

CHUCK TABLE

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a chuck table used when cutting a plate-shaped workpiece by a cutting blade to divide the workpiece into a plurality of chips.

Description of the Related Art

A package substrate obtained by sealing a plurality of semiconductor devices with a resin is cut along division lines called streets or the like, to be divided into a plurality of chips each including a semiconductor device. At the time of cutting a plate-shaped workpiece such as this package substrate to divide the workpiece into a plurality of chips, the workpiece may be held by use of a chuck table designed in conformity with the workpiece (see, for example, Japanese Patent Laid-open No. 2018-78253).

The above-described chuck table includes, for example, relief grooves for relieving a cutting blade so as to prevent interference with the cutting blade made to cut into the workpiece, and suction holes provided in surfaces of regions partitioned by the relief grooves, and can directly hold the workpiece after dividing (the

plurality of chips) under suction. In other words, the use of this chuck table eliminates the need to use consumables such as a dicing tape attached to the workpiece so as to prevent the plurality of chips formed from scattering, so that the workpiece can be divided at low cost.

SUMMARY OF THE INVENTION

Incidentally, since the above-described chuck table holds each chip by the surface of each of regions partitioned by the relief grooves, in the case where the chips are small in size, the area concerning the contact between each chip and the chuck table is small, as compared to the case where the chips are large in size. In other words, in the case of holding a small chip, the chuck table's force of holding the chip is weak, as compared to the case of holding a large chip.

Therefore, in the case of dividing a workpiece into small chips, positional deviation of the chips may occur or the chips may be vibrated, so that the accuracy of processing by cutting is liable to be lowered, as compared to the case of dividing a workpiece into large chips. In addition, the cutting blade may be markedly worn due to the vibration of the chips or the like.

Accordingly, it is an object of the present invention to provide a chuck table with which a workpiece can be cut with high accuracy while restraining wear of a cutting blade, even in the case of dividing the workpiece into small chips.

In accordance with an aspect of the present invention, there is provided a chuck table that is mounted to a table base of a cutting apparatus for cutting a workpiece by a cutting blade and holds the workpiece when cutting the workpiece along streets to divide the workpiece into a plurality of chips. The chuck table includes a first layer including a rubber having a dynamic viscoelastic modulus of 0.16 to 0.8 and a second layer that includes a rubber having a static frictional coefficient on the workpiece of equal to or more than 1 and is supported by the first layer. The second layer has a holding surface at an upper portion thereof making contact with the workpiece when holding the workpiece, opening sections of relief grooves provided so as to partition the holding surface correspondingly to the streets of the workpiece, and suction holes provided in regions partitioned by the opening sections in the holding surface.

Preferably, an upper surface of the first layer is

in contact with a lower surface of the second layer. In addition, preferably, the rubber constituting the first layer is any one of urethane rubber, nitrile rubber, ethylene rubber, butyl rubber, fluororubber, silicone rubber, isoprene rubber, butadiene rubber, acrylic rubber, and polysulfide rubber. Besides, preferably, the rubber constituting the second layer is chloroprene rubber.

The chuck table according to one aspect of the present invention includes the first layer including a rubber having a dynamic viscoelastic modulus of 0.16 to 0.8 and the second layer including a rubber having a static frictional coefficient on the workpiece of equal to or more than 1. In addition, the second layer is supported by the first layer, and, when holding the workpiece, the workpiece makes contact with the holding surface at the upper portion of the second layer.

By thus causing the first layer not making contact with the workpiece to include the rubber having a dynamic viscoelastic modulus of 0.16 to 0.8 and causing the second layer making contact with the workpiece to include the rubber having a static frictional coefficient on the workpiece of equal to or more than 1, it is possible to obtain both a high vibration isolation effect by the

first layer and a large frictional force by the second layer.

As a result, vibration of the chips and positional deviation of the chips are restrained from being occurred. In other words, wear of the cutting blade due to vibration of the chips or the like can be restrained, even in the case of dividing the workpiece into small chips. In addition, the accuracy of processing by cutting can be restrained from being lowered due to vibration of the chips, positional deviation of the chips, or the like, and the workpiece can be cut with high accuracy.

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 a preferred embodiment of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view depicting a cutting apparatus;

FIG. 2 is a perspective view depicting a workpiece as viewed from a predetermined direction;

FIG. 3 is a perspective view depicting the workpiece as viewed from a direction opposite to that of FIG. 2;

FIG. 4 is a perspective view depicting a table base and a chuck table;

FIG. 5 is a sectional view depicting the table base and the chuck table;

FIG. 6 is a sectional view depicting a manner in which the workpiece is cut;

FIG. 7 is a perspective view depicting a chip obtained by dividing the workpiece;

FIG. 8 is a side view obtained by enlarging a side surface of the chip; and

FIG. 9 is a sectional view depicting a manner in which a workpiece held by a chuck table according to a modification is cut.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

An embodiment according to one mode of the present invention will be described below referring to the attached drawings. FIG. 1 is a perspective view depicting a cutting apparatus 2 of the present embodiment. Note that, in FIG. 1, some of components of the cutting apparatus 2 are omitted. In addition, an X-axis direction

(a front-rear direction, a processing feeding direction), a Y-axis direction (a left-right direction, an indexing feeding direction), and a Z-axis direction (a vertical direction, a cutting-in feeding direction) used in the following description are mutually orthogonal.

As depicted in FIG. 1, the cutting apparatus 2 includes a base 4 that supports a plurality of components. An upper surface of the base 4 is formed with an opening 4a which is elongate in the X-axis direction. In the opening 4a, a ball screw type table moving mechanism 6 is disposed. The table moving mechanism 6 includes an X-axis moving table (not illustrated), and the X-axis moving table is moved in the X-axis direction. The table moving mechanism 6 and the X-axis moving table are covered from above with a table cover 8 and a bellows-like cover 10.

On the X-axis moving table, for example, a rectangular parallelepiped table base 12 is disposed in the manner of being exposed to above from the table cover 8. The table base 12 is connected, for example, to a rotational drive source (not illustrated) such as a motor, and is rotated around a rotational axis which is substantially parallel to the Z-axis direction. In addition, the table base 12 is moved in the X-axis

direction by the above-described table moving mechanism 6 together with the X-axis moving table.

A chuck table 14 for holding a plate-shaped workpiece 11 is mounted to an upper portion of the table base 12 in the manner of being detachable from the table base 12 as required. FIG. 2 is a perspective view depicting the workpiece 11 as viewed from a predetermined direction, and FIG. 3 is a perspective view depicting the workpiece 11 as viewed from a direction opposite to FIG. 2.

The workpiece 11 is, for example, a package substrate obtained by sealing a plurality of devices with a resin. As depicted in FIGS. 2 and 3, the workpiece 11 includes a substrate 13 having a rectangular first surface (front surface) 13a and a rectangular second surface (back surface) 13b located on the side opposite to the first surface 13a. The substrate 13 mainly includes, for example, a metal such as a 42 alloy (an alloy of iron and nickel) or copper, and is partitioned into a plurality of device areas 15 (in the present embodiment, three device areas 15) and a marginal area 17 surrounding the device areas 15.

Each device area 15 is further partitioned by a plurality of mutually intersecting streets 19 into a

plurality of areas (in the present embodiment, 16 areas). On the first surface 13a side of the substrate 13, a plurality of stages 21 partitioned by the streets 19 are exposed. In the periphery of each stage 21 (an area overlapping with the streets 19), for example, a plurality of metal layers (not illustrated) in the state of being mutually insulated by a resin or the like are disposed.

On the second surface 13b side of each stage 21, a device (device chip) (not illustrated) such as an integrated circuit (IC), a light emitting diode (LED), or micro electro mechanical systems (MEMS) are mounted. Electrodes of each device and the metal layer disposed in the periphery of the stage 21 are connected to each other by a metallic wire (not illustrated), and a part of each metal layer becomes an electrode of the chip (package device chip) obtained by dividing the workpiece 11.

On the second surface 13b side of the substrate 13, a resin layer 23 sealing the above-described devices, metal wires, and the like is provided. The resin layer 23 is formed in a predetermined thickness and projects from the second surface 13b of the substrate 13. By the resin layer 23, the whole part on the second surface 13b side of each device area 15 is covered. Note that, while the

package substrate including the substrate 13 is the workpiece 11 in the present embodiment, the shape, structure, size, material, and the like of the workpiece 11 are not limited.

As depicted in FIG. 1, on an upper side of the base 4, a gate-shaped support structure 16 is disposed in the manner of straddling the opening 4a. At an upper portion of a front surface of the support structure 16, a pair of cutting unit moving mechanisms 18 are provided. The cutting unit moving mechanisms 18 share a pair of Y-axis guide rails 20 disposed on the front surface of the support structure 16 and substantially parallel to the Y-axis direction. A Y-axis moving plate 22 constituting each cutting unit moving mechanism 18 is attached to the Y-axis guide rails 20 in the manner of being slidable along the Y-axis direction.

On the back surface (rear surface) side of each Y-axis moving plate 22, a nut (not illustrated) constituting a ball screw is provided. A screw shaft 24 substantially parallel to the Y-axis guide rails 20 is connected to the nut in a rotatable manner. A Y-axis pulse motor 26 is connected to one end portion of the screw shaft 24. When the screw shaft 24 is rotated by the Y-axis pulse motor 26, the Y-axis moving plate 22 is

moved in the Y-axis direction along the Y-axis guide rails 20.

On the front surface of each Y-axis moving plate 22, a pair of Z-axis guide rails 28 substantially parallel to the Z-axis direction are disposed. A Z-axis moving plate 30 is attached to the Z-axis guide rails 28 in the manner of being slidable along the Z-axis direction. On a back surface (rear surface) side of the Z-axis moving plate 30, a nut (not illustrated) constituting a ball screw is provided.

A screw shaft 32 substantially parallel to the Z-axis guide rails 28 is connected to the nut in a rotatable manner. A Z-axis pulse motor 34 is connected to one end portion of the screw shaft 32. When the screw shaft 32 is rotated by the Z-axis pulse motor 34, the Z-axis moving plate 30 is moved in the Z-axis direction along the Z-axis guide rails 28.

At a lower portion of the Z-axis moving plate 30, a cutting unit 36 used for cutting of the workpiece 11 is provided. The cutting unit 36 includes, for example, a spindle housing configured in a tubular shape. A spindle which becomes a rotary shaft substantially parallel to the Y-axis direction is accommodated in a space inside the spindle housing.

A rotational drive source such as a motor is connected to a base end side of the spindle. A tip portion of the spindle is exposed to the exterior from the spindle housing, and a cutting blade 38 is mounted to the tip portion of the spindle through a blade mounter. The cutting blade 38 is obtained, for example, by fixing abrasive grains of diamond or the like by a binder such as a resin, and is formed in an annular shape having a pair of substantially flat side surfaces.

As depicted in FIG. 1, a camera (imaging unit) 40 is fixed at a lower portion of the Z-axis moving plate 30. The camera 40 includes, for example, a two-dimensional optical sensor such as a complementary metal oxide semiconductor (CMOS) image sensor or a charge coupled device (CCD) image sensor having sensitivity to visible light, and an image forming lens, and is used at the time of imaging the workpiece 11 or the like held by the chuck table 14 to acquire an image.

Note that, when the Y-axis moving plate 22 of the cutting unit moving mechanism 18 is moved in the Y-axis direction, the cutting unit 36 and the camera 40 are both moved in the Y-axis direction. In addition, when the Z-axis moving plate 30 of the cutting unit moving mechanism 18 is moved in the Z-axis direction, the cutting unit 36

and the camera 40 are both moved in the Z-axis direction.

An upper portion of the base 4 is covered by a cover (not illustrated). At a side surface of the cover, a touch screen (input-output device) (not illustrated) serving as a user interface is disposed. For example, various conditions applied when cutting the workpiece 11 are inputted to the touch screen. Note that, in place of the touch screen in which a display device (output device) and an input device are united, a display device (output device) such as a liquid crystal display and an input device such as a keyboard or a mouse may separately be provided.

The components such as the table moving mechanism 6, the cutting unit moving mechanisms 18, the cutting units 36, the cameras 40, and the touch screen are each connected to a control unit (not illustrated). The control unit controls each of the above-described components according to a series of steps necessary for cutting of the workpiece 11.

The control unit includes a computer including, for example, a processing device such as a central processing unit (CPU), a main storage device such as a dynamic random access memory (DRAM), and an auxiliary storage device such as a hard disk drive or a flash memory. By

operating the processing device and the like according to software stored in the auxiliary storage device, functions of the control unit are realized. It is to be noted, however, that the functions of the control unit may be realized by only hardware.

FIG. 4 is a perspective view depicting the table base 12 and the chuck table 14, and FIG. 5 is a sectional view depicting the table base 12 and the chuck table 14. Note that, in FIG. 5, some of the components connected to the table base 12 are represented by symbols, functional blocks, or the like. As illustrated in FIGS. 4 and 5, the chuck table 14 includes a flat plate-shaped frame body 42 having a rectangular first surface (upper surface) 42a and a rectangular second surface (lower surface) 42b located on the side opposite to the first surface 42a. The frame body 42 includes, for example, a metal such as stainless steel.

The size of the first surface 42a and the size of the second surface 42b of the frame body 42 are greater than the size of the first surface 13a and the size of the second surface 13b of the workpiece 11. In addition, the size of the first surface 42a and the size of the second surface 42b of the frame body 42 are comparable to that of an upper surface 12a of the table base 12 to

which the chuck table 14 is mounted. On the first surface 42a side of the frame body 42, a recess 42c of which the shape of an opening at an upper end and the shape of a bottom surface are rectangular is provided.

A first layer 44 having a rectangular first surface (upper surface) 44a and a rectangular second surface (lower surface) 44b located on the side opposite to the first surface 44a is fixed to the recess 42c of the frame body 42, with the second surface 44b side in contact with the bottom surface of the recess 42c. The size of the first surface 44a and the size of the second surface 44b of the first layer 44 are, for example, slightly smaller than the size of the first surface 13a and the size of the second surface 13b of the workpiece 11.

It is to be noted, however, that the size of the first surface 44a and the size of the second surface 44b of the first layer 44 may be comparable to the size of the first surface 13a and the size of the second surface 13b of the workpiece 11. In addition, the size of the first surface 44a and the size of the second surface 44b may be greater than the size of the first surface 13a and the size of the second surface 13b.

The first layer 44 is formed by use of a flexible material capable of restraining vibration of the

workpiece 11 at the time of cutting. More specifically, the first layer 44 includes a rubber having a value of dynamic viscoelastic modulus represented by (loss modulus)/(storage modulus) of 0.16 to 0.8. As a result, vibration of chips obtained by dividing the workpiece 11 can be restrained, and quality of processing by cutting can be kept high. In addition, wear of the cutting blade 38 due to vibration of chips or the like can be restrained.

Specifically, it is recommendable to form the first layer 44 by use of any one of urethane rubber, nitrile rubber, ethylene rubber, butyl rubber, fluororubber, silicone rubber, isoprene rubber, butadiene rubber, acrylic rubber, and polysulfide rubber having a value of dynamic viscoelastic modulus of 0.16 to 0.8.

It is to be noted, however, that the specific material of the first layer 44 is not limited, insofar as the above-described dynamic viscoelastic modulus is satisfied. On the other hand, in order to obtain a sufficient vibration isolation effect by the first layer 44, for example, it is desirable that the thickness of the first layer 44 (namely, the distance between the first surface 44a and the second surface 44b) is set on the order of 0.3 mm to 5.0 mm.

Note that, in the present embodiment, the value of dynamic viscoelastic modulus (namely, (loss modulus)/(storage modulus)) measured by use of DMS6100 manufactured by Seiko Instruments Inc. was used. More specifically, the value obtained by measurement using a cylindrical sample of 2 mm in height and 8 mm in diameter under the conditions of a temperature of 20°C and a frequency of 2 Hz was used.

A second layer 46 having a rectangular first surface (upper surface, holding surface) 46a and a rectangular second surface (lower surface) 46b located on the side opposite to the first surface 46a is fixed to the first surface 44a of the first layer 44, with the second surface 46b side in contact with the first surface 44a. In other words, the second layer 46 is supported from below by the first layer 44. The size of the first surface 46a and the size of the second surface 46b of the second layer 46 are, for example, comparable to the size of the first surface 44a and the size of the second surface 44b of the first layer 44.

The second layer 46 is formed by use of a material by which a large static frictional force is obtained between the second layer 46 and the workpiece 11 such that occurrence of positional deviation of the workpiece

11 at the time of cutting can be restrained. More specifically, the second layer 46 includes a rubber having a static frictional coefficient on the workpiece 11 of equal to or more than 1. As a result, it is possible to prevent the positions of chips obtained by dividing the workpiece 11 from being deviated, and to keep high the quality of processing by cutting.

Specifically, it is recommendable to form the second layer 46 by use of chloroprene rubber having a static frictional coefficient on the workpiece 11 of equal to or more than 1. Note that, in the present embodiment, when the workpiece 11 is held by the chuck table 14, the resin layer 23 of the workpiece 11 is put in contact with the first surface 46a of the second layer 46 (see FIG. 6). Therefore, it is desirable that the second layer 46 is formed by use of chloroprene rubber having a static frictional coefficient on the resin layer 23 of the workpiece 11 of equal to or more than 1.

It is to be noted, however, that the specific material of the second layer 46 is not limited, insofar as the above-described static frictional coefficient is satisfied. On the other hand, in the case where the second layer 46 is thick, the vibration isolation effect by the first layer 44 would be weak. Therefore, for

example, it is desirable that the thickness of the second layer 46 (namely, the distance between the first surface 46a and the second surface 46b) is set on the order of 0.1 mm to 1.0 mm.

The second layer 46 is provided with relief grooves 46c into which a lower end of the cutting blade 38 (see FIG. 1) is inserted at the time of cutting the workpiece 11. The relief grooves 46c are disposed at positions corresponding to the streets 19 of the workpiece 11, and the first surface 46a of the second layer 46 is partitioned by openings at upper ends of the relief grooves 46c into a plurality of regions corresponding to the workpiece 11 after dividing.

The width of the relief grooves 46c is, for example, wider than the widths of the streets 19 and the cutting blade 38, and the height of bottom surfaces of the relief grooves 46c is, for example, lower than the height of the lower end of the cutting blade 38 when the cutting blade 38 is caused to cut into the workpiece 11 to divide the workpiece 11. Therefore, even when the cutting blade 38 is made to cut into the workpiece 11, the chuck table 14 and the cutting blade 38 do not interfere with each other.

Note that, in the present embodiment, the relief

grooves 46c having a depth same as the thickness of the second layer 46 are provided such that the bottom surfaces of the relief grooves 46c are disposed at the same height as the first surface 44a of the first layer 44 (the second surface 46b of the second layer 46), but the depth of the relief grooves 46c may be smaller than the thickness of the second layer 46. Similarly, the depth of the relief grooves 46c may be greater than the thickness of the second layer 46.

A suction hole 46d penetrating the second layer 46 in a thickness direction thereof is provided in each of the regions of the first surface 46a partitioned by the openings of the relief grooves 46c. In addition, the first layer 44 is provided, at positions corresponding to the suction holes 46d, with suction holes 44c penetrating the first layer 44 in the thickness direction. Similarly, the frame body 42 is provided, at positions corresponding to the suction holes 46d, with suction holes 42d penetrating the frame body 42 in the thickness direction. Lower ends of the suction holes 46d are connected to upper ends of the suction holes 44c, and lower ends of the suction holes 44c are connected to upper ends of the suction holes 42d.

An upper end portion (opening) of a flow channel

12b is opened in a central region on the upper surface 12a side of the table base 12 (a region corresponding to the recess 42c of the chuck table 14). Therefore, when the chuck table 14 is mounted to the upper surface 12a of the table base 12, the upper end portion of the flow channel 12b is connected to the suction holes 42d, the suction holes 44c, and the suction holes 46d.

An end portion of the frame body 42 of the chuck table 14 is provided with a through-hole 42e penetrating the frame body 42 in the thickness direction. In addition, the upper surface 12a of the table base 12 is formed, at a position corresponding to the through-hole 42e, with a tapped hole 12c. Therefore, when the second surface 42b of the frame body 42 is put in contact with the upper surface 12a of the table base 12 and then a screw 48 is fastened into the tapped hole 12c through the through-hole 42e, the chuck table 14 is fixed to the table base 12.

A suction source 52 such as a vacuum pump is connected through a valve 50 or the like to the flow channel 12b in the table base 12. Therefore, when the valve 50 is opened in a state in which the suction source 52 is operated, a negative pressure generated in the suction source 52 can be made to act on the first surface

46a of the second layer 46 of the chuck table 14 through the flow channel 12b, the suction holes 42d, the suction holes 44c, and the suction holes 46d.

FIG. 6 is a sectional view depicting a manner in which the workpiece 11 is cut. Note that, in FIG. 6, also, some of the components connected to the table base 12 are represented by symbols, functional blocks, or the like. At the time of cutting the workpiece 11, for example, the resin layer 23 of the workpiece 11 is put into contact with the first surface 46a of the second layer 46 of the chuck table 14.

In addition, the position of the workpiece 11 relative to the chuck table 14 is adjusted such that the streets 19 of the workpiece 11 are disposed directly above the respective relief grooves 46c. Then, the valve 50 is opened in a state in which the suction source 52 is operated. As a result, by a negative pressure acting through the suction holes 46d, the workpiece 11 is held by the chuck table 14.

Next, the positional relation of the workpiece 11 and the cutting blade 38 is adjusted, and the cutting blade 38 being rotated is made to cut into a street 19 of the workpiece 11, as depicted in FIG. 6. By making the cutting blade 38 cut into all the streets 19 of the

workpiece 11, the workpiece 11 is divided into a plurality of chips (package device chips).

FIG. 7 is a perspective view depicting a chip (package device chip) 1 obtained by dividing the workpiece 11. When the workpiece 11 is divided along the streets 19, the chip 1 as depicted in FIG. 7 in which a device is sealed with a resin is obtained. Note that, at the periphery of the chip 1, a plurality of electrodes 25 formed by cutting the metal layer on the streets 19 are exposed.

FIG. 8 is a side view obtained by enlarging a side surface of the chip 1 (a region including the electrodes 25). If the chip 1 is vibrated or the position of the chip 1 is deviated when the workpiece 11 is being cut by the cutting blade 38, the quality of processing by cutting would be lowered. Specifically, for example, the metal constituting the electrodes 25 is extended by the cutting blade 38 to generate burrs, and thus, the distance (interval) d between adjacent electrodes 25 is reduced, resulting in that a trouble such as short-circuit is liable to occur.

In view of this, based on the distance d between the adjacent electrodes 25, the performance of the chuck table 14 according to the present embodiment was

evaluated. Specifically, using a plurality of chuck tables 14 having different dynamic viscoelastic modulus of the rubber constituting the first layer 44, the workpiece 11 was divided. Then, in each of the plurality of chips 1 (20 chips each) obtained, the distance d was measured in regard of sets of adjacent electrodes 25 (12 sets for each chip, a total of 240 sets).

As the dynamic viscoelastic modulus of the rubber constituting the first layer 44, four values of 0.15 (Comparative Example), 0.16, 0.41, and 0.8 were selected. Note that it is difficult to constitute the first layer 44 by use of a rubber having a dynamic viscoelastic modulus exceeding 0.8. Therefore, the upper limit for the dynamic viscoelastic modulus of the rubber constituting the first layer 44 was set at 0.8. As the second layer 46, chloroprene rubber having a static frictional coefficient on the workpiece 11 of 1.0 was adopted. Note that the dynamic viscoelastic modulus of the chloroprene rubber constituting the second layer 46 was on the order of 0.1 to 0.15.

When the workpiece 11 was cut by the cutting blade 38 to divide the workpiece 11 into a plurality of chips 1, a resin bonded blade (#240) was used as the cutting blade 38. In addition, the rotational speed of the

cutting blade 38 was set to 20,000 rpm, and the processing feeding speed of the workpiece 11 was set to 25 mm/s. Note that, with any of the chuck tables 14 used, positional deviation of the chip 1 relative to the chuck table 14 was not confirmed.

The results of measurement of the distance d are set forth in Table 1. Note that, in Table 1, average values of the distance d measured for a total of 240 sets of adjacent electrodes 25 are set forth.

[Table 1]

Dynamic viscoelastic Modulus	Distance d (μm) between adjacent electrodes
0.15 (Comparative Example)	105
0.16	118
0.41	122
0.8	120

From Table 1, it is seen that the distance d between the adjacent electrodes 25 is in excess of a reference value (115 μm) in a range of dynamic viscoelastic modulus of the rubber constituting the first layer 44 of 0.16 to 0.8, and the quality of processing of the workpiece 11 is kept high at least in this range. Note that the distance d between the adjacent electrodes 25 is maximized, and particularly favorable, in the case

where the value of the dynamic viscoelastic modulus is 0.41.

As described above, the chuck table 14 according to the present embodiment includes the first layer 44 including a rubber having a dynamic viscoelastic modulus of 0.16 to 0.8, and the second layer 46 including a rubber having a static frictional coefficient on the workpiece 11 of equal to or more than 1. In addition, the second layer 46 is supported by the first layer 44, and, when the workpiece 11 is held, the workpiece 11 makes contact with the first surface (holding surface) 46a at an upper portion of the second layer 46.

In this way, by causing the first layer 44 not making contact with the workpiece 11 to include the rubber having a dynamic viscoelastic modulus of 0.16 to 0.8 and causing the second layer 46 making contact with the workpiece 11 to include the rubber having a static frictional coefficient on the workpiece 11 of equal to or more than 1, it is possible to obtain both a high vibration isolation effect by the first layer 44 and a large frictional force by the second layer 46.

As a result, occurrence of vibration of the chips 1 and positional deviation of the chips 1 can be restrained. In other words, even in the case of dividing

the workpiece 11 into the small chips 1, wear of the cutting blade 38 due to vibration of the chips 1 or the like can be restrained. In addition, it is possible to restrain the accuracy of processing by cutting from being lowered due to vibration of the chips 1, positional deviation of the chips 1, or the like, and to cut the workpiece 11 with high accuracy.

Note that the present invention is not limited to the description of the above-described embodiment, and can be carried out with various modifications. FIG. 9 is a sectional view depicting a manner in which the workpiece 11 held by a chuck table 114 according to a modification is cut. Note that, in FIG. 9, some of the components are represented by symbols, functional blocks, or the like.

As depicted in FIG. 9, the chuck table 114 according to the modification includes a flat plate-shaped support 142 that has a rectangular first surface (upper surface) 142a and a rectangular second surface (lower surface) 142b located on the side opposite to the first surface 142a. The support 142 is, for example, formed in a porous form by use of a resin such as urethane resin, and has predetermined gas permeability.

The size of the first surface 142a and the size of

the second surface 142b of the support 142 are smaller than the size of an upper surface 112a of a table base 112 to which the chuck table 114 is mounted, and are comparable to the size of an upper end portion (opening) of a flow channel 112b opened in a central region of the upper surface 112a. When the chuck table 114 is mounted to the table base 112, the second surface 142b side of the support 142 is inserted into the upper end portion of the flow channel 112b.

A first layer 144, that has a rectangular first surface (upper surface) 144a and a rectangular second surface (lower surface) 144b located on the side opposite to the first surface 144a, is fixed to the first surface 142a of the support 142, with the second surface 144b side in contact with the first surface 142a. The size of the first surface 144a of the first layer 144 is smaller than the size of the first surface 142a and the size of the second surface 142b of the support 142.

On the other hand, the size of the second surface 144b of the first layer 144 is comparable to the size of the first surface 142a and the size of the second surface 142b of the support 142. In other words, the size of the first layer 144 on the first surface 144a side is smaller than the size of the second surface 144b side. In

addition, a step is formed at a peripheral portion of the first layer 144.

The first layer 144 is formed by use of a flexible material that can restrain vibration of the workpiece 11 at the time of cutting. A specific characteristic of the first layer 144 may be the same as the characteristic of the first layer 44 according to the above-described embodiment. In other words, the first layer 144 includes a rubber having a value of dynamic viscoelastic modulus of 0.16 to 0.8.

A second layer 146, that has a rectangular first surface (upper surface, holding surface) 146a and a rectangular second surface (lower surface) 146b located on the side opposite to the first surface 146a, is fixed to the first surface 144a of the first layer 144, with the second surface 146b side in contact with the first surface 144a. In other words, the second layer 146 is supported from below by the first layer 144. The size of the first surface 146a and the size of the second surface 146b of the second layer 146 are, for example, comparable to the size of the first surface 144a of the first layer 144.

The second layer 146 is formed by use of a material by which a large static frictional force can be obtained

between the second layer 146 and the workpiece 11 such that it is possible to restrain occurrence of positional deviation of the workpiece 11 at the time of cutting. A specific characteristic of the second layer 146 may be the same as the characteristic of the second layer 46 according to the above-described embodiment. In other words, the second layer 146 includes a rubber having a static frictional coefficient on the workpiece 11 of equal to or more than 1.

The second layer 146 is provided with relief grooves 146c into which the lower end of the cutting blade 38 is inserted at the time of cutting the workpiece 11. The relief grooves 146c are disposed at positions corresponding to the streets 19 of the workpiece 11, and the first surface 146a of the second layer 146 is partitioned by openings at upper ends of the relief grooves 146c into a plurality of regions corresponding to the workpiece 11 after dividing. A specific characteristic of the relief grooves 146c may also be the same as the characteristic of the relief grooves 46c according to the above-described embodiment.

Each of the regions of the first surface 146a partitioned by the openings of the relief grooves 146c is provided with a suction hole 146d penetrating the second

layer 146 in the thickness direction. In addition, the first layer 144 is provided, at positions corresponding to the suction holes 146d, with suction holes 144c penetrating the first layer 144 in the thickness direction. Lower ends of the suction holes 146d are connected to upper ends of the suction holes 144c, and lower ends of the suction holes 144c are in contact with the first surface 142a of the support 142.

Therefore, when the chuck table 114 is mounted to the table base 112 by inserting the second surface 142b side of the support 142 into the upper end portion of the flow channel 112b, the upper end portion of the flow channel 112b is connected to the suction holes 144c and the suction holes 146d through the support 142. Note that, when the chuck table 114 is mounted to the table base 112, a fixing frame 148 that includes a metal such as stainless steel and presses a peripheral portion of the chuck table 114 is used.

The fixing frame 148 is provided in a central region thereof with an opening 148a penetrating the fixing frame 148 in the thickness direction. The opening 148a is configured in such a shape and size that a part of the first layer 144 on the second layer 146 side and the second layer 146 are passed therethrough but a part

of the first layer 144 on the support 142 side and the support 142 are not passed therethrough. Therefore, when the part of the first layer 144 on the second layer 146 side and the second layer 146 are inserted into the opening 148a and the fixing frame 148 is fixed to the table base 112, the chuck table 114 is also fixed to the table base 112.

An end portion of the fixing frame 148 is provided with a through-hole 148b penetrating the fixing frame 148 in the thickness direction. In addition, the upper surface 112a of the table base 112 is formed, at a position corresponding to the through-hole 148b, with a tapped hole 112c. By fastening a screw 150 into the tapped hole 112c through the through-hole 148b, the fixing frame 148 is fixed to the table base 112. In other words, the chuck table 114 is fixed to the table base 112.

A suction source 154 such as a vacuum pump is connected to the flow channel 112b in the table base 112 through a valve 152 or the like. Therefore, when the valve 152 is opened in a state in which the suction source 154 is operated, a negative pressure generated in the suction source 154 can be made to act on the first surface 146a of the second layer 146 of the chuck table

114 through the flow channel 112b, the support 142, the suction holes 144c, and the suction holes 146d.

The chuck table 114 according to this modification also includes the first layer 144 including a rubber having a dynamic viscoelastic modulus of 0.16 to 0.8 and the second layer 146 including a rubber having a static frictional coefficient on the workpiece 11 of equal to or more than 1. In addition, the second layer 146 is supported by the first layer 144, and, when the workpiece 11 is held, the first surface (holding surface) 146a at an upper portion of the second layer 146 makes contact with the workpiece 11.

In this way, by causing the first layer 144 not making contact with the workpiece 11 to include the rubber having a dynamic viscoelastic modulus of 0.16 to 0.8 and causing the second layer 146 making contact with the workpiece 11 to include the rubber having a static frictional coefficient on the workpiece 11 of equal to or more than 1, it is possible to obtain both a high vibration isolation effect by the first layer 144 and a large frictional force by the second layer 146.

As a result, it is possible to restrain occurrence of vibration of the chips 1 and positional deviation of the chips 1. In other words, even in the case of dividing

the workpiece 11 into small chips 1, wear of the cutting blade 38 due to vibration of the chips 1 or the like can be restrained. In addition, the accuracy of processing by cutting can be restrained from being lowered due to vibration of the chips 1, positional deviation of the chips 1, or the like, and the workpiece 11 can be cut with high accuracy.

Further, the chuck table 114 according to the modification has a structure in which the first layer 144 and the second layer 146 are fixed to the support 142, and is configured to be easily separable from the table base 112 and the fixing frame 148. As a result, a common fixing frame 148 can be used for a plurality of kinds of chuck tables 114, so that specifications of the chuck table 114 can be modified at low cost, as compared to the case of using the chuck table 14 in which the first layer 44 and the second layer 46 are fixed to the frame body 42.

In other words, since the chuck table 114 includes only a material which is easier to process than a metal such as stainless steel, the cost for manufacturing the chuck table 114 is lowered. In addition, since it is unnecessary to fix (adhere) the chuck table 114 to the fixing frame 148, the cost for manufacturing the chuck

table 114 is lowered in this point, too.

Note that, while in the above-described embodiment the second surface (lower surface) 46b of the second layer 46 is put into contact with the first surface (upper surface) 44a of the first layer 44, and, in the modification, the second surface (lower surface) 146b of the second layer 146 is put into contact with the first surface (upper surface) 144a of the first layer 144, the chuck table of the present invention is not limited to this mode. Other layer or layers may be interposed between the first layer 44 and the second layer 46 or between the first layer 144 and the second layer 146, insofar as the vibration isolation effect by the first layer 44 or the first layer 144 can be secured.

In addition, structures, methods, and the like according to the above-described embodiment and modification can be carried out with modifications, as required, within such ranges as not to depart from the scope of the object of the present invention.

The present invention is not limited to the details of the above described preferred embodiment. 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 chuck table that is mounted to a table base of a cutting apparatus for cutting a workpiece by a cutting blade and holds the workpiece when cutting the workpiece along streets to divide the workpiece into a plurality of chips, the chuck table comprising:

a first layer including a rubber having a dynamic viscoelastic modulus of 0.16 to 0.8; and

a second layer that includes a rubber having a static frictional coefficient on the workpiece of equal to or more than 1 and is supported by the first layer,

wherein the second layer has

a holding surface at an upper portion thereof making contact with the workpiece when holding the workpiece,

opening sections of relief grooves provided so as to partition the holding surface correspondingly to the streets of the workpiece, and

suction holes provided in regions partitioned by the opening sections in the holding surface.

2. The chuck table according to claim 1, wherein an upper surface of the first layer is in contact with a lower surface of the second layer.

3. The chuck table according to claims 1 or 2, wherein the rubber constituting the first layer is any one of urethane rubber, nitrile rubber, ethylene rubber, butyl rubber, fluororubber, silicone rubber, isoprene rubber, butadiene rubber, acrylic rubber, and polysulfide rubber.

4. The chuck table according to any one of claims 1 to 3, wherein the rubber constituting the second layer is chloroprene rubber.