer configuration of a variation of the first LED module;

(32) FIG. **32** shows directivity characteristics of the first LED module shown in FIG. **31**;
(33) FIG. **33** is a schematic view showing the outer configuration of a variation of the second LED module;
(34) FIG. **34** shows directivity characteristics of the second LED module shown in FIG. **33**;
(35) FIG. **35** is a schematic view showing the outer configuration of a variation of the second LED module;
(36) FIG. **36** shows directivity characteristics of the second LED module shown in FIG. **35**;
(37) FIG. **37** is a schematic view showing the outer configuration of a variation of the second LED module;
(38) FIG. **38** shows directivity characteristics of the second LED module shown in FIG. **37**;
(39) FIG. **39** is a schematic view showing the outer configuration of a variation of the second LED module;
(40) FIG. **40** shows directivity characteristics of the second LED module shown in FIG. **39**;
(41) FIG. **41** is a schematic view showing the outer configuration of a variation of the second LED module;
(42) FIG. **42** shows directivity characteristics of the second LED module shown in FIG. **41**;
(43) FIG. **43** is a schematic view showing the outer configuration of a variation of the third LED module;
(44) FIG. **44** shows directivity characteristics of the third LED module shown in FIG. **43**;
(45) FIG. **45** is a schematic view showing the outer configuration of a variation of the third LED module;
(46) FIG. **46** shows directivity characteristics of the third LED module shown in FIG. **45**;
(47) FIG. **47** is a schematic view showing the outer configuration of a variation of the third LED module;
(48) FIG. **48** shows directivity characteristics of the third LED module shown in FIG. **47**;
(49) FIG. **49** is a schematic view showing the outer configuration of a variation of the third LED module;
(50) FIG. **50** shows directivity characteristics of the third LED module shown in FIG. **49**;
(51) FIG. **51** is a schematic view showing the outer configuration of a variation of the third LED module;
(52) FIG. **52** shows directivity characteristics of the third LED module shown in FIG. **51**;
(53) FIG. **53** is a schematic view showing the outer configuration of a variation of the third LED module;
(54) FIG. **54** shows directivity characteristics of the third LED module shown in FIG. **53**;
(55) FIG. **55** is a schematic view showing the outer configuration of a variation of the third LED module;
(56) FIG. **56** shows directivity characteristics of the third LED module shown in FIG. **55**;
(57) FIG. **57** is a schematic view showing the outer configuration of a variation of the third LED module;
(58) FIG. **58** shows directivity characteristics of the third LED module shown in FIG. **57**;
(59) FIG. **59** is a side view showing a variation of the LED module;
(60) FIG. **60** shows directivity characteristics of the LED module shown in FIG. **59**;
(61) FIG. **61** is a side view showing a variation of the LED module;
(62) FIG. **62** shows directivity characteristics of the LED module shown in FIG. **61**; and
(63) FIG. **63** is a sectional view showing an example of a conventional LED lamp.

MODE FOR CARRYING OUT THE INVENTION

(64) Preferred embodiments of the present invention are described below with reference to the accompanying drawings.
(65) FIGS. **1** and **2** show an example of LED lamp according to the present invention. FIG. **1** is a schematic perspective view of the LED lamp, whereas FIG. **2** is a schematic sectional view taken

along lines II-II in FIG. **1**.

(66) The LED lamp A of this embodiment includes a support substrate **1**, a plurality of LED modules **2**, a heat dissipation member **3**, a case **4** and a pair of bases **5**. The LED lamp A is to be used as attached to a general-use fluorescent lighting fixture, as a substitute for e.g. a straight-tube fluorescent lamp. When the general-use fluorescent lighting fixture is attached to e.g. an indoor ceiling, the LED lamp A is usually mounted to the lighting fixture in such a manner that the main light emission direction of the LED modules **2** is oriented downward.

(67) The support substrate **1** supports the LED modules **2**. The support substrate **1** is made of e.g. glass-fiber-reinforced epoxy resin and has an elongated plate-like shape. The mount surface **1***a* of the support substrate **1** is formed with a wiring pattern, not shown, made of e.g. Cu for supplying power to the LED modules **2**.

(68) As shown in FIG. **1**, the LED modules **2** are mounted in a matrix arrangement on the mount surface **1***a*. The arrangement and number of the LED modules **2** on the mount surface **1***a* of the support substrate **1** shown in FIG. **1** are merely an example, and the present invention is not limited to this example. In this embodiment, the LED modules **2** comprise first, second and third LED modules **2**A, **2**B and **2**C. The first, the second and the third LED modules **2**A, **2**B and **2**C differ from each other in luminous intensity distribution (directivity characteristics).

(69) FIGS. **3-5** show the first LED module **2**A. The first LED module **2**A includes an LED chip **21**, a substrate **22**, metal wiring patterns **23** and **24** spaced from each other, a wire **25**, a frame **26** and a sealing resin **27**. The first LED module **2**A is about 1.6 mm in length, about 0.8 mm in width and about 0.55 mm in thickness. Thus, the thickness, which is the dimension in the direction normal to the mount surface **1***a*, is smaller than the length and the width, which are dimensions in the in-plane direction of the mount surface **1***a*.

(70) The directivity characteristics of the LED modules **2**A are such that the intensity of the light emitted from the LED chip **21** is relatively high in the direction normal to the mount surface **1***a* of the support substrate **1**. FIG. **6** shows the directivity characteristics of the first LED module **2**A. In this directivity characteristics, the relative intensity RI is highest at the direction angle Da of 0°. In this embodiment, as shown in FIGS. **1** and **2**, the first LED modules **2**A are arranged in the longitudinal direction of the support substrate **1** at the center of the support substrate **1**. Each of the first LED modules **2**A is arranged in such a manner that its main light emission direction corresponds to the direction normal to the mount surface **1***a*.

(71) As shown in FIG. **4**, the LED chip **21** is mounted on the mount surface **22***a* of the substrate **22** via the wiring patterns **23** and **24**. The LED chip **21** comprises lamination of e.g. an n-type semiconductor, a p-type semiconductor and an active layer sandwiched between these semiconductors (none of these are shown). The LED chip **21** emits blue light when it is made of e.g. a GaN-based semiconductor.

(72) The LED chip **21** includes two electrodes (not shown) on the upper and the lower surfaces. By mounting the LED chip **21** on the obverse surface of the lead **23**, the electrode on the lower surface of the LED chip **21** is electrically connected to the wiring pattern **23**. As shown in FIGS. **4** and **5**, the wiring pattern **23** reaches the reverse surface **22***b* of the substrate **22** through the inner surface of a recess **28** having a semicircular cross section. The wiring pattern **23** on the reverse surface **22***b* constitutes a mount terminal **29** to be bonded to the wiring pattern, not shown, of the support substrate **1**. The electrode on the upper surface of the LED chip **21** is connected to the wiring pattern **23**, **24** via the wire **25**. Thus, the electrode on the upper surface of the LED chip **21** is electrically connected to the wiring pattern **23**, **24**. Similarly to the wiring pattern **23**, the wiring pattern **23**, **24** reaches the reverse surface **22***b* of the substrate **22** through a recess **28**. The lead **24** on the reverse surface **22***b* constitutes a mount terminal **29** to be bonded to the wiring pattern of the support substrate **1**.

(73) The frame **26** is made of e.g. a white resin and extends upward from the periphery of the mount surface **22***a*. The frame **26** includes a reflective surface **26***a* surrounding the LED chip **21**,

the wire **25** and the sealing resin **27**. The reflective surface **26***a* reflects the light emitted from the LED chip **21** to cause the light to travel upward. In this way, the first LED module **2**A is designed as an LED module with a reflector. With this arrangement, in the first LED module **2**A, the intensity of the light from the LED chip **21** which travels in the direction normal to the mount surface **1***a* of the support substrate **1** is increased.

(74) The sealing resin **27** is provided for protecting the LED chip **21** and the wire **25**. The sealing resin **27** comprises e.g. a silicone resin that transmits light emitted from the LED chip **21**. In the case where a fluorescent material that emits yellow light when excited by blue light is mixed in the sealing resin **27**, white light can be emitted from the LED module **2**. Instead of the fluorescent material that emits yellow light, fluorescent materials each of which emits green light or red light may be mixed in.

(75) FIGS. **7** and **8** show the second LED module **2**B. In FIGS. **7** and **8**, the elements that are identical or similar to those of the first LED module **2**A are designated by the same reference signs as those used for the first LED module. The second LED module **2**B is about 3.8 mm in length, about 1 mm in width and about 0.6 mm in thickness. Thus, the thickness, which is the dimension in the direction normal to the mount surface **1***a*, is smaller than the length and the width, which are dimensions in the in-plane direction of the mount surface **1***a*.

(76) As shown in FIG. **7**, in the second LED module **2**B, the leads **23**, **24** extend from the mount surface **22***a* of the substrate **22** onto the side surface **22***c*. The portion of each of the leads **23** and **24** which covers the side surface **22***c* constitutes a mount terminal **29**. As shown in FIG. **9**, the second LED module **2**B is disposed on the support substrate **1** in such a manner that the substrate **22** is oriented sideways, and fixed to the support substrate **1** by bonding the mount terminals **29** to the wiring pattern (not shown) of the support substrate **1** using solder **30**. Thus, unlike the first LED module **2**A, the main light emission direction of the LED chip **21** of the second LED module **2**B corresponds to the in-plane direction of the mount surface **1***a* of the support substrate **1**.

(77) FIG. **10** shows the directivity characteristics of the second LED module **2**B. In this figure, the direction corresponding to the direction angle Da of 0° is the outward direction within the plane of the mount surface **1***a* of the support substrate **1**. In the second LED module **2**B, the relative intensity RI is highest at the direction angle Da of 0°, i.e., in the outward direction within the plane of the mount surface **1***a*. In this embodiment, as shown in FIGS. **1** and **2**, the second LED modules **2**B are arranged along the edges of the support substrate **1** that are spaced in the width direction.

(78) As the second LED module, the second LED module **2**B′ as shown in FIGS. **11** and **12** may be employed which is not provided with a frame **26** and hence does not have a reflector. In the second LED module **2**B′, the sealing resin **27** is substantially trapezoidal in side view. The leads **23**, **24** of the second LED module **2**B′ extend from the mount surface **22***a* of the substrate **22** onto the reverse surface **22***b* via the side surface **22***c*. In the second LED module **2**B′ again, the portion of each of the leads **23** and **24** which is positioned on the side surface **22***c* constitutes amount terminal **29**. FIG. **13** shows the directivity characteristics of the second LED module **2**B′. As compared with the second LED module **2**B, the relative intensity RI is high in a wider region in the outward direction within the plane of the mount surface **1***a*.

(79) FIGS. **14-16** show the third LED module **2**C. In these figures, the elements that are identical or similar to those of the first and the second LED modules **2**A, **2**B are designated by the same reference signs as those used for the first and the second LED modules. The third LED module **2**C is about 1.6 mm in length, about 0.8 mm in width and about 0.36 mm in thickness. Thus, the thickness, which is the dimension in the direction normal to the mount surface **1***a*, is smaller than the length and the width, which are dimensions in the in-plane direction of the mount surface **1***a*.

(80) The third LED module **2**C is different from the first and the second LED modules **2**A, **2**B in that the third LED module does not have a frame **26** on the substrate **22**. That is, as shown in FIG. **15**, in the third LED module **2**C, the sealing resin **27** is substantially trapezoidal in side view and its most part is exposed. Thus, in the third LED module **2**C, light from the LED chip **21** is emitted not

only in the main light emission direction but also obliquely or sideways at a relatively high ratio.
(81) FIG. **17** shows the directivity characteristics of the third LED module **2**C. In a strict sense, in this directivity characteristics, the relative intensity RI is not highest at the direction angle Da of 0°. As compared with the first LED module **2**A, for example, the relative intensity RI at the direction angle Da of 0° is slightly lower, but the distribution of the relative intensity RI is more uniform. In this embodiment, as shown in FIGS. **1** and **2**, the LED modules **2**C are aligned on the mount surface **1***a* in each of the regions between the first LED modules **2**A and the second LED modules **2**B. Each of the third LED modules **2**C is arranged such that the main light emission direction of the LED chip **21** corresponds to the direction perpendicular to the mount surface **1***a* of the support substrate **1**.
(82) The heat dissipation member **3** is provided for dissipating the heat generated at the LED modules **2** and attached to the reverse side of the support substrate **1**, as shown in FIGS. **1** and **2**. The heat dissipation member **3** is made of e.g. A**1** and has a thin block-like shape extending in the longitudinal direction of the support substrate **1**.
(83) The surface of the heat dissipation member **3** may be treated to provide insulation so that the heat dissipation member can directly support the LED modules **2**. That is, the support substrate **1** may be dispensed with. In this case, a wiring pattern similar to the wiring pattern formed on the mount surface **1***a* of the support substrate **1** is formed between the LED modules **2** and e.g. an insulating sheet (not shown) having insulating property. With this arrangement, it is not necessary to prepare the support substrate **1** for mounting the LED modules **2**, in addition to the heat dissipation member **3**, so that the cost for the parts is reduced.
(84) The case **4** is provided for accommodating the support substrate **1**, the heat dissipation member **3** and so on, and is cylindrical, as shown in FIG. **2**. The case **4** comprises a single-piece member made by extrusion of a synthetic resin such as polycarbonate. When part of the light emitted from the LED modules **2** reaches the inner surface of the case **4**, the case **4** allows the light to pass through while diffusing the light.
(85) A pair of projecting pieces **41** are formed integrally on the inner surface of the case **4** to project inward. In the state shown in FIG. **2**, part of the heat dissipation member **3** is held in engagement with the projecting pieces **41** so that the movement of the heat dissipation member **3** relative to the case **4** in a direction perpendicular to the center axis **01** (upward direction in the figure) is restricted. The support substrate **1**, the heat dissipation member **3** and so on are housed in the case **4** by inserting the heat dissipation member **3** into the case **4** by sliding movement on the inner side of the projecting pieces **41**.
(86) The paired bases **5** are to be attached to a socket (not shown) of a general-use fluorescent lighting fixture to supply AC power from a commercial power supply. As shown in FIG. **1**, each of the bases **5** is provided with two terminals **51**. The terminals **51** are the portions to be fitted into the insertion ports of the socket of the general-use fluorescent lighting fixture.
(87) The advantages of the LED lamp A are described below with reference to FIG. **18**. FIG. **18** shows the cross section of the LED lamp A attached to a general-use fluorescent lighting fixture fixed to e.g. an indoor ceiling P. It is to be noted that the illustration of FIG. **18** is upside down.
(88) According to this embodiment, when the LED lamp A is turned on, light is emitted from the LED chips **21** of the first through the third LED modules **2**A, **2**B and **2**C. The dotted line SA shows the directivity characteristics of the first LED modules **2**A. The directivity characteristics of the first LED modules **2**A are such that the intensity of light is extremely high in the direction normal to the mount surface **1***a*. The dotted lines SB show the directivity characteristics of the second LED modules **2**B. The directivity characteristics of the second LED modules **2**B are such that the intensity of light is high in the outward direction within the plane of the mount surface **1***a*. The dotted lines SC show the directivity characteristics of the third LED modules **2**C. The directivity characteristics of the third LED modules **2**C are such that the intensity of light is relatively uniform around a line normal to the mount surface **1***a*.

(89) In this way, since the first through the third LED modules **2**A, **2**B and **2**C that are different from each other in light directivity characteristics are disposed on the support substrate **1** in the present embodiment, the light emitted from the LED lamp A is directed substantially uniformly in almost all directions except the direction toward the ceiling P. Thus, sufficient brightness is obtained at every point around the LED lamp A.
(90) The LED lamp according to the present invention is not limited to the foregoing embodiment. The specific structure of each part of the LED lamp according to the present invention may be changed in design in many ways. For instance, the shapes of the support substrate **1**, the LED modules **2**, the heat dissipation member **3** and the case **4** and so on are not limited to those described above. The manner of mounting the LED modules **2** on the support substrate **1** (e.g. the way of alignment, number and arrangement of the LED modules **2**) is not limited to the foregoing embodiment.
(91) In the foregoing embodiment, the movement of the heat dissipation member **3** is restricted by the paired projecting pieces **41** projecting from the inner side of the case **4** (see FIG. **2**). Instead of this arrangement, a pair of projecting pieces **41**′ as shown in FIG. **19** may be employed to restrict the movement of the heat dissipation member **3** and the support substrate **1**.
(92) In the foregoing embodiment, the arrangement of the LED modules is adapted to an LED lamp used as a substitute for a straight-tube fluorescent lamp. However, the present invention is not limited to this, and the arrangement of the LED modules may be adapted to an LED lamp used as a substitute for a circular fluorescent lamp or a downlight used as embedded in an indoor ceiling.
(93) As the first through the third LED modules **2**A, **2**B and **2**C, the LED modules shown in FIGS. **20-58** may be employed. These figures show the schematic outer configuration or directivity characteristics of each LED module. Each view showing the outer configuration of an LED module includes, from the top, a top view, a side view and a bottom view, and a right side view on the right of the top view. FIGS. **20-32** each shows an LED module with a reflector which can be employed as the first LED module **2**A. The directivity characteristics of the first LED module **2**A are such that the relative intensity RI is highest at the direction angle Da of 0°. FIGS. **33-42** each shows an LED module for sideways light emission which can be employed as the second LED module **2**B. The directivity characteristics of the second LED module **2**B are such that the direction in which the direction angle Da=0° corresponds to the outward direction within the plane of the mount surface **1***a* of the support substrate **1**. FIGS. **43-58** each shows an LED module with uniform intensity distribution which can be employed as the third LED module **2**C. The directivity characteristics of the third LED module **2**C are such that the relative intensity RI is not highest at the direction angle Da of 0°. It is to be noted that the LED modules shown in FIGS. **24** and **49** are of the type that emits two colors of light, whereas the LED modules shown in FIGS. **29**, **39** and **57** are of the type that emits three colors of light.
(94) Instead of the above-described LED modules, bullet-shaped LED modules as shown in FIGS. **59** through **62** may be employed. The bullet-shaped LED module shown in FIG. **59** can be mounted on the support substrate **1** vertically or horizontally. Thus, by appropriately selecting the mounting orientation, the direction in which the relative intensity RI is highest can be set to correspond to the direction normal to the mount surface of the support substrate **1** or to the outward direction within the plane of the mount surface. The bullet-shaped LED module shown in FIG. **61** has a simpler structure as compared with the bullet-shaped LED module shown in FIG. **59**, and the directivity characteristics of this bullet-shaped LED module is such that the intensity of light is high in the direction normal to the mount surface of the support substrate **1**. Instead of bullet-shaped LED modules shown in FIGS. **59** through **62**, use may be made of a conventional LED module having two lead pins. In using such a conventional LED module, the LED module is mounted by guiding each lead pin through the support substrate **1** or bending each lead pin. This allows the LED module to have directivity characteristics such that the intensity of light is relatively high in the

direction normal to the mount surface of the support substrate **1** or the outward direction within the plane of the mount surface of the support substrate **1**.

Claims

1. An LED lamp comprising: a substrate; a plurality of LEDs mounted on a mount surface of the substrate; and a light-transmitting cover covering the plurality of LEDs, wherein each of the plurality of LEDs comprises: a package body having a bottom surface; a first lead having a first bottom surface that is exposed from the bottom surface of the package body and a first top surface that is opposite to the first bottom surface; a second lead spaced apart from the first lead in a first direction and having a second bottom surface that is exposed from the bottom surface of the package body; an LED chip electrically connected to the first lead and the second lead; and a transparent sealing resin covering the LED chip, wherein the first bottom surface has a first area when viewed in a second direction perpendicular to the first bottom surface, wherein the first area has a first length in the first direction and a first width in a third direction perpendicular to the first and second directions, the first width being constant in the first direction, wherein the first length of the first area is larger than the first width of the first area, wherein the bottom surface of the package body has a width in the third direction that is larger than the first width of the first area of the first bottom surface of the first lead, and wherein the first bottom surface is bonded to the mount surface of the substrate.
2. The LED lamp according to claim 1, wherein an area of the first bottom surface and an area of the second bottom surface are different when viewed in a bottom view of the each on the plurality of LEDs.
3. The LED lamp according to claim 2, wherein the area of the first bottom surface is larger than the area of the second bottom surface as viewed in the bottom view of the each of the plurality of LEDs.
4. The LED lamp according to claim 1, wherein when viewed in the bottom view of the each of the plurality of LEDs, the first bottom surface and the second bottom surface are equal to each other in size along the second direction, and the first bottom surface is larger in size along the first direction than the second bottom surface.
5. The LED lamp according to claim 1, wherein the first bottom surface further has a second area that extends outward in the first direction from the first area, the second area includes one outermost end and another outermost end that are spaced apart from each other in the third direction, a distance from the one outermost end to the another outermost end in the third direction is equal to or larger than the first width of the first area in the third direction.
6. The LED lamp according to claim 1, wherein the first bottom surface further has second and third areas that protrudes outward in the first direction from the first area, the second and third areas are overlapped with each other when viewed in the third direction, the second and third areas are overlapped with the package body when viewed in the second direction.
7. The LED lamp according to claim 6, wherein a portion of the package body is exposed between the second area and the third area when viewed in the second direction.
8. The LED lamp according to claim 1, wherein the package body comprises a reflector surrounding the LED chip as viewed in the second direction and reflecting light from the LED chip to a light emitting direction such that light emitted from the LED chip has highest reflective intensity at the second direction within the light emitting direction.
9. The LED lamp according to claim 8, wherein the reflecting light has an angle spread of more than 60 degrees from the second direction.
10. The LED lamp according to claim 8, wherein the reflector is made of a white resin.
11. The LED lamp according to claim 1, wherein each of the plurality of LEDs is longer in the first direction than in the second direction, wherein each of the plurality of LEDs is mounted such that

the first direction is parallel to the longitudinal direction of the substrate.

12. The LED lamp according to claim 1, wherein the bottom surface of the package body is flush with the first bottom surface and the second bottom surface.

13. The LED lamp according to claim 1, wherein the bottom surface of the package body is in direct contact with the first bottom surface and the second bottom surface.