US010297731B2

(12) United States Patent
Odnoblyudov et al.

(10) Patent No.: US 10,297,731 B2
(45) Date of Patent: May 21, 2019

(54) **LIGHT EMITTING DIODE CONSTRUCTIONS AND METHODS FOR MAKING THE SAME**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **14/555,508**

(22) Filed: **Nov. 26, 2014**

(65) **Prior Publication Data**

US 2016/0149100 A1 May 26, 2016

(51) **Int. Cl.**

H01L 33/58 (2010.01)
H01L 33/62 (2010.01)
H01L 21/56 (2006.01)

(52) **U.S. Cl.**

CPC ***H01L 33/58*** (2013.01); *H01L 21/568* (2013.01); *H01L 33/62* (2013.01); *H01L 2224/18* (2013.01); *H01L 2924/0002* (2013.01); *H01L 2924/181* (2013.01); *H01L 2933/005* (2013.01); *H01L 2933/0033* (2013.01); *H01L 2933/0058* (2013.01); *H01L 2933/0066* (2013.01)

(58) **Field of Classification Search**

CPC H01L 33/58; H01L 33/54; H01L 33/36; H01L 33/505; H01L 33/38

See application file for complete search history.

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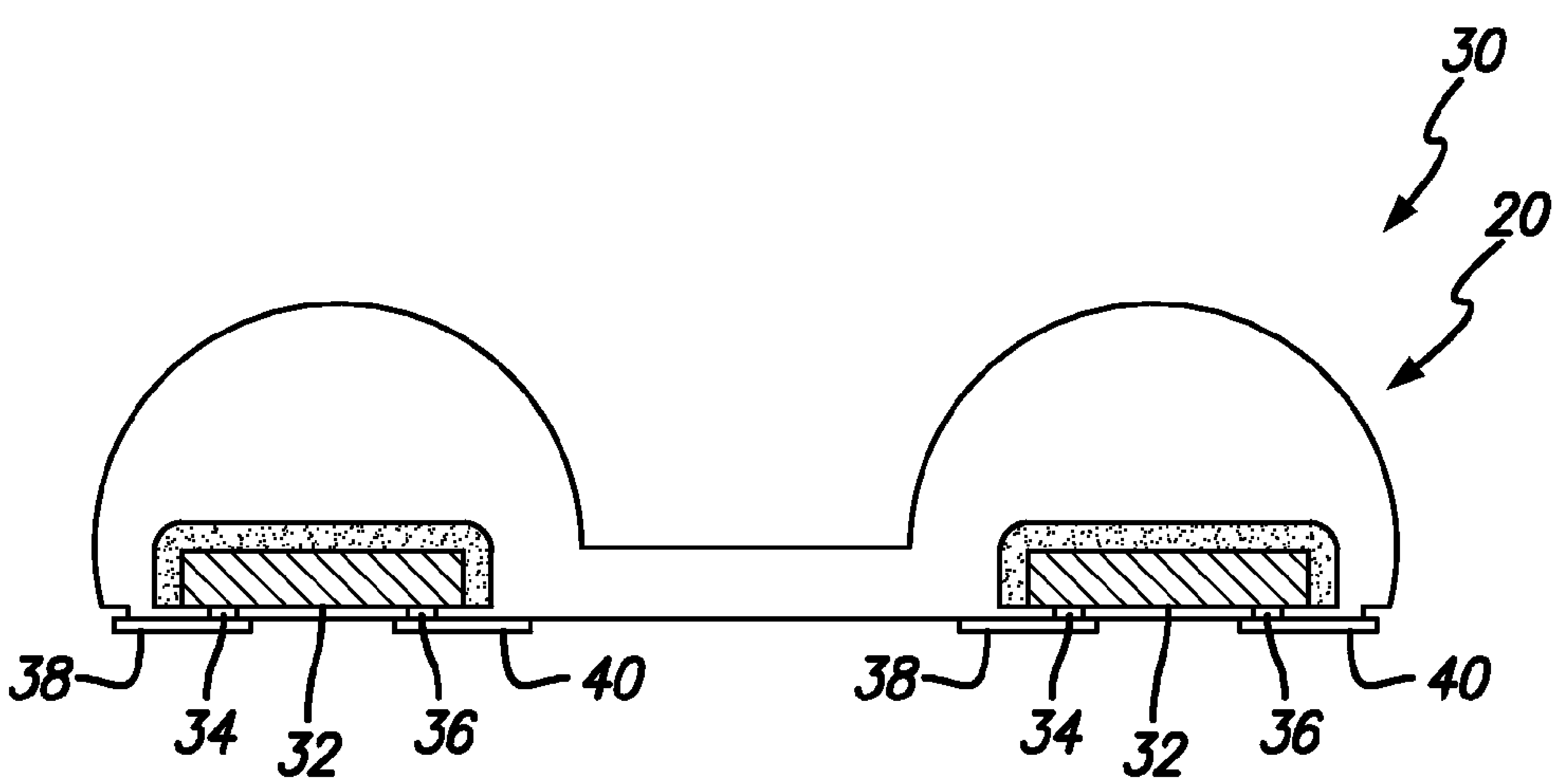
(57) **ABSTRACT**

Light emitting diode (LED) constructions comprise an LED having a pair of electrical contacts along a bottom surface. A lens is disposed over the LED and covers a portion of the LED bottom surface. A pair of electrical terminals is connected with respective LED contacts, are sized larger than the contacts, and connect with the lens material along the LED bottom surface. A wavelength converting material may be interposed between the LED and the lens. LED constructions may comprise a number of LEDs, where the light emitted by each LED differs from one another by about 2.5 nm or less. LED constructions are made by attaching 2 or more LEDs to a common wafer by adhesive layer, forming a lens on a wafer level over each LED to provide a rigid structure, removing the common wafer, forming the electrical contacts on a wafer level, and then separating the LEDs.

21 Claims, 3 Drawing Sheets



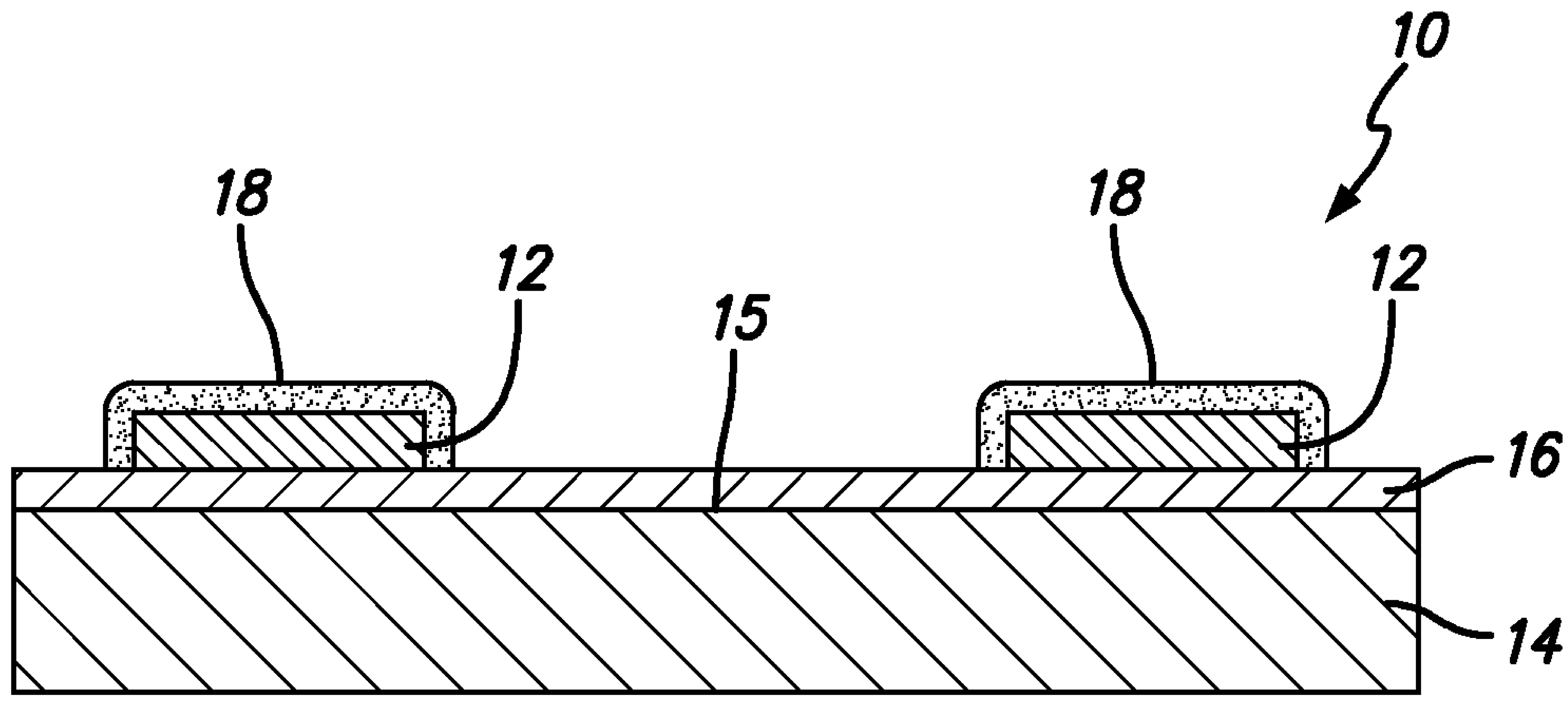


FIG. 1

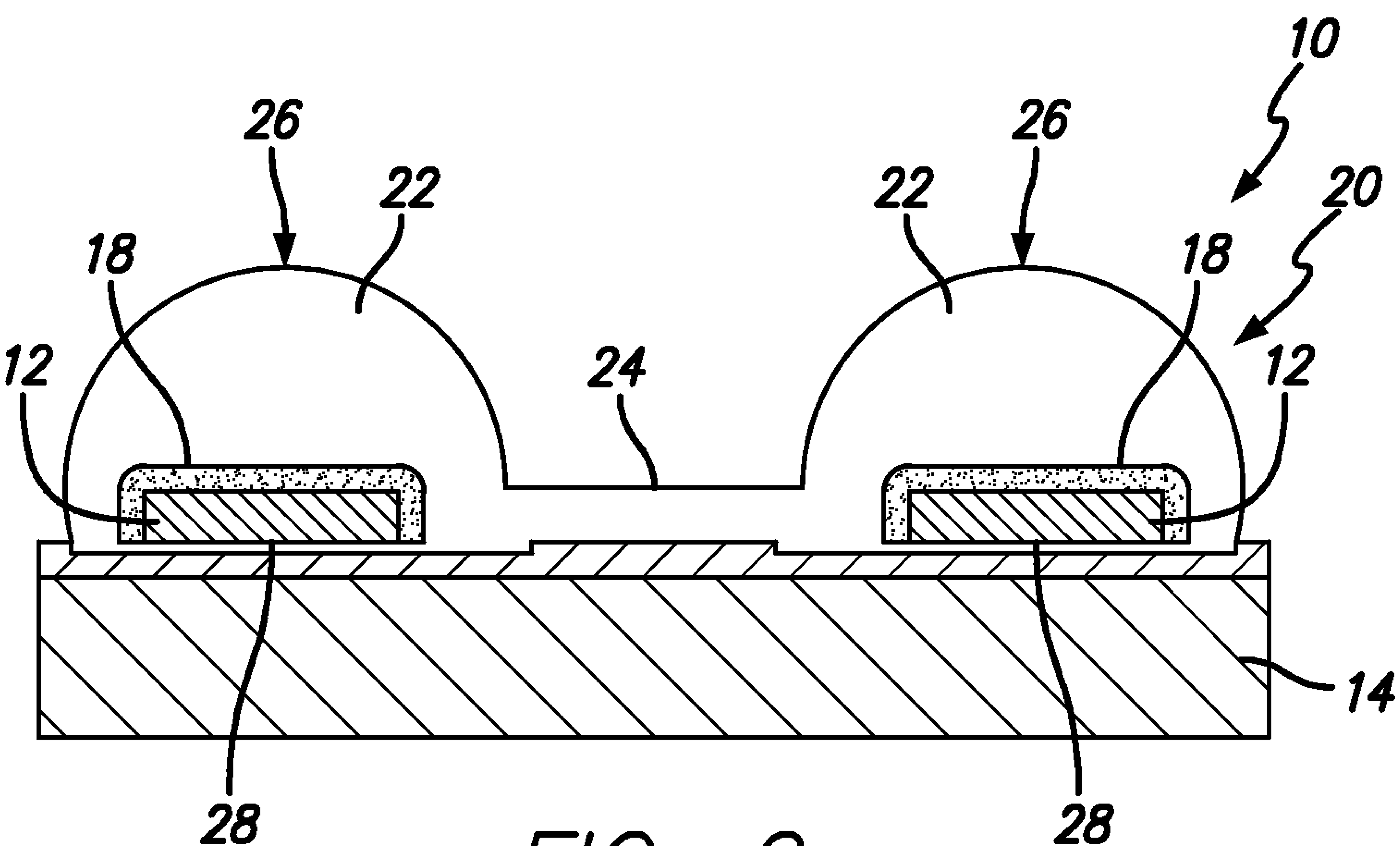


FIG. 2

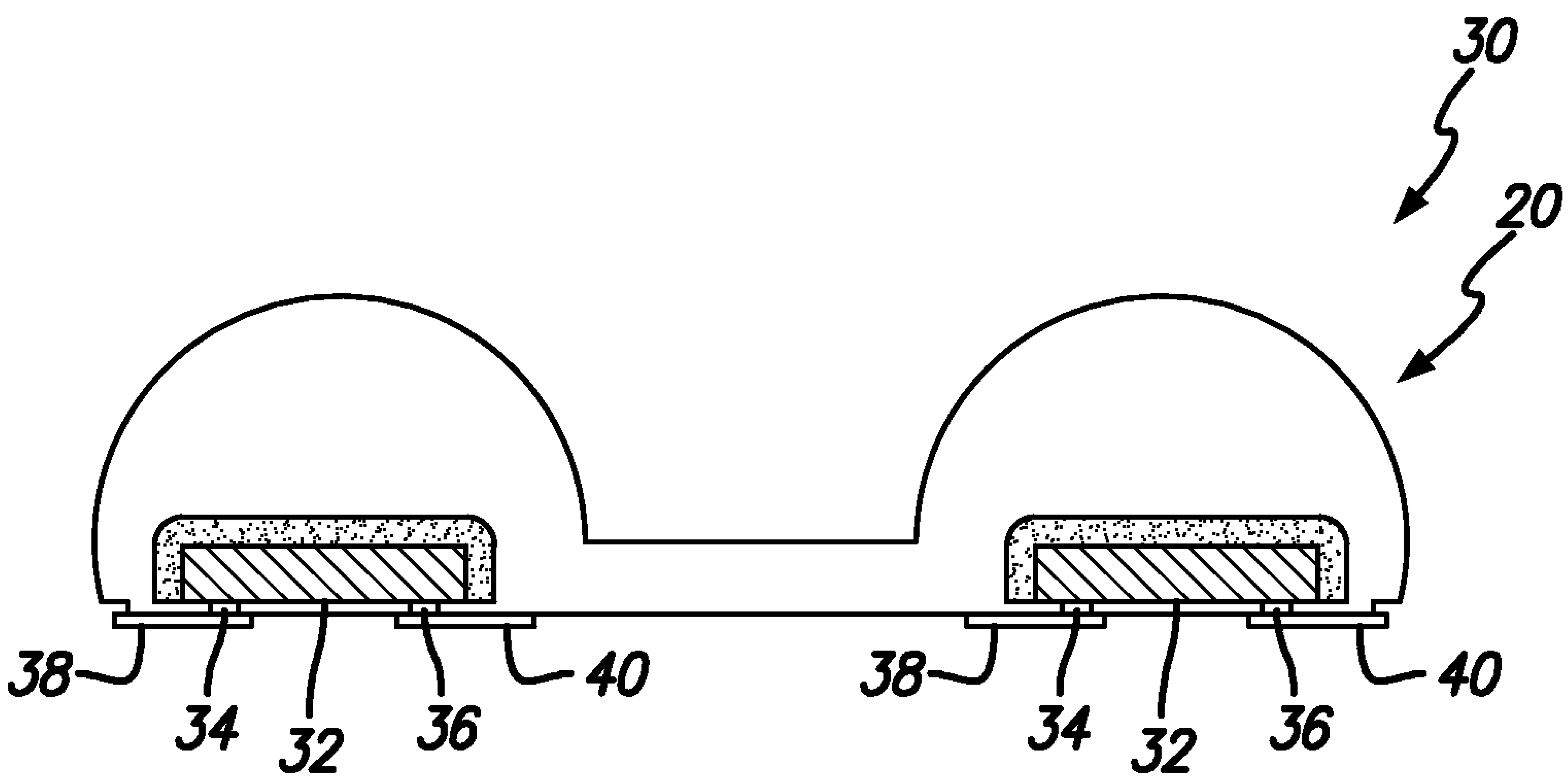


FIG. 3

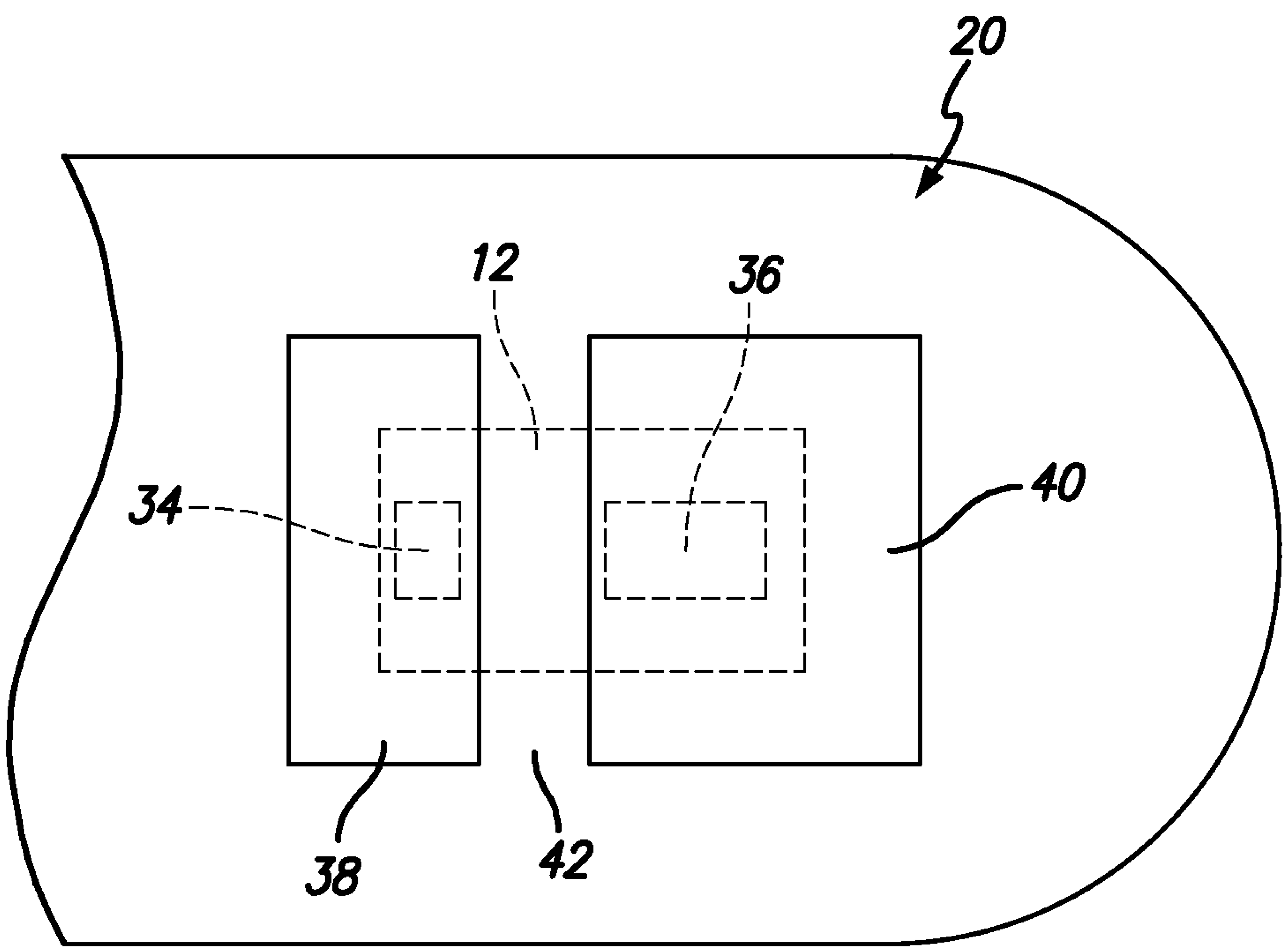


FIG. 4

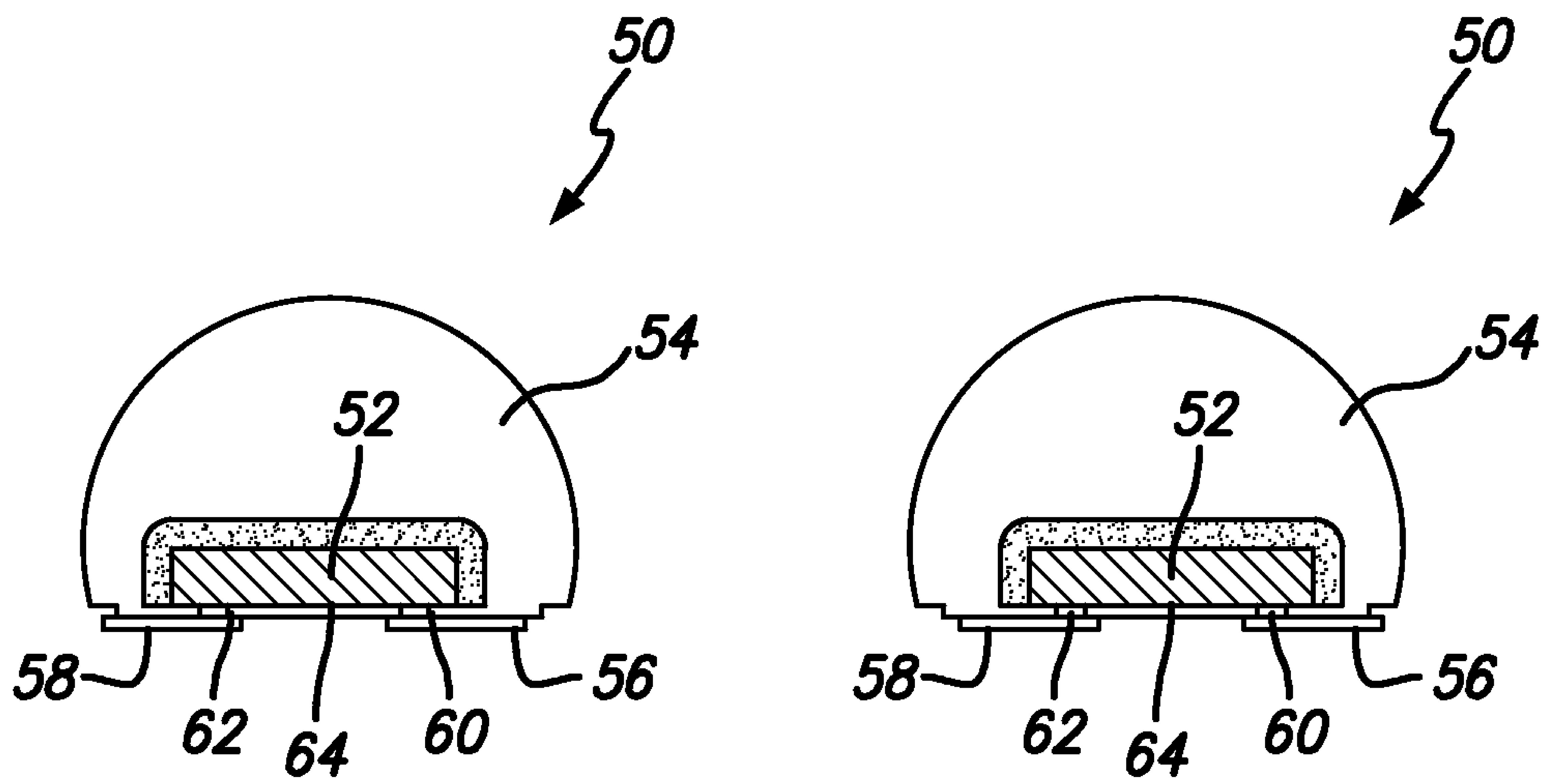


FIG. 5

LIGHT EMITTING DIODE CONSTRUCTIONS AND METHODS FOR MAKING THE SAME

FIELD

Disclosed herein are light emitting diodes, assemblies comprising the same, and methods for making such assemblies constructions and, more specifically, wafer level light emitting diode assemblies and method for making the same.

BACKGROUND

Light emitting diodes (LEDs) are known in the art and are useful for the purpose of meeting the needs of numerous end-use lighting applications. Such LEDs are typically formed on a substrate or wafer containing a number of such LEDs. The wafer is diced to obtain the number of LEDs formed thereon and the separate LEDs are then processed, e.g., to include any wavelength conversion material disposed thereon to obtain a desired wavelength light output, and one or more lenses, and then used to form a desired LED assembly or package comprising a number of the so-formed LEDs. The LEDs in the assembly or package are also electrically connected with one another and configured to make electrical contact with a desired connection substrate.

The above-noted conventional manner of making LED assemblies, by working with the diced or individual LEDs for the purpose downstream processing for making LED constructions useful for including in an LED assembly or package, is not the most effective from a manufacturing perspective. The process of dicing the LEDs, and then processing the separated LEDs through the downstream manufacturing steps needed for making final LED constructions useful for then forming an LED assembly or LED package comprising the same, is one that is cost and labor intensive as a result of such downstream processing for such individual LEDs.

Accordingly, it is desired that LED constructions and method for making the same be developed in a such a manner so as to enable a number of LEDs to be subjected to such downstream manufacturing processing at one time to thereby improve the manufacturing efficiency associated with making the same when compared to the above-described method of making LED constructions. It is further desired that such LED constructions and method for making the same be developed in a manner that optimizes certain properties of the LED constructions and LED assemblies and packaging formed therefrom, including but not limited to obtaining a desired degree of control over the wavelength of light emitted, i.e., white point control from the LEDs within an LED construction and LED assemblies and packaging comprising the same.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other features and advantages of light emitting diode constructions, assemblies comprising the same, and methods for making the same as disclosed herein will be appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings.

FIG. **1** is a cross-sectional side view of an example light emitting diode construction during an initial step of making as disclosed herein;

FIG. **2** is a cross-sectional side view of the example light emitting diode construction of FIG. **1** during a subsequent step of making as disclosed herein;

FIG. **3** is a cross-sectional side view of the example light emitting diode construction of FIG. **2** during a subsequent step of making as disclosed herein;

FIG. **4** is a bottom view of an enlarged section of the example light emitting diode construction of FIG. **3** better illustrating some of the features as disclosed herein; and

FIG. **5** is a cross-sectional side view of the example light emitting diode construction of FIG. **3** during a subsequent step of making as disclosed herein.

SUMMARY

Light emitting diode constructions and light emitting assemblies as disclosed herein comprise a light emitting diode comprising a pair of electrical contacts positioned along a bottom surface. A lens is disposed over the light emitting diode, wherein the lens is formed from an optically transparent material that encapsulates top and side surfaces of the light emitting diode. In an example, the optically transparent material is a silicone such as phenyl silicone. In an example, the lens covers a portion of the light emitting diode bottom surface, and may have a hemispherical shape along a top portion.

The assembly further comprises a pair of electrical terminals each connected with a respective light emitting diode electrical contacts, wherein the pair of electrical terminals are greater in size than the respective electrical contacts and are also connected with the optically transparent material. In an example, the electrical terminals may be provided in the form of printed copper. In an example, the assembly may comprise a layer of wavelength converting material such as conformal phosphor interposed between the light emitting diode and the lens. In an example, the lens may comprise a sidewall portion that extends upwardly from the electrical terminals to the hemispherical top portion. In another example, the sidewall portions that extend upward are rectangular and/or contiguous with the hemispherical top portion.

The assembly may comprise two or more of the light emitting diodes each comprising the lens and the electrical terminals, wherein the lenses of the two or more light emitting diodes are connected with one another to form a rigid assembly connecting together the two or more light emitting diodes and facilitating wafer level downstream processing. In an example, the two or more light emitting diodes each emit light at a different wavelength. For example, the wavelength of light emitted by each light emitting diode can differ from one another by about 2.5 nm or less.

Light emitting constructions and assemblies as disclosed herein may be made by disposing two or more light emitting diodes on a common wafer, forming a light conversion material over the two or more light emitting diodes to thereby provide an initial rigid structure for subsequently wafer level forming an optically transparent material over the light conversion material, thereby providing a further level of rigidity to the resulting construction. In an example, the two or more light emitting diodes are attached to the common wafer by an adhesive material interposed therebetween. In an example, the two or more light emitting diodes are selected having a light emission that differs from one another by about 2.5 nm or less. In an example, the optically transparent material is used to form a lens over the light conversion material by compression molding.

The common wafer is removed to expose electrical contacts on the two or more light emitting diodes for facilitating wafer level forming electrical terminals on the two or more light emitting diodes, wherein each electrical terminal is connected with a respective electrical contact and is sized larger than a respective electrical contact and also contacts the optically transparent material. In an example, where the adhesive material used to attach the light emitting diodes is a thermal adhesive, the common wafer is removed by subjecting the construction to an elevated temperature. In an example, the electrical terminals are formed by depositing a metallic material onto the two or more light emitting diodes, wherein the metallic material is deposited in a desired configuration of the electrical terminals. Alternatively, the electrical terminals may be formed by depositing a metallic material onto the two or more light emitting diodes, wherein the metallic material is deposited in excess and a stencil is used to define a desired configuration of the electrical terminals. In an example, the metallic material deposited comprises a binder, and wherein after forming electrical terminals on the two or more light emitting diodes, the deposited metallic material to an elevated temperature to volatize the binder.

The so-partially fabricated device is then treated to separate the rigid structure with electrical contacts into separate light emitting diode packages wherein each package has electrical terminals exposed. In an example, the constructed is separated by sawing the rigid structure into separate light emitting diode packages.

DESCRIPTION

Light emitting diodes (LEDs) and constructions and assemblies comprising the same as disclosed herein make use of LEDs having contacts on a common surface of the LED, which may include but are not limited to LEDs having a flip chip architecture, to promote processing and use in an array assembly and/or packaging for meeting the needs of a particular connection substrate and end-use application. A feature of the LED constructions and methods for making the same as disclosed herein is that they are specifically developed and engineered to promote downstream processing of multiple LEDs on a wafer level, to thereby provide an improved level of manufacturing control and efficiency when compared to the conventional chip level LED construction and processing techniques disclosed above.

In an example embodiment, LEDs useful for making LEDs constructions according to the methods disclosed herein are flip chip LEDs, which may be manufactured to emit light at different wavelengths depending on the particular end-use application. However, it is to be understood that LEDs having other types of architectures may also be used. A feature of such LEDs useful for making LED constructions as disclosed herein is that they be configured to include electrical contacts along a common surface of the LED to thereby promote forming a desired electrical contact with adjacent LEDs in an LED assembly and/or to facilitate forming desired electrical contact with a connection substrate along a common surface of such LEDs.

FIG. **1** illustrates an example LED construction **10** during an initial step of a method of making as disclosed herein. During this initial step, a desired number of LEDs **12** (e.g., two or more) are attached to a carrier or substrate **14**. The LEDs **12** comprise electrical contacts (not shown) that are disposed along a common surface of each respective LED, and that are oriented adjacent the carrier or substrate **14**. The carrier or substrate **14** as used herein may also be referred to as a wafer and is employed as a temporary member for the purpose of downstream processing of the LEDs disposed therein. A feature of the carrier or substrate is that it be formed from a sufficiently rigid material so as to facilitate downstream processing of the LEDs in a manner that resists unwanted bending, flexing, or distortion as it relates to the position of the LEDs disposed thereon. In an example, the carrier or substrate is formed from silicone, quartz, and the like. Because the wafer is to be removed during a subsequent processing step, it is not necessary that the wafer be optically transparent or have other properties typically associated with making an LED assembly.

In an example, the wafer has a thickness that may vary depending on the particular material that is used. In an example where the wafer is quartz, that thickness of the wafer may be from about 0.2 mm to 1.5 mm, from about 0.5 mm to 1 mm, and in a particular example is approximately 0.7 mm.

The LEDs **12** are attached to the wafer **14** via a removable adhesive **16**. In an example, the adhesive can be provided in the form of a preformed layer of adhesive material, or can be provided in a non-preformed form, such as one that is spray or otherwise provided, and that is interposed between the LEDs **12** and a top surface **15** of the wafer **14**. In an example, the adhesive is formed from a material that can be treated or otherwise activated to lose its adhesive properties so as to permit the removal of wafer from the LEDs during a downstream processing step. It is desired that the LEDs **12** be removed from the wafer **14** in a manner that does not damage the LEDs or any other features or elements of the LED construction **10** that may exist or be present at the time of such removal process. In an example, the adhesive layer may be formed from a material that loses its adhesive properties upon exposure to heat, ultra-violet radiation, and/or chemical treatment. In an example embodiment, the adhesive that is used is a two-sided adhesive that loses its adhesive properties so as to permit removal of the LEDs from the wafer at an elevated temperature, i.e., is a thermal adhesive, wherein in an example embodiment the temperature is between about 150 to 200° C., and in a particular example is approximately 180° C.

In an example, the adhesive has a thickness that may vary depending on the particular material that is used. In an example, where the adhesive is a thermal adhesive, the adhesive later has a thickness of from about 0.1 mm to 1 mm, from about 0.2 mm to 0.8 mm, and in a particular example has a thickness of approximately 0.3 mm.

The LEDs **12** are positioned onto the wafer in a particular predetermined manner/pattern, i.e., they are spaced apart from one another a predetermined distance, so as to facilitate forming lenses over the number of LEDs during a single downstream manufacturing step as better described below. Thus, the LED construction **10** as illustrated in FIG. **1**, and as disclosed herein according to the principles of this concept, is one that is intentionally developed for the purpose of facilitating downstream processing of the LEDs **12** at a wafer level so as to expedite and render more efficient the manufacturing process of making LED constructions comprising the same. In an example embodiment, the LEDs are spaced apart from one another a distance that is from about 0.2 mm to 2 mm, 0.3 mm to 1 mm, and in and in a particular example is approximately 0.5 mm. In a particular embodiment, the LEDs **12** are arranged on the wafer **14** in the form of an array of 2×2, 2×4, 4×4, or more LEDs having the desired spaced apart distance from one another. In some embodiments, the LEDs are disposed on an 8 inch round wafer at a predetermined spacing and substantially covering the entire 8 inch round wafer.

A feature of such wafer level processing provided by the constructions and methods of the concept as disclosed herein is the ability to use LEDs having specific performance characteristics to form the wafer and ultimate LED constructions resulting from downstream wafer level processing. In an example, it is desired that the LEDs selected for such wafer level processing be ones having a similar/controlled wavelength of light output, to thereby provide LED constructions having the same controlled light output or controlled white point. Accordingly, in an example embodiment, it is desired that LEDs useful in making LED constructions as disclosed herein have a tight or narrowly-controlled white point. In an example, the white point of LEDs used herein may be within about a 3 step MacAdam Ellipse or a 2 step MacAdam Ellipse, and in a particular embodiment have a white point of about 3,000K within a 2 step MacAdam Ellipse.

LEDs **12** as used herein may include a layer of conformal wavelength conversion material **18** disposed thereover, which may be in the form of a conformal phosphor layer or the like. In an example, the wavelength conversion material **18** may be disposed over the light emitting surfaces, e.g., the top and/or side surfaces, of the LEDs before the LEDs are attached to the wafer. Alternatively, the layer of wavelength conversion material **18** may be disposed over the LEDs after the LEDs have been adhered to the wafer. In an example embodiment, the LEDs flip chip LEDs and include conformal phosphor **18** disposed over the top and side surfaces of the LEDs **12** after being attached with the wafer **14**.

FIG. **2** illustrates an example of the LED construction **10** as illustrated in FIG. **1** and as disclosed above during a subsequent wafer level processing step. Specifically, the LED construction has been further processed to include a lens member **20** disposed over the LEDs **12**. In an example, the lens member **20** is configured comprising a number of different lenses or lens elements **22** that are each integral with and interconnected with one another via webs or channels **24** to thereby form a unitary lens member construction. In an example, where the LEDs **12** are provided in the form of an array attached to the wafer **14**, the lens member **20** comprises an array of lens elements **22** each disposed over the respective LEDs. The lens elements **22** are disposed over and encapsulate respective LEDs so as to cover the top surface and side surfaces of the respective LED, wherein any layer of wavelength conversion material **18** is interposed therebetween.

In an example, the lens elements **22** each include a dome-shaped or hemispherical portion **26** that is disposed along a top surface of the respective LEDs. The lens elements **22** also include a portion that extends downwardly from the hemispherical portion along a sidewall portion that at least partially covers an underside or bottom surface **28** of the LED, which bottom surface **28** is positioned adjacent the wafer and includes the electrical contacts of the LED. In an example, lens element sidewall portion is rectangular in shape and surrounds the respective LED **12**.

The lens member **20** is formed from an optically transparent material and may be selected from those polymeric materials capable of being formed by molding process such as by compression molding. In an example, it is also desired that the material for forming the lens member have a sufficient degree of rigidity because, as described in more detail below, the lens member is used and relied upon once the wafer is removed for keeping the encapsulated LEDs together in the form of a sufficiently rigid structure for further downstream wafer level processing of the LED construction. In an example embodiment, it is desired that the lens member be formed from an optically transparent material having a Shore D hardness of about 30 or more. In an example, the lens member is selected from the group of silicone polymers, and in a particular embodiment is phenyl silicone that is cured at a temperature of approximately 180° C.

It is to be understood that the size and configuration of the lens member **20** and individual lenses or lens elements **22** may vary depending on such factors as the type of LEDs used, the material selected to form the lens member, and/or the particular end-use LED construction lighting application. In an example, the lens elements **22** hemispherical portion **24** have a radius of curvature of from about 0.3 mm to 1 mm, 0.5 to 0.8 mm, and in a particular embodiment approximately 0.5 mm. The lens member web **24** may have a height as measured from a surface of the wafer of from about 30 to 200 microns, 50 to 100 microns, and in a particular embodiment approximately 50 microns.

As mentioned above, in an example the lens member is formed during compression molding process, during which process the LEDs are placed into a volume of the lens material disposed within a respective mold for forming a respective lens element. During this compression molding process an edge of the lens mold is placed into contact with the surface of the adhesive layer **16** and held at an elevated pressure for a length of time useful for the lens material to cure and harden. In an example, prior to attaching the LEDs to the wafer the electrical contacts of the LEDs may be protected or covered with a material such as a tape or the like. Covering the LED electrical contacts in this manner before adhering the LEDs to the wafer may be desired during downstream processing, e.g., such as when the lens member is being formed, to protect the electrical contacts along the bottom surface of the LEDs from being in direct contact with and attached to the lens material.

FIGS. **3** and **4** illustrate an example LED construction **30**, as illustrated in FIG. **2**, at a further stage of wafer-level processing. After forming the lens member **20**, the LED construction comprising the wafer is further processed to remove the wafer and adhesive material from the rigid structure/LED construction that now exists and that comprises the LEDs **12** encapsulated in the lens member **20**. The wafer **14** is removed from the remaining rigid structure by subjecting the adhesive material to conditions causing it to reduce or lose its adhesive properties. In an example, where a thermal adhesive is used to form the adhesive layer, the adhesive layer is heated to a temperature sufficient to permit removal of the wafer without harming or damaging the remaining LED construction **30**. In an example, the adhesive layer is heated to about 180° C. and the rigid construction **30** comprising the LEDs encapsulated in the lens member **20** is removed from the wafer. Once the wafer is removed, the bottom surface **32** of the remaining LED construction **30** may be cleaned and/or otherwise prepared for further processing. In an example where the LED electrical contacts **34** and **36** are covered by tape or other material, such tape or other material is removed for purposes of gaining access to the electrical contacts **34** and **36**, e.g., N and P electrical contacts.

Electrical terminals **38** and **40** are formed on the bottom or underside surface **32** of the LED construction **30** during wafer level processing. In an example, the electrical terminals are fanned out and sized having surface area that is greater than the N and P electrical contacts **34** and **36** of the respective LEDs (as best illustrated in FIG. **4**) so as to facilitate a desired attachment and electrical connection with other LEDs (e.g., when combined to form an LED assembly) and/or an electrical contact substrate in a particular end-use application. In an example, one of the electrical terminals **38** and **40** may be sized larger than the remaining electrical terminal, e.g., in an example embodiment the electrical terminal **40** that is attached to the P contact **36** of an LED may be sized larger than that of the electrical terminal **38** that is attached to the N contact **34**. In an example, the electrical terminals **38** and **40** are sized having an area that is about 50 to 500%, 100 to 300% larger than the LED electrical contacts **34** and **36**. In one example, the electrical terminals **38** and **40** are sized having an area that is 300% larger than the LED electrical contacts **34** and **36**.

The electrical terminal **38** and **40** are formed by depositing a desired layer thickness of a metallic material onto the underside surface **32** of the LEDs **12** in the LED construction so as to cover and make electrical contact with each of the respective LED N and P electrical contacts **34** and **36**. In an example, the metallic material used to form the electrical terminals **38** and **40** is applied to the underside surface **32** of the LED construction **30** in a manner covering each of the respective LED N and P electrical contacts **34** and **36**, and also covering the lens material **42** that is adjacent the N and P electrical contacts **34** and **36** and that is covering the underside surface of the LED construction **30** (as best illustrated in FIG. **4**). The electrical terminals **38** and **40** may have a thickness of from about 30 to 500 microns, 100 to 200 microns, and in a particular embodiment approximately 100 microns. Metallic materials useful for forming the electrical terminals **38** and **40** include copper, solder, indium containing materials, gold containing materials, and combinations thereof. In an example, the electrical terminals comprise copper.

The process of depositing the metallic material to form the electrical terminals **38** and **40** may be conducted using different techniques. For example, the metallic material can be provided by a jetting or printing process whereby a composition comprising the desired metallic material and a binder is loaded into a machine that is designed to deposit a discrete/precise amount of the material in desired configuration onto the respective P and N electrical contacts in pattern form to thereby form the desired electrical terminals without the need for a stencil or removal of excess deposited material. This technique of printing is one that is very precise and that is similar to dot matrix printing for the purpose of precisely forming the electrical terminals **38** and **40**. Once the metallic material is disposed using such method, the deposited material is subjected to an elevated temperature for the purpose of evaporating or flashing off the binder component, thereby leaving the metallic constituent that forms the desired electrical terminals. An advantage of using this process is that the electrical terminals on the LED construction can be formed on the fly without having to perform a subsequent clean-up process, e.g., removing any excess deposited metallic material, before further processing.

In an example, binder materials useful for applying the electrical terminal according to such printing technique may include materials known in the art of metal printing. Polymeric materials that operate to facilitate the desired control of the printing process and that can be removed by thermal process at a temperature that will not damage the remaining LED construction **30** can also be used. In an example, the metallic material is copper and the binder used in the printing process can be removed by heating to a temperature of about 150° C.

Another technique that may be used to deposit the metallic material for forming the electrical terminals **38** and **40** is one that makes use of a stencil, screen, mask or the like for the purpose of providing the desired configuration of the electrical terminals **38** and **40**. Unlike the precise printing process described above, the technique of depositing the metallic material using a stencil is one that is less precise in that it relies on the stencil to provide the desired electrical terminal configuration and excess metallic material is disposed on the stencil and is removed with the stencil during a subsequent process. The metallic and binder materials useful for forming the electrical terminals using such a stencil process may be the same as those noted above, wherein the binder is formed from a material, e.g., an epoxy, that may be removed at a temperature of about 150° C. in a particular embodiment. Once the metallic material is deposited onto the stenciled underside surface of the LED construction, the stencil is removed to remove the excess applied metallic material, and the deposited metallic material is subjected to thermal treatment to remove the binder material.

Another technique that may be used to deposit the metallic material for forming the electrical terminals **38** and **40** is one that may be referred to as a sintering technique. In an example, the sintering technique make use of a metallic composition comprising a binder that is applied using a stencil or the like, as described above, for the purpose of providing the desired configuration of the electrical terminals onto the underside surface of the LED construction. Once deposited, and the stencil is removed, the deposited metallic composition is subjected to an elevated temperature of greater than about 150° C., e.g., about 250° C., for the purpose of quickly removing the binder. In an example, the deposited metallic composition is subjected to such elevated temperature for a short period of time by IR process or the like. An advantage of such sintering technique is that it results in a greater degree of binder material removal, by virtue of the higher temperature treatment, to thereby provide a resulting electrical terminals having a higher metal content, e.g., essentially just comprising the metallic constituent, and having a resulting higher level of electrical conductivity.

Prior to depositing the metallic material it may be useful to treat the underside surface of the LED construction for the purpose of promoting adhesion of the metallic material use to form the electrical terminals with the lens material. Such treatment may be in the nature of a chemical treatment, thermal treatment, and or a mechanical treatment. For example, an adhesion promoter may be used to promote adhesion, by forming a seed layer or the like, between the silicone lens material and the metallic material.

FIG. **5** illustrates LED constructions **50** as disclosed herein during a subsequent step of wafer level processing. Namely, after the electrical terminals are formed to connect with respective LED N and P electrical contacts, the LED construction is further processed to isolate or separate the individual LEDs in the construction. In an example embodiment, the LEDs are diced by conventional technique to form individual LED constructions **50** that each comprise an LED **52** encapsulated by the lens element **54** and comprising the electrical terminals **56** and **58** having a fanned out/expanded surface area (when compared to the respective LED P and N electrical contacts) that are in contact with both the LED P and N electrical contacts **60** and **62** and the lens material disposed along an underside surface **64** of each respective the LED **52**.

A feature of LED constructions and methods for forming the same as disclosed herein is that they are specifically formed and developed to facilitate downstream manufacturing of multiple LEDs at a wafer level, e.g., whereby the lens member/lens elements, the expanded electrical terminals, and the individual LED constructions are all processed at a wafer level, rather than at a chip level, to thereby improve manufacturing efficiency and reduce manufacturing cost. A further feature of LED constructions as disclosed herein is the ability to provide a wafer level LED construction for manufacturing processing comprising LEDs having a controlled white point, such that all of the LEDs included in the construction has a tight white point of within 2 step MacAdam Ellipse, and forming completed (with lenses and fanned out electrical contacts) individual LED constructions therefrom that retain such tight white point control.

Although certain specific embodiments of LED constructions and methods for making the same have been described and illustrated for purposes or reference, it is to be understood that the disclosure and illustrations as provided herein not limited to the specific embodiments. Accordingly, various modifications, adaptations, and combinations of various features of the described embodiments can be practiced without departing from the scope what has been disposed herein including the appended claims.

What is claimed is:

1. A method of making a light assembly comprising:

disposing two or more light emitting diodes each having a bottom surface on a common wafer;

forming or positioning a light conversion material over the two or more light emitting diodes;

forming or positioning an optically transparent material over the light conversion material;

forming a rigid structure comprising the optically transparent material, the light conversion material, and the two or more light emitting diodes;

removing the common wafer from the rigid structure and exposing electrical contacts on the two or more light emitting diodes;

forming or positioning electrical terminals on the rigid structure such that each electrical terminal is connected to a respective electrical contact, wherein at least a portion of the optically transparent material contacts bottom surface portions of the light emitting diodes, and wherein the optically transparent material extends beyond the light conversion material such that the electrical terminals directly contact only the optically transparent material and respective electrical contracts; and

separating the rigid structure with the electrical contacts into separate light emitting diode packages wherein each package has the electrical terminals exposed.

2. The method as recited in claim **1** wherein disposing the two or more light emitting diodes on the common wafer comprises picking and placing two or more light emitting diodes onto the common wafer, wherein each light emitting diode that is picked and placed on the common wafer emits light at a wavelength that differs from one another by 2.5 nm or less.

3. The method as recited in claim **1** wherein forming the rigid structure comprises curing the optically transparent material, the light conversion material, and the two or more light emitting diodes.

4. The method as recited in claim **1** wherein disposing the two or more light emitting diodes on the common wafer comprises attaching the two or more light emitting diodes to the common wafer with an adhesive that is interposed between the two or more light emitting diodes and the common wafer.

5. The method as recited in claim **1** wherein forming or positioning the optically transparent material over the light conversion material comprises forming a lens over each light emitting diode by compression molding.

6. The method as recited in claim **1** wherein removing the common wafer from the rigid structure comprises subjecting the common wafer to an elevated temperature.

7. The method as recited in claim **1** wherein forming or positioning the electrical terminals on the rigid structure comprises depositing a metallic material onto the rigid structure to cover the respective electrical contact and a portion of the optically transparent material that is on the bottom surface of the light assembly, wherein the metallic material is deposited in a desired configuration of the electrical terminals.

8. The method as recited in claim **1** wherein forming or positioning the electrical terminals on the rigid structure comprises depositing a metallic material onto the rigid structure, wherein the metallic material is deposited in excess and a selected portion of the excess is removed to provide a desired configuration of the electrical terminals.

9. The method as recited in claim **8** wherein the metallic material comprises a binder, and wherein after forming or positioning the electrical terminals on the rigid structure, the method further comprises subjecting the deposited metallic material to an elevated temperature to volatize the binder.

10. The method as recited in claim **1** wherein separating the rigid structure with the electrical contacts into the separate light emitting diode packages comprises sawing the rigid structure into the separate light emitting diode packages.

11. A method of making a light emitting diode construction comprising:

disposing two or more light emitting diodes each having a bottom surface on a common wafer;

disposing an optically transparent material over the light emitting diodes to form a rigid structure;

removing the common wafer from the rigid structure and exposing electrical contacts on the two or more light emitting diodes;

forming or disposing electrical terminals to be in connection with respective electrical contacts of the two or more light emitting diodes, wherein the electrical contacts are positioned on the bottom surface a distance inwardly from respective opposed side edges of the light emitting diodes, and wherein the optically transparent material contacts portions of the bottom surfaces that extends outwardly away from the respective electrical contacts to light emitting diode side edges, and wherein the electrical terminals directly contact only respective electrical contacts and the optically transparent material; and

separating the rigid structure with the electrical contacts into separate light emitting diode packages, wherein each package has exposed electrical terminals.

12. The method as recited in claim **11** wherein before the disposing the optically transparent material, a light conversion material is disposed over the two or more light emitting diodes, and wherein a portion of the optically transparent material is disposed over and contacts a bottom surface of the light conversion material.

13. The method as recited in claim **11** wherein during the step of disposing the optically transparent material, the optically transparent material forms a hemispherical lens over each of the two or more light emitting diodes.

14. The method as recited in claim **13** wherein lenses of each of the two or more light emitting diodes are integral and connected with one another before the step of separating the rigid structure into separate light emitting diode packages.

15. The method as recited in claim **11** wherein the electrical terminals are formed or disposed after disposing the optically transparent material over the light emitting diodes.

16. The method as recited in claim **11** wherein during the step of forming or disposing the electrical terminals, the electrical terminals are sized larger than the respective electrical contacts that the electrical terminals are connected with.

17. The method as recited in claim **11** wherein an adhesive material is interposed between the common wafer and the two or more light emitting diodes.

18. The method as recited in claim **11** wherein during the step of forming or disposing the electrical terminals, the electrical terminals are formed to cover the respective electrical contacts and a portion of the optically transparent material.

19. A method of making a light emitting diode construction comprising:

disposing two or more light emitting diodes each having a bottom surface on a common wafer;

disposing an optically transparent material over a surface of the two or more light emitting diodes to form a lens over each light emitting diode, wherein the optically transparent material extends along portions of the bottom surface of each light emitting diode;

removing the common wafer from the rigid structure and exposing electrical contacts on the two or more light emitting diodes; and

forming or disposing electrical terminals to be in connection with respective electrical contacts of the two or more light emitting diodes, and wherein the electrical terminals directly contact only respective electrical contacts and the optically transparent material.

20. The method as recited in claim **19** wherein the electrical terminals are sized larger than the electrical contacts.

21. The method as recited in claim **19** further comprising the step of separating the rigid structure with the electrical contacts into separate light emitting diode packages.

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