IN THE UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF TEXAS
TYLER DIVISION

Jakuta Diodes, LLC,	§	
	§	
Plaintiff,	§	
	§	**Case No. 6:16-cv-01179**
v.	§	
	§	
Soraa, Inc., a Delaware corporation,	§	
	§	**JURY TRIAL**
Defendant.	§	
	§	
	§	
	§	
	§	

FIRST AMENDED COMPLAINT FOR PATENT INFRINGEMENT

Plaintiff Jakuta Diodes, LLC, ("Jakuta" or "Plaintiff"), by and through its undersigned counsel, for its First Amended Complaint against Defendant Soraa, Inc. ("Defendant") makes the following allegations. These allegations are made upon information and belief.

NATURE OF THE ACTION

1. This is an action against Defendant for infringement of one or more claims of United States Patent No. 6,079,854 ("the '854 Patent").

PARTIES

2. Plaintiff Jakuta Diodes, LLC is a Texas limited liability company with its principal office located in Texas, at 211 East Tyler Street, Suite 600-A, Longview, Texas 75601.

3. Defendant Soraa, Inc. is a corporation incorporated under the laws of the State of Delaware, with a business address of 6500 Kaiser Drive, Fremont, California 94555.

JURISDICTION AND VENUE

4. This patent infringement action arises under the patent laws of the United States, including 35 U.S.C. §§ 271, et seq.

5. This Court has subject matter jurisdiction over this action pursuant to 28 U.S.C. § § 1331 and 1338(a) because it arises under United States Patent law.

6. This Court has personal jurisdiction over the Defendant because it (either directly or through its subsidiaries, divisions, groups or distributors) has sufficient minimum contacts with the forum as a result of business conducted within the State of Texas and this district; and/or specifically over the Defendant (either directly or through its subsidiaries, divisions, groups or distributors) because of its infringing conduct within or directed at the State of Texas and this district.

7. Venue is proper in this district pursuant to 28 U.S.C. §1391(c) and 1400(b).

FACTS

8. Plaintiff is the owner, by assignment, of U.S. Patent No. 6,079,854 ("the '854 Patent"), entitled "Device and Method for Diffusing Light," which was duly and legally issued on June 27, 2000 by the United States Patent and Trademark Office ("USPTO").

9. A copy of the '854 Patent is attached to this Complaint as Exhibit A.

10. The claims of the '854 Patent are valid and enforceable.

COUNT I: CLAIM FOR PATENT INFRINGEMENT UNDER 35 U.S.C. § 271(a) ('307 PATENT) (AGAINST DEFENDANT)

11. Plaintiff hereby incorporates by reference the allegations of paragraphs 1 through 10 of this Complaint as if fully set forth herein.

12. Defendant makes, has made, sells, offer for sale, uses and/or imports into the United States, motor vehicles that include LED headlamps, including without limitation the Point Source Optics product line sold by Defendant ("Accused Product(s)").

13. Each of the Accused Product(s) uses a method of diffusing light, including providing a light source from which light radiates, namely a Soraa GaN-on-GaN LED. See Exhibit B.

14. Each of the Accused Products interrupts the light with a substantially transparent member, including utilizing unique folded optics with precision-cut prismatic lenses. See Exhibit B.

15. Each of the Accused Products segregate a substantial portion of the light to a plurality of channels within the member, including utilizing TIR (for Total Internal Reflection) optics to create 25 degree to 36 degree beam angles. See Exhibit B.

16. Each of the Accused Products disperses the light transmitted in a widening ray along the plurality of channels utilizing TIR (for Total Internal Reflection) optics to create 25 degree to 36 degree beam angles. . See Exhibit B.

17.Each of the Accused Products also radiates a diffused pattern of light emitted from the plurality of channels utilizing TIR (for Total Internal Reflection) optics to create 25 degree to 36 degree beam angles. See Exhibit B.

18. Each one of the elements of the Accused Product(s), itemized in paragraphs 13-17 above, is an element in Claim 27 of the ‘854 patent.

19. Thus, each of the Accused Products infringes at least Claim 27 of the ‘854 patent.

20. Plaintiff has been, and will continue to be, irreparably harmed by Defendant’s ongoing infringement of the ‘854 patent.

21. As a direct and proximate result of Defendant’s infringement of the ‘854 Patent, Plaintiff has been and will continue to be damaged in an amount yet to be determined, including but not limited to Plaintiff’s lost profits and/or a reasonable royalty.

PRAYER FOR RELIEF

WHEREFORE, Plaintiff prays for relief against Defendant as follows:

A. In favor of Plaintiff that Defendant has infringed one or more claims of the ‘854 Patent, either literally or under the doctrine of equivalents;

B. Requiring Defendant to pay Plaintiff its damages, costs, expenses, and prejudgment and post-judgment interest for Defendant’s infringement of the ‘854 Patent as provided under 35 U.S.C. § 284, but not less than a reasonable royalty; and

C. For such other and further relief as may be just and equitable.

DEMAND FOR TRIAL BY JURY

Pursuant to Rule 38 of the Federal Rules of Civil Procedure, Plaintiff hereby demands a jury trial on all issues and causes of action triable to a jury.

DATED: October 4, 2016

Respectfully submitted,

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US006079854A

United States Patent [19]

Ra

[11] **Patent Number: 6,079,854**

[45] **Date of Patent: Jun. 27, 2000**

[54] **DEVICE AND METHOD FOR DIFFUSING LIGHT**

[76] Inventor: **Dojin Ra**, 101 E. Edsall Ave., #C5, Palisades Park, N.J. 07650

[21] Appl. No.: **09/023,528**

[22] Filed: **Feb. 13, 1998**

[51] **Int. Cl.**[7] **F21V 8/00**

[52] **U.S. Cl.** **362/342**; 362/342; 362/301; 362/346; 362/297; 362/351; 362/362; 362/355; 362/356; 362/360; 362/329; 362/328; 362/308; 362/309; 362/551; 362/552; 362/554

[58] **Field of Search** 362/342, 301, 362/346, 297, 351, 362, 355, 356, 360, 329, 328, 308, 309, 551, 552, 554

[56] **References Cited**

U.S. PATENT DOCUMENTS

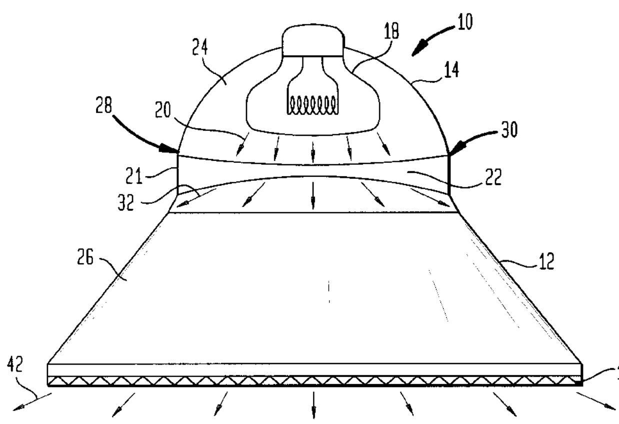
3,526,764	9/1970	Klie et al. .	
3,710,093	1/1973	Riehl et al. .	
3,731,079	5/1973	Porsche .	
3,735,114	5/1973	Porsche .	
4,112,483	9/1978	Small, Jr. et al.	362/301
4,142,229	2/1979	Hulbert, Jr. .	
4,191,990	3/1980	Beeftink et al. .	
4,458,303	7/1984	Berns .	
4,482,939	11/1984	Tishman .	
4,559,589	12/1985	Sassmannshausen .	
4,644,448	2/1987	Heiler .	
4,743,082	5/1988	Mori	350/69.1
4,891,559	1/1990	Matsumoto et al. .	
5,032,955	7/1991	Jurgens .	
5,113,321	5/1992	Suzuki	362/301
5,122,940	6/1992	Wiegand	362/342
5,191,264	3/1993	Hammond .	
5,810,469	9/1998	Weinreich	362/342

Primary Examiner—Sandra O'Shea
Assistant Examiner—Bertrand Zeade
Attorney, Agent, or Firm—Weingram & Associates, P.C.

[57] **ABSTRACT**

A device is provided to diffuse a beam of light, the device consisting of a plurality of truncated cells nested together along their respective sidewalls for collecting and diffusing the light rays as they extend along the plurality of cells having an expansive, tapered interior volume. The device diffuses the main light beam in a headlamp, for example, thereby substantially reducing the glare experienced by oncoming drivers and permitting high beams of the headlamp to be used in the presence of the oncoming drivers. The device of the present invention is retrofitable to existing headlamps. In another embodiment of the present invention, a concave lens is disposed in the headlamp assembly to diffuse the main light beam prior to it entering the truncated cells, while each one of the cells of the dispersion device is also provided with its own respective concave lens to augment the diffusing effect.

27 Claims, 3 Drawing Sheets



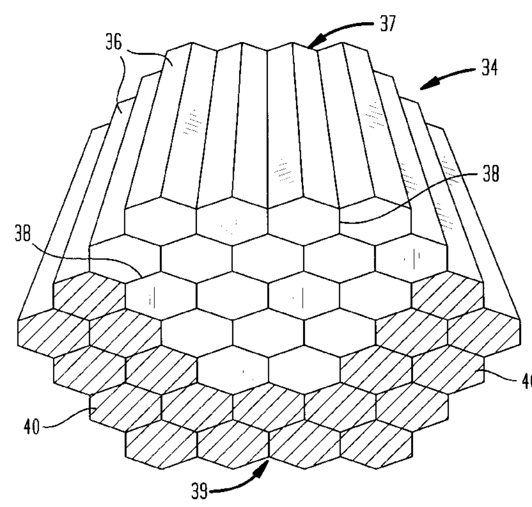


EXHIBIT A

FIG. 1

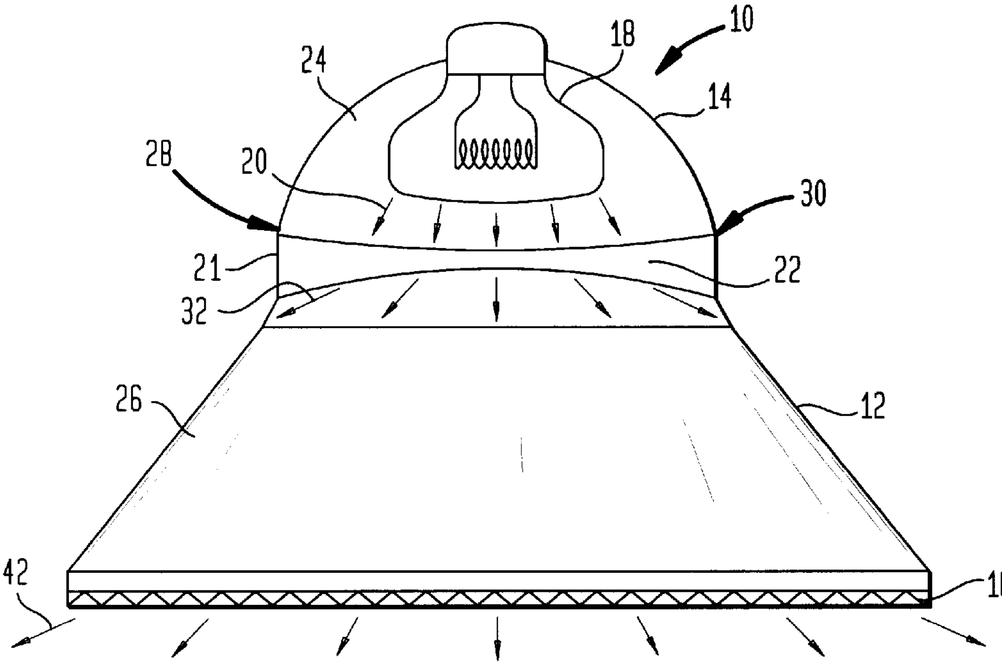


FIG. 2

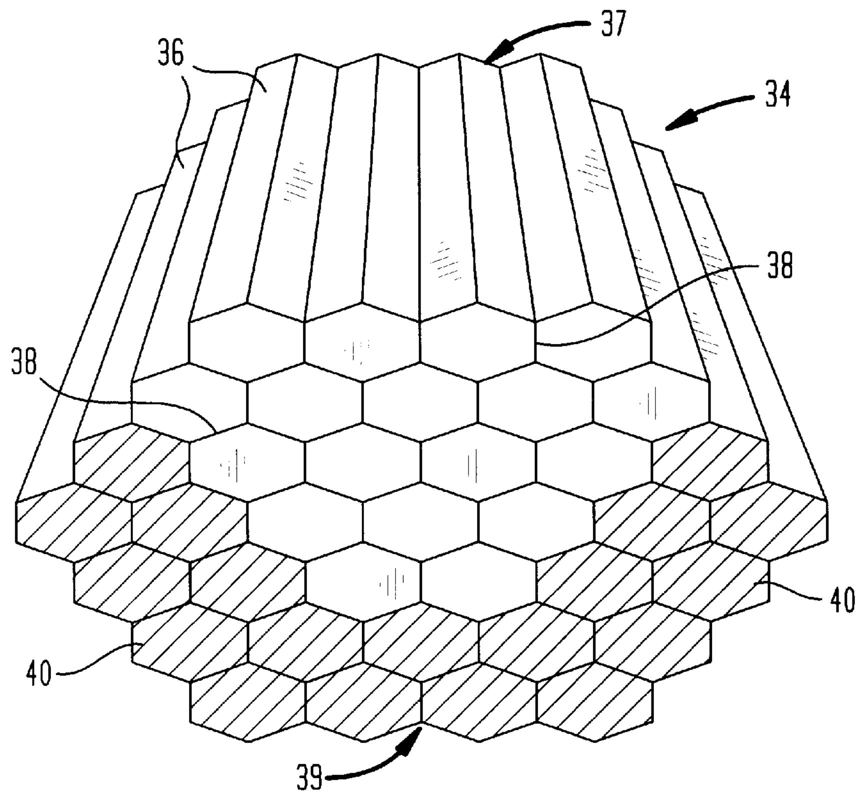


FIG. 3

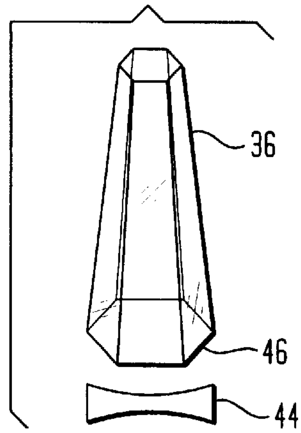


FIG. 4

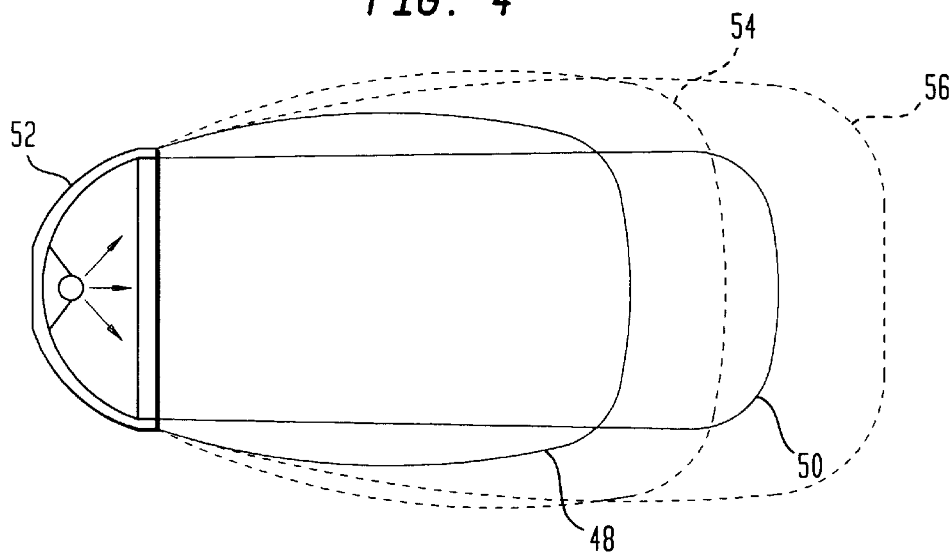


FIG. 5

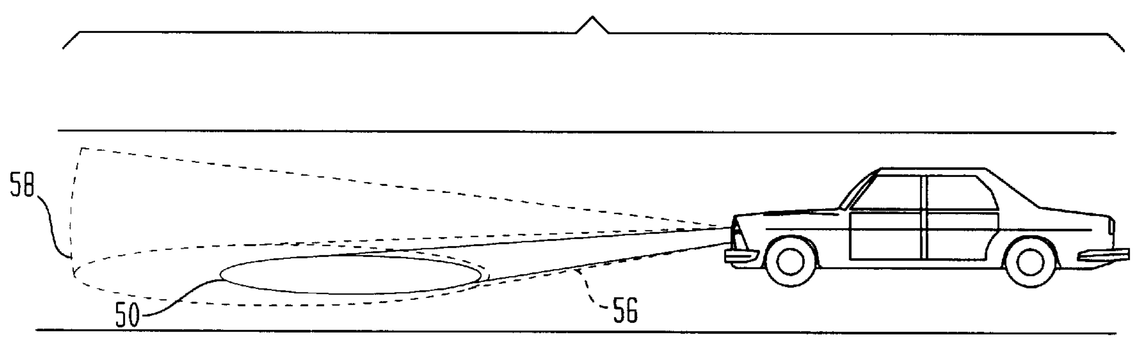


EXHIBIT A

FIG. 6

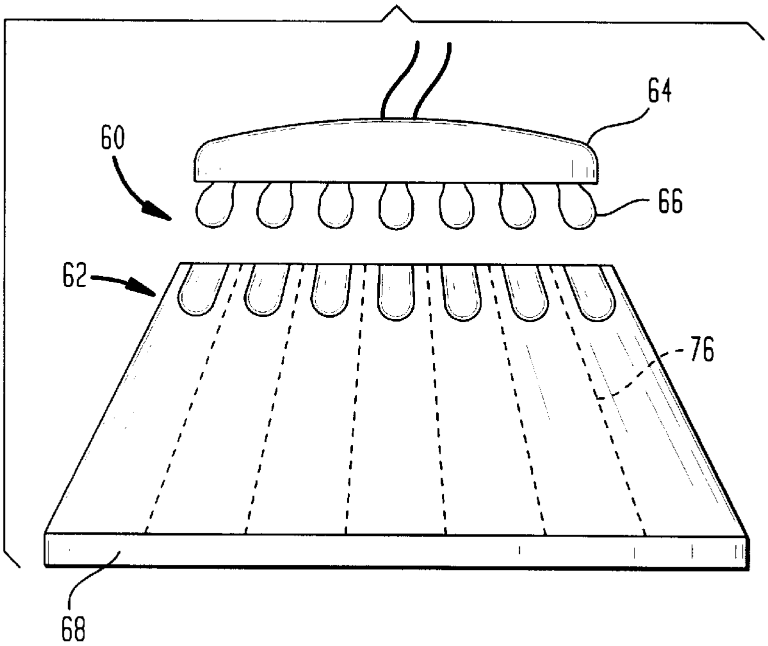


FIG. 8

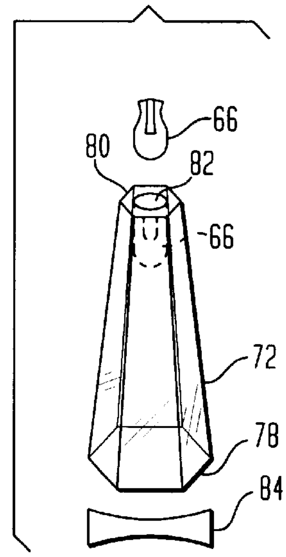
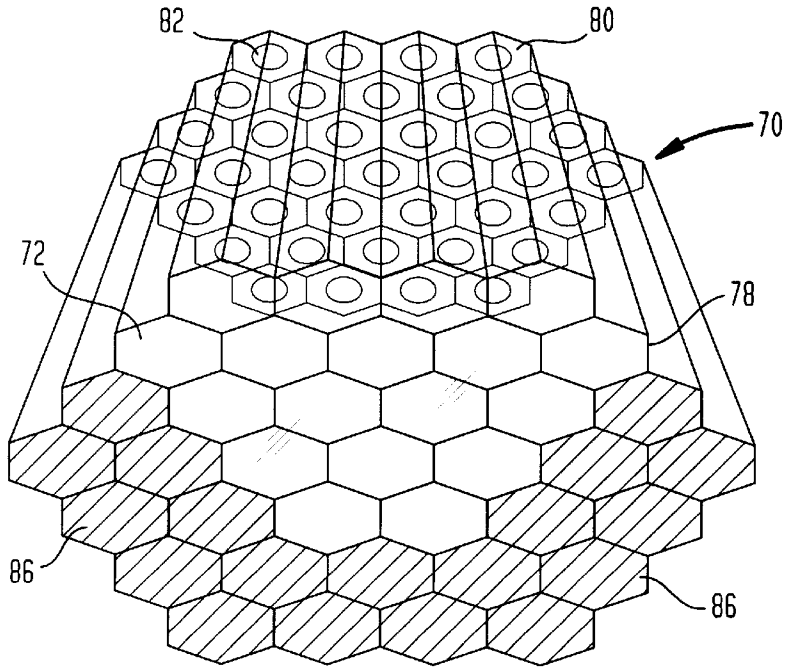


FIG. 7



DEVICE AND METHOD FOR DIFFUSING LIGHT

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to automobile lighting fixtures and methods for directing and diffusing light emitted from the fixtures.

2. Discussion of the Related Art

Automobile headlights and methods for controlling and shaping a light beam are disclosed in the following patents:

U.S. Pat. No.	Inventor(s)
3,526,764	Klie et al
3,710,093	Riehl et al
3,731,079	Porsche
3,735,114	Porsche
4,142,229	Hulbert, Jr.
4,191,990	Beeftink et al
4,458,303	Berns
4,482,939	Tishman
4,559,589	Sassmannshausen
4,644,448	Heiler
4,891,559	Matsumoto et al
5,032,955	Jurgens
5,191,264	Hammond

U.S. Pat. No. 3,526,764 to Klie et al discloses a retractable motor headlight arrangement consisting of a lens having a prism profiled surface for directing light beams from the vehicle headlight in the direction of travel, i.e. for bending the light beams toward the direction of travel.

U.S. Pat. No. 4,142,229 to Hulbert, Jr. discloses a method of shaping a light beam wherein a sealed beam lamp lens cover is composed of a number of different optical light control elements, such as prisms or cylindrical lenses, areas of which are systematically covered so that maximum candela requirements are not exceeded.

U.S. Pat. No. 4,458,303 to Berns discloses a light beam concentrating, intensifying and filtering device, wherein a parallel ray light source of the parabolic reflector type is employed in association with a leaf shutter, not unlike that used in conventional cameras, to vary the beam of light.

U.S. Pat. No. 4,559,589 to Sassmannshausen discloses a lighting fixture with a concave reflector such as a tail light, warning or signal light, etc., wherein a reflector for the light is provided with slits through which light passes to contact a prism for scattering the light.

U.S. Pat. No. 5,032,955 to Jurgens discloses a mud flap mounted vehicle reference lighting system wherein a plurality of lamps are mounted to a parabolic reflector for coaction with a louver to effectively position the light pattern at a desirable location observable to the driver.

The remaining patents to Riehl, Porsche, Beeftink, Tishman, Heiler, Matsumoto, and Hammond disclose apparatus and systems which relate generally to the present invention and are directed toward manipulating the headlamp assembly with respect to the road and other vehicles in the area.

The known devices include intricate and complex structures which are not retrofitable to existing light fixtures without substantial structural modification of the fixture. Certain of the devices, such as that disclosed in Hulbert, Jr., teach to cover or coat portions of the lens cover of the device to reduce candela and glare.

In addition, the lighting fixtures discussed above rely substantially on flutes, prisms and lenses only to direct the light from the luminous element, which results in erratic, uncontrolled scattering of the light, not necessarily in the desired direction.

Among the patents above, the devices and methods disclosed do not include a structure mountable within a housing for the light fixture, which structure consists of a plurality of truncated hollow cells ganged together to diffuse the light emitted from a luminous body for the light fixture. The device of the present invention also provides for controlled diffusion of the light beam.

The present invention also provides for structure which permits increased candela for the light beam without the detrimental side effect of increased glare associated with the known light fixture devices. Therefore, the diffusion of the light beam emitted from the present invention will be compensated for by the device permitting an increase in the maximum candela emitted by the luminous body of the light fixture.

OBJECTS AND SUMMARY OF THE INVENTION

It is an object of the present invention to provide a device and method for directing a light beam, and more particularly, to diffuse a light beam emitted from an automobile headlight.

It is another object of the present invention to provide a device which permits use of a luminous body having increased candela without a corresponding amount of glare.

It is another object of the present invention to provide a diffusing element which substantially reduces, if not eliminates, the blinding glare from headlamps experienced by oncoming drivers, regardless of whether the headlight fixture is in low or high beam mode.

It is another object of the present invention to provide a light beam diffuser which provides an increased zone of coverage by the light beam, whether in the low beam or high beam mode.

It is another object of the present invention to provide a lighting fixture for an automobile wherein the fixture includes a plurality of luminous bodies, each one of which operatively coacts with a corresponding cell of the diffuser device for diffusing light emitted from the illuminating bodies.

It is another object of the present invention to provide a light diffuser device consisting of a plurality of cells which when ganged together coact to provide a synergistic effect for diffusing light emitted from a luminous body.

It is another object of the present invention to provide a head lamp housing consisting of a light diffuser device of the present invention in combination with a concave lens to interrupt and gather a secondary beam of light for further diffusion.

It is another object of the present invention to provide a light diffuser device consisting of a plurality of cells in each one of which there is disposed a concave lens for further diffusion of the light transmitted from each one of the plurality of cells.

It is another object of the present invention to provide a diffuser device consisting of a plurality of cells ganged together in a configuration for certain of the cells to be angled with respect to the remaining cells to intersect the diffused light being emitted from the device to reduce the glare of the resulting light beam.

It is another object of the present invention to provide a diffuser device consisting of a plurality of cells in each one of which is disposed a concave lens angled with respect to a longitudinal axis of the respective cell to effect diffusion of the light beam being emitted from the particular cell.

The foregoing objects are examples only of the objects and resulting advantages that are obtained from the diffuser device and method of the present invention.

The objects of the present invention are realized by providing a device and method for diffusing a light beam which consists of a truncated body having: a first truncated region at a first side of the truncated body for receiving light from the luminous body; a second truncated region at a second side of the truncated body substantially opposite to the first side and adapted for emitting light; and a central region interconnecting the first and second truncated regions and adapted for diffusing the light transmitted along the central region for providing a diffused pattern of light emitted from the second truncated region.

BRIEF DESCRIPTION OF THE DRAWINGS

For a more complete understanding of the present invention, reference may be had to the description of the preferred embodiments taken in conjunction with the accompanying drawings, of which:

FIG. **1** is a view showing an embodiment of a light diffuser device of the present invention disposed in a light fixture assembly;

FIG. **2** is a perspective view of another embodiment of a light diffuser device according to the present invention for being disposed in the light fixture assembly of FIG. **1**;

FIG. **3** is a perspective view of a single cell of the diffuser device shown in FIG. **2**;

FIG. **4** is a top plan view showing diagrammatically the disposition and scope of high and low beams produced by the present invention, as compared to high and low beams produced by conventional headlight fixtures;

FIG. **5** is a side view of a motor vehicle showing diagrammatically the disposition and scope of the light beam produced according to the present invention, as compared to the light beam produced by conventional headlight fixtures;

FIG. **6** is a view of another embodiment of a light fixture assembly for the present invention;

FIG. **7** is a perspective view of still another embodiment of a light diffuser device according to the present invention for being disposed in the light fixture assembly of FIG. **6**; and

FIG. **8** is a perspective view of another embodiment of a single cell of the diffuser device shown in FIG. **7**.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. **1**, a light beam diffusing headlamp assembly of the present invention is shown generally at **10**. The assembly **10** includes a housing **12** having at one end a reflecting surface **14** or reflector, such as known in the art, and a lens cover **16** at an opposite end of the housing **12**. A luminous body **18**, such as a light bulb, extends through a rear wall portion of the housing **12** and the reflector **14** to coact with the reflector **14** to provide a primary light beam indicated generally by arrows **20**.

A first diffuser means **22** constructed as a concave lens is disposed in the housing **12** between the reflector **14** and the lens cover **16**. The construction and arrangement of the concave lens **22** is to divide an interior of the housing **12** into a primary chamber **24** and a secondary chamber **26** of the housing. In a preferred construction, the concave lens **22** is of a length sufficient to span the interior of the housing **12** such that opposed ends **28,30** of the concave lens **22** abut corresponding portions of the inner surface of the housing **12** to segregate the primary chamber **24** from the secondary chamber **26**. In another preferred embodiment, a peripheral edge **21** of the lens **22** abuts continuously against an inner surface of the housing **12**. In still another preferred embodiment, the reflector **14** is disposed in the housing **12** to extend completely along an inner surface of the housing in the primary chamber **24**. The primary light beam **20** passes through the concave lens **22** to be diffused further into the secondary chamber **26** as a secondary light beam indicated generally by arrows **32**.

The secondary chamber **26** of the housing **12** is sized and shaped to receive a second light diffuser means **34**, which is shown in FIG. **2**.

Referring to FIGS. **2** and **3**, the light beam diffuser device **34** resembles a truncated body or mass, and is constructed from a plurality of truncated hollow receptacles **36** or cells, each one of which has a hexagonal-shaped cross-section. The cross-section of the plurality of receptacles **36** resembles a honeycomb. The receptacles **36** have a tapered diameter, shown more particularly in FIG. **2**. That is, the widest portion of each one of the cells **36** faces the lens cover **16**, with each one of the cells tapering to a reduced diameter as it extends toward the bulb **16** of the headlamp **10**. The narrowest end of each one of the cells **36** collectively forms a light receiving region shown generally at **37**. The widest end of each one of the cells **36** collectively forms a light transmitting region shown generally at **39**.

The cells **36** are nested or ganged together along their respective sidewalls **38**, as shown in FIG. **2**, so that preferably, none of the secondary light **32** is permitted to pass between the abutting sidewalls of the respective cells **36**. The ganged arrangement of a plurality of the individual cells **36** is constructed to have a cross-section resembling a honeycomb as well, such as shown in FIG. **2**.

The truncated cells **36** can be manufactured of substantially any material, provided the material is heat resistant to the effects of light emitted from the bulb **18**. The material to construct the cells **36** is preferably substantially opaque, but can be translucent.

The individual construction of each cell **36** and the ganged arrangement **34** of a plurality of the cells **36** is to provide a radiating honeycomb to diffuse the light rays **20,32**.

The tapering effect of the cells **36** of the ganged arrangement shown in FIG. **2** results in a longitudinal axis along each one of the cells **36** tapering toward each other to a common origin. In another embodiment, certain cells **40** indicated with cross-hatching are at a slightly different angle than the remaining cells **36**. This provides for still further dispersion of a headlamp beam indicated by arrows **42**.

In FIG. **3**, an individual cell **36** is shown having a concave lens **44** dispersed therein. The concave lens **44** is constructed to be disposed at a wider opening **46** of the cell **36**. This provides for still further diffusion of the light emitted from each one of the individual cells **36**.

FIGS. **4** and **5** show the result of employing the light diffusing device **10** having a plurality of the truncated cells **36** nested together.

In FIG. **4**, solid lines **48,50** show low **48** and high **50** beam scope, respectively, for an automobile headlamp **52** employing conventional headlight construction. In contrast, broken lines **54,56** show the disposition and scope of a lighted area for low **54** and high **56** beams, respectively, that are obtained when the diffuser devices **22** and/or **34** of the present invention are employed.

In FIG. **5**, the dispersion of the light beam **56** produced by the present invention provides for an extended field **58** of light projected further from the front of the vehicle than the conventional high beam **50**. There is therefore less of a chance of an automobile driving beyond the reach of its headlamp beam. The device also increases the ability to read signage from a further distance as a result of the field **58**.

The plurality of truncated cells **36** nested together in an array disperses the light and therefore, substantially reduces the glare experienced by oncoming drivers. In addition, the array of nested, truncated cells **36** permits the user to drive with both high and low beams, since the light beams are sufficiently diffused to substantially reduce the glare normally experienced by oncoming drivers. With this arrangement of cells **36**, a bulb **18** having higher candela output can be employed without the associated excessive glare that occurs in conventional lamp structures. Another embodiment of the present invention is shown in FIGS. **6–8**. The embodiment and elements thereof as shown in FIGS. **6–8** operate to provide a similar light diffusing result and attendant advantages, unless otherwise stated.

In FIG. **6**, another embodiment of a light beam diffusing headlamp assembly in the present invention is shown generally at **60**. The assembly **60** includes a housing **62** having a reflector **64** and a plurality of luminous bodies **66**, i.e bulbs, which extend to an interior of the housing. The housing also includes a lens cover **68** mounted to the housing at an end opposite to the reflector **64**. A concave lens (similar to lens **22**) disposed in the housing can also be employed with this embodiment.

A plurality of light bulbs **66** are provided to each extend into the housing **62** to a corresponding cell of another embodiment of the light diffuser means shown generally at **70** in FIG. **7**. The embodiment of FIG. **7** provides advantages similar to those discussed with reference to FIG. **5**.

The light diffuser means **70** is constructed of a plurality of individual cells **72** which have a hexagonal-shaped cross-section, as that shown with respect to FIGS. **2** and **3**. As shown in FIG. **7**, the plurality of cells **72** are ganged together along their respective sidewalls **74** into a body or mass having a hexagonal-shaped cross-section. The light diffuser means **70** is sized and shaped to be disposed in the housing **62**, with broken lines **76** of FIG. **6** representing generally the disposition of the diffuser means **70** in the housing **62**.

Each one of the cells **72** from which the diffuser means **70** is composed, has a truncated shape with a wider opening **78** extending to an end wall **80**, having a width less than a width of the opening **78**. The end wall **80** of each one of the cells is provided with an aperture **82** which is constructed and arranged to receive a corresponding one of the bulbs **66**. The coaction between an individual bulb **66** and a corresponding cell **72** is shown in FIG. **8**.

The diffuser means **70** can also include a plurality of concave lenses **85** which are sized and shaped to be received at the wider opening **78** of each one of the cells **72**. This construction provides for a further dispersing of the light rays transmitted through each one of the cells.

In FIG. **7**, certain of the cells **72** are cross-hatched at **86**. The cells **86** are arranged at a slightly different angle than the remaining cells **72** for providing a further diffusing effect similar to that discussed with respect to FIG. **2**. The arrangement of these cells **72** at an angle slightly different with respect to the remaining cells provides for further diffusion of the light beam, thereby promoting the advantage that high beams as well as low beams can be used by the vehicle without exposing the oncoming driver to adverse glare effects.

The material from which the light diffuser device is constructed is similar to that discussed with respect to the embodiment in FIG. **2**.

It will be understood that the embodiments described herein are merely exemplary and that a person skilled in the art may make many variations and modifications without departing from the spirit and scope of the invention. All such modifications and variations are intended to be covered by the appended claims.

What is claimed is:

1. A light fixture, comprising:

a housing having:
- a front end,
- a back end opposite to the front end, and
- a sidewall interconnecting the front end and the back end for providing an interior space of the housing,
- an opening in the front end communicating with the interior space;

a reflector disposed at the back end and facing the front end;

a light source extending through the back end of the housing and the reflector to be operatively associated with the reflector at the interior space of the housing;

a transparent cover extending across the opening at the front end of the housing;

a concave lens disposed within the housing between the light source and the front end of the housing, the concave lens having:
- a peripheral edge for abutting against an inner surface of the housing,
- a receiving surface facing the light source, and
- a transmitting surface opposite to the receiving surface and facing the opening at the front end of the housing;

a first region in the housing occupying an area between the reflector and the receiving surface of the concave lens and into which light from the light source is radiated to impact the receiving surface of the concave lens; and

a second region in the housing occupying an area between the transmitting surface of the concave lens and the front end of the housing, the second region segregated into a plurality of channels into which light from the concave lens is radiated to provide a diffused pattern of dispersed light to exit the front end of the housing.

2. A light fixture, comprising:

a housing having:
- a front end,
- a back end opposite to the front end, and
- a sidewall interconnecting the front end and the back end for providing an interior space of the housing,
- an opening in the front end communicating with the interior space;

a reflector disposed at the back end and facing the front end;

a light source extending through the back end of the housing and the reflector to be operatively associated with the reflector at the interior space of the housing;

a transparent cover extending across the opening at the front end of the housing;

a truncated body disposed within the housing between the light source and the front end of the housing, the truncated body having:

a plurality of hexaganolly-shaped hollow cells nested together along respective sidewalls of the cells,

each one of the plurality of cells having a first end terminating at a receiving surface facing the light source, and

a second end opposite to the first end and terminating in a transmitting surface facing the opening at the front of the housing,

wherein a diameter of the receiving surface is less than a diameter of the transmitting surface of the truncated body;

a first region in the housing occupying an area between the reflector and the receiving surface of the truncated body and into which light from the light source is radiated to impact the receiving surface of the truncated body; and

a second region in the housing occupying an area between the transmitting surface of the truncated body and the front end of the housing and into which light from the truncated body is radiated in a diffused pattern to exit the front end of the housing.

3. A light fixture, comprising:

a housing having an interior region extending to an opening for the housing;

means for illuminating the housing operatively associated with the interior region of the housing; and

means for diffusing light emitted from the illuminating means, the diffusing means comprising:

a body portion having:

a first end for receiving light from the illuminating means,

a second end opposite to the first end and facing the opening of the housing for radiating light to the opening, and

a plurality of channels tapering outward toward the second end, and extending between the first end and the second end for diffusing light transmitted therethrouqh from the first end to the second end,

wherein the light radiated from the second end is in the diffused pattern to exit the opening of the housing.

4. The light fixture according to claim **3**, further comprising:

a reflector disposed at the interior region of the housing and in operative association with the illuminating means for reflecting light at the interior region toward the diffusing means.

5. The light fixture according to claim **3**, further comprising:

a concave lens disposed between the illuminating means and the diffusing means.

6. The light fixture according to claim **5**, further comprising:

a first region in the housing between the illuminating means and the diffusing means and into which light from the illuminating means is radiated to impact a first surface of the concave lens, and

a second region in the housing between a second surface of the concave lens opposite to the first surface and the opening for the housing and into which light from the concave lens is radiated in a diffused pattern to exit the opening at the front end of the housing.

7. The light fixture according to claim **3**, wherein each one of the plurality of channels extends along a respective one of the hollow cells which are nested together along their respective sidewalls.

8. The light fixture according to claim **7**, wherein each one of the plurality of cells has a hexagonal-shaped cross-section.

9. The light fixture according to claim **3**, wherein a diameter of the first end of the body portion facing the illuminating means is less than a diameter of the second end of the body portion facing the opening of the housing.

10. The light fixture according to claim **3**, wherein the diffusing means has a hexagonal-shaped cross-section.

11. The light fixture according to claim **7**, wherein a diameter of each one of the cells increases from the respective first end through to the respective second end of the cell.

12. The light fixture according to claim **7**, wherein each one of the plurality of cells includes a longitudinal axis which intersects longitudinal axes of the remaining cells beyond the receiving end of the body portion.

13. The light fixture according to claim **3**, further comprising:

secondary means for diffusing light, the secondary diffusing means disposed between the diffusing means and the opening of the housing for further diffusion of light to exit from the housing.

14. The light fixture according to claim **7**, wherein each one of the hollow cells includes:

a secondary diffusing means disposed at the second end of each one of the cells.

15. The light fixture according to claim **14**, wherein the secondary diffusing means comprises:

a concave lens.

16. The light fixture according to claim **15**, wherein select ones of the cells are angularly offset with respect to the remaining cells of the body portion for further diffusing light radiated from the body portion.

17. The light fixture according to claim **3**, wherein the illuminating means comprises:

a plurality of bulbs constructed and arranged to extend into the interior region of the housing for insertion into a corresponding one of the plurality of the channels.

18. In a light fixture consisting of an open-ended housing, a reflector disposed at a first end of the housing away from the opening, and a light source disposed at an interior of the housing for operative association with the reflector, a diffuser device adapted to be disposed at the interior of the housing, the device comprising:

a plurality of truncated cells nested together, each one of the truncated cells including:

a first end with a first opening having a first diameter for facing the light source,

a second end with a second opening having a second diameter greater than the first diameter for facing the opening of the housing, and

a hexagonally-shaped sidewall extending between the first and second ends of the truncated cell and tapering from the second end to the first end of the truncated cell,

wherein the construction and arrangement of the plurality of truncated cells provides the diffuser device with a hexagonal-shaped cross-section for light from the light source to be received at the first openings of the plurality of truncated cells and transmitted through the plurality of truncated cells in a diffused pattern for radiation from the second openings of the truncated cells to exit the housing.

19. A device for diffusing light from a luminous body, the device comprising:

a truncated body having:

a first truncated region at a first side of the truncated body for receiving light from the luminous body;

a second truncated region at a second side of the truncated body substantially opposite to the first side and adapted for emitting light; and

a central region interconnecting the first and second truncated regions, the central region increasing in diameter from the first truncated region to the second truncated region and adapted for diffusing the light transmitted along the central region for providing a diffused pattern of light emitted from the second truncated region.

20. The diffuser device according to claim **19**, wherein the first and second truncated regions and the central region each have a hexagonal-shaped cross-section.

21. The diffuser device according to claim **20**, wherein the truncated body comprises:

a plurality of hollow cells nested together, each one of the plurality of cells having:

a first end terminating at the first truncated region, and

a second end terminating at the second truncated region.

22. The device according to claim **21**, wherein each one of the plurality of cells has a hexagonal-shaped cross-section.

23. The device according to claim **21**, wherein the first end of each one of the plurality of cells has a first diameter and a second end of each one of the plurality of cells has a second diameter greater than the first diameter.

24. The device according to claim **21**, wherein each of the cells comprises:

an opening at the first end thereof, the openings constructed and arranged for receipt of an individual illuminating means.

25. The device according to claim **21**, wherein select ones of the plurality of cells are angularly offset with respect to the remainder of the plurality of cells in the truncated body.

26. A method of diffusing light, comprising the steps of:

providing a light source from which light radiates;

containing the light radiated to a first region;

interrupting the light with a concave lens in the first region;

transmitting the light from the first region in a first diffused pattern through the concave lens;

radiating the first diffused pattern of light emitted from the concave lens to a second region;

containing the first diffused pattern of light emitted from the concave lens to the second region;

interrupting the light with a truncated body in the second region;

transmitting the light from the second region in a second diffused pattern through the truncated body;

dispersing the diffused pattern of light in a widening ray; and

radiating the second diffused pattern of light emitted from the truncated body.

27. A method of diffusing light, comprising the steps of:

providing a light source from which light radiates;

interrupting the light with a substantially transparent member;

segregating a substantial portion of the light to a plurality of channels within the member;

dispersing the light transmitted in a widening ray along the plurality of channels; and

radiating a diffused pattern of light emitted from the plurality of channels.

* * * * *

Application Guide for Soraa Optical Light Engines

Introduction

This document provides background information relevant to incorporating Soraa Optical Light Engines into light fixtures or luminaires. It is intended for fixture or luminaire designers. Proper integration of Soraa Optical Light Engines ensures best results in terms of longevity, light output, cost and overall performance. This document helps to predict expected performance, in line with design targets for life time.

This application guide is relevant for Soraa Optical Light Engines, with and without heat-sink incorporated. Soraa Optical Light Engines with heat-sink, are designed to be integrated without additional thermal management. Soraa Optical Light Engines without heat-sink need additional heat-sinking, which can be in the form of the fixture shell.

Soraa Optical Light Engines are based on unique Soraa GaN-on-GaN™ LED technology and have optimized optics incorporated. This combination results in unprecedented directional lighting with perfect beam definition in a very compact form factor. Integration of optics, heat-sink and on-board temperature registration makes the fixture design cycle short and simple without a compromise to the best possible performance.

This application guide provides a suggestion for the design-in process for Soraa Optical Light Engines. It discusses LED driver specification, mechanical integration and optical integration. From the explanation of how to do on-board temperature read-out, it is discussed how temperature and drive current settings can be used to estimate life time and in fixture performance. Tables are provide to make these estimates.

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Proposed performance validation process

Soraa Optical Light Engines are easy to integrate. Below is a summary of the proposed procedure to validate performance of Soraa Optical Light Engines incorporated in a fixture. More detail on each step is provided further in the document.

Equipment needed

- Variable power supply - preset to a voltage of 35V and variable current between 0 and 700mA.
- Multimeter to read out resistance between 0.5 and 50kOhm

Procedure

1. Determine goals for lifetime, based on color and light output maintenance
2. Incorporate Soraa Optical Light Engine into fixture, choose a current setting close to nominal
3. Allow sufficient time for thermal stabilization, then read out on board NTC resistance using a multimeter and resistance to temperature conversion table
4. Look up expected color shift and lumen maintenance from life expectancy table
5. If necessary, adjust current if necessary if expectations from 1. are not met
6. Use relative light output from lumen maintenance and life expectance table and nominal light output from specification sheet to determine Optical Light Engine light output at selected current and temperature conditions
7. Select driver to provide selected current

Electrical integration

Wire information

Soraa Optical Light Engines have a 4 wire ribbon cable – 2 wires for DC power and 2 wires for NTC (thermally sensitive resistor) read-out. The wire function can be determined based on their color and location as shown in figure 1.

- Wire type: 4-wire ribbon
- Wire gauge: AWG28 - 0.321mm diameter with 0.050 inch / 1.27mm spacing between the wires
- Wire tip finish: tinned
- Wire length: 300mm

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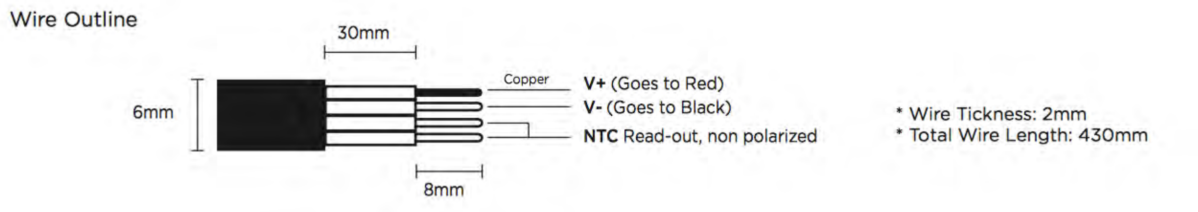

Figure 1: Wire-end schematic

- Wire harness material: transparent silicone based.

Driver specification

A constant current, class 2 isolated constant current LED driver or equivalent is required. The driver shall be able to provide the specified maximum current over the entire voltage range of 20 to 35VDC. This voltage requirement is the same for all Soraa Optical Light Engines. Depending on the light engine type, the required current setting can be different. The lower end of the voltage range is related to operation at low current amplitude, for example under current amplitude dimming.

Soraa Optical Light Engines are not designed to be driven in reverse voltage.

Light output can be varied by both Pulse Width Modulation (PWM) or amplitude variation. For uniform light output across the light beam, a current amplitude of at least 20mA is recommended.

Depending on the LED driver type, good dimming compatibility can be achieved with various dimming methods, both phase cut based and 0-10V or DALI based.

Soraa recommends to use one LED driver (or one driver channel in the case of multiple channel driver) per light engine. Parallel configuration of Optical Light Engines can result in un-predictable light output and series configuration results in an increase of overall system voltage potentially beyond the design limits of the product.

Several market available driver types have the capability to include the NTC as an input to the driver and provide thermal feedback. This can be used to ensure that the Optical Light Engine cannot exceed set temperature limits.

Mechanical integration

Soraa Optical Light Engines have been developed to provide multiple options for integration into a fixture. Optical Light Engines with heat-sink (part-number starting with SLE) can be operated without additional heat-sinking. Optical Light Engines without a heat-sink (part-number starting with SLC) require additional heat-sinking, which can be in the form of the fixture itself.

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Integration of Optical Light Engine with Heatsink (SLE-xx)

Optical Light Engines with heat-sink, can be fixated by grabbing the lip at the front (mounting option 1), can be screwed onto an external surface (mounting option 2), or can be suspended by the wire.

Mounting option 1

The lip at the front of the product for mounting option 1, matches the lip definition of MR11 (SLE11-xx), MR16 (SLE16-xx) or PAR30 (SLE30-xx) lamps. Fixtures with features to hold these lamps at the lip, will typically be able to hold Soraa Optical Light Engines in a similar way.

Mounting option 2

Soraa Optical Light Engines can be attached to an external surface on the back using 2 thread forming screws. Preformed hole pitch and screw dimensions vary by model. Additional material for thermal transport (grease or pad material) is not required.

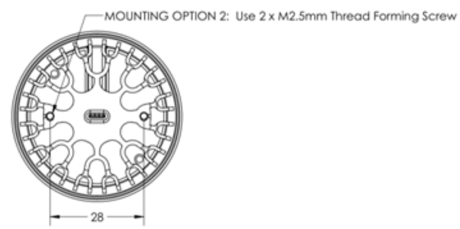
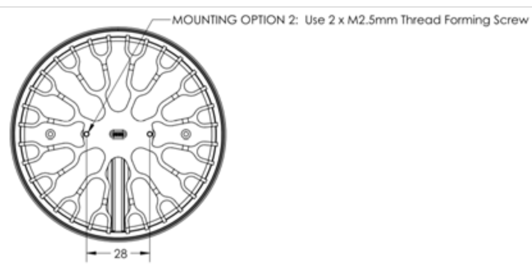
Optical Light Engine Type	Pitch between holes(mm)	Screw dimension	
SLE11-xx	16	M2x8mm	
SLE16-xx	28	M2.5x8mm	
SLE30-xx	28	M2.5x8mm	

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Figure 2: Lens attachment with circular spring-clip

Integration of Optical Light Engines without heat-sink (SLC-xx)

Soraa Optical Light Engines have a unique thin form factor. Narrow spot options in SLC30 and SLC16 diameter size are available with a a height of only 25mm and 17mm only. They are intended to enable very thin fixture design, when the fixture shell can perform the function of heat-sink.

For seamless integration the wire can be routed sideways in the horizontal plane. The backside features a channel so when side mounting of the wire is chose, flush mounting can still be achieved.

A thermal graphite pad comes standard on the backside for optimal thermal transfer. No additional thermal contact material is needed.

Figure 3: Wire routing options for SLC type. Left: center wire routing. Right: Side wire routing.

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Option 1: Mounting from the topside - requires lens removal

This option requires the lens to be removed to access the inside of the Optical Light Engine cup.

Step 1: Remove the lens by removing the spring clip. Suggested is to use a small plier or flat screw driver. Be careful not to scratch the lens.

Step 2: Take out the lens by tilting the Optical Light Engines over. To avoid finger print stains, it is recommended that direct skin contact to the lens is avoided.

Step 3: Screw in 2 screws, torque 0.5Nm. Use great care no to touch the exposed LED and its wire contacts, as this might compromise its function or reliability.

Step 4: Place back the lens and fasten it with the retained clip.

Option 2: Mounting from the back side

By using M2.5 thread forming screws the Optical Light Engine can also be attached from the back side. Recommended torque 0.5Nm.

Design resources

Two dimensional outline drawings and 3D CAD models are available on request.

Optical Light Engine		Pitch between holes (mm)	Screw size
SLC-11-xx	Option 1: from top	16	M2x8mm
	Option 2: from back	26	M2x5mm
SLC16-xx	Option 1: from top	28	M2.6x8mm or M2.5x8mm
	Option 2: from back	36	M2.5x5mm
SLC30-xx	Option 1: from top	28	M2.6x8mm or M2.5x8mm
	Option 2: from back	60	M2.5x6mm

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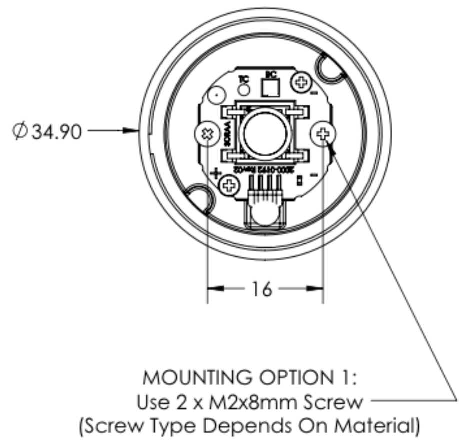
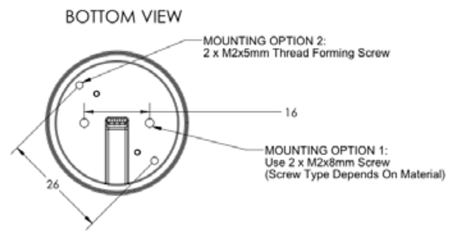
<tr><td>SLC11-xx</td><td>
</td><td>
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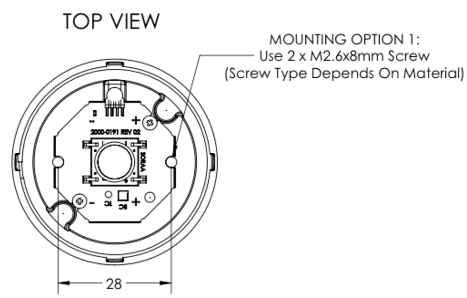
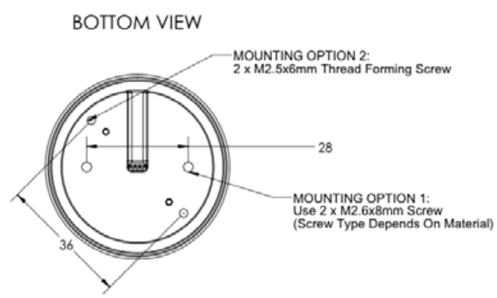
<tr><td>SLC16-xx</td><td>
</td><td>
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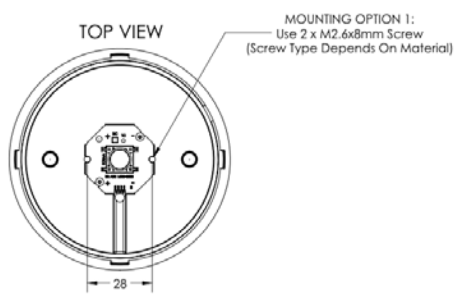
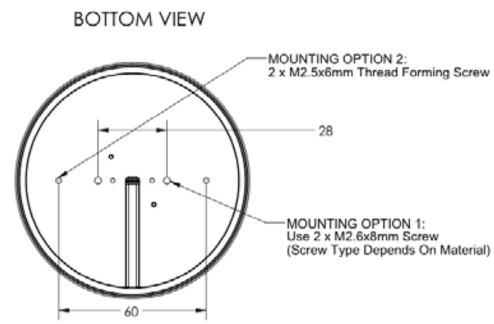
<tr><td>SLC30-X</td><td>
</td><td>
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Optical integration

Soraa Optical Light Engines are directional light sources with the optic designed and optimized to unique Soraa GaN-on-GaN LED technology. Soraa designs the optics in-house, based on in-depth understanding of the LED itself. The combination of Soraa GaN-on-GaN LED with optimized optics is referred to as Point Source Optics™. The aim in optical design is to maximize peak intensity for a given beam angle, provide very uniform color across beam and field, ensure smooth artifact-free transitions and limit wide angle light that can cause glare.

In comparison with typical LED directional lighting solutions, Soraa Optical Light Engines have a substantially smaller aperture for a given beam angle and intensity. In addition, the height of LED and optic can be less than half or a third compared to a typical LED with reflector combination of the same beam angle. Soraa Optical Light Engines provide substantially higher peak intensity (Candela) per unit of luminous flux (Lumen) for a given beam angle. The ratio of candela per lumen can be twice as high when compared to other LED solutions. The benefit of a high candela per lumen ratio is that system power can be reduced and smaller heat-sinks can be applied.

Soraa uses two types of lens optics, both based on optical grade polycarbonate molded material. The first type is referred to as TIR (for Total Internal Reflection) and is used for 25 degree and 36 degree beam angles. The second type is referred to as prism optic and provides very narrow spot and spot options (9 to 15 degree beam angle). To attach SNAP System™ optical accessories a magnet has been attached in the center of the prism optic. SNAP accessories can only be used in combination with the prism optic. Optical Light Engines SLE16 can be used with SNAP accessories AC-XXX. Optical Light Engines SLE30 are compatible with SNAP accessories AC-E-XXX.

Soraa optics are designed to provide the desired beam distribution without additional reflectors or shields.

Lenses are held in place with circular spring retainer clip, as shown in figure 2. In general, prism type lenses are not interchangeable with TIR type lenses.

Optical design resources

IES files are available for download at the www.soraa.com. It is recommended to generate optical design files at the fixture levels as the integration into the fixture might impact the light distribution and depending on the current and temperature conditions the actual output can differ from what is provided in Soraa's IES files.

Thermal integration

LED temperature has a strong correlation to the expected life of the product, as defined by customer criteria on acceptable color stability and light output maintenance. Soraa Optical Light Engines make it very easy to measure the reference temperature with the Optical Light Engine incorporated in the fixture.

Temperature Measurement

Temperature can be assessed through an NTC resistor component that is mounted on the circuit board inside the Optical Light Engine. Its temperature is representative for the temperature at the Tc point on the board. The advantage of using the NTC is that it becomes very easy to do in-situ measurement with basic equipment like a standard multi meter through two wires of the four wire ribbon cable. The resistance values measured from the NTC can be translated to temperature with the table below.

Tc	-20ºC	-10ºC	0ºC	10ºC	20ºC	30ºC	40ºC	50ºC	60ºC	70ºC	80ºC	90ºC	100ºC
Resistance (KOhm)	**480**	**271**	**158**	**95**	**59**	**38**	**25**	**16**	**11**	**7.8**	**5.6**	**4.0**	**2.9**

Typically, it will take 20 to 50 minutes for the Optical Light Engine itself to reach a stable operating temperature. Depending on the total system configuration it can take up to a few hours for the total system to reach stable operating temperature. It is recommended to do temperature evaluations at a stable operating temperature.

In most cases, it is expected that ambient temperature fluctuations outside the fixture translate directly to reference temperature changes in the Optical Light Engine by the same amount.

Depending on the drive conditions, the LED junction temperature can be up to 20ºC higher than the reference temperature on the circuit board.

Soraa's color and lumen maintenance predictions presented in this document are all based on reference temperature measurements through the NTC.

Life time predictions

Soraa defines the life of its products based on the deviation over time from its initial performance. This includes reduction in light output over time and change in color over time. The same predictions apply for different CCT and CRI options, as well as beam angle options. Life predictions apply to the entire product and include the stability of the lens.

Life predictions are based on 10,000 hours of life testing that is conducted according to LM-80 by an accredited external lab across a range of temperature and current conditions. Projections shared in this document are averages. Two sets of predictions are given. One for Optical Light Engines starting with part number SLExx-08 (SLExx can be SLE30-08 and SLE16-08) and another for part numbers starting with SLExx-06 (can be SL11-06 and SLE16-06).

Color stability over time

Soraa GaN-on-GaN LEDs provide consistent color over time, thanks to the combination of violet primary LED emission and red, green and blue phosphors that create white light. To provide insight in how an installation will appear over time, color stability is presented in two separate parts.

The first part of color stability is color spread. This indicates how much color difference can be expected within a group of Optical Light Engines in an installation. The second part is color drift over time. This indicates how much color change the Optical Light Engines exhibit as a group. While a group as a whole can drift in color, if the spreading is minimal, the lighting installation can keep its uniform appearance as time goes by. The effect of drift will become visible in comparison with a new Optical Light Engine.

It is important to split color change into spread and drift because just looking at color change in du’v’ does not provide sufficient insight in how an installation will appear over time. For example, two light sources can have a small amount of color shift but if they shift in opposite directions (for example one towards green tint and the other one towards pink tint), the effect will be clearly visible. In the context of this example, these light source may not move as a group, but show considerable color spread. In the case of this example, because of their color shift in opposite directions, the

Lumen and color maintanance predictions SLExx-06-xx / SLCxx-06-xx

If (mA)	Hours of evaluation	50000										
	Degrees Celsius	50	55	60	65	70	75	80	85	90	95	100
	Degrees Fahrenheit	122	131	140	149	158	167	176	185	194	203	212
	NTC readout (kOhm)	16.4	13.5	11.2	9.35	7.82	6.57	5.55	4.70	4.00	3.42	2.94
225	du'v' color drift	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.002	0.002	0.002	0.002
	Lumen maintenance	89%	87%	84%	81%	78%	75%	71%	67%	63%	58%	54%
	Relative light-output at T_o	79%	79%	78%	78%	77%	77%	76%	76%	75%	75%	74%
250	du'v' color drift	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.002	0.002	0.002	0.003
	Lumen maintenance	86%	84%	81%	77%	74%	70%	66%	61%	56%	52%	47%
	Relative light-output at T_o	87%	87%	86%	86%	85%	85%	84%	83%	83%	82%	82%
275	du'v' color drift	0.001	0.001	0.001	0.001	0.001	0.002	0.002	0.002	0.002	0.003	0.003
	Lumen maintenance	84%	80%	77%	73%	69%	65%	60%	55%	50%	45%	40%
	Relative light-output at T_o	95%	94%	94%	93%	93%	92%	91%	91%	90%	89%	89%
300	du'v' color drift	0.001	0.001	0.001	0.001	0.002	0.002	0.002	0.002	0.003	0.003	0.003
	Lumen maintenance	81%	77%	73%	69%	64%	60%	55%	49%	44%	39%	34%
	Relative light-output at T_o	102%	102%	101%	101%	100%	99%	99%	98%	97%	96%	96%
325	du'v' color drift	0.001	0.001	0.001	0.002	0.002	0.002	0.002	0.002	0.003	0.003	0.003
	Lumen maintenance	78%	74%	69%	65%	60%	55%	49%	44%	38%	33%	28%
	Relative light-output at T_o	110%	109%	109%	108%	107%	106%	106%	105%	104%	103%	102%
350	du'v' color drift	0.001	0.001	0.001	0.002	0.002	0.002	0.002	0.003	0.003	0.003	0.004
	Lumen maintenance	74%	70%	65%	60%	55%	50%	44%	39%	33%	28%	23%
	Relative light-output at T_o	117%	116%	116%	115%	114%	113%	113%	112%	111%	110%	109%

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spreading between the sources is actually twice their individual shift.

Soraa has found negligible color spread in its LM80 test data. The color "cloud" of parts was observed to be stable over the 10,000h test duration, across different temperature and current test conditions. Because of the absence of spreading in test data, no color spreading predictions could be generated and predictive data is not presented in this document. It is expected that color spreading will be very minimal over the life of a group of products.

Life expectation tables

Predictions for color spreading, color drift and lumen maintenance are given for 50,000h operation. In addition, the relative light output is given for current and temperature conditions. An estimate of the light output can be obtained for a given Optical Light Engine by multiplying the % number from the table with the luminous flux or peak intensities given in the specification sheet.

Lumen and color maintanance predictions SLExx-08-xx / SLCxx-08-xx

If (mA)	Hours of evaluation	50000										
	Degrees Celsius	50	55	60	65	70	75	80	85	90	95	100
	Degrees Fahrenheit	122	131	140	149	158	167	176	185	194	203	212
	NTC readout (kOhm)	16.4	13.5	11.2	9.35	7.82	6.57	5.55	4.70	4.00	3.42	2.94
450	du'v' color drift	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.002	0.002	0.002	0.002
	Lumen maintenance	88%	85%	82%	79%	76%	72%	69%	64%	60%	56%	51%
	Relative light-output at T_0	79%	79%	78%	78%	78%	77%	77%	76%	76%	75%	74%
500	du'v' color drift	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.002	0.002	0.002	0.003
	Lumen maintenance	84%	82%	78%	75%	71%	67%	62%	58%	53%	48%	43%
	Relative light-output at T_0	87%	87%	86%	86%	85%	85%	84%	84%	83%	82%	82%
550	du'v' color drift	0.001	0.001	0.001	0.001	0.001	0.002	0.002	0.002	0.002	0.003	0.003
	Lumen maintenance	81%	78%	74%	70%	66%	61%	56%	51%	46%	41%	36%
	Relative light-output at T_0	95%	94%	94%	93%	93%	92%	91%	91%	90%	89%	89%
600	du'v' color drift	0.001	0.001	0.001	0.001	0.002	0.002	0.002	0.002	0.003	0.003	0.003
	Lumen maintenance	78%	74%	70%	65%	60%	55%	50%	45%	40%	35%	30%
	Relative light-output at T_0	102%	102%	101%	101%	100%	99%	99%	98%	97%	96%	96%
650	du'v' color drift	0.001	0.001	0.001	0.002	0.002	0.002	0.002	0.002	0.003	0.003	0.003
	Lumen maintenance	74%	70%	65%	60%	55%	50%	44%	39%	34%	29%	24%
	Relative light-output at T_0	110%	109%	109%	108%	107%	106%	106%	105%	104%	103%	102%
700	du'v' color drift	0.001	0.001	0.001	0.002	0.002	0.002	0.002	0.003	0.003	0.003	0.004
	Lumen maintenance	70%	65%	60%	55%	50%	44%	39%	33%	28%	23%	19%
	Relative light-output at T_0	117%	116%	116%	115%	114%	113%	112%	111%	111%	110%	109%

Light depreciation tables

In addition to the tables for 50,000h performance extrapolations, tables are given to estimate the time to light output maintenance of 70%. Soraa extrapolates up to 6 times the tested time of 10,000 hours. Light output maintenance can be applied to both peak intensity and luminous flux. Similar to the 50,000h prediction tables, a separate table is given for SLExx-08 and SLExx-06 type Optical Light Engines.

Time to lumen maintenance SLExx-06-xx / SLCxx-06-xx

Lumen maintenance		70%										
Degrees Celsius		50	55	60	65	70	75	80	85	90	95	100
Degrees Fahrenheit		122	131	140	149	158	167	176	185	194	203	212
If (mA)	NTC readout (kOhm)	16.4	13.5	11.2	9.35	7.82	6.57	5.55	4.70	4.00	3.42	2.94
225		>60,000	>60,000	>60,000	>60,000	>60,000	>60,000	52,000	45,000	39,000	34,000	29,500
250		>60,000	>60,000	>60,000	>60,000	58,000	49,500	42,500	36,500	32,000	27,500	24,000
275		>60,000	>60,000	>60,000	56,500	48,500	41,500	35,500	30,500	26,500	23,000	20,000
300		>60,000	>60,000	56,500	48,000	41,000	35,000	30,000	26,000	22,500	19,500	17,000
325		>60,000	57,500	48,500	41,500	35,000	30,000	26,000	22,500	19,500	17,000	14,500
350		60,000	50,000	42,500	36,000	30,500	26,000	22,500	19,500	17,000	14,500	13,000

Time to lumen maintenance SLExx-08-xx / SLCxx-08-xx

Lumen maintenance		70%										
Degrees Celsius		50	55	60	65	70	75	80	85	90	95	100
Degrees Fahrenheit		122	131	140	149	158	167	176	185	194	203	212
If (mA)	NTC readout (kOhm)	16.4	13.5	11.2	9.35	7.82	6.57	5.55	4.70	4.00	3.42	2.94
450		>60,000	>60,000	>60,000	>60,000	>60,000	55,000	47,500	41,000	35,500	31,000	27,500
500		>60,000	>60,000	>60,000	>60,000	51,500	44,500	38,500	33,000	29,000	25,000	22,000
550		>60,000	>60,000	58,500	50,000	42,500	36,500	31,500	27,500	24,000	20,500	18,000
600		>60,000	58,000	49,000	42,000	35,500	30,500	26,500	23,000	20,000	17,500	15,000
650		58,500	49,500	42,000	35,500	30,500	26,000	22,500	19,500	17,000	15,000	13,000
700		50,500	42,500	36,000	30,500	26,000	22,500	19,500	17,000	14,500	12,500	11,000

EXHIBIT B

Handling and assembly

General handling

To ensure optimal optical performance, it is recommended that the lens is not directly touched. Otherwise the Optical Light Engines can be handled manually or by machine.

Considerations for assembly into fixture

The 4-lead ribbon wire has a strain relief incorporated. Soraa Optical Light Engines have been burned-in for 12 hours.

Identification

All Soraa Optical Light Engines have a manufacturing data code on the label. The date code consists of year and week of manufacture. For example: 1502 refers to the second week of 2015.