

DOWNHOLDER FOR HOLDING DOWN THE SUBSTRATE PLACES OF A SUBSTRATE

FIELD OF THE INVENTION

[0001] The invention concerns a downholder for holding down the substrate places of a substrate.

BACKGROUND OF THE INVENTION

[0002] Such downholders are used in automatic mounting machines for the mounting of components which are known as “dies” in the field, i.e. in so-called die bonders, in order to press the substrate places of the substrate during mounting against a support. Examples for dies are especially semiconductor chips, but also capacitors, metal platelets, metal lids etc.

[0003] It is common practice in the mounting of semiconductor chips to connect the semiconductor chips, mainly power semiconductors, to the substrate by means of solder in order to ensure via the solder connection an effective dissipation of the heat loss from the semiconductor chip which occurs during operation. A die bonder which is suitable for this process is distributed by the applicant under the name DB2009 SSI. Said die bonder comprises a through-type furnace with a downholder. The downholder is subjected to a process temperature of 300 to 450°C.

SUMMARY OF THE INVENTION

[0004] The invention is based on the object of developing a downholder with a simple construction and high reliability which can be used at working temperatures of 300 to 450°C.

[0005] According to the invention, a downholder for holding down the substrate places of a substrate comprises

- a plate with a central opening and two further openings arranged on either side adjacent to the central opening,

- a downholder plate with an opening and downholder webs arranged on the bottom side at the opening, wherein the downholder plate is mounted in an articulated manner and in such a way on the bottom side of the plate that the opening of the downholder plate is in alignment with the central opening of the plate,

- a first and second pneumatic drive, wherein each of the first and second pneumatic drives comprises a cylinder and a drive element, between which a pressure chamber is formed, wherein the cylinder of the first drive is fixed on the upper side of the plate above the first of the further openings, and the cylinder of the second drive is fixed on the upper side of the plate above the second of the further openings, and

first pressure lines for supplying a compressed gas to the pressure chambers of the two pneumatic drives.

[0006] Preferably, the drive element of the first pneumatic drive comprises a spherical projection which engages in a spherical recess of the downholder plate, and the drive element of the second pneumatic drive comprises a spherical projection which engages in an elongated recess of the downholder plate which comprises a middle section with a circular cross-section, wherein the spherical projection of the drive element of the first pneumatic drive and the spherical recess of the downholder plate have the same radius, and wherein the radius of the spherical projection of the drive element of the second pneumatic drive is equal to the radius of the cross-section of the middle section of the elongated recess of the downholder plate.

[0007] The drive element of the pneumatic drives may for example be a piston or a membrane.

[0008] The downholder preferably comprises second pressure lines for supplying a gas to the pressure chambers of the two pneumatic drives and sensors for monitoring a pressure or gas flow in the second pressure lines, so that it can be checked in operation whether the pistons or the membranes, respectively, return to a retracted position when the supply with compressed gas is terminated.

[0009] The bearing of the downholder plate on the bottom side of the plate advantageously occurs by means of screws, which are guided through return springs arranged on the upper side of the plate and through threadless boreholes in the plate and are screwed into the downholder plate, wherein the return springs are pretensioned, so that the screws pull the downholder plate against the bottom side of the plate.

BRIEF DESCRIPTION OF THE DRAWING FIGURES

[0010] The accompanying drawings, which are incorporated into and constitute a part of this specification, illustrate one or more embodiments of the present invention and, together with the detailed description, serve to explain the principles and implementations of the invention. For reasons of clarity, the figures are not drawn to scale. In the drawings:

- Fig. 1 shows a perspective view of a first embodiment of a downholder in accordance with the invention with a plate and a downholder plate;
- Fig. 2 shows the downholder of the first embodiment from below;
- Fig. 3 shows a second embodiment of a downholder in accordance with the invention from below;
- Fig. 4, 5 shows the downholder in the cross-sectional view in two operating states, and

Fig. 6 shows a second embodiment of a downholder in accordance with the invention in a cross-sectional view.

DETAILED DESCRIPTION OF THE INVENTION

[0011] Fig. 1 shows a first embodiment of a downholder in accordance with the invention in a perspective view. The downholder comprises a plate 1 with a central opening 2 and two further openings 3 and 4 (Figs. 4 and 5). The further openings 3 and 4 are arranged on either side adjacent to the central opening 2 and are advantageously substantially round, but can also have any other shape. The central opening 2 is elongated in this embodiment and allows access to substrate places of a substrate for the bonding of the dies, which substrate places are arranged at least in one row.

[0012] The downholder further comprises a first and a second pneumatic drive. Each of the two pneumatic drives contains a cylinder 5 and 6 and a drive element between which a pressure chamber is formed. The drive elements are displaceable pistons 7 and 8 (Figs. 4 and 5) for example, or also elastically deformable and/or deflectable membranes 18, 19 (Fig. 6). The cylinder 5 of the first pneumatic drive is fixed on the upper side of the plate 1 above the opening 3 and the cylinder 6 of the second pneumatic drive on the upper side of the plate 1 above the opening 4. In the embodiment with the pistons 7 and 8, they are displaceable perpendicularly to the plane spanned by the plate 1, and in the embodiment of the membranes 18 and 19 they are at least deformable in this direction. First pressure lines 9 are arranged on the upper side of the plate 1 for supplying a compressed gas to the pressure chambers of the two pneumatic drives. A protective gas can be used as a compressed gas so that the substrates do not oxidise. Frequently used protective gases are nitrogen or forming gases such as N_2H_2 for example.

[0013] The downholder further comprises a downholder plate 10 with a opening 11. Fig. 2 shows the downholder of the first embodiment in a partial view from below. In this embodiment, the opening 11 is elongated and the downholder plate 10 is accordingly cross-shaped. The downholder plate 10 comprises on its bottom side, i.e. its side facing away from the plate 1, several downholder webs 12 arranged in the opening 11. The downholder webs 12 are arranged here along the two elongated side edges of the opening 11. The downholder webs 12 can extend transversely over the opening 11 if necessary. The downholder plate 10 is arranged on the bottom side of the plate 1 and mounted on the plate 1 in such a way that the elongated opening 11 of the downholder plate 10 is in alignment with the central opening 2 of the plate 1, which opening is also elongated in this embodiment. The downholder plate 10 is mounted in an articulated manner on the plate 1, so that when the pneumatic drives are actuated with compressed gas it can adjust to the orientation of the substrate. The downholder plate 10 is fixed by means of four screws 13 to the plate 1 for example.

The screws 13 are guided through return springs 14 (Fig. 1) and through threadless boreholes in the plate 1 and screwed into the downholder plate 10, wherein the return springs 14 arranged between the screw heads of the screws 13 and the upper side of the plate 1 are pretensioned. The return springs 14 therefore press the screw heads away from the plate 1, so that the screws 13 draw the downholder plate 10 against the bottom side of the plate 1.

[0014] The downholder plate 10 comprises two recesses 15 and 16 on its upper side, which recesses are arranged on either side of the center of the opening 11 and whose position is indicated in Fig. 2 with broken lines, which illustration shows the bottom side of the downholder plate 10. The recess 15 is spherical. The recess 16 is elongated and consists of two approximately semi-spherical end regions and a middle section with a circular cross-section. The longitudinal direction of the recess 16 extends orthogonally to the longitudinal direction of the opening 11 which is elongated in this embodiment.

[0015] Fig. 3 shows a sectional view of a second embodiment of the downholder from below. In this embodiment, the central opening 2 of the plate 1 and also the opening 11 of the downholder plate 10 are square or rectangular/elongated in order to make accessible for example the substrate place of a single-placed substrate. Accordingly, the downholder plate 10 is wide and narrow or elongated, respectively. The longitudinal direction of the recess 16 of the downholder plate 10 extends in this embodiment parallel to the longitudinal direction of the downholder plate 10.

[0016] The further openings 3 and 4 are preferably arranged symmetrically in both embodiments with respect to the central opening 2. Symmetric means on both sides of the center of the opening 2 and at the same distance therefrom.

[0017] Figs. 4 and 5 show the downholder in the embodiment with the pistons 7, 8 as the drive elements in a cross-sectional view, wherein Fig. 4 shows the first operating state when the pressure chambers of the two pneumatic drives are relieved and Fig. 5 shows the second operating state when the pressure chambers of the two pneumatic drives are actuated by the compressed gas, so that the pistons 7, 8 press the downholder plate 10 away from the plate 1 and against the substrate. The upper edge of the pistons 7, 8 has a lowered shoulder, so that the pistons 7, 8 never fully cover the orifice openings of the first pressure lines 9.

[0018] Fig. 6 shows the downholder in the embodiment with the membranes 18 and 19 as the drive elements in a cross-sectional view. The pressure chamber that can be supplied with compressed gas is formed between the cylinders 5 and 6 and the membranes 18 and 19. The membranes 18 and 19 are elastically deformable in the perpendicular direction in relation to the plane spanned by the plate 1. In this embodiment, the cylinders 5 and 6 can also be formed as depressions as an integral component of the plate 1, which depressions then form the pressure chambers.

[0019] The drive elements, i.e. the pistons 7, 8 and the membranes 18, 19, of the pneumatic drives comprise a spherical projection 17, or a component with a spherical projection 17 is attached to the membranes 18 and 19. The spherical projection 17 of the piston 7 or the membrane 18 of the first pneumatic drive engages in the spherical recess 15 of the downholder plate 10. The spherical projection 17 of the piston 7 or the membrane 18 of the first pneumatic drive as well as the spherical recess 15 of the downholder plate are provided with the same radius. As a result of this configuration, the downholder plate 10 can be inclined in any direction in relation to the plate 1, but it is unable to be displaced. The spherical projection 17 of the piston 8 or the membrane 19 of the second pneumatic drive engages in the elongated recess 16 of the downholder plate 10. The radius of the spherical projection 17 of the piston 8 or membrane 19 of the second pneumatic drive is equal to the radius of the circular cross-section of the middle section of the elongated recess 16 of the downholder plate 10. This configuration of the articulated bearing allows a displacement of the downholder plate 10 relative to the plate 1 and allows the precise alignment and adjustment of the downholder webs 12 with respect to the substrate places of the substrates during the setup of the downholder, and allows inclination of the downholder plate 10 in any direction during the mounting operation and thus the adjustment of the downholder plate 10 to the substrate, wherein the position of the spherical recess 15 of the downholder plate 10 with respect to the plate 1 is predetermined by the position of the spherical projection 17 of the piston 7 or membrane 18 of the first pneumatic drive, whereas the spherical projection 17 of the piston 8 or membrane 19 of the second pneumatic drive can be displaced within the elongated recess 16 and is thus capable of compensating thermally induced expansions of the plate 1 and the downholder plate 10.

[0020] The plate 1 and the two cylinders 5 and 6 can be of integral configuration, or they can be arranged in such a way that the cylinders 5 and 6 can displaceably be fixed to the plate 1. In the second case, the diameter of the openings 3 and 4 are dimensioned to be so large that the cylinders 5 and 6 can be displaced within a specific range without the pistons 7, 8 touching the opening 3 or 4. The fixing of the cylinders 5 and 6 to the plate 1 occurs for example by means of two screws 20 each (Fig. 1), wherein the cylinders 5 and 6 are displaceable relative to the screws 20. This embodiment offers the advantage that the position and alignment of the two pneumatic drives can be adjusted in a simple manner.

[0021] If the pressure chambers of the pneumatic drives are supplied with compressed gas in the embodiment with the membranes 18, 19, the membranes 18, 19 are elastically deformed and the projections 17 are thus deflected (downwardly). If the pressure chambers are vented, the downholder plate 10, which is drawn by the return springs 14 against the bottom side of plate 1, presses against the projections 17, so that the membranes 18, 19 are deformed in the opposite direction. The height of the cylinders 5, 6 is advantageously dimensioned in such a way that the membranes 18, 19 come to

rest on the cylinder cover in this case.

[0022] The pistons 7, 8 as well as the membranes 18, 19 can assume two positions, namely a retracted position when the pressure chambers are not supplied with compressed gas and an extended position when the pressure chambers are supplied with compressed gas.

[0023] In order to check whether the pistons 7, 8 or membranes 18, 19 return to their retracted position when the supply with compressed gas is terminated, second pressure lines 21 which lead to the pressure chambers of the two pneumatic drives and sensors (not shown) are provided. During operation, a gas is supplied with low-pressure to the second pressure lines 21 permanently or at the end of the supply of the pressure chambers with compressed gas. Once the pistons 7, 8 or membranes 18, 19 return to the retracted position, the pistons 7, 8 or membranes 18, 19 close the end of the associated second pressure line 21, so that the pressure in the pressure lines 21 rises and the gas flow stops. If the pistons 7, 8 or membranes 18, 19 do not return to their retracted position, the gas supplied via the pressure lines 21 flows via the first pressure lines 9 and/or optionally via the gap between the pistons 7, 8 and the associated cylinder 5 or 6 and the pressure does not rise. The sensors are pressure sensors for example which monitor the pressure in the pressure lines 21, or flow sensors which monitor the gas flow.

[0024] While embodiments and applications of this invention have been shown and described, it would be apparent to those skilled in the art having the benefit of this disclosure that many more modifications than mentioned above are possible without departing from the inventive concepts herein. The invention, therefore, is not to be restricted except in the spirit of the appended claims and their equivalents.

CLAIMS

1. Downholder for holding down substrate places of a substrate, comprising
 - a plate (1) with a central opening (2) and with two further openings (3, 4) arranged on either side adjacent to the central opening (2),
 - a downholder plate (10) with an opening (11) and downholder webs (12) arranged on the bottom side at the opening (11), wherein the downholder plate (10) is mounted in an articulated manner and in such a way on the bottom side of the plate (1) that the opening (11) of the downholder plate (10) is in alignment with the central opening (2) of the plate (1),
 - a first and second pneumatic drive, wherein each of the first and second pneumatic drives comprises a cylinder (5, 6) and a drive element, between which a pressure chamber is formed, wherein the cylinder (5) of the first drive is fixed on the upper side of the plate (1) above the first of the further openings (3), and the cylinder (6) of the second drive is fixed on the upper side of the plate (1) above the second of the further openings (4), and
 - first pressure lines (9) for supplying a compressed gas to the pressure chambers of the two pneumatic drives.
2. Downholder according to claim 1, wherein the drive element of the first pneumatic drive comprises a spherical projection (17) which engages in a spherical recess (15) of the downholder plate (10), and the drive element of the second pneumatic drive comprises a spherical projection (17) which engages in an elongated recess (16) of the downholder plate (10) which comprises a middle section with a circular cross-section, wherein the spherical projection (17) of the drive element of the first pneumatic drive and the spherical recess (15) of the downholder plate (10) have a same radius, and wherein a radius of the spherical projection (17) of the drive element of the second pneumatic drive is equal to a radius of the cross-section of the middle section of the elongated recess (16) of the downholder plate (10).
3. Downholder according to claim 1 or 2, wherein the drive element of the pneumatic drives is a piston (7, 8).
4. Downholder according to claim 1 or 2, wherein the drive element of the pneumatic drives is a membrane (18, 19).
5. Downholder according to claim 3 or 4, further comprising second pressure lines (21) for supplying a gas to the pressure chambers of the two pneumatic drives and sensors for monitoring a pressure or gas flow in the second pressure lines (21), so that it can be checked in operation whether the pistons (7, 8) or the membranes (18, 19), respectively, return to a retracted position when the supply with compressed gas is terminated.

6. Downholder according to any of claims 1 to 5, wherein a bearing of the downholder plate (10) on the bottom side of the plate (1) occurs by means of screws (13), which are guided through return springs (14) arranged on the upper side of the plate (1) and through threadless boreholes in the plate (1) and are screwed into the downholder plate (10), wherein the return springs (14) are pretensioned, so that the screws (13) pull the downholder plate (10) against the bottom side of the plate (1).