The arrangement comprises a substrate (15) with a plurality of electrically conductive traces (10) and at least one light emitting device (2), a light emitting diode or a chip comprising one or more light emitting diodes, preferably surface mounted on the substrate (15) and connected with a first and a second electrical electrode (21, 22) to said electrically conductive traces (10). A ring (6), that is placed onto the substrate (15) and that surrounds the light emitting device (2) comprises a lower surface (62), that is attached to the substrate (15), and an upper surface (61), that is designed to reflect the light emitted by the light emitting device (2) into a desired direction. Besides the advantageous collection and redirection of light, the ring (2) allows precise placement of an encapsulation (3) or a lens (31) that may be part of the encapsulation (3) and absorbs thermal energy from the encapsulation (3) that has been transferred from the top and sidewalls of the light emitting device (2).
Arrangement with a light emitting device on a substrate

The present invention relates to an arrangement with at least one light emitting device, a light emitting diode (LED) or a chip comprising one or more light emitting diodes (LEDs), placed on a substrate according to claim 1.

The present invention further relates to an arrangement with an array of light emitting devices placed on said substrate.

The present invention relates in particular to an arrangement with at least one light emitting device and means designed to dissipate the thermal energy generated by the light emitting device as well as means used to reflect the light emitted by the light emitting device.

As described in [1], US 6,498,355 B1, arrays of LEDs may be employed in a variety of high flux (optical energy/unit time) applications such as street lighting, traffic signals, and liquid crystal display back-lighting. In order to increase the flux provided per unit area of the LED array, the spacing between LEDs in the array is decreased (thus increasing the number of LEDs per unit area of the array) and/or the flux provided by the individual LEDs is increased. However, either approach to increasing the flux per unit area of an LED array also increases the thermal energy that must be dissipated to avoid significant degradation of the performance of the LEDs. In order to improve heat dissipation, LED arrays described in [1] are placed on an insulated metal substrate IMS comprising a dielectric layer disposed above a metal substrate that acts i.a. as a heat sink (see figure 1 below). A plurality of electrically conductive traces is disposed on the dielectric layer and a plurality of vias pass through the dielectric layer. Each of the LEDs is disposed above a corresponding one of said vias and includes a first and a second electrical
contact electrically coupled to separate ones of the electrically conductive traces. Each of the vias contains a thermally conductive material in thermal contact with the metal substrate and the corresponding LED. The thermally conductive material may include, for example, a solder material. In some embodiments described in [1], the thermally conductive material in a via is in direct physical contact with the metal substrate and the corresponding LED. Such direct physical contact is sufficient but not necessary to establish thermal contact.

The thermally conductive material in a via provides a low thermal resistance path for heat to flow from an LED disposed above the via to the metal substrate, which then effectively conducts the heat away. Consequently, LEDs in arrays may be operated at higher currents and may be spaced closer together without raising their temperatures to levels that degrade their performance.

The requirement of efficient heat dissipation in LED arrays is emphasized in [2], US 2002/0042156 A1 stating that latest white light LEDs no longer use 15 mA to 20 mA as standard currents, but above 50 mA, even up to 100 mA, causing corresponding thermal energies requiring an effective heat conductance.

In [2] it is further stated that traditional surface mounted LEDs frequently do not have reflective bases. According to [2], a reflective base may be realised by forming a concave recess on the substrate, e.g. on a printed circuit board. Then a metal reflective layer is applied to the recess, followed by die bonding or wire bonding the mounted LED and encapsulation. A disadvantage resulting from this technique, particularly caused by the curved shape of the recess, is the low quality of the connections obtained through the bonding processes, which require a flat surface.
Hence, in [2] it is proposed to drill holes into a printed circuit board PCB at the positions LEDs or LED chips are placed, followed by through-hole plating, followed by passing the printed circuit board through a solder furnace to completely fill all through-plated holes with high-temperature solder, followed by pressing solder points with moulds to form a dish-shaped groove, which is suitable for die bonding of LED chips and light reflection, followed by gold or silver plating the groove surface to form a highly reflective metal film, finally followed by die bonding, wire bonding and encapsulation of the LEDs, e.g. by means of a resin. The solder points act as vias that, as described in [1], transport the thermal energy generated by the LED to its other end, where a heat-dissipating material, such as a metal substrate is preferably applied (see [2], figure 5 and figure 2 below).

The solutions described in [1] and [2] allow therefore efficient transfer of thermal energy generated from one side of an LED or an LED chip to a metal substrate that acts as a heat sink. From the other sides of the LED, thermal energy is dissipating into the encapsulation that is insignificantly cooled by air. During operation the LED is therefore exposed to a resulting temperature gradient that may have negative impact on the performance of the LED.

Further, the solution described in [1] does not comprise a reflective element that directs the light emitted by the LED towards the application area. Hence, in addition to the occurrence of stray light losses the efficiency of the LED array is reduced by a partial misguidance of the light beams. This is especially disadvantageous in applications where the light should be emitted in a narrow beam, as often required with traffic lights.

The process for manufacturing the reflecting element as described in [2] is however extremely laborious, requiring
numerous process steps. Still further, this process may not be used with substrates, e.g. multi-layered substrates that do not allow drilling holes. A second embodiment described in [2] (see figures 8 to 14) that requires the build up and forming of metal structures on the surface of the printed circuit board is cumbersome as well. The placement and bonding procedures in the grooves formed in the solder points (vias) or the metal structures are difficult to perform as well. The use of further bonding techniques is limited since electrically conductive traces are not available or can not easily be arranged within said dish-shaped grooves.

Still further, the resin encapsulations and lenses used to seal the LEDs and/or to direct the light beams can often not easily and precisely be placed with the arrangements described in [1] and [2].

It would therefore be desirable to provide an improved arrangement with at least one light emitting device, a light emitting diode (LED) or a chip comprising one ore more light emitting diodes (LEDs), placed on a substrate.

It would be desirable in particular to provide an improved arrangement that can be produced with less effort and cost; that can be realised without limitations regarding substrates and bonding techniques; that provides improved dissipation of thermal energy generated by the LEDs and that provides improved reflection of light emitted by the LEDs.

SUMMARY OF THE INVENTION

The above and other objects of the present invention are achieved by an arrangement with at least one light emitting diode according to claim 1.

The arrangement comprises a substrate with a plurality of electrically conductive traces and at least one light emitting
device, a light emitting diode or a chip comprising one or more light emitting diodes, preferably surface mounted on the substrate and connected with a first and a second electrical contact to said electrically conductive traces. According to the present invention, a ring is placed onto the substrate in such a way that it surrounds the light emitting device. The ring comprises a lower surface, that is attached, preferably bonded to the substrate, and an upper surface, that is designed to reflect the light emitted by the light emitting device.

The light emitting device can therefore be placed, preferably surface mounted on the substrate and bonded to the electrically conductive traces with conventional techniques and machinery as used for any other device that is mounted on the substrate. Preferably the light emitting device is contained in a ball grid array package and bonded to the electrically conductive traces by means of ball grid array technique (ball grid array techniques are described in [3], BGA (Ball Grid Array), National Semiconductor Corporation, Application Note 1126, issued August 2003). Since the surface of the substrate is flat, the connections resulting from the bonding processes, i.e. processes used for connecting the electrodes of the light emitting device to the electrically conductive traces, are of standard high quality.

The rings, which may be round, circular or rectangular, can be picked and placed, e.g. by means of a vacuum picker device, in the same manner as any surface mounted device so that the manufacturing of the inventive arrangements can be performed rapidly and at low cost. For this purpose the rings are formed accordingly, preferably provided with a flat area that allows coupling with the vacuum picker device.

Preferably the rings are made of a thermally and electrically conductive material that allows efficient transfer of thermal energy and that can be bonded to electrical contacts, e.g. to
the metal substrate, an electrode of the light emitting device or to the electrically conductive traces.

In a preferred embodiment an array of rings formed in one piece is placed onto the substrate so that each of the rings surrounds a light emitting device. All the interconnected rings, i.e. the ring array, can therefore be mounted in one process step. Further the ring array itself can easily be manufactured with an individual orientation of the reflection axes of the reflecting upper surfaces of the rings.

The light emitting device and the ring are attached to the substrate preferably by means of a thermally conducting adhesive or solder. In order to achieve an optimal transfer of thermal energy the lower surface of the ring may directly be soldered to a metallic element of the substrate, possibly to one of the electrically conductive traces that lead to ground and that may be connected to the metallic heat sink. Efficient heat dissipation from the light emitting device to the heat sink results further from the bonding connections.

In order to obtain a narrow light beam the reflecting upper surface of the ring is formed at least approximately as a parabolic reflector, a conical reflector or an angular, e.g. a pyramidal reflector. Furthermore the light emitting device is preferably placed in or close to the focus of the parabolic reflector or the vertex of the conical reflector. The reflecting upper surface of the ring is preferably coated with a film of highly reflective material such as silver in order to obtain a good light reflection with low losses. The metal coating may be plated or evaporated onto the upper surface of the ring.

The reflective upper surface of the ring may be formed in such a way that the axis of the reflector of the ring is in line or inclined to a line standing perpendicular to the substrate. The
axes auf the light beams emitted by the LEDs of an array may therefore individually be directed towards at least one distant target (regarding technological background see [4], US 6,554,451 B1, a method for illuminating an object by means of a plurality of LEDs).

The inventive solution may be applied on different substrates that comprise heat-dissipating material such as printed circuit boards or insulated metal substrates (IMS), for example as described in [1] and [2].

The substrate is preferably an insulated metal substrate (IMS) with an electrically insulating, but thermally conducting dielectric layer or an insulated metal substrate (IMS) with a dielectric layer through which pass one or more thermally conducting vias, that are located at positions, where the light emitting devices or the rings are placed, in order to transfer thermal energy from the light emitting devices directly or via the rings to the heat sink.

In a further preferred embodiment the light emitting device and the ring are covered by an optically transmissive encapsulation preferably made by at least one layer of a resin, for example as described in [5], US 6,351,069 B1. The use of a ring that preferably contacts the encapsulation with the upper surface, allows transferring thermal energy at a high rate from the encapsulation to the heat sink. Hence, with the inventive solution in this preferred embodiment, thermal energy is transferred efficiently away from all sides of the light emitting device.

As described in [5], the encapsulation may be formed with one or more layers that may have different functionalities. The lowest layer, that covers the light emitting device, may have a high thermal conductivity while an upper layer may comprise
supplementary fluorescent material that radiates secondary light, in order to adjust the spectrum of the emitted light.

In a further preferred embodiment the ring comprises an annular groove, preferably arranged concentrically above the reflective upper surface and designed; either to receive resin during the fabrication of the encapsulation, preferably to provide a borderline for the flow of resin and to hold the encapsulation in place; or to receive and hold a lens that collects and directs light emitted by the light emitting device. Hence, the ring also facilitates the fabrication of the encapsulation.

BRIEF DESCRIPTION OF THE DRAWINGS

Some of the objects and advantages of the present invention have been stated, others will appear when the following description is considered together with the accompanying drawings, in which:

Figure 1 shows an arrangement 1000 with an LED or LED chip mounted on a substrate as described in [1];

Figure 2 shows an arrangement 1001 with an LED or LED chip mounted on a substrate as described in [2];

Figure 3 shows a preferred embodiment of an inventive arrangement 1 with a light emitting device 2 that is placed on a substrate 15, asymmetrically BGA-bonded to conductive traces 101, 102 and that is surrounded by a ring 6 with a reflective upper surface 61;

Figure 4 shows a further embodiment of an inventive arrangement 1 with a light emitting device 2 that is BGA bonded to one conductive trace 102 and that is wire-bonded to the ring 6, which is soldered to the other conductive trace 101;
Figure 5 shows a further embodiment of an inventive arrangement 1 with a light emitting device 2 that is placed on a substrate 15 and that is thermally connected to a heat sink layer 12 of the substrate 15 by means of a via 13;

Figure 6 a further inventive arrangement with an encapsulation 3 that comprises a lens 31, which is placed onto the ring 6 and an encapsulant, which has been injected through a channel 150 provided in the substrate 15;

Figure 7 shows a sectional view of a ring 6 comprising a vertical reflection axis x;

Figure 8 shows a sectional view of a ring 6 comprising an non-vertical reflection axis x';

Figure 9 shows a section of an inventive arrangement 1 with an array of light emitting devices 2 and rings 6 from the top;

Figure 10 shows an array of six light emitting devices 2 that are connected in parallel to conductive traces 101, 102 by means of asymmetrical BGA bonding;

Figure 11 shows a further circuit arrangement for the light emitting devices 2; and

Figure 12 an inventive arrangement with an array 60 of interconnected rings 6a; ..., 6i.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Figure 1 shows the arrangement of [1], figure 1 with an LED 2 or LED-chip mounted on an insulated metal substrate IMS 15 consisting of a metal substrate 12 that is covered by a dielectric layer 11 and a trace layer 10 comprising conventional electrically conductive traces that are connected
by means of solder points 4 to the electrodes 21, 22 of the LED 2. Located below the LED 2 is thermally conducting material 13 of a via, which passes through the trace layer 10 and the dielectric layer 11 to terminate on or in metal substrate 12. LED 2 also includes a thermal contact 131 (e.g., a metal pad) that in some implementations may electrically be isolated from the electrodes 21, 22 of the LED 2. Such electrical isolation may be provided, for example, by an optional dielectric layer.

The arrangement also includes an encapsulation with a lens 3 that is disposed over the LED 2 to collect and direct light emitted by the LED 2. According to [1], such lenses may be conventionally cast or moulded in clear plastic or elastomer onto some or all of the LEDs 2 of a an LED-array. Alternatively, small portions of silicone or similar clear material, below called resin, may be conventionally dispensed onto some or all of the LEDs 2 and then cured to form simple lenses. Alternatively hollow clear lenses may be conventionally heat staked, glued, or press fit over some or all of the LEDs 2 and then filled with silicone, for example, to encapsulate the LEDs 2.

LEDs that may be used for an LED array are described for example in [1], which is incorporated herein in its entirety.

As described above, the arrangement described in [1] does not use a reflector. The light, which is not collected by the lens 3, is not directed to the target, but lost as stray light.

Figure 2 shows the arrangement of [2], figure 5 with an LED 2 or LED-chip mounted on a printed circuit board PCB 15' that is covered on the lower side with heat-dissipating material and on the upper side with a trace layer 10 comprising conventional electrically conductive traces that are bonded to the electrodes of the LED 2. The LED 2 is disposed on a solder point 5 that has been filled into a hole, which was drilled
into the PCB 15' and plated with a metal sleeve 7. As in the arrangement shown in [1] or figure 1 below, the LED 2 is located above thermally conducting material 13 of a via that passes through the trace layer 10 and the PCB 15' to terminate on or in a metal substrate 12. The upper side of the solder point comprises a dish shaped form with a flat central portion 52, that is designed for mounting the LED 2, that is adjoined by a conical sidewall 51 designed to reflect the light emitted by the LED 2.

Fabricating the solder point with the dish shaped form on one side requires numerous process steps. Further, the placement and contacting of the LED can not be performed on the same plane and with the same means as with other electrical elements placed on the PCB 15' that can be connected to the electrically conductive traces of the trace layer 10.

Figure 3 shows an inventive arrangement 1 with a light emitting device 2, an LED or a chip comprising one or more LEDs, that is placed on an insulated metal substrate 15 comprising a metal substrate 12 that is covered by a dielectric layer 11 and a trace layer 10 incorporating electrically conductive traces 101, 102. The electrodes of the light emitting device 2 are connected to the trace layer 10 by means of a ball grid array technique, for example as described in [3]. Ball grid array (BGA) techniques provide several advantages over conventional bonding techniques, in particular higher packing densities and improved thermal and electrical performance, while being compatible with existing Surface Mount Technology (SMT) infrastructure. Light emitting devices 2 can therefore be designed as ball grid array packages and placed and connected with BGA-technology to the electrically conducting traces 10 provided on the surface of the substrate 15. However any other Surface Mount Technology (SMT) is also applicable.
Concentrically to the light emitting device 2 a ring 6 has been placed, which comprises a lower surface 62, that is attached to the substrate 15, and an upper surface 61, that is designed to reflect and direct the light emitted by the light emitting device 2. The ring 6 can easily be picked and placed before or preferably after the light emitting device 2 has been mounted.

The lower surface 62 of the ring 6 may be attached to the substrate 15 in different ways. In a preferred embodiment, the ring 6 is attached, soldered or glued with a thermally conducting adhesive, to the trace layer 10 and/or to the dielectric layer 11. As shown in figure 3 the lower surface 62 of the ring 6 is electrically insulated from the first conductive trace 101 by means of a varnish layer 18.

As shown symbolically the second conductive trace 102 is connected, e.g. soldered or glued to the lower surface 62 of the ring 6 and/or to the metal substrate 12. Thermal energy can therefore efficiently be transferred to the ring 6 and/or to the metal substrate 12 via the second conductive trace 102. Hence, in preferred embodiments, the light emitting device 2 comprises asymmetrical bonding areas for the electrodes 21, 22.

The first electrode 21 comprises a small area which is sufficient for bonding the electrode 21 to the first conducting trace 101. The second electrode 21 comprises a large area which is designed for bonding the electrode 21 to a corresponding area of the second conducting trace 101 in order to establish an electrical connection and to provide a high thermal conductivity. If BGA-technology is applied, then the second electrode 22 comprises therefore a ball grid array with a comparably high number of balls. After the placement of the light emitting device 2 a heating process is applied that melts and connects the balls to the conductive traces 101, 102.

Figure 4 shows a further embodiment of an inventive arrangement 1 with a multi-layered light emitting device 2 with the second
electrode 22 BGA-bonded to one conductive trace 102 and with the first electrode 21 wire-bonded to the ring 6 (see wire 210), which is connected by solder 110 to the other conductive trace 101. In this embodiment the lower surface of the light emitting device 2 is completely covered and connected to the conductive trace 102 by means of the second electrode 22, thus providing an optimal transfer of thermal energy.

The light emitting device 2, the ring 6 and/or the trace layer 10 may also be thermally connected to the metal substrate 12 by means of vias.

Figure 5 shows an inventive arrangement 1 with a light emitting device 2 that is mounted on a substrate 15. Located below the light emitting device 2 is thermally conducting material of a via 13, which passes through the trace layer 10 and the dielectric layer 11 to terminate on or in the metal substrate 12. The light emitting device 2 in this preferred embodiment includes a thermal contact 131 that in some implementations is electrically isolated from one or both of the electrodes 21, 22.

The ring 6, or a part 69 of it, is in direct contact with the metal substrate 12. In order to avoid contact with electrically conducting traces 101, 102 the ring 6 may have recesses 64 acting as passage ways (see figure 4). As an alternative a section of the ring 6 may be cut off.

With the described solutions, thermal energy originating from the light emitting device 2 and possibly received by the ring 6 via an encapsulation 3, that covers the light emitting device 2, is efficiently transferred to the metal substrate 12.

The upper surface 61 of the rings 6 shown in figures 3 to 5 is designed to reflect the light emitted by the light emitting device 2. The ring 6 is preferably made of metal that may be covered with a film of highly reflective material such as
silver, gold or ni-palladium in order to avoid diffuse reflectance.

Preferably the upper surface 61 of the ring 6 is formed at least approximately as a parabolic reflector, a conical reflector or an angular reflector, e.g. a pyramidal reflector in order to obtain good beam directivity.

The light emitting device 2 is preferably placed in or close to the focus of the parabolic reflector or the vertex of the conical reflector, so that all the stray light emitted by the light emitting device 2 is redirected by the reflecting upper surface 61.

As shown in figures 7 and 8 the reflecting upper surface 61 of the ring 6, 6' designed in such a way, that the axis x; x' of the reflector is in line (see figure 7) or inclined (see figure 8) to a line standing perpendicular to the substrate 15 or to the plane of the lower surface 62, thus pointing into a desired direction.

As shown in figures 9 and 12 the arrangement may comprise an array of light emitting devices 2, each placed in a central, round or angular gap 65 of the related ring 6; 6a, ..., 6i.

Figure 12 shows that the rings 6 of the array comprise a flat wing element 68 that, for mounting purposes, can be grasped by means of a vacuum picker device. After the light emitting device 2 and the ring 6 has been mounted and possibly soldered to one of the conductive traces 101, the wing element 68 can be wire-bonded to the corresponding electrode 21 of the light emitting device 2 (see figure 5). Other techniques for picking and placing the rings 6 are also applicable. E.g., as shown in figure 7, an adhesive tape 150 may be applied to the rings 6 that can be contacted by a picking tool.
In the embodiment shown in figure 12 the array of rings 6a, ..., 6i is formed as one piece or a ring mask that can be placed onto the substrate 15 in one process step. The reflecting upper surfaces 61, 61' of the rings 6a, ..., 6i may comprise flat planes or a round, conical or parabolic form.

Figures 10 and 11 show electrical circuits with light emitting devices 2 connected to electrically conductive traces.

Figure 10 shows an array of six light emitting devices 2 that are connected in parallel to the conductive traces 101, 102 by means of the inventive asymmetrical BGA bonding. The contact areas of the second electrodes 22 of the light emitting devices 2, which are approximately four times the size of the areas of the first electrode 21, are arranged adjacent to each other above a rectangular stripe of the second conductive trace 102, which is preferable connected to the electrical and/or to the thermal ground, e.g. to the metal substrate 12. The thermal energy generated by each light emitting device 2 can therefore be transferred across a large electrode area while the comparably small size of the area of the first electrode 21 is absolutely sufficient for establishing an electrical contact. The ratio of the areas of the electrodes 21, 22 may be selected in such a way that a sufficient electrical contact can be established with the first electrode 21 while the area of the second electrode is maximised. The ratio, that depends on the size of the light emitting device 2 and the applied bonding technology may therefore be up to 1:10 or far higher.

Figure 11 shows a further circuit arrangement with four light emitting devices 2 that are connected, pair by pair in series and parallel.

As mentioned above, the light emitting device 2 and the ring 6 are preferably covered by an optically transmissive encapsulation 3 that may provide several functions. Preferably
the encapsulation 3 is designed to protect the light emitting device 2, to collect and direct the light emitted by the light emitting device 2, to adjust the wavelength spectrum and, as described below, to transfer thermal energy from the light emitting device 2 to the ring 2. As described in [5], the encapsulation 3 may be formed with one or more layers that may have different functionalities. The lowest layer, that covers the light emitting device 2, may have a high thermal conductivity while an upper layer may comprise supplementary fluorescent material that radiates secondary light, in order to adjust the spectrum of the emitted light.

As shown in figures 6 and 8 the ring 6 may also be covered by a lens 31 that collects and directs the light of the light emitting device 2. The space enclosed within the ring 6 and the lens 31 may preferably be filled with an encapsulant 32 such as silicone.

In order to securely and precisely hold the encapsulation 3 and the lens 31 in position, the ring 6 preferably comprises holding means such as an annular groove 63 that is preferably arranged above the reflective upper surface 61, said groove 63 being designed either to be filled with resin during the fabrication process of the encapsulation 3 or to receive and hold the lens 31. Placement and precise alignment of the lens 31 is therefore facilitated.

Figure 6 shows an arrangement with a lens 31 that has been placed into the annular groove 63 of the ring 6. The space below the lens 31 has been filled with an encapsulant 32 that has been injected through a channel 150 provided in the substrate 15. In order to allow the air, which is enclosed by the lens 31 and the ring 6, to escape during the injection process, one or more vent channels 151, 67 are provided in the substrate 15 and/or in the ring 6.
What has been described above is merely illustrative of the application of the principles of the present invention. Other arrangements can be implemented by those skilled in the art without departing from the spirit and scope of protection of the present invention. The invention can be applied with different substrate architectures, different kinds of LEDs, different LED-packages, in particular Ball Grid Array or Land Grid Array-chip-packages or derivates thereof, and different techniques to connect the LEDs and LED-packages to the electrically conductive traces 10. Further, various forms and materials are applicable for the encapsulation 3. Hence, besides Ball Grid Array technology further grid array technologies such as Land Grid Array technology is analogously applicable. Form, material and coating of the ring 2, as well as the materials, adhesives or solder, and techniques to attach the ring 2 to the substrate 15 or to the metal layer 12 can be selected according to the given requirements by a man skilled in the art. Still further the invention is not limited to

REFERENCES:

[1] US 6,498,355 B1


[3] BGA (Ball Grid Array), National Semiconductor Corporation, Application Note 1126, issued August 2003


[5] US 6,351,069 B1
CLAIMS

1. Arrangement (1) with a substrate (15) comprising a plurality of electrically conductive traces (10) with at least one light emitting device (2), a light emitting diode or a chip with one or more light emitting diodes, placed on the substrate (15) and connected with its electrodes (21, 22) to said electrically conductive traces (10), and with a ring (6) placed on the substrate (15) surrounding the light emitting device (2) and comprising a lower surface (62), that is attached to the substrate (15), and an upper surface (61), that is designed to reflect the light emitted by the light emitting device (2).

2. The arrangement of claim 1, wherein an array of light emitting devices (2) is provided, each surrounded by a discrete ring (6) or by a ring (6a; ..., 6i) of a ring-array (60) that is formed as one piece.

3. The arrangement of claim 1 or 2, wherein the ring (6)
   a) is designed in such a way that it can be grasped and held by a tool, preferably a vacuum picker device; and/or
   b) consists at least partially of metal that can be soldered or bonded to a metal substrate (12), an electrode (21; 22) of the light emitting device (2) or to the electrically conductive traces (10); and/or
   c) is formed round or angular; and/or
   d) is made of a thermally and electrically conductive material.

4. The arrangement of claim 1, 2 or 3, wherein the upper surface (61) of each ring (6) is formed at least
approximately as a parabolic reflector, a conical reflector
or an angular reflector.

5. The arrangement of claim 4, wherein the light emitting
device (2) is placed in or close to the focus of the
parabolic reflector or the vertex of the conical reflector.

6. The arrangement of claim 4 or 5, wherein the axis \((x; x')\)
of the reflector of the ring (6) is in line or inclined to
a line standing perpendicular to the substrate (15).

7. The arrangement according to one of the claims 1 to 6,
wherein the ring (6) or the ring array (60) is made of
metal or wherein the ring (6) or the ring array (60) is
made of metal with the reflective upper surfaces (61)
covered with a film of highly reflective material such as
silver, gold, palladium, ni-palladium.

8. The arrangement according to one of the claims 1 to 7,
wherein the substrate (15), a printed circuit board or an
insulated metal substrate, comprises or is adjoined by
heat-dissipating material (12), that is thermally connected
to the light emitting device (2) and/or to the ring (6).

9. The arrangement according to one of the claims 1 to 8,
wherein the substrate (15) is an insulated metal substrate
with a thermally conducting dielectric layer (11) and/or
wherein the substrate (15) is an insulated metal substrate
with a dielectric layer (11) through which pass one or more
thermally conducting vias (13), that are located at
positions, where the light emitting devices (2),
electrically conductive traces (10) or the rings (6) are
placed.

10. The arrangement according to one of the claims 1 to 9,
wherein the light emitting device (2) and the ring (6) are
covered by an optically transmissive encapsulation (3)
preferably made by at least one layer of a resin or wherein the ring (6) is covered by a lens (31) and the space enclosed within the ring (6) and the lens (31) is preferably filled with an encapsulant (32) such as silicone.

11. The arrangement according to claim 10, wherein at least one of the layers covering the light emitting device (2) is thermally conductive and/or comprises supplementary fluorescent material that radiates secondary light.

12. The arrangement according to one of the claims 1 to 11, wherein the ring (6) comprises an annular groove (63) preferably arranged above the reflective upper surface (61), said groove (63) being designed either to be filled with resin, to provide a borderline for the flow of resin and to hold the encapsulation (3) or to receive and hold the lens (31).

13. The arrangement according to one of the claims 1 to 12, wherein the light emitting device (2) is contained in a ball grid array package and bonded to the electrically conductive traces (10) by means of a grid array technique such as ball grid array or land grid array technique, and/or wherein the light emitting device (2) is contained in a grid array package, such as ball grid array or land grid array package, with a smaller and with a larger electrode (21; 22) that is thermally and/or electrically connected to the metal substrate (12).

14. The arrangement according to one of the claims 1 to 13, wherein the light emitting device (2) and the ring (6) are attached to the substrate (15) by means of a thermally conducting adhesive or that the ring (6) is soldered to the metallic elements (10; 12) of the substrate (15).
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H01L33/00

According to international Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H01L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, PAJ, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
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<td>A</td>
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<td>X</td>
<td>PATENT ABSTRACTS OF JAPAN vol. 2003, no. 02, 5 February 2003 (2003-02-05) &amp; JP. 2002 319711 A (CITIZEN ELECTRONICS CO LTD), 31 October 2002 (2002-10-31) paragraph '0028' - paragraph '0034'; figures 1-4</td>
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Further documents are listed in the continuation of box C.

Date of the actual completion of the international search
19 October 2004

Date of mailing of the international search report
29/10/2004

Name and mailing address of the ISA
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