

SPECIFICATION

[TITLE OF INVENTION]

SUBSTRATE TRANSPORT AND FEEDING METHOD AND SUBSTRATE
TRANSPORT AND FEEDING APPARATUS

TECHNICAL FIELD

[1] The invention relates to substrate transport and feeding methods and apparatuses for transporting and feeding a substrate mounted with electronic components to a predetermined position in a molding unit of a compression resin molding apparatus, more particularly to substrate transport and feeding methods improved in that, a substrate, which is transported to and retained on an upper-die surface for compression resin molding, can be more efficiently and reliably retained on the upper-die surface, and substrate transport and feeding apparatuses used to carry out the methods.

BACKGROUND ART

[2] Conventionally, substrates are transported such that a substrate is securely held on an upper surface of a substrate transport plate unit and then transported, or a substrate is adsorbed to an upper surface of an adsorption plate and then transported (for example, see the patent document 1). In transporting a substrate that a plurality of (a large number of) electronic components (for example, semiconductor devices) are mounted on the surface (an upper surface) thereof by using a substrate transport plate unit, the substrate is usually located on the substrate transport plate unit in a state with the upper surface of the substrate looking upward or the back

surface (bottom surface) of the substrate being joined to the upper surface of the substrate transport plate unit in order to avoid any contact between the electronic components on the substrate and the upper surface of the substrate transport plate unit.

[3] Describing compression resin molding conventionally performed, a substrate is transported to and retained on an upper-die surface of a compression resin molding apparatus, where a molten resin material filled in a lower-die cavity is compressed after the electronic components on the substrate are dipped therein to produce a resin-molded product. The compression resin molding, however, cannot directly employ the substrate transport plate unit. To mold electronic components mounted on a substrate by compression resin molding as schematically illustrated in Fig. 10, a substrate W is retained with electronic components 3 mounted thereon looking downward, while its back-surface side is adsorbed to a surface 1a of an upper die 1 of a compression resin molding apparatus by a substrate adsorption mechanism 2 provided in the upper die 1. Therefore, it is necessary to locate a substrate transport plate unit 4 with the electronic components 3 mounted on the substrate W looking downward. The substrate transport plate unit 4 is accordingly provided with engaging portions 4a engageable with a surface perimeter of the substrate W having the components 3 thereon, and a recessed housing portion 4b where the electronic components 3 can be housed without any contact with the substrate transport plate unit. To resin-mold the electronic components 3, upper and lower dies 1 and 5 are closed to each other. The electronic components 3 mounted on the substrate W are dipped in a molten resin material 6 in

a lower-die cavity 5a of the lower die 5. Then, the molten resin material 6 is compressed by a pressing member 5b. Thus the electronic components 3 are resin-molded.

[4] As described above, the substrate W is adsorbed to and retained on the surface 1a of the upper die 1 by the substrate adsorption mechanism 2. This, however, raises problems described below.

Due to the facts that the surface perimeter of the substrate W disposed on the substrate transport plate unit 4 is engaged with upper surfaces of the engaging portions 4a, the substrate W is a thin plate, and the electronic components 3 mounted on the surface of the substrate W are looking downward, the center part of the substrate W is likely to warp downward due to own weight as illustrated in Fig. 10 (2). A problem with such structural aspects is failure to securely adsorb and retain the warping substrate W with respect to the upper-die surface 1a, or poor adsorbing and retaining performances. The likelihood of such downward warp due to own weight is more apparent with substrates increasingly larger these days. Possibly, the substrate W per se has a warped shape, which further worsens the adsorbing and retaining performances.

Related Art Document

Patent Document

[5]

Patent Document 1: JP01-119100 A (page 1, lower-right column, lines 4 to 9, Figs. 2, and 4 to 5)

SUMMARY OF THE INVENTION

PROBLEM TO BE SOLVED BY THE INVENTION

[6] The invention provides a substrate transport and feeding method wherein a substrate disposed on a substrate transport and feeding apparatus (substrate transport plate unit), even if the substrate is warping downward at its center due to own weight or already warping before use, can be efficiently and reliably adsorbed to and retained on an upper-die surface of a compression resin molding apparatus. The invention further provides a substrate transport and feeding apparatus used to implement the method.

MEANS FOR SOLVING THE PROBLEM

[7] A substrate transport and feeding method according to the invention is a substrate transport and feeding method wherein a substrate W having a plurality of electronic components 30 mounted on a surface thereof is transported to a position below an upper-die surface 10a of a compression resin molding apparatus A, and a back surface of the substrate W is adsorbed to and retained on the upper-die surface 10a with the surface of the substrate W looking downward.

The substrate transport and feeding method includes:

a preparation step for preparing a substrate transport and feeding apparatus 40 provided with engaging portions 41a engageable with a surface perimeter of the substrate W to secure the surface perimeter at predetermined positions, and a recessed housing portion 41b where all of the electronic components 30 can be housed without any contact with the engaging portions 41a;

a substrate disposing step for engaging the surface perimeter of the substrate W with the engaging portions 41a

of the substrate transport and feeding apparatus 40, and housing the electronic components 30 in the recessed housing portion 41b of the substrate transport and feeding apparatus 40;

an advancing step for moving the substrate transport and feeding apparatus 40 to a position below the upper-die surface 10a after the substrate disposing step;

a substrate locating step for moving the substrate transport and feeding apparatus 40 upward relative to the compression resin molding apparatus A after the advancing step to secure the back surface of the substrate W at a predetermined position on the upper-die surface 10a;

a substrate joining step for joining the back surface of the substrate W to the upper-die surface 10a after the substrate locating step;

a substrate deformation correcting step for feeding compressed air 43a to the surface of the substrate W to correct deformation of the substrate W during the substrate joining step;

a substrate adsorbing step for causing the substrate W to adsorb to the upper-die surface 10a at one or both of a point of time during the substrate deformation correcting step and a point of time after the substrate deformation correcting step;

a substrate retaining step for retaining the substrate W on the upper-die surface 10a at one or both of a point of time during the substrate adsorbing step and a point of time after the substrate adsorbing step; and

a retracting step for moving the substrate transport and feeding apparatus 40 downward relative to the compression resin molding apparatus A after the substrate retaining step, and

further moving the substrate transport and feeding apparatus 40 away from the compression resin molding apparatus A.

[8] According to an aspect of the invention, the substrate deformation correcting step of the substrate transport and feeding method corrects deformation of the substrate by feeding the compressed air 43a to the recessed housing portion 41b through a plurality of compressed air feed holes 41c formed in a bottom surface of the recessed housing portion 41b of the substrate transport and feeding apparatus 40.

[9] According to another aspect of the invention, the substrate deformation correcting step of the substrate transport and feeding method corrects deformation of the substrate by feeding the compressed air 43a to the recessed housing portion 41b sealed with the substrate W and the engaging portions 41a of the substrate transport and feeding apparatus through a plurality of compressed air feed holes 41c formed in a bottom surface of the recessed housing portion 41b.

[10] According to yet another aspect of the invention, the substrate deformation correcting step of the substrate transport and feeding method corrects deformation of the substrate by feeding the compressed air 43a to the recessed housing portion 41b sealed with the substrate W and the engaging portions 41a of the substrate transport and feeding apparatus by means of a fluid pressure reducing mechanism 56 provided in a bottom surface of the recessed housing portion 41b.

[11] A substrate transport and feeding apparatus according to the invention is a substrate transport and feeding apparatus wherein a substrate W having a plurality of electronic components 30 mounted on a surface thereof is transported to a position below an upper-die surface 10a of a compression

resin molding apparatus A, and a back surface of the substrate W is adsorbed to and retained on the upper-die surface 10a with the surface of the substrate W looking downward.

The substrate transport and feeding apparatus includes:
a substrate transport plate unit 41 on which the substrate W can be disposed;

an advancing and retracting mechanism 42 for providing the substrate transport plate unit 41 in an advanceable and retractable manner with respect to a position below the upper-die surface 10a; and

a substrate deformation corrector 43, wherein
the substrate transport plate unit 41 has:
engaging portions 41a engageable with a surface perimeter of the substrate W to secure the surface perimeter at predetermined positions; and

a recessed housing portion 41b where all of the electronic components 30 can be housed without any contact with the engaging portions 41a, and

the substrate deformation corrector 43 has:
a plurality of compressed air feed holes 41c formed in a bottom surface of the recessed housing portion 41b; and
a compressed air feed mechanism connected to and in communication with the compressed air feed holes 41c.

[12] According to an aspect of the invention, the substrate deformation corrector 43 of the substrate transport and feeding apparatus feeds the compressed air 43a to the recessed housing portion 41b sealed with the substrate W and the engaging portions 41a of the substrate transport plate unit 41 through the compressed air feed holes 41c.

[13] According to another aspect of the invention, the

substrate deformation corrector 43 of the substrate transport and feeding apparatus feeds the compressed air 43a to the recessed housing portion 41b sealed with the substrate W and the engaging portions 41a of the substrate transport plate unit 41 by means of a fluid pressure reducing mechanism 56 provided in a bottom surface of the recessed housing portion 41b.

EFFECTS OF THE INVENTION

[14] Conventionally, the center part of the substrate W disposed on the substrate transport and feeding apparatus (substrate transport plate unit) often warps due to own weight, or the substrate W per se has a warped shape. According to the invention, however, the substrate W in such a condition can be efficiently and reliably adsorbed to and retained on the upper-die surface of the compression resin molding apparatus A. The invention is particularly advantageous for substrates increasingly larger these days whose center parts are even more likely to warp.

BRIEF DESCRIPTION OF THE DRAWINGS

[15] Fig. 1 is a longitudinal sectional view schematically illustrating main parts of a substrate transport and feeding apparatus according to the invention, wherein some parts are omitted. This drawing illustrates the substrate transport and feeding apparatus that moved to a position below an upper-die surface of a compression resin molding apparatus in an advancing step.

Fig. 2 is a schematic plan view of the substrate transport and feeding apparatus illustrated in Fig. 1.

Figs. 3 are longitudinal sectional views of the substrate transport and feeding apparatus illustrated in Fig. 1, wherein Fig. 3 (1) is a longitudinal sectional view of main parts of the substrate transport and feeding apparatus, and Fig. 3 (2) is an enlarged longitudinal sectional view of the main parts.

Figs. 4 are drawings illustrated to describe an operation to dispose a substrate on the upper-die surface of the compression resin molding apparatus, wherein Fig. 4 (1) illustrates the substrate transport and feeding apparatus in the advancing step, and Fig. 4 (2) is an enlarged view of main parts of the substrate transport and feeding apparatus at the time.

Figs. 5 are drawings illustrated to describe the operation to dispose the substrate on the upper-die surface of the compression resin molding apparatus, wherein Fig. 5 (1) illustrates the substrate transport and feeding apparatus when the substrate is jointed to the upper-die surface in a substrate joining step, and Fig. 5 (2) is an enlarged view of main parts of the substrate transport and feeding apparatus at the time.

Figs. 6 are drawings illustrated to describe the operation to dispose the substrate on the upper-die surface of the compression resin molding apparatus, wherein Fig. 6 (1) illustrates the substrate transport and feeding apparatus when the substrate is retained on the upper-die surface in a substrate retaining step, and Fig. 6 (2) is an enlarged view of main parts of the substrate transport and feeding apparatus at the time.

Fig. 7 is a schematic plan view of a substrate transport and feeding apparatus according to another example of the invention.

Fig. 8 is a schematic plan view of a substrate transport and feeding apparatus according to yet another example of the invention.

Figs. 9 are longitudinal sectional views of the substrate transport and feeding apparatus illustrated in Fig. 8, wherein Fig. 9 (1) is a longitudinal sectional view of main parts of the substrate transport and feeding apparatus, and Fig. 9 (2) is an enlarged longitudinal sectional view of the main parts.

Figs. 10 are drawings illustrated to describe an operation to dispose a substrate on an upper-die surface of a compression resin molding apparatus by a conventional substrate transport and feeding method, wherein Fig. 10 (1) is a longitudinal sectional view of the substrate transport and feeding apparatus that moved to a position below an upper-die surface of the compression resin molding apparatus, and Fig. 10 (2) is an enlarged longitudinal sectional view of main parts after the substrate is disposed on the upper-die surface.

MODES FOR CARRYING OUT THE INVENTION

[16] Hereinafter, examples of the invention are described in detail referring to Figs. 1 through 9.

First Example

[17] Fig. 1 illustrates a substrate transport and feeding apparatus 40 according to a first example that moved to a position below an upper die 10 (upper-die surface 10a) of a compression resin molding apparatus A. Figs. 2 and 3 illustrate main parts of the substrate transport and feeding apparatus 40. Figs. 4 to 6 illustrate an operation to dispose a substrate W onto the upper-die surface 10a of the compression resin molding apparatus A.

[18] First, the compression resin molding apparatus A is briefly described. The compression resin molding apparatus A is usually provided with a stationary upper die 10, and a movable lower die 50 which is allowed to move upward and downward and located at a position below the upper-die surface 10a (see Fig. 1). The upper die 10 has a substrate adsorption mechanism 20 whereby the substrate W is suctioned to adsorb to the upper-die surface 10a, and a substrate retaining mechanism 70 whereby the substrate W adsorbed to the upper-die surface 10a is retained.

[19] The substrate adsorption mechanism 20 has a plurality of air suction holes 20a formed in the upper-die surface 10a, and a decompression mechanism (not illustrated in the drawings) connected to and in communication with the air suction holes 20a. By this construction, the substrate W joined to the upper-die surface 10a can be adsorbed to the upper-die surface 10a by suction (vacuum suction) exerted through the air suction holes 20a by the decompression mechanism.

[20] The lower die 50 has a lower-die cavity 50a where a resin material is filled, and a pressing member 50b for compressing a resin material 60 heated and melted in the lower-die cavity 50a. The substrate W is disposed on the upper-die surface 10a, according to steps described below, by causing the back surface of the substrate W, which is not mounted with the electronic components 30, to adsorb to the upper-die surface to be retained thereon. When the substrate W is thus retained, therefore, the electronic components 30 mounted on the substrate W adsorbed to the upper-die surface 10a are looking downward. In the drawings, a plurality of (a large number of) electronic components mounted on the surface of the substrate W are

schematically illustrated.

[21] To resin-mold the electronic components 30 mounted on the substrate W by using the compression resin molding apparatus A, first, the substrate transport and feeding apparatus 40 is moved away from the compression resin molding apparatus A. Then, the upper die 10 and the lower die 50 are closed to each other to dip the electronic components 30 mounted on the substrate W in the molten resin material 60 of the lower-die cavity 50a. Then, the molten resin material 60 is compressed and molded by the pressing member 50b under a given resin pressure. As a result, the electronic components 30 are molded with the compressed resin.

[22] All of the electronic components 30 mounted on the substrate W are embedded at once in the resin molded in a shape corresponding to that of the lower-die cavity 50. Each piece of these resin-molded electronic components 30 is cut and separated as a product.

[23] Next, the substrate transport and feeding apparatus 40 is described. The substrate transport and feeding apparatus 40 has a substrate transport plate unit 41 on which the substrate W is disposed, and an advancing and retracting mechanism 42 which provides the substrate transport plate unit 41 in an advanceable and retractable manner with respect to a position below the upper-die surface 10a of the compression resin molding apparatus A. The substrate transport plate unit 41 has engaging portions 41a engageable with a surface perimeter of the substrate W to secure the surface perimeter at predetermined positions, and a recessed housing portion 41b where the electronic components mounted on the substrate surface can be housed without any contact with the engaging portions 41a.

In the recessed housing portion 41b of the substrate transport plate unit 41, there are a plurality of compressed air feed holes 41c formed in a bottom surface thereof. The compressed air feed holes 41c and a compressed air feed mechanism (not illustrated in the drawings) connected to and in communication with the compressed air feed holes 41c constitute a substrate deformation corrector 43.

[24] Next is described a substrate retaining mechanism 70 provided to be operative in association with the compression resin molding apparatus A and the substrate transport and feeding apparatus 40. The substrate retaining mechanism 70 has at least a pair of substrate retaining claws 71 provided at suitable positions at, for example, both end parts of the upper die 10, and operation pins 72 of the substrate retaining claws provided in a standing manner at positions on a base 44 of the substrate transport and feeding apparatus 40. The operation pins 72 are provided at positions corresponding to the positions of the substrate retaining claws 71 in an equal number to these claws. The substrate retaining claws 71 are each pivotable around a support shaft 73 fixedly provided on the upper die 10. An elastic pressing force exerted by pressing pins 71c which are energized downward by the elasticity of elastic members 71b is applied to base end parts 71a of the substrate retaining claws 71. While the base end parts 71a of the substrate retaining claws 71 are under the elastic pressing force applied by the pressing pins 71c, tip parts 71d of the substrate retaining claws 71 respectively pivot around the support shafts 73, protruding to position near the upper-die surface 10a (see Figs. 4).

[25] The operation pins 72 of the substrate retaining claws

71 are provided in a standing manner at positions on the base 44 corresponding to the positions of the base end parts 71a of the substrate retaining claws 71. As described later, the operation pins 72 move in the same direction as the substrate transport and feeding apparatus 40 along with the advancing movement of the substrate transport and feeding apparatus 40 to position near the upper-die surface 10a, retracting movement to be away from this position, upward movement to a position at which the substrate W is joined to the upper-die surface 10a, and downward movement to be away from this position.

[26] As described earlier, while the base end parts 71a of the substrate retaining claws 71 are under the elastic pressing force applied by the pressing pins 71c, the tip parts 71d pivot around the support shafts 73, protruding to positions near the upper-die surface 10a. On the other hand, when the operation pins 72 of the substrate retaining claws 71 and the substrate W on the substrate transport plate unit 41 are moved upward at the same time, upper end parts of the operation pins 72 push the base end parts 71a of the substrate retaining claws 71 upward, causing the tip parts 71d to pivot around the support shafts 73 and move away from the upper-die surface 10a. The apparatus is configured so that upward movement of the substrate W on the substrate transport plate unit 41 occurs after the tip parts 71d are moved away from the upper-die surface 10a. This avoids the risk that the tip parts 71d of the substrate retaining claws 71 disturb the upward movement of the substrate W on the substrate transport plate unit 41.

[27] The upper-die surface 10a of the upper die 10 has locating pins 10b provided in a protruding manner to guide the substrate W to a predetermined position on the upper-die surface 10a

(see Fig. 1). At positions of the engaging portions 41a of the transport and feeding apparatus 40 corresponding to the positions at which the locating pins 10b are protruding (see Fig. 2), clearance holes 71d are formed for the locating pins 10b. The positions and the numbers of the locating pins 10b of the upper-die surface 10a and the clearance holes 41d of the engaging portions 41a are suitably decided depending on structural needs.

[28] At positions on side surfaces of the engaging portions 41a of the substrate transport plate unit 41, clearance grooves 41e are formed so that the pivoting movement of the tip parts 71d of the substrate retaining claws is not disturbed. More specifically, the clearance grooves 41e are formed at positions on side surfaces of the engaging portions 41a corresponding to the positions on the base 44 at which the operation pins 72 are protrudingly provided (see Fig. 2).

[29] At both end parts of the engaging portions 41a on the substrate transport plate unit 41, locating pins 41f, which are for locating the substrate W, are provided at predetermined positions of the engaging portions 41a (see Figs. 3). When the substrate W is located by means of the locating pins 41f, upper end parts of the locating pins 41f are protruding above the substrate W in the thickness (height) direction thereof through engaging pin holes 31 which are for the substrate W. As schematically illustrated in Fig. 3 (1), however, the locating pins 41f are provided in a manner that these pins can be pushed downward against the elasticity of elastic members 55. For this, at the time of the joining of the substrate W for the upper-die surface 10a, the locating pins 41f abutting the upper-die surface 10a move downward. The locating pins

41f, therefore, are not obstacles in joining these members. The positions and the numbers of the locating pins 41f of the engaging portions 41a and the substrate engaging pin holes 31 are suitably decided depending on structural needs.

[30] A description is hereinafter given to an example in which the substrate W is transported by the substrate transport and feeding apparatus 40 onto the stationary upper die 10 of the compression resin molding apparatus A with the back surface of the substrate W, which is not mounted with the electronic components 30, being securely adsorbed to the upper-die surface 10a.

[31] A first step, which is a step of preparing the substrate transport and feeding apparatus 40, is followed by a substrate disposing step. In this step, as illustrated in Fig. 3 (1), the surface perimeter of the substrate W is engaged with the engaging portions 41a of the substrate transport and feeding apparatus 40 (more specifically, substrate transport plate unit 41), and the electronic components 30 mounted on the surface of the substrate W are housed in the recessed housing portion 41b of the substrate transport plate unit 41. The substrate W is engaged with the engaging portions 41a at predetermined positions thereof by means of the locating pins 41f of the engaging portions 41a (see Fig. 2). The substrate W is a rectangular substrate large enough to allow the surface perimeter to engage with the engaging portions 41a of the substrate transport plate unit 41. When the substrate W is engaged with the engaging portions 41a, therefore, a part of the substrate W is disposed on the clearance grooves 41e which are provided for the tip parts 71d of the substrate retaining claws (see Figs. 3).

[32] Next, an advancing step is performed. In this step, the substrate transport and feeding apparatus 40 is transported to a position below the upper-die surface 10a of the compression resin molding apparatus A (see Figs. 1 and 4).

[33] Next, a substrate locating step is performed. In this step, the substrate transport and feeding apparatus 40 is moved upward to locate the back surface of the substrate W (surface on the upper side in the drawings, which is not mounted with the electronic components 30) at a predetermined position on the upper-die surface 10a of the compression resin molding apparatus A. Then, a substrate joining step is performed. In this step, the back surface of the substrate W located at the predetermined position on the upper-die surface 10a is joined to the upper-die surface 10a (see Figs. 5). As illustrated in Figs. 4 and 5, the substrate locating step and the substrate joining step are both performed through upward movement of the substrate transport and feeding apparatus 40 toward the upper-die surface 10a of the compression resin molding apparatus A. When the elastic pressing force exerted by the pressing pins 71 alone is applied to the base end parts 71a of the substrate retaining claws 71, the tip parts 71d pivot, protruding to positions near the upper-die surface 10a as illustrated in Figs. 4. As illustrated in Figs. 5, the upper end parts of the operation pins 72 of the substrate retaining claws 71 push the base end parts 71a of the substrate retaining claws 71 upward, causing the tip parts 71a to pivot and move away from the upper-die surface 10a. This allows for smooth upward movement of the substrate W on the substrate transport plate unit 41.

[34] When the back surface of the substrate W is joined to

the upper-die surface 10a at a predetermined position thereof, a substrate deformation correcting step is performed as illustrated in Fig. 3 (2). In this step, the compressed air 43a is blown to the surface of the substrate W mounted with the electronic components 30 to correct deformation of the substrate W. The structural aspects of the substrate W disposed on the substrate transport plate unit 41 are; the surface perimeter is engaged with the upper surfaces of the engaging portions 4a, and the electronic components 3 mounted on the surface of the substrate W are looking downward. Due to a small thickness of the substrate W as well as these structural aspects, the center part of the substrate W is warping downward due to own weight as illustrated in the drawings. When the center part of the substrate W is pushed upward by feeding the compressed air 43a to the surface of the substrate W, the substrate W thus warping downward can be corrected to be substantially horizontally straight as illustrated with a dashed line. How to feed the compressed air 43a should be arbitrarily decided depending on a degree of warp of the substrate W.

[35] At the time of correcting deformation of the substrate W by feeding the compressed air 43a to the surface of the substrate W, a substrate adsorbing step is performed (see Figs. 5). In this step, the substrate W joined to the upper-die surface 10a is adsorbed to the upper-die surface 10a of the compression resin molding apparatus A by suction exerted through the air suction holes 20a by the decompression mechanism.

[36] The substrate adsorbing step, in which the substrate W is adsorbed to the upper-die surface 10a of the compression resin molding apparatus A, may be performed after deformation

of the substrate W is corrected by blowing the compressed air 43a to the surface of the substrate W (see Figs. 5). By thus performing the substrate adsorbing step, the substrate W joined to the upper-die surface 10a is similarly adsorbed to the upper-die surface 10a by suction exerted through the air suction holes 20a by the decompression mechanism.

[37] When the substrate W is adsorbed to the upper-die surface 10a, a substrate retaining step is performed (see Figs. 6). In this step, the substrate W is retained on the upper-die surface 10a of the compression resin molding apparatus A. The substrate W, while being adsorbed to the upper-die surface 10a, can be retained on the upper-die surface 10a. The substrate retaining step is performed by moving the substrate transport and feeding apparatus 40 downward to disengage the upper end parts of the operation pins 72 and the base end parts 71a of the substrate retaining claws 71. When the upper end parts of the operation pins 72 and the base end parts 71a of the substrate retaining claws 71 are disengaged, the elastic pressing force exerted by the pressing pins 71c is applied to the base end parts 71a of the substrate retaining claws, and the tip parts 71d thereof accordingly pivot, protruding to position near the upper-die surface 10a as illustrated in Figs. 6. The clearance grooves 41e are formed at positions on the side surfaces of the engaging portions 41a of the substrate transport plate unit 41 to avoid any interference with the pivoting movement of the tip parts 71d of the substrate retaining claws. The tip parts 71d of the substrate retaining claws are allowed to pivot by virtue of these clearance grooves 41e. The tip parts 71d are then joined to and engaged with parts of the surface of the substrate W (surface mounted with the

electronic components 30) located on the upper surfaces of the engaging portions 41a (clearance grooves 41e) to thereby support and hold these surface parts from therebelow.

[38] The substrate retaining step, in which the substrate W is retained on the upper-die surface 10a of the compression resin molding apparatus A, may be performed after the substrate W is adsorbed to the upper-die surface 10a (see Figs. 6). The substrate retaining step is similarly performed by moving the substrate transport and feeding apparatus 40 downward to disengage the upper end parts of the operation pins 72 and the base end parts 71a of the substrate retaining claws 71.

[39] Next, a retracting step is performed. In this step, the substrate transport and feeding apparatus 40 is moved downward and further moved away from the compression resin molding apparatus A.

[40] In the case where the center part of the substrate W disposed on the substrate transport plate unit 41 is warping downward due to own weight or the substrate W per se has a warped shape, such deformation of the substrate W is corrected to be horizontally straight in the first example. Then, the substrate W, which is no longer warping, can be efficiently and reliably adsorbed to and retained on the upper-die surface 10a of the compression resin molding apparatus A. This is even more advantageous for substrates increasingly larger these days, center parts of which are more likely to warp downward.

[41] Next, a second example is described referring to Fig. 7.

Second Example

[42] The first example described the structure where the engaging portions 41a of the substrate transport plate unit

41 are partly cut out, so that the upper surfaces of the engaging portions 41a are discontinuous. The second example is different to the first example in that the engaging portions 41a have continuous upper surfaces. To avoid redundant description, structural elements of the second example substantially the same as those of the first example are identifiable by the same reference symbols.

[43] According to the first example, when the substrate W is engaged with the partly cut-out upper surfaces of the engaging portions 41a, the recessed housing portion 41b, where the electronic components 30 can be housed, is partly left open. The recessed housing portion 41b according to the second example is a closed-end space forming a box-like shape by arranging the upper surfaces of the engaging portions 41a to be continuous. When the substrate W is engaged with the continuous upper surfaces of the engaging portions 41a, the recessed housing portion 41b is completely sealed with the substrate W and the continuous upper surfaces of the engaging portions 41a. A substrate deformation corrector 43 according to this example feeds the compressed air 43a through a plurality of compressed air feed holes 41c formed in the bottom surface of the sealed recessed housing portion 41b.

[44] According to the second example, the internal pressure of the sealed recessed housing portion 41b can be increased by feeding the compressed air 43a through the compressed air feed holes 41c formed in the bottom surface of the sealed recessed housing portion 41. At the time, the substrate W housed in the sealed recessed housing portion 41b is acted upon by a deformation correcting force that gradually (slowly) pushes the center part of the substrate W upward. Thus, the substrate

W warping downward can be corrected to be substantially horizontally straight in the substrate deformation correcting step. How to feed the compressed air 43a should be arbitrarily decided depending on a degree of warp of the substrate W.

[45] According to the second example, when the compressed air 43a blown into the sealed recessed housing portion 41b, the internal pressure of the recessed housing portion 41b is readily increased. Therefore, the substrate deformation correcting step can be more efficiently performed than the first example.

[46] Next, a third example is described referring to Figs. 8 and 9.

Third Example

[47] The substrate deformation corrector according to the first and second examples feeds the compressed air 43a through the compressed air feed holes 41c provided in the bottom surface of the recessed housing portion 41b. A third example of the invention is different to the first and second examples in that the recessed housing portion 41b is sealed by arranging the upper surfaces of the engaging portions 41a to be continuous, and a fluid pressure reducing mechanism 56 provided in the bottom surface of the sealed recessed housing portion 41b is used to feed the compressed air 43a. To avoid redundant description, structural elements of the third example substantially the same as those of the first and second examples are identifiable by the same reference symbols.

[48] As illustrated in Figs. 8 and 9, the recessed housing portion 41b according to the third example is a closed-end space forming a box-like shape by arranging the upper surfaces of the engaging portions 41a to be continuous. When the

substrate W is engaged with the continuous upper surfaces of the engaging portions 41a, the recessed housing portion 41b is completely sealed with the substrate W and the continuous upper surfaces of the engaging portions 41a. The substrate deformation corrector 43 according to this example feeds the compressed air 43a by means of the fluid pressure reducing mechanism 56 provided in the bottom surface of the sealed recessed housing portion 41b. As illustrated in the drawings, an example of the fluid pressure reducing mechanism 56 provided in the bottom surface of the sealed recessed housing portion 41b is a generally called baffle plate. The substrate deformation corrector 43 according to this example feeds the compressed air 43a through compressed air feed grooves 56a of the fluid pressure reducing mechanism 56 provided in the bottom surface of the sealed recessed housing portion 41b. At the time, the substrate W housed in the sealed recessed housing portion 41b is acted upon by a deformation correcting force that gradually pushes the center part of the substrate W upward. As a result, the substrate W warping downward can be corrected to be substantially horizontally straight in the substrate deformation correcting step. How to feed the compressed air 43a should be arbitrarily decided depending on a degree of warp of the substrate W.

[49] According to the third example, the internal pressure of the sealed recessed housing portion 41b can be increased by blowing the compressed air 43a thereinto through the compressed air feed grooves 56a of the fluid pressure reducing mechanism 56 provided in the bottom surface of the sealed recessed housing portion 41b. As a result, the substrate W warping downward can be corrected to be substantially

horizontally straight in the substrate deformation correcting step. At the time, the fluid pressure reducing mechanism 56 reduces the fluid pressure of the compressed air 43a introduced into the sealed recessed housing portion 41b, and it is thereby prevented that the compressed air 43a is directly blown against the electronic components 30. Assuming that the electronic components 30 include thin wires routed therein for electrical connection, the compressed air 43, if directly blown against the wires, possibly deform or break the wires. The third example, wherein the fluid pressure of the compressed air 43a is reduced, successfully avoids the occurrence of such an unfavorable event.

[50] The third example, wherein the recessed housing portion 41b is a closed-end space, can readily increase the internal pressure of the recessed housing portion 41b as compared to the first example. Therefore, the substrate deformation correcting step according to the third example can be more efficiently performed than the first example.

[51] While there has been described what is at present considered to be preferred examples of this invention, it should be understood that various modifications may be made therein, and it is intended to cover in the appended claims all such modifications as fall within the true spirit and scope of this invention.

DESCRIPTION OF REFERENCE SYMBOLS

[52]

A	compression resin molding apparatus
W	substrate
10	upper die

10a upper-die surface
10b locating pin
20 substrate adsorbing mechanism
20a air suction hole
30 electronic component
31 pin hole
40 substrate transport and feeding apparatus
41 substrate transport plate unit
41a engaging portion
41b recessed housing portion
41c compressed air feed hole
41d clearance hole
41e clearance groove
41f locating pin
42 advancing and retracting mechanism
43 substrate deformation corrector
43a compressed air
44 base
50 lower die
50a lower-die cavity
50b pressing member
55 elastic member
56 fluid pressure reducing mechanism
56a compressed air feed groove
60 molten resin material
70 substrate retaining mechanism
71 substrate retaining claw
71a base end part
71b elastic member
71c pressing pin

71d tip part
72 operation pin
73 support shaft

CLAIMS

1. A substrate transport and feeding method, wherein a substrate having a plurality of electronic components mounted on a surface thereof is transported to a position below an upper-die surface of a compression resin molding apparatus, and a back surface of the substrate is adsorbed to and retained on the upper-die surface with the surface of the substrate looking downward, the substrate transport and feeding method comprising:

a preparation step for preparing a substrate transport and feeding apparatus provided with an engaging portion engageable with a surface perimeter of the substrate to secure the surface perimeter at a predetermined position, and a recessed housing portion where all of the electronic components can be housed without any contact with the engaging portion;

a substrate disposing step for engaging the surface perimeter of the substrate with the engaging portion of the substrate transport and feeding apparatus, and housing the electronic components in the recessed housing portion of the substrate transport and feeding apparatus;

an advancing step for moving the substrate transport and feeding apparatus to a position below the upper-die surface after the substrate disposing step;

a substrate locating step for moving the substrate transport and feeding apparatus upward relative to the compression resin molding apparatus after the advancing step to secure the back surface of the substrate at a predetermined position on the upper-die surface;

a substrate joining step for joining the back surface of the substrate to the upper-die surface after the substrate

locating step;

5 a substrate deformation correcting step for correcting the substrate warping downward so as to be substantially horizontally straight by feeding compressed air from below to above to the surface of the central part of the substrate to push upward the central part of the substrate during the substrate joining step;

10 a substrate adsorbing step for causing the substrate to adsorb to the upper-die surface at one or both of a point of time during the substrate deformation correcting step and a point of time after the substrate deformation correcting step;

15 a substrate retaining step for retaining the substrate on the upper-die surface at one or both of a point of time during the substrate adsorbing step and a point of time after the substrate adsorbing step; and

20 a retracting step for moving the substrate transport and feeding apparatus downward relative to the compression resin molding apparatus after the substrate retaining step, and further moving the substrate transport and feeding apparatus away from the compression resin molding apparatus.

2. The substrate transport and feeding method as claimed
25 in claim 1, wherein

the substrate deformation correcting step corrects deformation of the substrate by feeding the compressed air to the recessed housing portion through a plurality of compressed air feed holes formed in a bottom surface of the
30 recessed housing portion of the substrate transport and feeding apparatus.

3. The substrate transport and feeding method as claimed
in claim 1, wherein

35 the substrate deformation correcting step corrects deformation of the substrate by feeding the compressed air to the recessed housing portion sealed with the substrate and

the engaging portion of the substrate transport and feeding apparatus through a plurality of compressed air feed holes formed in a bottom surface of the recessed housing portion.

4. The substrate transport and feeding method as claimed in claim 1, wherein

the substrate deformation correcting step corrects deformation of the substrate by feeding the compressed air to the recessed housing portion sealed with the substrate and the engaging portion of the substrate transport and feeding apparatus by means of a fluid pressure reducing mechanism provided in a bottom surface of the recessed housing portion.

5. A substrate transport and feeding apparatus, wherein a substrate having a plurality of electronic components mounted on a surface thereof is transported to a position below an upper-die surface of a compression resin molding apparatus, and a back surface of the substrate is adsorbed to and retained on the upper-die surface with the surface of the substrate looking downward, the substrate transport and feeding apparatus comprising:

a substrate transport plate unit on which the substrate can be disposed;

an advancing and retracting mechanism for providing the substrate transport plate unit in an advanceable and retractable manner with respect to a position below the upper-die surface; and

a substrate deformation corrector, wherein

the substrate transport plate unit includes:

an engaging portion engageable with a surface perimeter of the substrate to secure the surface perimeter at a predetermined position; and

a recessed housing portion where all of the electronic components can be housed without any contact with the engaging portion, and

the substrate deformation corrector includes:

5 a plurality of compressed air feed holes formed in a bottom surface of the recessed housing portion; and

a compressed air feed mechanism connected to and in communication with the compressed air feed holes,

wherein the substrate deformation corrector pushes
10 upward the central part of the substrate by feeding compressed air to the surface of the substrate through the compressed air feed holes, thereby correcting the substrate warping downward so as to be substantially horizontally straight.

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6. The substrate transport and feeding apparatus as claimed in claim 5, wherein

the substrate deformation corrector feeds the compressed air to the recessed housing portion sealed with
20 the substrate and the engaging portion of the substrate transport plate unit through the compressed air feed holes.

7. The substrate transport and feeding apparatus as claimed in claim 5, wherein

25 the substrate deformation corrector feeds the compressed air to the recessed housing portion sealed with the substrate and the engaging portion of the substrate transport plate unit by means of a fluid pressure reducing mechanism provided in a bottom surface of the recessed
30 housing portion.