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(54) **LIGHTING MODULE OF MEDICAL ENDOSCOPE AND THE METHOD OF MAKING THE SAME**

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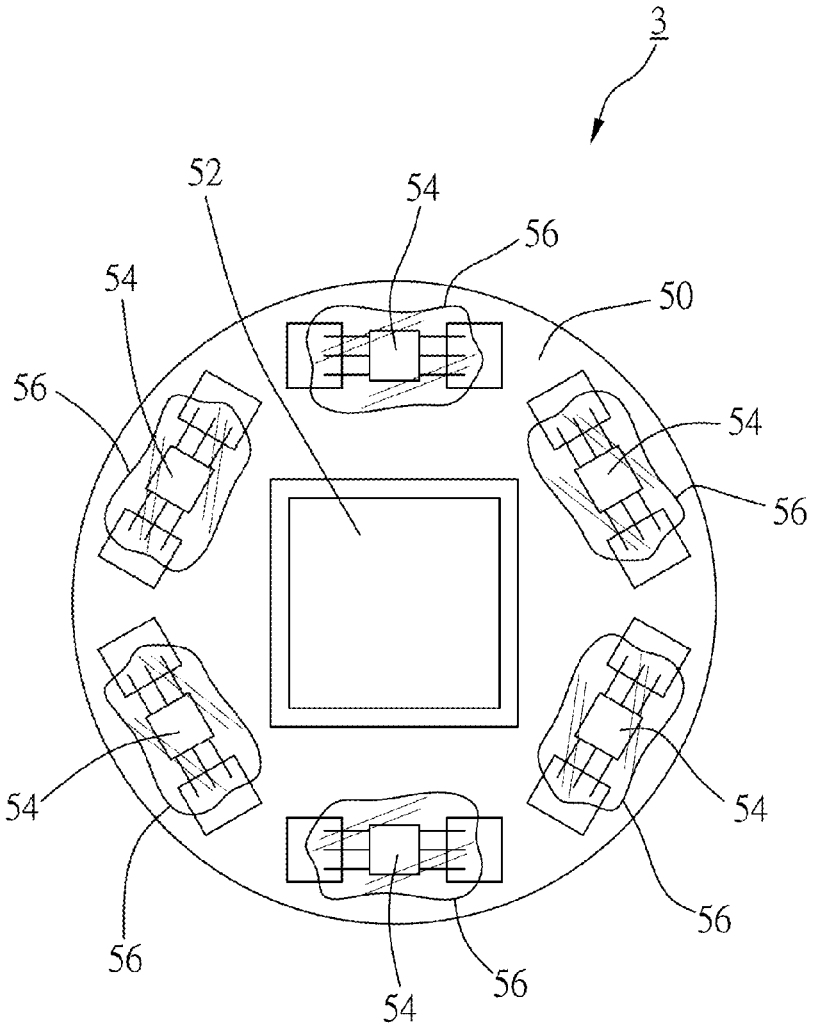
(57) **ABSTRACT**

A medical endoscope includes a circuit board, on which an image capture device and a LED bare die are mounted. The LED die is attached to the circuit board and electrically connected to a conductor pattern of the circuit board by conductive members. Next, a sealing member is coated onto the circuit board to embed the LED bare and the conducting members therein. The medical endoscope will have smaller size than the prior arts.



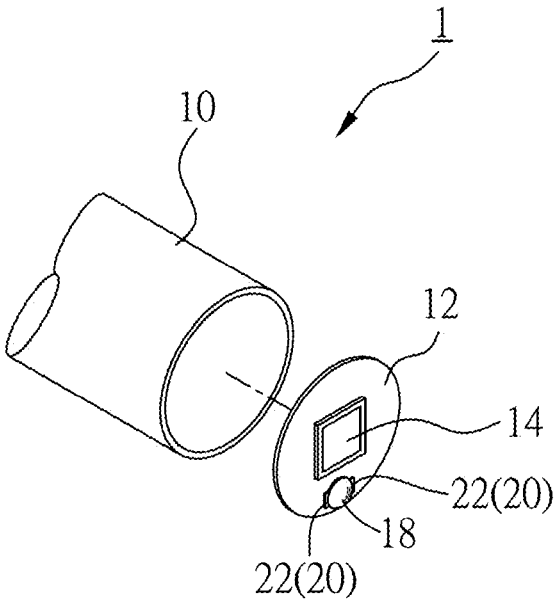


FIG. 1

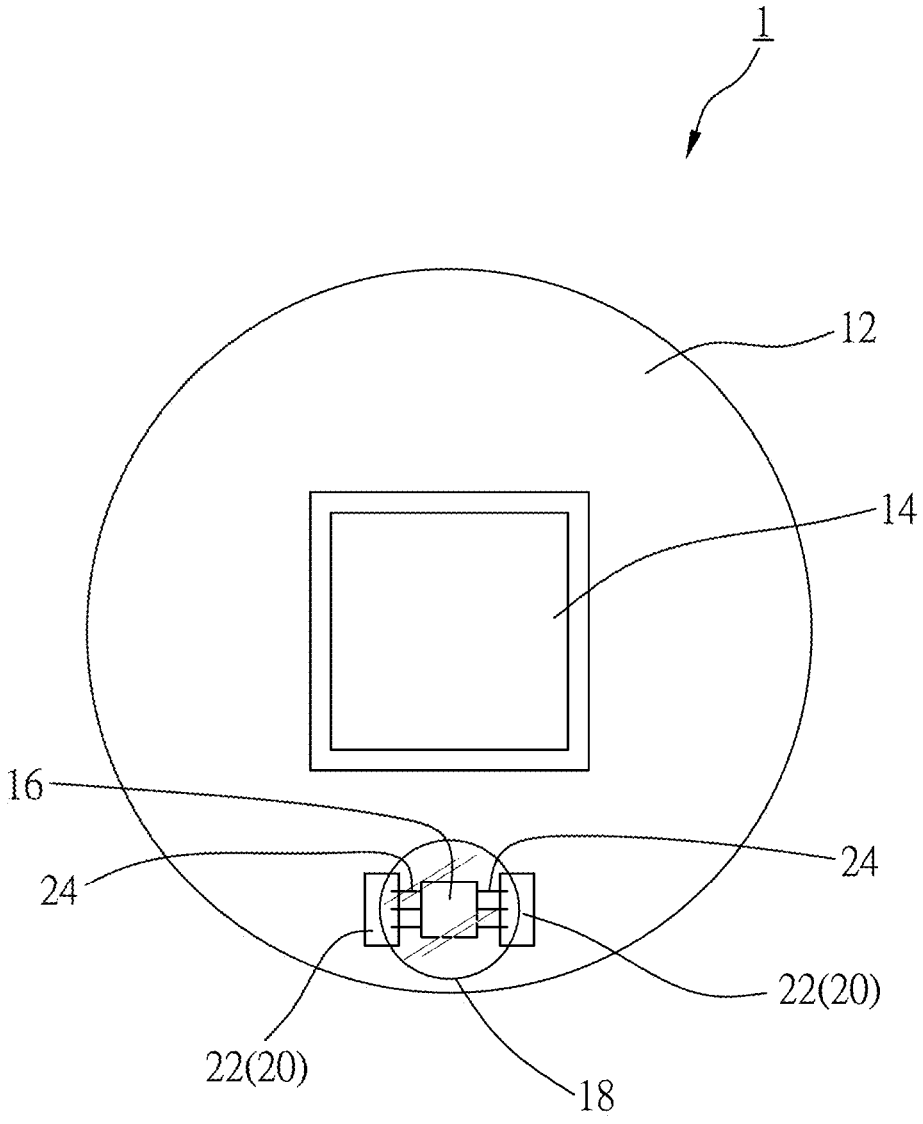


FIG. 2

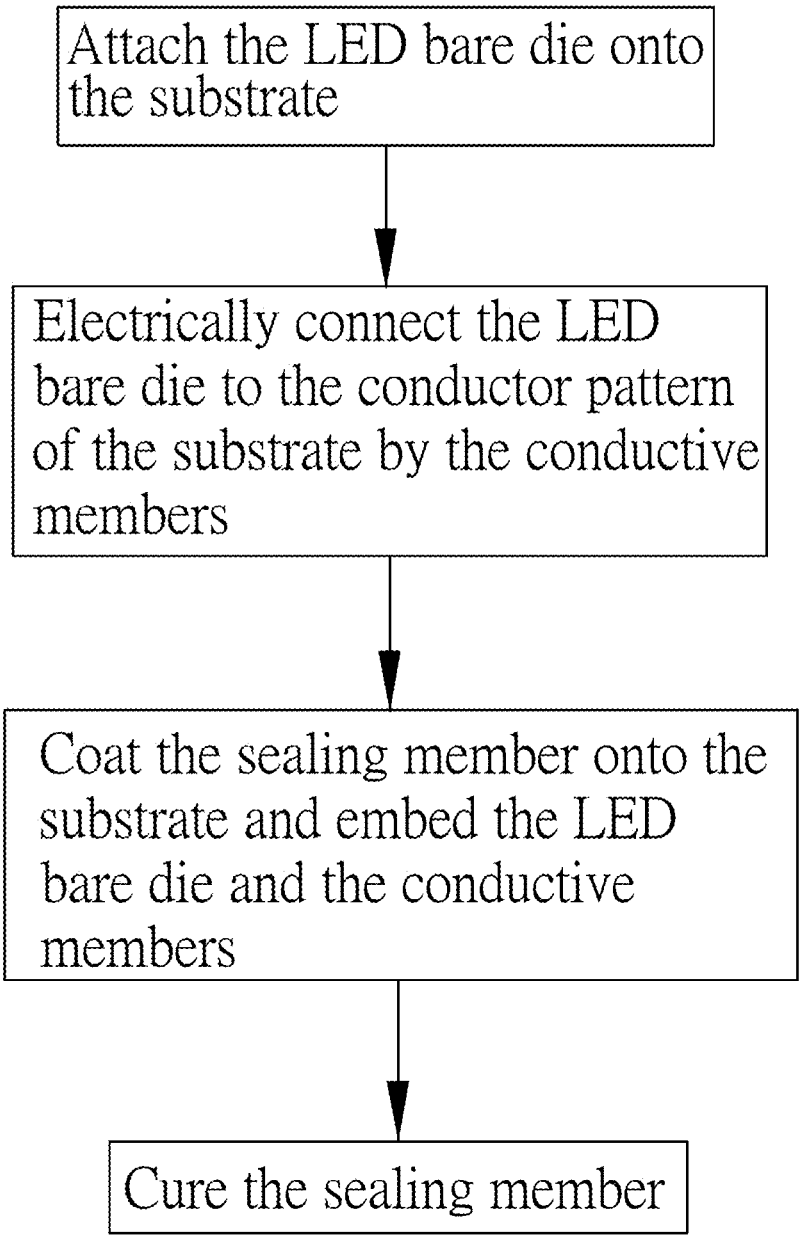

Attach the LED bare die onto the substrate
Electrically connect the LED bare die to the conductor pattern of the substrate by the conductive members
Coat the sealing member onto the substrate and embed the LED bare die and the conductive members
Cure the sealing member

FIG. 3

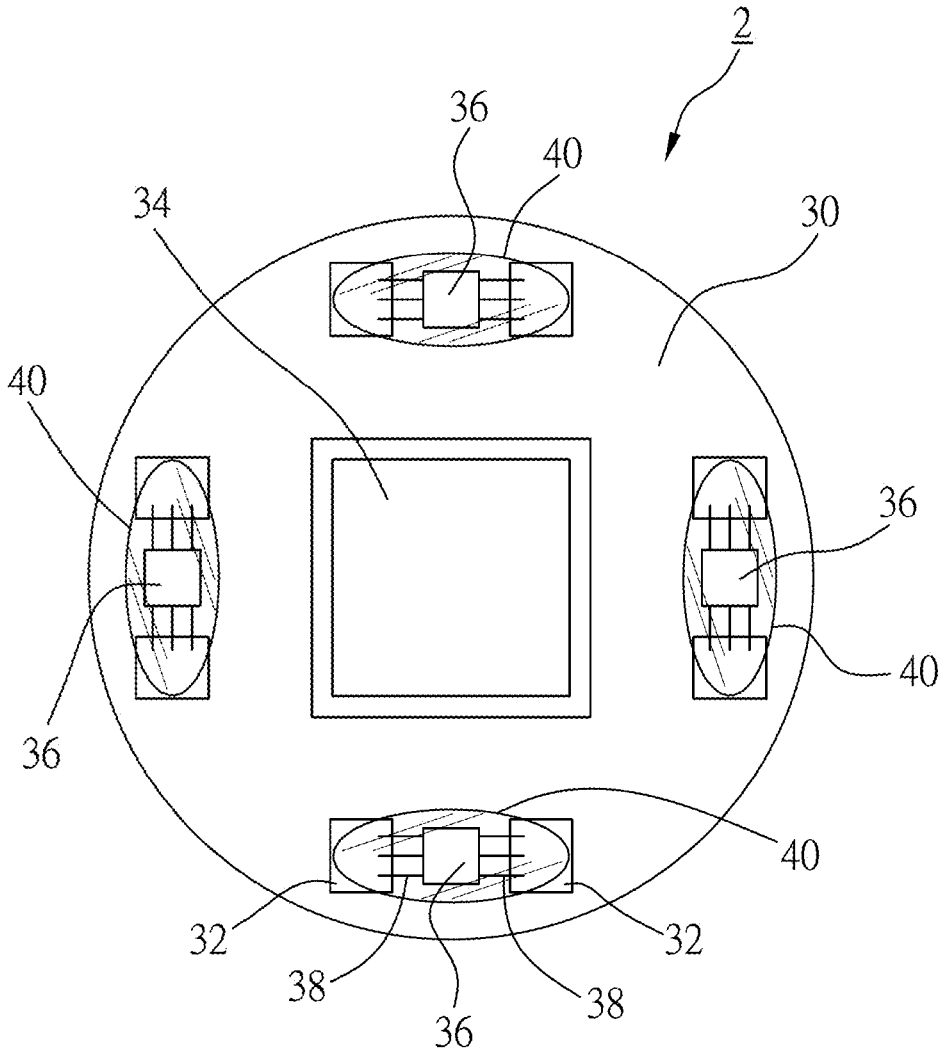


FIG. 4

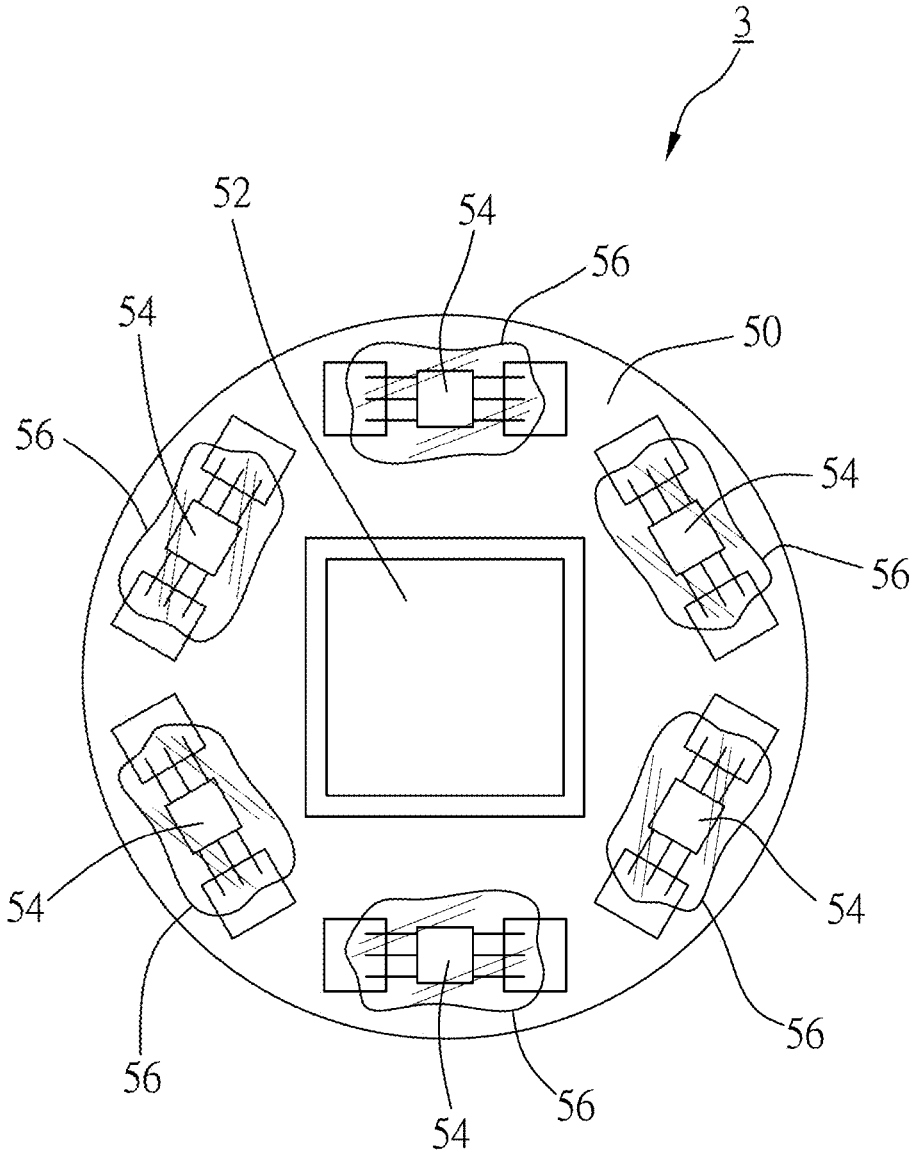


FIG. 5

LIGHTING MODULE OF MEDICAL ENDOSCOPE AND THE METHOD OF MAKING THE SAME

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present application is a Continuation-In-Part (CIP) of U.S. patent application Ser. No. 16/229,592 filed on Dec. 21, 2018, the entire disclosures of all of which are hereby incorporated by reference herein.

BACKGROUND OF THE INVENTION

1. Technical Field

[0002] The present invention relates to medical equipment, and more particularly to a lighting module of a medical endoscope and the method of making the same.

2. Description of Related Art

[0003] Endoscopy is a common medical procedure in the hospitals to examine the interior of a hollow organ or cavity of the body. Endoscopy may be used for many medical purposes, such as investigation of symptoms, confirmation of a diagnosis, and giving treatment. The common endoscopes include cystoscopy, esophagogastroduodenoscopy, colonoscopy, bronchoscope, and celioscope.

[0004] Typically, the endoscopy procedure inserts a thin and long endoscope into human body. However, it will make the patient uncomfortable. The thinner endoscope may reduce the uncomfortable feeling, and in some circumstances, the patient will be anesthetized before endoscopy procedure.

[0005] A conventional endoscope includes an image capturing device and a lighting device. The common image capturing device is micro CMOS, and the common lighting device is LED. The LED is attached on a circuit by surface-mount technology (SMT).

[0006] However, the conventional endoscope has a limitation in size. It can't reduce the size for the modern design.

BRIEF SUMMARY OF THE INVENTION

[0007] In view of the above, the primary objective of the present invention is to provide a medical endoscope and the method of making the same, which may sufficiently reduce its size.

[0008] In order to achieve the objective of the present invention, a medical endoscope includes a substrate provided with a conductor pattern; an image capturing device provided on the substrate and electrically connected to the conductor pattern; at least a LED bare die directly attached to the substrate and electrically connected to the conductor pattern by conductive members; and at least a sealing member provided to the substrate to embed the LED bare die and the conductive members.

[0009] In an embodiment, a glue is provided between the LED bare die and the substrate to attach the LED bare die to the substrate.

[0010] In an embodiment, the conductor pattern of the substrate has a plurality of bonding pads, to which ends of the conductive member are connected.

[0011] In an embodiment, the sealing member is transparent or has a predetermined color to emit UV light or visible light respectively

[0012] The present invention further provides a method of mounting a LED bare die onto a substrate of a medical endoscope, including the following steps:

[0013] A. Attach a LED bare die on a predetermined position of a substrate;

[0014] B. Electrically connect the LED bare die to a conductor pattern of the substrate by a plurality of conductive members;

[0015] C. Coat a sealing member onto the substrate and embedding the LED bare die and the conductive members therein; and

[0016] D. Cure the sealing member.

[0017] In an embodiment, the method further includes the step of cleaning the substrate and eliminating static electricity of the substrate before the step A.

[0018] In an embodiment, the step A includes the following steps:

[0019] Provide a glue on the predetermined position of the substrate;

[0020] Press the LED bare die onto the glue; and

[0021] Curing the glue.

[0022] In an embodiment, the method further includes testing an electrical connection between the LED bare die and the conductor pattern of the substrate after the step B and after the step D.

[0023] In an embodiment, the conductor pattern of the substrate has a plurality of bonding pads, the conductive members have ends connected to the bonding pads in the step B, and the sealing member embeds at least a portion of each of the bonding pads in the step C.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0024] The present invention will be best understood by referring to the following detailed description of some illustrative embodiments in conjunction with the accompanying drawings, in which

[0025] FIG. **1** is an exploded view of a first preferred embodiment of the present invention;

[0026] FIG. **2** is a front view of the first preferred embodiment of the present invention;

[0027] FIG. **3** is a flow chart of the first preferred embodiment of the present invention;

[0028] FIG. **4** is a front view of a second preferred embodiment of the present invention; and

[0029] FIG. **5** is a front view of a third preferred embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0030] FIG. **1** shows a medical endoscope **1** of the first preferred embodiment of the present invention, including a housing **10**, in which a substrate **12**, an image capturing device **14**, a LED bare die **16**, and a sealing member **18**, and the image capturing device **14**, the LED bare die **16**, and the sealing member **18** are provided on the substrate **12** (referring to FIG. **2**). The substrate **12** has a conductor pattern **20**, and the conductor pattern **20** as several bonding pads **22** to be electrically connected to the image capturing device **14** and the LED bare die **16**.

[0031] As shown in FIG. **3**, a method of mounting the LED bare die **16** onto the substrate **12** includes the following steps:

[0032] A. Attach the LED bare die **16** on a predetermined position of the substrate **12**.

[0033] In the first preferred embodiment, the substrate **12** is cleaned and processed for eliminating static electricity of the substrate **12**. Next, provide a glue on the predetermined position of the substrate **12**, and then press the LED bare die **16** onto the adhesive. After that, the substrate **12** is sent to an oven for curing the adhesive and for firmly attaching the LED bare die **16** on the substrate **12**. The temperature and curing time are depended on the quantity and the content of the glue.

[0034] B. Electrically connect the LED bare die **16** to the conductor pattern **20** of the substrate **12** by conductive elements **24**.

[0035] A process of electrically connecting the LED bare die **16** to the substrate **12** includes wire bonding, flip chip, and tape automatic bonding (TAB). In the first preferred embodiment, wire bonding process is used to electrically connect the LED bare die **16** to the substrate **12**. The conductive elements **24** are conductive wires, each of which has opposite ends connected to a pad of the LED bare die **16** and one of the bonding pads **22** of the conductor pattern **20** of the substrate **12**, respectively.

[0036] After the LED bare die **16** is electrically connected to the conductor pattern **20** of the substrate **12**, a testing procedure is performed to check whether the LED bare die **16** is correctly connected to the conductor pattern **20** of the substrate **12**. If it passes the testing procedure, it can continue the following steps, and if it does not, the LED bare die **16** and the substrate **12** may be repaired or abandoned.

[0037] C. Coat the sealing member **18** onto a region of the substrate **12** to embed the LED bare die **16** and the conductive elements **24** therein.

[0038] In the first preferred embodiment, except the LED bare die **16** and the conductive elements **24**, at least a portion of each of the bonding pads **22** of the conductor pattern **20** are embedded in the sealing member **18**.

[0039] D. Cure the sealing member **18**.

[0040] The substrate **12** is sent to an oven to heat the sealing member **18** under a predetermined temperature for a predetermined time. The temperature and curing time are depended on the quantity and the content of the sealing member **18**. In the first preferred embodiment, the cured sealing member **18** is round in a top view to encapsulate one piece of LED bare die **16** with connecting conductive elements **24** and at least a portion of each of the bonding pads **22** of the conductor pattern **20**. In addition, the cured sealing member **18** has a predetermined color, such as blue and yellow, to pass a visible light provided by the LED bare die **16** and let the light have a predetermined color.

[0041] After curing, a testing procedure is performed is performed again to check whether the LED bare die **16** is correctly connected to the conductor pattern **20** of the substrate **12**. If it passes the testing procedure, it can continue the following steps, and if it does not, the LED bare die **16** and the substrate **12** may be repaired or abandoned.

[0042] With the steps as described above, the LED bare die **16** is directly bonded onto the substrate **12** to reduce a sufficient size of the substrate **12**. According to a test of the inventor, the substrate made by the conventional process has a diameter over 3 mm. On the contrary, a diameter of the substrate **12**, which is made by the method of the present invention, is 2.6 mm. In conclusion, with the method of the present invention, it may reduce about 10% in diameter.

[0043] FIG. **4** shows a medical endoscope **2** of the second preferred embodiment of the present invention, which is similar to the first preferred embodiment, including a substrate **30** having a conductor pattern **32**, an image capturing device **34** attached to the substrate **20** and electrically connected to the conductor pattern **32**, four LED bare dies **36** attached to the substrate **20** and electrically connected to the conductor pattern **32** by a plurality of conductive members **38**, and four sealing members **40** provided on the substrate **20** to embed the LED bare dies **36** and the conductive members **38** respectively. Otherwise, a part of the cured sealing members **40** is transparent to pass an UV light provided by the LED bare die **36** for ablation procedure. A method of making the medical endoscope **2** of the second preferred embodiment is the same as above. The cured sealing members **40** are elliptical in top views. According to the test by the inventor, a diameter of the substrate **30** of the second preferred embodiment is about 2.6 mm.

[0044] FIG. **5** shows a medical endoscope **3** of the third preferred embodiment of the present invention, which is similar to the first and the second preferred embodiments, including a substrate **50**, an image capturing device **52**, eight LED bare dies **54**, and eight sealing members **56**. The different parts are that a number of the LED bare dies **54** is eight, and the cured sealing members **56** are random in top views. According to the test by the inventor, a diameter of the substrate **30** of the second preferred embodiment is about 2.6 mm.

[0045] It must be pointed out that the embodiments described above are only some preferred embodiments of the present invention. All equivalent structures which employ the concepts disclosed in this specification and the appended claims should fall within the scope of the present invention.

What is claimed is:

1. A medical endoscope, comprising:

a substrate provided with a conductor pattern;

an image capturing device provided on the substrate and electrically connected to the conductor pattern;

at least a LED bare die directly attached to the substrate and electrically connected to the conductor pattern by conductive members; and

at least a sealing member provided to a region of the substrate to embed the LED bare die, the conductive members and a part of the conductor pattern.

2. The medical endoscope of claim **1**, wherein a glue is provided between the LED bare die and the substrate to attach the LED bare die to the substrate.

3. The medical endoscope of claim **1**, wherein the conductor pattern of the substrate has a plurality of bonding pads, to which ends of the conductive member are connected.

4. The medical endoscope of claim **1**, wherein a plurality of the sealing members are formed on the substrate, one part of the sealing members are transparent and the other part of the sealing members have a predetermined color.

5. The medical endoscope of claim **4**, wherein a plurality of LED bare dies directly attached to the substrate, one part of the LED bare dies used for generating an invisible light, the other part of the LED bare dies used for generating a visible light.

6. A method of mounting a LED bare die onto a substrate of a medical endoscope, comprising the steps of:

A. attaching a plurality of LED bare dies on a predetermined position of a substrate;

B. electrically connecting the LED bare dies to a conductor pattern of the substrate by a plurality of conductive members;

C. coating a sealing member onto a region of the substrate and embedding the LED bare dies, the conductive members therein and a part of the conductor pattern; and

D. curing the sealing member.

7. The method as defined in claim **6**, further comprising cleaning the substrate and eliminating static electricity of the substrate before the step A.

8. The method as defined in claim **6**, wherein the step A comprises:

providing a glue on the predetermined position of the substrate;

pressing the LED bare die onto the glue; and

curing the glue.

9. The method as defined in claim **7**, further comprising testing an electrical connection between the LED bare die and the conductor pattern of the substrate after the step B.

10. The method as defined in claim **6**, wherein the conductor pattern of the substrate has a plurality of bonding pads, the conductive members have ends connected to the bonding pads in the step B, and the sealing member embeds at least a portion of each of the bonding pads in the step C.

11. The method as defined in claim **6**, further comprising testing an electrical connection between the LED bare die and the conductor pattern of the substrate after the step D.

12. The method as defined in claim **6**, wherein a plurality of the sealing members are formed on the substrate to encapsulate a plurality of the LED bare dies respectively, one part of the sealing members are transparent and the other part of the sealing members have a predetermined color.

13. The method as defined in claim **12**, wherein one part of the LED bare dies used for generating an invisible light, the other part of the LED bare dies used for generating a visible light.

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