

DESCRIPTION

CUTTING DEVICE AND CUTTING METHOD FOR PRODUCING ELECTRONIC
PARTS

5

TECHNICAL FIELD

[0001]

The present invention relates to a cutting device and cutting method used for producing a plurality of electronic parts by cutting a sealed substrate having a plurality of
10 areas into individual pieces corresponding to those areas.

BACKGROUND ART

[0002]

One of the conventional methods which have been carried out for efficiently
15 producing a plurality of electronic parts is as follows: A group of chip condensers, LED chips, semiconductor chips or similar parts mounted on a circuit substrate (such parts are hereinafter referred to as "chips") are collectively resin-sealed to form a sealed substrate, after which this sealed substrate is singulated into individual pieces to obtain a plurality of electronic parts (for example, refer to Patent Document 1). According to Patent Document 1,
20 a dicing saw or laser can be used to cut the sealed substrate. Each of the individual electronic parts obtained by cutting the sealed substrate is often referred to as a package.

[0003]

In the method according to Patent Document 1, a glass epoxy substrate can be used as the circuit substrate, while epoxy resin, phenol resin or silicon resin can be used as the
25 sealing resin in the resin-sealing process. Accordingly, it can be said that both the circuit

substrate and the sealing resin are made of similar types of materials, i.e. resin materials. Therefore, no major problem occurs in the cutting process irrespective of whether a dicing saw (which uses a rotary blade) or a laser is used.

[0004]

5 In recent years, new types of substrates whose base material is made of a ceramic (this type is hereinafter referred to as a “ceramic substrate”) or a metal (this type is hereinafter referred to as a “metal substrate”) have begun to be used as the circuit substrate in addition to the resin substrates represented by the glass epoxy substrate. Both the ceramic substrate and metal substrate have an excellent heat-releasing characteristic and are used in
10 optoelectronic parts (e.g. LEDs or semiconductor lasers), power semiconductor devices, and other applications.

[0005]

The nature of the base material of the ceramic or metal substrate is different from that of the sealing resin. As a result, the following problems occur in the case where a sealed
15 substrate having a ceramic or metal substrate is cut at a virtual cutting line by using a laser:

[0006]

The first problem is that the material used in the circuit substrate easily melts, forming dross, which adheres to the package and lowers the product yield in terms of its appearance quality. The second problem occurs when a ceramic substrate is used as the
20 circuit substrate. In this case, an internal stress arises due to the thermal shock applied on the ceramic substrate. This stress can cause cracking or chipping of the ceramic substrate, particularly at a point immediately before the end of the cutting process at one cutting line.

BACKGROUND ART DOCUMENT

25 PATENT DOCUMENT

[0007]

Patent Document 1: JP-A 09-036151 (page 3, Fig. 2)

DISCLOSURE OF THE INVENTION

5 PROBLEM TO BE SOLVED BY THE INVENTION

[0008]

The problem to be solved by the present invention is to prevent, in the process of cutting a sealed substrate including a circuit substrate consisting of a ceramic or metal substrate by means of a laser, the adhesion of dross to the sealed substrate and the cracking
10 or chipping of the ceramic substrate due to an internal stress.

MEANS FOR SOLVING THE PROBLEM

[0009]

In the following description, the numbers or symbols in parentheses correspond to
15 the numerals used in the attached drawings and are intended for facilitating comparison between the terms used in the description and the components shown in the drawings. The use of these numbers does not mean that “the terms in the description should be interpreted as being limited to the components shown in the drawings.”

[0010]

20 To solve the aforementioned problem, the present invention provides a cutting device used for producing a plurality of electronic parts by forming a sealed substrate (1) by resin-sealing a chip (3) mounted on each of a plurality of areas (7) provided on a circuit substrate (2), and by cutting the sealed substrate (1) at a boundary line (6) of the plurality of areas (7). The cutting device for producing electronic parts according to the present invention
25 includes a fixing means (8) for fixing the sealed substrate (1), a laser-beam generating means

(11) for generating a laser beam (12, 18), and a moving means (9) for moving the sealed substrate (1) and/or the laser beam (12, 18) relative to each other, characterized in that the laser-beam generating means (11) generates a first laser beam (12) for forming perforations (17, 19) on the boundary line (6) and a second laser beam (18) for cutting the sealed
5 substrate (1) at the boundary line (6) on which the perforations (17, 19) have been formed.

[0011]

In one mode of the cutting device for producing electronic parts according to the present invention, the first laser beam (12) is a pulsed beam, and the second laser beam (18) is a continuous beam.

10 [0012]

In another mode of the cutting device for producing electronic parts according to the present invention, the laser-beam generating means (11) includes a fiber laser oscillator or a YAG laser oscillator.

[0013]

15 In still another mode of the cutting device for producing electronic parts according to the present invention, the perforations (17, 19) are through-holes (17).

[0014]

In still another mode of the cutting device for producing electronic parts according to the present invention, the perforations (17, 19) are blind holes (19).

20 [0015]

In still another mode of the cutting device for producing electronic parts according to the present invention, a base material of the circuit substrate (2) is a ceramic or a metal.

[0016]

In still another mode of the cutting device for producing electronic parts according to
25 the present invention, the electronic parts are optoelectronic parts or power semiconductor

parts.

[0017]

The present invention also provides a cutting method used for producing a plurality of electronic parts by forming a sealed substrate (1) by resin-sealing a chip (3) mounted on each of a plurality of areas (7) provided on a circuit substrate (2), and by cutting the sealed substrate (1) at a boundary line (6) of the plurality of areas (7). The cutting method for producing electronic parts according to the present invention includes a step for fixing the sealed substrate (1) and an irradiation step for moving the sealed substrate (1) and/or the laser beam (12, 18) relative to each other while throwing a laser beam (12, 18) at the sealed substrate (1), characterized in that, in the irradiation step, perforations (17, 19) are formed on the boundary line (6) by throwing a first laser beam (12) at the sealed substrate (1), after which the sealed substrate (1) is cut by throwing a second laser beam (18) at the boundary line (6).

[0018]

In one mode of the cutting method for producing electronic parts according to the present invention, the first laser beam (12) is a pulsed beam, and the second laser beam (18) is a continuous beam.

[0019]

In another mode of the cutting method for producing electronic parts according to the present invention, a fiber laser oscillator or a YAG laser oscillator is used to generate the first laser beam (12) and the second laser beam (18) in the irradiation step.

[0020]

In still another mode of the cutting method for producing electronic parts according to the present invention, the perforations (17, 19) are through-holes (17).

[0021]

In still another mode of the cutting method for producing electronic parts according to the present invention, the perforations (17, 19) are blind holes (19).

[0022]

In still another mode of the cutting method for producing electronic parts according to the present invention, a base material of the circuit substrate (2) is a ceramic or a metal.

[0023]

In still another mode of the cutting method for producing electronic parts according to the present invention, the electronic parts are optoelectronic parts or power semiconductor parts.

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EFFECTS OF THE INVENTION

[0024]

According to the present invention, after the perforations (17, 19) are formed on the boundary line (6) of the sealed substrate (1) by using the first laser beam, the substrate (1) is (fully) cut at the boundary line (6) by using the second laser beam. The sum of the volume of the portions removed in the process of forming the perforations (17, 18) and the volume of the portions removed in the subsequent (full) cutting process equals the volume of the portions removed by the conventional method in which the sealed substrate (1) is (fully) cut by a single cycle of laser irradiation. That is to say, the volume of the portions removed from the sealed substrate (1) by each of the two cycles of laser irradiation in the present invention is smaller than the volume of the portions removed from the sealed substrate (1) by the conventional method in the sealed substrate (1) is (fully) cut by a single cycle of laser irradiation. In the present invention, the volume of the portions removed per one cycle of laser irradiation is small, and the amount of dross resulting from each cycle of laser irradiation is accordingly small. Particularly, the decrease in the amount of dross resulting

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from the irradiation of the second laser beam is effective for reducing the amount of dross that will eventually adhere to the cut portion. Furthermore, since the amount of dross resulting from one cycle of laser irradiation is decreased, it is easy to remove the dross by a jet of gas or other means during the laser-irradiating process. Accordingly, adhesion of the dross to the sealed substrate (1) in the process of cutting the sealed substrate (1) is suppressed, and a sufficiently high level of cut quality is obtained at the cut surface.

[0025]

In the case where the present invention is applied to the cutting of a sealed substrate (1) including a ceramic substrate, the perforations (17, 19) are initially formed in the sealed substrate (1) by using the first laser beam, after which the substrate (1) is cut by using the second laser beam. Since the perforations (17, 19) are formed beforehand on an intended cut line, the full-cutting process can be completed in a comparatively short period of time. Forming the perforations (17, 19) also increases the surface area of the cut portion and thereby helps the release of heat generated by the laser irradiation. Therefore, accumulation of heat at around the perforations (17, 19) barely occurs, and the thermal stress due to the irradiation with the second laser beam is alleviated. As a result, the stress that arises in the substrate (1) at around the perforations (17, 19), and particularly the stress that the ceramic substrate undergoes, is reduced. Accordingly, no cracking or chipping of the ceramic substrate due to the internal stress occurs.

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BRIEF DESCRIPTION OF THE DRAWINGS

[0026]

Fig. 1 is a sectional view showing the state where perforations are being formed in a sealed substrate by a cutting device for producing electronic parts according to the first embodiment.

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Fig. 2(1) is a sectional view showing the state where through-holes as the perforations are being formed in a sealed substrate by the cutting device for producing electronic parts according to the first embodiment, Fig. 2(2) is a sectional view showing the sealed substrate in which the through-holes in the form of perforations have been formed, and Fig. 2(3) is a sectional view showing the state where the sealed substrate is being cut.

Fig. 3(1) is a sectional view showing the state where blind holes as the perforations are being formed in a sealed substrate by a cutting device for producing electronic parts according to the second embodiment, Fig. 3(2) is a sectional view showing the sealed substrate in which the blind holes in the form of perforations have been formed, and Fig. 3(3) is a sectional view showing the state where the sealed substrate is being cut.

Fig. 4(1) is a sectional view showing the state where a groove is being formed in a sealed substrate by a cutting device for producing electronic parts according to the third embodiment, Fig. 4(2) is a sectional view showing the state where through-holes in the form of perforations are being formed in the circuit substrate, and Fig. 4(3) is a sectional view showing the state where the sealed substrate is being cut by the cutting device.

BEST MODES FOR CARRYING OUT THE INVENTION

[0027]

The cutting method for producing electronic parts according to the present invention is a cutting method used for producing a plurality of electronic parts by forming a sealed substrate (1) by resin-sealing a chip (3) mounted on each of a plurality of areas (7) provided on a circuit substrate (2), and by cutting the sealed substrate (1) at a boundary line (6) of the plurality of areas (7). The cutting method includes a step for fixing the sealed substrate (1) on a table (9) and an irradiation step for moving an irradiation head (10) and/or the sealed substrate (1) relative to each other while throwing a first laser beam (12) or a second laser

beam (18) at the sealed substrate (1). In the irradiation step, perforations (17) are formed on the boundary line (6) by throwing the first laser beam (12) at the sealed substrate (1), after which the sealed substrate (1) is cut by throwing the second laser beam (18) at the boundary line (6).

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FIRST EMBODIMENT

[0028]

The first embodiment of the cutting device for producing electronic parts according to the present invention is hereinafter described with reference to Fig.1. Fig. 1 is a schematic
10 sectional view showing the state where perforations are being formed in a sealed substrate by the cutting device for producing electronic parts according to the present embodiment. The cutting device shown in Fig. 1 is a cutting device for singulating a sealed substrate 1 into individual electronic parts. It should be noted that, for simplicity, any of the figures used in the present application documents is schematically drawn with appropriate omissions and
15 exaggerations. The term “perforations” used herein means a series of holes discretely formed at predetermined intervals. A perforation may be a through-hole or a blind hole.

[0029]

As shown in Fig. 1, the sealed substrate 1 has a circuit substrate 2, a plurality of chips 3 mounted on the circuit substrate 2, and a sealing resin 4 covering the entire group of the
20 chips 3. In Fig. 1, a ceramic or metal substrate is used as the circuit substrate 2, a translucent silicon resin as the sealing resin 4, and an LED chip as the chip 3. Accordingly, it can be said that the sealed substrate 1 is a composite of a ceramic or metal substrate and a plastic material. Metal substrates include metal core substrates, metal base substrates and enameled substrates.

25 [0030]

The sealing resin 4 has a plurality of lens parts 5 each of which corresponds to one chip 3. The sealed substrate 1 is separated into a plurality of areas 7 by grid-like boundary lines 6. This means that each boundary line 6 is formed by a line segment. Accordingly, each area 7 has a rectangular shape (including a square). In the example shown in Fig. 1, one chip 5 3 is mounted on each of the areas 7.

[0031]

In the example shown in Fig. 1, the lens part 5 is formed as a convex lens, with each lens part 5 corresponding to one chip 3. The lens part 5 is not limited to this example; it may be any type of lens capable of converging, collimating or diffusing light. The lens part 5 may 10 have a plurality of lens elements, or it may be a Fresnel lens or similar lens.

[0032]

The sealed substrate 1 is fixed to a table 9 with an adhesive tape 8. The table 9 is movable in the X, Y and Z directions shown in the figure, and is also rotatable in the θ direction. An irradiation head 10 is provided above the sealed substrate 1. A laser oscillator 15 11 is optically connected to the irradiation head 10. The irradiation head 10 throws a laser beam generated by the laser oscillator 11 at the sealed substrate 1 as the first laser beam 12. The irradiation head 10 can also throw another laser beam generated by the laser oscillator 11 at the sealed substrate 1 as the second laser beam (which will be described later). The laser oscillator 11 can generate the first laser beam 12 and the second laser beam. The first 20 laser beam 12 is a pulsed beam, while the second laser beam is a continuous beam.

[0033]

The irradiation head 10 is provided with a tube 13, through which an assist gas 14 is supplied into the irradiation head 10. A nozzle 15 is provided on the lower side of the irradiation head 10. The nozzle 15 has an opening, through which the first laser beam 12, 25 along with a jet of the assist gas 14, is thrown at a target portion 16 on the sealed substrate 1.

[0034]

An operation of the cutting device for producing electronic parts according to the present embodiment is hereinafter described with reference to Figs. 1 and 2. Fig. 2(1) is a sectional view showing the state where through-holes in the form of perforations are being
5 formed in the sealed substrate by the cutting device for producing electronic parts according to the present embodiment, Fig. 2(2) is a sectional view showing the sealed substrate in which the through-holes in the form of perforations have been formed, and Fig. 2(3) is a sectional view showing the state where the sealed substrate is being cut.

[0035]

10 Initially, as shown in Figs. 1 and 2(1), while the first laser beam 12 of a pulsed form is thrown at the boundary line 6 of the sealed substrate 1, the table 9 is moved in the positive direction of the X axis shown in the figures relative to the irradiation head 10. Along with the first laser beam 12, a jet of the assist gas 14 is also supplied to the boundary line 6 of the sealed substrate 1. The jet of the assist gas 14 has the effect of blowing off the generated
15 dross. The irradiation conditions of the first laser beam 12 are appropriately set beforehand so that a through-hole can be created in the sealed substrate 1 made of a composite material. By this process, as shown in Fig. 2(2), perforations 17 consisting of through-holes can be created on one boundary line 6 extending along the X direction among the boundary lines 6 of the sealed substrate 1.

20 [0036]

Next, perforations 17 consisting of through-holes are similarly created on every remaining boundary line 6 extending along the X direction among the boundary lines 6 of the sealed substrate 1. As a result, perforations 17 consisting of through-holes are created on every boundary line 6 extending along the X direction among all the boundary lines 6.

25 [0037]

Next, perforations 17 consisting of through-holes are formed on the boundary lines 6 extending along the Y direction among the grid-like boundary lines 6. More specifically, while the first laser beam 12 is thrown at one boundary line 6 extending along the Y direction, the table 9 is moved in the positive (or negative) direction of the Y axis shown in the figures relative to the irradiation head 10. Similarly, perforations 17 consisting of through-holes are created on every remaining boundary line 6 extending along the Y direction among the boundary lines 6 of the sealed substrate 1. As a result of the process described thus far, perforations 17 consisting of through-holes are created on all the boundary lines 6 of the sealed substrate 1.

10 [0038]

Next, as shown in Fig. 2(3), while the second laser beam 18 of the continuous form is thrown at one boundary line 6 of the sealed substrate 1, the table 9 is moved in the positive direction of the X axis shown in the figures relative to the irradiation head 10. Along with the second laser beam 18, a jet of the assist gas 14 (see Fig. 1) is also supplied to the boundary line 6 of the sealed substrate 1. The irradiation conditions of the second laser beam 18 are appropriately set beforehand so that the sealed substrate 1 in which the perforations 17 consisting of through-holes have been created can be completely cut by the laser beam. By this process, the sealed substrate 1 will be completely (fully) cut at one boundary line 6 extending along the X direction among the boundary lines 6 of the sealed substrate 1.

20 [0039]

Next, the sealed substrate 1 is completely cut at every remaining boundary line 6 extending along the X direction among the boundary lines 6 of the sealed substrate 1.

[0040]

Next, the sealed substrate 1 is completely cut at all the boundary lines 6 extending along the Y direction among the grid-like boundary lines 6. More specifically, while the

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second laser beam 18 is thrown at one boundary line 6 extending along the Y direction, the table 9 is moved in the positive (or negative) direction of the Y axis shown in the figures relative to the irradiation head 10. Subsequently, the sealed substrate 1 is similarly cut at every remaining boundary line 6 extending along the Y direction among the boundary lines 6 of the sealed substrate 1. By the process described thus far, the sealed substrate 1 is cut at all the boundary lines 6. Accordingly, the sealed substrate 1 is singulated into individual packages each of which corresponds to one of the aforementioned areas 7.

[0041]

According to the present embodiment, the following effects are obtained: The first effect is that the generation of dross in the process of cutting the sealed substrate 1 is suppressed. In the present embodiment, the volume of the portions removed from the sealed substrate 1 by each of the two cycles of laser irradiation is smaller than the volume of the portions removed from the sealed substrate 1 by a method in which the sealed substrate 1 is cut by a single cycle of laser irradiation. Therefore, the portion that melts in the sealed substrate 1 due to each of the two cycles of laser irradiation can be easily removed by the assist gas. Accordingly, adhesion of the dross to the sealed substrate 1 in the process of cutting the sealed substrate 1 is prevented.

[0042]

The second effect is that a sufficiently high level of cut quality is obtained at the cut surface. As already explained, the portion that melts in the sealed substrate 1 due to each of the two cycles of laser irradiation can be easily removed by the assist gas. Accordingly, a high level of cut quality is obtained at the cut surface of the produced electronic parts.

[0043]

The third effect is that, when a ceramic substrate is used as the circuit substrate 2, the cracking or chipping of the ceramic substrate due to the internal stress is prevented. In the

present embodiment, perforations 17 are formed in the sealed substrate 1 by using a pulsed laser beam, after which the substrate is cut by using a continuous laser beam. At around the perforations, the thermal stress that arises due to the irradiation with the continuous laser beam is alleviated. As a result, the stress that arises in the substrate 1 at around the perforations 17, and particularly the stress that the circuit substrate 2 consisting of the ceramic substrate undergoes, is reduced. Accordingly, no cracking or chipping of the circuit substrate 2 due to the internal stress occurs.

[0044]

In the present embodiment, the diameter of the perforations 17 and the interval between the centers of these perforations (the center-to-center pitch) are determined by the irradiation conditions of the first laser beam 12. The irradiation conditions includes, for example, the kind, energy, frequency, duty ratio and spot diameter of the laser beam, the moving speed of the table 9, as well as the kind and pressure of the assist gas 14. The diameter of the perforations 17 and the interval between the centers of the perforations are also determined beforehand so that the sealed substrate 1 in which the perforations 17 have been created can be completely cut by irradiation with the second laser beam 18. The present embodiment can be applied to various circuit substrates 2 of different specifications by appropriately setting the diameter of the perforations 17 and the interval between the centers of the perforations according to the materials, thicknesses and other properties of the sealing resin 4 and the circuit substrate 2.

[0045]

In the present invention, a YAG laser (e.g. with a wavelength of 1,064 nm), a fiber laser (e.g. with a wavelength of 1,070 nm) or another type of laser is used to generate the first laser beam 12. For example, the irradiation conditions for the pulsed laser beam are 200 W in the beam energy and 300 mm/sec in the moving speed of the table 9, and those for the

continuous laser beam are 300 W in the beam energy and 150 mm/sec in the moving speed of the table 9. By setting the energy of the continuous laser beam to be higher than that of the pulsed laser beam and the moving speed of the table 9 for the continuous laser beam to be lower than the moving speed for the pulsed laser beam, a sufficiently high level of cut
5 quality can be obtained at the cut portion.

SECOND EMBODIMENT

[0046]

The second embodiment of the cutting device for producing electronic parts
10 according to the present invention is hereinafter described with reference to Figs. 3(1)-3(3). Fig. 3(1) is a sectional view showing the state where blind holes in the form of perforations are being formed in a sealed substrate by the cutting device for producing electronic parts according to the present embodiment, Fig. 3(2) is a sectional view showing the sealed substrate in which the blind holes in the form of perforations have been formed, and Fig. 3(3)
15 is a sectional view showing the state where the sealed substrate is being cut.

[0047]

In the present embodiment, as shown in Fig. 3(1), while the first laser beam 12 of a pulsed form is thrown at one boundary line 6 of the sealed substrate 1, the table 9 is moved in the positive direction of the X axis shown in the figures relative to the irradiation head 10.
20 The irradiation conditions of the first laser beam 12 are appropriately set beforehand so that a blind hole will be created in the sealed substrate 1 made of a composite material. By this process, as shown in Fig. 3(2), perforations 19 consisting of blind holes can be created on one boundary line 6 extending along the X direction among the boundary lines 6 of the sealed substrate 1.

25 [0048]

Next, perforations 19 consisting of blind holes are similarly created on every remaining boundary line 6 extending along the X direction among the boundary lines 6 of the sealed substrate 1. As a result, perforations 19 consisting of blind holes are created on every boundary line 6 extending along the X direction among all the boundary lines 6.

5 [0049]

Next, perforations 19 consisting of blind holes are formed on every boundary line 6 extending along the Y direction among the grid-like boundary lines 6.

[0050]

Next, as shown in Fig. 3(3), while the second laser beam 18 of the continuous form is
10 thrown at one boundary line 6 of the sealed substrate 1, the table 9 is moved in the positive direction of the X axis shown in the figures relative to the irradiation head 10. By this process, the sealed substrate 1 can be completely (fully) cut at one boundary line 6 extending along the X direction among the boundary lines 6 of the sealed substrate 1.

[0051]

15 Next, the sealed substrate 1 is completely cut at every remaining boundary line 6 extending along the X direction among the boundary lines 6 of the sealed substrate 1.

[0052]

Next, the sealed substrate 1 is completely cut at every boundary line 6 extending along the Y direction among the grid-like boundary lines 6. By the process described thus far,
20 the sealed substrate 1 is cut at all the boundary lines 6. Accordingly, the sealed substrate 1 is singulated into individual packages each of which corresponds to one of the aforementioned areas 7.

[0053]

The characteristic of the present embodiment is that the perforations 19 consisting of
25 blind holes are formed by throwing the first laser beam 12 of a pulsed form. Each of these

perforations 19 has an opening on the upper side of the sealing resin 4 and an inner bottom in the circuit substrate 2. In other words, the perforations 19 extend from the upper side of the sealing resin 4 to the middle of the circuit substrate 2 in the thickness direction of the sealed substrate 1. Similar to the case of the first embodiment, the diameter and depth of the perforations 19 as well as the interval between the centers of these perforations (the center-to-center pitch) are determined by the irradiation conditions of the first laser beam 12. The diameter and depth of the perforations 19 and the interval between the centers of the perforations are also determined beforehand so that the sealed substrate 1 in which the perforations 19 have been created can be completely cut by irradiation with the second laser beam 18.

[0054]

By the present embodiment, the same effects as described in the first embodiment can be obtained. The present embodiment can be applied to various circuit substrates 2 of different specifications by appropriately setting the diameter and depth of the perforations 19 as well as the interval between the centers of these perforations according to the materials, thicknesses and other properties of the sealing resin 4 and the circuit substrate 2.

THIRD EMBODIMENT

[0055]

The third embodiment of the cutting device for producing electronic parts according to the present invention is hereinafter described with reference to Fig. 4. Fig. 4(1) is a sectional view showing the state where a groove is being formed in a sealed substrate by the cutting device for producing electronic parts according to the present embodiment, Fig. 4(2) is a sectional view showing the state where through-holes in the form of perforations are being formed in the circuit substrate, and Fig. 4(3) is a sectional view showing the state

where the sealed substrate is being cut by the cutting device.

[0056]

In the present embodiment, as shown in Fig. 4(1), a groove is initially formed in the sealing resin 4 of the sealed substrate by using a rotary blade 20. Fig. 4(1) shows the process of forming the groove (with no numeral assigned) on the left side of the rotary blade 20 by moving the table 9 in the negative direction of the X axis (leftwards). It should be noted that, for ease of understanding, the rotary blade 20 in Fig. 4 is depicted smaller than its actual size.

[0057]

Next, as shown in Fig. 4(2), the first laser beam 12 is thrown at the circuit substrate 2 at one boundary line 6 extending along the X direction among the boundary lines 6 of the sealed substrate 1. By this process, perforations 21 consisting of through-holes are formed in the circuit substrate 2. Subsequently, perforations 21 consisting of through-holes are similarly formed in the circuit substrate 2 at every boundary line 6 of the sealed substrate 1.

[0058]

Next, as shown in Fig. 4(3), while the second laser beam 18 of the continuous form is thrown at the circuit substrate 2 on the boundary line 6 of the sealed substrate 1, the table 9 is moved in the positive direction of the X axis shown in the figures relative to the irradiation head 10 (see Fig. 1). By this process, the sealed substrate 1 can be completely (fully) cut at one boundary line 6 extending along the X direction among the boundary lines 6 of the sealed substrate 1. Then, the sealed substrate 1 is completely cut at every remaining boundary line 6 extending along the X direction among the boundary lines 6 of the sealed substrate 1. Subsequently, the sealed substrate 1 is completely cut at every boundary line 6 extending along the Y direction among the boundary lines 6 of the sealed substrate 1.

[0059]

By the present embodiment, the same effects as described in the first and second

embodiments can be obtained. Furthermore, in the present embodiment, the cutting of the sealing resin 4 is performed by using an appropriate rotary blade for cutting a resin, while the cutting of the circuit substrate 2 is performed by using an appropriate type of laser beam under appropriate irradiation conditions. Accordingly, the efficiency of cutting the sealed substrate is further improved.

[0060]

In the present embodiment, both the rotary blade 20 and the laser oscillator 11 (see Fig. 1) for generating the first laser beam 12 and the second laser beam 18 are provided in the same cutting device. This is not the only possible configuration. For example, it is possible to initially form grooves in the sealing resin 4 of the sealed substrate 11 by a cutting device having a rotary blade 20, and then convey the sealed substrate 1 to another cutting device having a laser oscillator 11 (see Fig. 1).

[0061]

In the present embodiment, a laser beam may be used instead of the rotary blade 20 to form grooves in the sealing resin 4 of the sealed substrate 1. In this case, it is preferable to use a laser beam that can be easily absorbed by the sealing resin 4, such as a laser beam generated by a CO₂ laser oscillator.

[0062]

In the present embodiment, the grooves in the sealing resin 4 may be formed in the resin-sealing process. In this case, the grooves can be formed in the sealing resin 4 by previously providing thin plate-like projections in the cavity of the molding die used for resin sealing.

[0063]

In the present embodiment, the surface of the circuit substrate 2 may be exposed in the groove formed in the sealing resin 4, with no resin 4 left at the bottom of the groove. It is

also possible to leave some amount of the sealing resin 4 at the bottom of the groove. The point of the present embodiment is that the sealing resin 4 has a reduced thickness at the boundary lines 6.

[0064]

5 In any of the previous embodiments, the perforations 17 or 19 were initially formed on every boundary line 6 extending in the X direction, after which the perforations 17 or 19 were formed on every boundary line 6 extending in the Y direction. Subsequently, the sealed substrate 1 was cut at every boundary line 6 extending along the X direction, after which the sealed substrate 1 was cut at every boundary line 6 extending along the Y direction.

10 [0065]

 In the present invention, it is possible to initially cut the sealed substrate 1 into relatively large blocks and then divide each block into individual areas 7. One example is as follows: Initially, perforations 17 are formed on every boundary line 6 of the sealed substrate 1. Next, the sealed substrate 1 is equally divided into four blocks by cutting it at the
15 boundary lines 6 near the center lines of the sealed substrate 1 in the X and Y directions. Subsequently, each of the four blocks is divided into individual areas 7. When such a method is used for cutting a sealed substrate 1 that is likely to undergo significant deformations (e.g. warping, undulation or deflection), the perforations 17 formed at all the boundary lines 6 alleviate the stress due to such deformations and thereby suppress negative effects resulting
20 from those deformations in the process of cutting the sealed substrate 1.

[0066]

 Another possible example is as follows: Perforations 17 are formed on the boundary lines 6 near the central lines of the sealed substrates in the X and Y directions. Next, the sealed substrate 1 is equally divided into four blocks by cutting it at the aforementioned
25 boundary lines 6. Subsequently, for each of the four blocks, perforations 17 are formed on

every boundary line 6. Then, for each of the four blocks, the sealed substrate 1 is cut at every boundary line 6. Such a method is also effective for suppressing negative effects resulting from warping, undulation, deflection or other deformations in the process of cutting the sealed substrate 1.

5 [0067]

In any of the previous embodiments, the sealed substrate 1 had LED chips as the chips 3 and a translucent silicon resin as the sealing resin 4. This is not the only possible configuration. For example, laser diode chips may be used as the chips 3. It is also possible to apply the present invention in the production of power semiconductor parts by using
10 power semiconductor chips as the chips 3 and an epoxy resin or the like as the sealing resin 4.

[0068]

It is also possible to mount a plurality of chips 3 on one area 7. For example, if a plurality of LED chips are mounted on one area 7, this area 7 can function as a surface light
15 source after being singulated. It is not always necessary that the plurality of chips 3 mounted on each area 7 have the same function. For example, if a light-emitting element and a light-receiving element are mounted on one area 7, this area 7 can function as an optical sensor after being singulated.

[0069]

20 In any of the previous embodiments, the table 9 was moved in the X or Y direction shown in the figures relative to the irradiation head 10 while the first laser beam 12 or the second laser beam 18 was thrown at the boundary line 6 of the sealed substrate 1. This is not the only possible operation. For example, it is possible to move the irradiation head 10 in the X or Y direction relative to the table 9. Alternatively, both the table 9 and the irradiation
25 head 10 may be moved in the X or Y direction. The point is to move the table 9 and the

irradiation head 10 relative to each other in the X or Y direction.

[0070]

Another possible method is to change the irradiation angle of the first laser beam 12 and the second laser beam 18 thrown from the irradiation head 10 onto the sealed substrate 1, so as to move the spot of the laser beam on the sealed substrate 1 and thereby change the relative position between the laser beam and the sealed substrate 1. During this operation, the sealed substrate 1 and the irradiation head 10 may be held static or moved relative to each other in the previously described manner.

[0071]

10 In any of the previous embodiments, each boundary line 6 was formed by one line segment. This is not the only possible form. For example, the present invention is also applicable in the case where the boundary line 6 includes a curved line or a polygonal line composed of line segments. Accordingly, the present invention can also be used in the case where a package having a curved or polygonal line included in its external form (e.g. a
15 certain kind of memory card) is produced by cutting a sealed substrate. In this case, the perforations 17 or 19 are arranged in the form of the curved or polygonal line.

[0072]

In any of the previous embodiments, the sealed substrate 1 was fixed to the table 9 with the adhesive tape 8. This is not the only possible form. For example, the sealed
20 substrate 1 may be held on the table 9 by suction. In this case, it is preferable to form grooves in the surface of the table 9 at the portions on which the boundary line 6 will lie. These grooves serve as a passage for removing the dross produced in both the process of forming the perforations 17 or 19 in the sealed substrate and the process of completely cutting the sealed substrate 1 (particularly, in the latter process).

25 [0073]

It should be noted that the present invention is not limited to the previously described embodiments. These embodiments can be arbitrarily and appropriately combined, changed or selectively adopted as needed without departing from the spirit and scope of the present invention.

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EXPLANATION OF NUMERALS

[0074]

- 1... Sealed Substrate
- 2... Circuit Substrate
- 10 3... Chip
- 4... Sealing Resin
- 5... Lens Part
- 6... Boundary Line
- 7... Area
- 15 8... Adhesive Tape (Fixing Means)
- 9... Table (Moving Means)
- 10... Irradiation Head
- 11... Laser Oscillator (Laser-Beam Generating Means)
- 12... First Laser Beam (Laser Beam)
- 20 13... Tube
- 14... Assist Gas
- 15... Nozzle
- 16... Target Portion
- 17, 21... Perforation (Through-Hole)
- 25 18... Second Laser Beam (Laser Beam)

19... Perforamtion (Blind Hole)

20... Rotary Blade

CLAIMS

1. A cutting device used for producing a plurality of electronic parts by forming a sealed substrate by resin-sealing a chip mounted on each of a plurality of areas provided on a circuit substrate, and by cutting the sealed substrate at a boundary line of the plurality of areas, comprising a fixing means for fixing the sealed substrate, a laser-beam generating means for generating a laser beam, and a moving means for moving the sealed substrate and/or the laser beam relative to each other, characterized in that the laser-beam generating means generates a first laser beam for forming perforations on the boundary line and a second laser beam for cutting the sealed substrate at the boundary line on which the perforations have been formed.

2. The cutting device for producing a plurality of electronic parts according to claim 1, characterized in that the first laser beam is a pulsed beam, and the second laser beam is a continuous beam.

3. The cutting device for producing a plurality of electronic parts according to claim 1 or 2, characterized in that the laser-beam generating means includes a fiber laser oscillator or a YAG laser oscillator.

4. The cutting device for producing a plurality of electronic parts according to one of claims 1-3, characterized in that the perforations are through-holes.

5. The cutting device for producing a plurality of electronic parts according to one of claims 1-3, characterized in that the perforations are blind holes.

6. The cutting device for producing a plurality of electronic parts according to one of claims 1-5, characterized in that a base material of the circuit substrate is a ceramic or a metal.

5

7. The cutting device for producing a plurality of electronic parts according to one of claims 1-6, characterized in that the electronic parts are optoelectronic parts or power semiconductor parts.

10 8. A cutting method used for producing a plurality of electronic parts by forming a sealed substrate by resin-sealing a chip mounted on each of a plurality of areas provided on a circuit substrate, and by cutting the sealed substrate at a boundary line of the plurality of areas, comprising a step for fixing the sealed substrate and an irradiation step for moving the sealed substrate and/or the laser beam relative to each other while throwing a
15 laser beam at the sealed substrate, characterized in that, in the irradiation step, perforations are formed on the boundary line by throwing a first laser beam at the sealed substrate, after which the sealed substrate is cut by throwing a second laser beam at the boundary line.

9. The cutting method for producing a plurality of electronic parts according to
20 claim 8, characterized in that the first laser beam is a pulsed beam and the second laser beam is a continuous beam.

10. The cutting method for producing a plurality of electronic parts according to claim 8 or 9, characterized in that a fiber laser oscillator or a YAG laser oscillator is used to
25 generate the first laser beam and the second laser beam in the irradiation step.

11. The cutting method for producing a plurality of electronic parts according to one of claims 8-10, characterized in that the perforations are through-holes.
- 5 12. The cutting method for producing a plurality of electronic parts according to one of claims 8-10, characterized in that the perforations are blind holes.
13. The cutting method for producing a plurality of electronic parts according to one of claims 8-12, characterized in that a base material of the circuit substrate is a ceramic
10 or a metal.
14. The cutting method for producing a plurality of electronic parts according to one of claims 8-13, characterized in that the electronic parts are optoelectronic parts or power semiconductor parts.