

CUTTING APPARATUS

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a cutting apparatus suitable for use in cutting a QFN substrate into chip size packages (CSPs).

Description of the Related Art

In recent years, electrical equipment such as a mobile phone and a personal computer has been required to more reduce in size and weight, and there has been developed a technique called a chip size package (CSP) such that a semiconductor chip is packaged to form a device suitable for such a size reduction. This technique has been put to practical use. For example, such a CSP is formed by dividing a QFN (Quad Flat Non-Lead Package) substrate into individual devices. The QFN substrate is composed of a plurality of semiconductor chips arranged at given intervals, an electrode frame formed like a lattice to partition these semiconductor chips, a plurality of electrode terminals extending from the electrode frame like a fish bone and connected to bonding pads formed on the surface of each semiconductor chip, and a resin layer molded so as to enclose each

semiconductor chip and the electrode frame.

The QFN substrate is divided into the individual CSPs in the following manner. The electrode frame of the QFN substrate is cut by a cutting apparatus having a rotatable cutting blade to thereby separate the electrode terminals having a shape like a fish bone into individual pieces for each device (see Japanese Patent Laid-open No. 2004-259936, for example). However, when the electrode frame of the QFN substrate is cut by the cutting blade to separate the electrode terminals having a shape like a fish bone into individual pieces for each device, there arises a problem such that the adjacent electrode terminals separated may be short-circuited because of ductility, causing a remarkable degradation in electrical characteristics of each device.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide a cutting apparatus which can exhibit a cutting performance so that even when the electrode frame is cut by a cutting blade to separate the electrode terminals of the adjacent devices, a possible short circuit between the adjacent electrode terminals due to ductility is prevented.

In accordance with an aspect of the present invention, there is provided a cutting apparatus including a chuck table configured to hold a workpiece and cutting means having a circular cutting blade configured to cut the workpiece held on the chuck table, the cutting blade being supported by a pair of flanges mounted on a spindle; the cutting means including a blade cover composed of a first cover configured to cover a first side surface of a cutting edge of the cutting blade and a second cover configured to cover a second side surface of the cutting edge; each of the first and second covers being formed with a plurality of cutting water nozzles arranged along the outer circumference of the cutting edge configured to supply a jet of cutting water to a root portion of the cutting edge projecting radially outward from the outer circumference of the flanges.

Preferably, the cutting edge of the cutting blade projects from the lower end of the blade cover by an amount required for cutting of the workpiece. Preferably, the jet of cutting water is supplied from the cutting water nozzles at a rate of 2 to 5 liters/min.

According to the present invention, the jet of cutting water supplied to the root portion of the cutting edge projecting radially outward from the outer

circumference of the flange is moved radially outward to the outer circumference of the cutting edge so as to flow thereon by a centrifugal force, so that the cutting water on the cutting edge is rotated therewith to be sufficiently supplied to a cutting point on the workpiece. Accordingly, extension of each electrode due to its ductility can be suppressed to thereby prevent a short circuit between the adjacent electrode terminals. As a result, it is possible to form a device (CSP) having good electrical characteristics.

The above and other objects, features and advantages of the present invention and the manner of realizing them will become more apparent, and the invention itself will best be understood from a study of the following description and appended claims with reference to the attached drawings showing some preferred embodiments of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a plan view of a QFN substrate;

FIG. 2 is a cross section taken along the line II-II in FIG. 1;

FIG. 3 is a perspective view of a cutting apparatus;

FIG. 4 is an exploded perspective view for illustrating a structure of mounting a cutting blade to a spindle;

FIG. 5 is a perspective view showing a mounted condition of the cutting blade to the spindle;

FIG. 6 is an exploded perspective view of a blade cover;

FIG. 7A is an exploded perspective view of the blade cover in the condition where it is mounted on a spindle housing;

FIG. 7B is a perspective view showing a mounted condition of the blade cover to the spindle housing;

FIG. 8 is a vertical sectional view of the blade cover;

FIG. 9 is a sectional view of the QFN substrate in the condition where an electrode frame is cut by the cutting blade; and

FIG. 10 is a plan view of a CSP (device) incorporating a semiconductor chip.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

A preferred embodiment of the present invention will now be described in detail with reference to the drawings. Referring to FIG. 1, there is shown a plan view

of a QFN substrate 2 to be suitably cut by the cutting apparatus of the present invention. The QFN substrate 2 has a rectangular metal frame 4. The metal frame 4 has a peripheral marginal area 5, a non-device area 5a, and three device areas 6a, 6b, and 6c surrounded by the peripheral marginal area 5 and the non-device area 5a. In each of the device areas 6a, 6b, and 6c, a plurality of device forming portions 10 are formed so as to be partitioned by a plurality of first and second electrode frames 8a and 8b respectively extending in the vertical and horizontal directions as viewed in FIG. 1 and intersecting at right angles. A plurality of electrode terminals 12 extend from the opposite sides of each of the electrode frames 8a and 8b like a fish bone. Each electrode terminal 12 is connected to a bonding pad (not shown) on a semiconductor chip 14 (see FIG. 2).

The electrode frames 8a and 8b and the electrode terminals 12 are formed integrally with the metal frame 4. As shown in FIG. 2, the metal frame 4 is molded with a resin layer 16, and the electrode terminals 12 are insulated from each other by the resin layer 16. The semiconductor chip 14 is provided on the back side of each device forming portion 10, and each semiconductor chip 14 is sealed with the resin layer 16.

Referring to FIG. 3, there is shown a perspective view of a cutting apparatus 22 suitable for cutting the QFN substrate 2 shown in FIG. 1. The front portion of the cutting apparatus 22 is provided with operating means 24 through which an operator inputs instructions such as working conditions to the cutting apparatus 22. The upper portion of the cutting apparatus 22 is provided with displaying means 26 such as a CRT for displaying a guide screen for the operator or an image obtained by imaging means to be hereinafter described.

The QFN substrate 2 as an object to be cut is attached to a dicing tape T as an adhesive tape, and the outer circumferential portion of the dicing tape T is attached to an annular frame F. Thus, the QFN substrate 2 is supported through the dicing tape T to the frame F. A plurality of such QFN substrates 2 supported to the frames F are stored in a cassette 28 shown in FIG. 3. The cassette 28 is placed on a vertically movable cassette elevator 29.

There is provided behind the cassette 28 pickup means 30 for picking up one of the QFN substrates 2 out of the cassette 28 before cutting and bringing the QFN substrate 2 into the cassette 28 after cutting. A temporary placement area 32 is formed between the

cassette 28 and the pickup means 30, wherein the QFN substrate 2 to be picked up by the pickup means 30 is temporarily placed in the temporary placement area 32. A pair of positioning means 34 for positioning the QFN substrate 2 are provided in the temporary placement area 32.

There is provided in the vicinity of the temporary placement area 32 handling means 36 having a swivel arm for handling the QFN substrate 2 by holding the frame F integrated with the QFN substrate 2 under suction, wherein the QFN substrate 2 placed in the temporary placement area 32 is handled by the handling means 36 and carried onto a chuck table 38. The QFN substrate 2 is held on the chuck table 38 under suction and the frame F is fixed to the chuck table 38 by a plurality of clamps 39.

The chuck table 38 is rotatable and reciprocatable in the X direction shown by an arrow X in FIG. 3. Alignment means 40 for detecting the electrode frames 8a and 8b of the QFN substrate 2 to be cut is provided above a path of movement of the chuck table 38 in the X direction. The alignment means 40 includes imaging means 42 for imaging the upper surface of the QFN substrate 2, wherein the electrode frames 8a and 8b to be cut can be

detected by image processing such as pattern matching according to an image obtained by the imaging means 42. The image obtained by the imaging means 42 is displayed by the displaying means 26.

Cutting means (cutting unit) 44 for cutting the QFN substrate 2 held on the chuck table 38 is provided on the left side of the alignment means 40 as viewed in FIG. 3. The cutting unit 44 is integrated with the alignment means 40, so that both the cutting unit 44 and the alignment means 40 are movable together in the Y direction and the Z direction respectively shown by arrows Y and Z in FIG. 3. The cutting unit 44 includes a rotatable spindle 46 and a cutting blade 48 mounted on the spindle 46 at its front end, and is movable in the Y and Z directions. The cutting blade 48 is formed by bonding diamond abrasive grains with resin. The cutting blade 48 is located on an extension line extending from the imaging means 42 in the X direction. Reference numeral 45 denotes handling means for carrying the QFN substrate 2 after cutting to a cleaning unit 47. In the cleaning unit 47, the QFN substrate 2 is cleaned and next dried by a jet of air from an air nozzle.

Referring to FIG. 4, there is shown an exploded perspective view for illustrating a structure of mounting

the cutting blade 48 like a washer to the spindle 46. The cutting blade 48 is a resin blade formed by bonding diamond abrasive grains with a resin bond, and it is a hubless blade having a center hole so as to form a cutting edge as a whole. The cutting blade 48 has a thickness of 100 to 300 μm . Reference numeral 52 denotes a mount flange composed of a boss portion 54 and a fixed flange 56 formed integrally with the boss portion 54. The boss portion 54 is formed with an external thread 58. The mount flange 52 is mounted on the front end portion of the spindle 46 in such a manner that a mounting hole of the mount flange 52 is fitted to a small-diameter front end portion and a tapering portion (both not shown) of the spindle 46 and that a nut 60 is threadedly engaged with an external thread formed on the small-diameter front end portion of the spindle 46.

The cutting blade (resin blade) 48 is mounted through the mount flange 52 to the spindle 46 in the following manner. The center hole of the cutting blade 48 is fitted to the boss portion 54 of the mount flange 52. Thereafter, a mounting hole of a detachable flange 62 is fitted to the boss portion 54, and a fixing nut 64 is threadedly engaged with the external thread 58 of the boss portion 54. Thus, the cutting blade 48 is mounted to

the spindle 46 in the condition where it is sandwiched between the fixed flange 56 and the detachable flange 62 as shown in FIG. 5.

Referring to FIG. 6, there is shown an exploded perspective view of a blade cover 66. The blade cover 66 is composed of a first cover 68 and a second cover 70 joined to the first cover 68. As shown in FIG. 7A, the first cover 68 is mounted to a spindle housing 50. The first cover 68 has an arcuate inner circumferential surface 72 so formed as to surround the cutting blade 48. The arcuate inner circumferential surface 72 is formed with a plurality of cutting water nozzles 74 spaced apart from each other at given intervals in the circumferential direction. As shown in FIG. 8, each cutting water nozzle 74 is connected through a cutting water passage 75 to a connection pipe 76. Although not shown, a hose is connected at its one end to the connection pipe 76, and the other end of this hose is connected to a cutting water source. The first cover 68 is further formed with a pair of projections 78 and a tapped hole 80.

Similarly, the second cover 70 has an arcuate inner circumferential surface 82 so formed as to surround the cutting blade 68. The arcuate inner circumferential surface 82 is formed with a plurality of cutting water

nozzles 84 spaced apart from each other at given intervals in the circumferential direction. As shown in FIG. 8, each cutting water nozzle 84 is connected through a cutting water passage 85 to a connection pipe 86. Although not shown, a hose is connected at its one end to the connection pipe 86, and the other end of this hose is connected to the cutting water source. The second cover 70 is further formed with a through hole 88 for insertion of a tightening bolt 90 (see FIG. 7A) and a pair of recesses (not shown) for engaging the projections 78 of the first cover 68.

The blade cover 66 is assembled in the following manner. As shown in FIG. 7A, the projections 78 of the first cover 68 are inserted into the recesses of the second cover 70, and the bolt 90 is inserted through the through hole 88 of the second cover 70 and threadedly engaged with the tapped hole 80 of the first cover 68. Thus, the second cover 70 is mounted to the first cover 68 to complete the blade cover 66 as shown in FIG. 7B.

The operation of the cutting apparatus 22 will now be described with reference to FIG. 3. The frame F supporting the QFN substrate 2 stored in the cassette 28 is picked up by the pickup means 30, and the pickup means 30 is moved in the Y direction to the temporary placement

area 32. In the temporary placement area 32, the QFN substrate 2 supported to the frame F is released from the pickup means 30 and is placed in a temporary position. Thereafter, the pair of positioning means 34 are moved toward each other to thereby position the QFN substrate 2 in the temporary placement area 32.

Thereafter, the frame F is held under suction by the handling means 36, and the handling means 36 is swiveled to thereby carry the QFN substrate 2 integrated with the frame F to the chuck table 38. The QFN substrate 2 is held on the chuck table 38 under suction, and the frame F is fixed by the clamps 39. Thereafter, the chuck table 38 is moved in the X direction to thereby position the QFN substrate 2 directly below the alignment means 40.

The alignment means 40 performs an alignment operation such that the electrode frame 8a of the QFN substrate 2 to be cut is imaged and the cutting blade 48 is aligned to the electrode frame 8a to be cut by using a well known technique such as pattern matching. After finishing this alignment operation for all of the vertical electrode frames 8a, the chuck table 38 is rotated 90° to similarly perform an alignment operation for all of the horizontal electrode frames 8b.

Thereafter, in the condition where the cutting

blade 48 is aligned to the electrode frame 8a to be cut, the chuck table 38 is moved in the X direction. At the same time, the cutting blade 48 is rotated at a high speed and the cutting unit 44 is lowered to thereby cut the target electrode frame 8a, so that the electrode terminals 12 of the adjacent semiconductor chips 14 are separated from each other as shown in FIG. 9.

In performing this cutting operation, a jet of cutting water is supplied from the cutting water nozzles 74 and 84 of the blade cover 66 toward a root portion of the cutting edge of the cutting blade 48 projecting radially outward from the outer circumferences of the flanges 56 and 62 as shown in FIG. 8. In other words, a jet of cutting water is supplied from the cutting water nozzles 74 and 84 toward the boundary between the flanges 56 and 62 and the cutting edge of the cutting blade 48 during cutting the QFN substrate 2. Preferably, a jet of cutting water is supplied at a rate of 2 to 5 liters/min from the cutting water nozzles 74 and 84.

The jet of cutting water supplied to the root portion of the cutting edge 48 projecting radially outward from the outer circumferences of the flanges 56 and 62 is moved radially outward to the outer circumference of the cutting edge 48 so as to flow

thereon by a centrifugal force, so that the cutting water on the cutting edge 48 is rotated therewith to be sufficiently supplied to a cutting point on the QFN substrate 2. Accordingly, extension of each electrode terminal 12 due to its ductility can be suppressed to thereby prevent a short circuit between the adjacent electrode terminals 12.

After finishing the cutting operation for the target electrode frame 8a, the cutting unit 44 is indexed in the Y direction with the pitch of the electrode frames 8a which pitch is preliminarily stored in a memory, and the cutting operation for the next electrode frame 8a is similarly performed. This operation is repeatedly performed for all of the vertical electrode frames 8a. Thereafter, the chuck table 38 is rotated 90° to similarly perform the cutting operation for all of the electrode frames 8b. As a result, the QFN substrate 2 is divided into a plurality of CSPs (chip size packages) 15, one of which is shown in FIG. 10.

While the cutting water nozzles 74 and 84 of the first and second covers 68 and 70 are formed on the whole of the inner circumferential surfaces 72 and 82 in this preferred embodiment, the cutting water nozzles 74 may be formed on a part of the inner circumferential surface 72

of the first cover 68. Similarly, the cutting water nozzles 84 may be formed on a part of the inner circumferential surface 82 of the second cover 70.

The present invention is not limited to the details of the above described preferred embodiments. The scope of the invention is defined by the appended claims and all changes and modifications as fall within the equivalence of the scope of the claims are therefore to be embraced by the invention.

WHAT IS CLAIMED IS:

1. A cutting apparatus comprising:
a chuck table configured to hold a workpiece; and
cutting means having a circular cutting blade
configured to cut said workpiece held on said chuck table,
said cutting blade being supported by a pair of flanges
mounted on a spindle;

said cutting means including

a blade cover composed of a first cover
configured to cover a first side surface of a cutting
edge of said cutting blade and a second cover configured
to cover a second side surface of said cutting edge,

each of said first and second covers being formed
with a plurality of cutting water nozzles arranged along
the outer circumference of said cutting edge configured
to supply a jet of cutting water to a root portion of
said cutting edge projecting radially outward from the
outer circumference of said flanges.

2. The cutting apparatus according to claim 1,
wherein said cutting edge of said cutting blade projects
from the lower end of said blade cover by an amount
required for cutting of said workpiece.

3. The cutting apparatus according to claim 1 or 2,
wherein said jet of cutting water is supplied from said

cutting water nozzles at a rate of 2 to 5 liters/min.