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APPARATUS FOR MOUNTING SOLDER BALLS ON A WAFER

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to the improvement of an apparatus for mounting very small solder balls used for semiconductor chips in order to connect them, and particularly relates to an apparatus for mounting solder balls on a wafer by means of a mask applied to a mount head in which solder ball suction holes are arranged in a matrix.

The present application is based on Japanese Patent Application No. Hei. 10-262453, which is incorporated herein by reference.

2. Description of the Related Art

In mounting solder balls in a BGA (ball grid array), solder balls are sucked, carried and mounted by a mount head provided with solder ball suction holes in accordance with a wiring pattern. However, it has been impossible to mount solder balls on a large number of chips (for example, all over a wafer) in a lump, in the view point of the precision of a suction plate attached to the lower surface of the mount head. Even if it is possible, the equipment cost wound be large impracticably.

Accordingly, in order to keep the precision while mounting solder balls on a large number of chips in a lump, it

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can be considered to divide the extent where the mount head can mount solder balls at a time. For this division, it is necessary to alter the pattern of the suction holes of the mount head.

To change the pattern of the suction holes of the mount head, there has been made such a proposal that a removable plate for sucking solder balls is provided in a lower portion of the mount head so that the alteration of the pattern can be coped with by exchanging the plate. There has been another proposal in which a lower end portion of a mount head for sucking solder balls is itself exchanged in accordance with the pattern.

However, each of these methods is intended to cope with the alteration of the pattern of individual chips. For example, on the assumption that solder balls are mounted on a large number of chips in a lump, it is necessary to prepare a suction plate in accordance with the alteration of the array or the number of the chips. Because of the fact that it costs much to manufacture a suction plate in the present circumstances, these methods increase the equipment cost in order to cope with the alteration of the array pattern on the assumption that solder balls are mounted in a lump. Therefore, the methods are not practical.

SUMMARY OF THE INVENTION

In order to solve the foregoing problem, the present invention provides an apparatus for mounting solder balls on a wafer, in which a mask is used for a suction head having a basic

ball mount layout so that the pattern of available solder ball suction holes of a mount head can be altered easily, and it is possible to cope with difficulty of mounting solder balls on a large number of chips on a wafer in a lump.

In order to solve the foregoing problem, provided is an apparatus for mounting solder balls on a wafer, the apparatus comprises a mount head connected to a negative pressure source and provided with solder ball suction holes which are arranged in a matrix in a lower surface of the mount head in accordance with a wiring pattern, and in that a mask for covering the solder ball suction holes in portions where it is not necessary to mount solder balls is prepared so that the mask is used in accordance with necessity when solder balls are to be mounted. Further provided is an apparatus for mounting solder balls on a wafer, a plurality of masks for covering the solder ball suction holes in portions where it is not necessary to mount solder balls are prepared so that the masks are selectively used for mounting solder balls, and further provided is an apparatus for mounting solder balls on a wafer, wherein at least when solder balls have been mounted on a wafer, the apparatus is operated while the mask is removed from the mount head.

Features and advantages of the invention will be evident from the following detailed description of the preferred embodiments described in conjunction with the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In the accompanying drawings:

Fig. 1 is a schematic front view showing an embodiment of a solder-ball mounting apparatus;

Fig. 2 is a schematic plan view of the same apparatus;

Fig. 3 is a side view of a masking plate moving mechanism;

Fig. 4 is an explanatory diagram showing a relationship between a wafer and a mask;

Fig. 5 is an explanatory diagram showing a relationship between the mask and solder ball suction holes;

Fig. 6 is a schematic front view when flux is supplied in the case where a mask A is used;

Fig. 7 is a schematic front view when the flux is transferred and solder balls are sucked in the same case;

Fig. 8 is a schematic front view when the suction of the solder balls is inspected in the same case;

Fig. 9 is a schematic front view when the solder balls are mounted in the same case;

Fig. 10 is a schematic front view when solder balls are sucked in the case where a mask C is used;

Fig. 11 is a schematic front view when the suction is inspected in the same case; and

Fig. 12 is a schematic front view when the solder balls are mounted in the same case.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Description will be made about an embodiment of the present invention with reference to the drawings. Fig. 1 is a schematic front view showing an embodiment of an apparatus for mounting solder balls on a wafer according to the present invention, and Fig. 2 is a schematic plan view of the same. The solder-ball mounting apparatus has a flux supply unit 2 having a flux transfer head 1, a solder ball supply unit 3, a mount head 4, a mask unit 7 having masking plates 5 and 6 in which four kinds of masks A, B, C and D are formed, an inspection device 8 for detecting erroneous solder-ball suction, and a mount stage 13. Although a solder-ball mounting apparatus according to the present invention includes a case where a single mask is prepared, and an operation for performing mounting without using any mask, this embodiment shows a solder-ball mounting apparatus in which such a plural masks A, B, C and D are used selectively.

The mounting operation steps in this embodiment are shown in Figs. 6 to 12. The detailed configurations will be described in the order of the mounting operation steps. Fig. 6 is a schematic front view when flux is supplied immediately after the start. The transfer head 1 of the flux supply unit 2 is made movable vertically and between a flux tray 21 and a wafer 12 on the mount stage 13, as shown by the arrows in Fig. 1, by means of a not-shown driving mechanism. In the first step in this embodiment, the transfer head 1 is moved down to the flux tray

21 so as to be supplied with flux.

The wafer 12 is disposed on the mount stage 13 in advance as shown in Fig. 6. The mount stage 13 is made movable by a driving mechanism in the X-axis direction (vertical direction), in the Y-axis direction (horizontal direction) and the Θ-axis direction (rotation direction) as shown by the arrows in the mount stage 13 in Fig. 2.

The transfer head 1 supplied with the flux moves to the wafer 12 on the mount stage 13, and transfers the flux onto the wafer 12. Fig. 7 shows the state at the time of this step. The mount head 4 is sucking solder balls 9 while the transfer head 1 is transferring the flux.

The mount head 4 is made movable vertically and between the solder ball supply unit 3 and the mount stage 13, by means of a driving mechanism, as shown by the arrow above the mount head 4 in Fig. 1. A suction plate 11 is attached to the lower surface of the mount head 4, and in the suction plate 11, suction holes 10 for sucking the solder balls 9 are disposed in a matrix in accordance with the wiring pattern of individual chips as shown in Fig. 5.

This suction plate 11 is designed so as to be able to cover a fraction of the wafer 12. Since the wafer 12 is divided into four pieces as shown in Fig. 4 so as to divide the mounting operation into four in the illustrated embodiment, the suction holes 10 of the suction plate 11 is formed to have a layout so

as to be able to cover a quarter of the wafer 12.

On the other hand, the masking plates 5 and 6 formed with the masks A, B, C and D designed in accordance with the chip pattern of the wafer 12 are prepared above the solder ball supply unit 3. Some of the suction holes 10 of the suction plate 11 are suction holes 20 which do not require ball mounting. Therefore, the masks A, B, C and D are placed on the portions of the suction holes 20 which do not require ball mounting to thereby prevent the solder balls 9 from being sucked uselessly.

The masks A, B, C and D are of a size in accordance with the suction plate 11, and the number of the masks to be prepared is equal to the number of times of use of the suction plate 11 for every wafer 12. In the illustrated embodiment, the wafer 12 is divided into four as shown in Fig. 4, and mounting operation is performed four times. It is therefore necessary to prepare four kinds of masks, as the masks A, B, C and D. However, in this embodiment, two masking patterns (masks A and D) are formed in the left and right of one masking plate 5 in Fig. 2, so that the two masking plates 5 and 6 have four masks A, B, C and D.

The masks A, B, C and D are opened at places where balls are to be mounted on the wafer 12, and closed at places where balls are not mounted. Although the masking plates 5 and 6 where the masks A, B, C and D are formed are preferably thinner than the size of solder balls to project over the lower surface of the mount head 4 when the solder balls are sucked in the suction holes 10,

there is no problem if the masking plates 5 and 6 are somewhat thick.

The masking plates 5 and 6 are used when solder balls are to be sucked and when missing balls are detected by means of the inspection device 8. The masking plates 5 and 6 are exchangeable automatically or manually.

When solder balls are to be sucked as shown in Fig. 7, the mount head 4 first moves down toward the mask A of the masking plate 5. At the same time a ball storage portion 31 of the solder ball supply unit 3 moves up toward the mask A of the masking plate 5. The solder ball supply unit 3 is also made movable vertically and horizontally as shown by the arrows in Fig. 1.

The masking plate 5 has moved to a predetermined position before the solder balls 9 are sucked. After that, the mount head 4 sucks the solder balls 9 from the ball storage portion 31 into only necessary ones of the suction holes 10 as shown in Fig. 5. The mount head 4 is connected to a not-shown vacuum suction apparatus as a negative pressure source for sucking the solder balls 9 into the suction holes 10.

Successively, as shown in Fig. 8, the mount head 4 which has sucked the solder balls 9 stands still together with the masking plate 5 while the solder ball supply unit 3 moves down and the inspection device 8 for detecting erroneous solder-ball suction moves to a position under the mount head 4 and the masking plate 5.

When an error in sucking is inspected and it is confirmed that the solder balls 9 have been sucked in all the suction holes 10, only the mount head 4 moves toward the mount stage 13. On the way of movement, a double-ball error is inspected by means of a line sensor. This double-ball inspection method is a known technique, and the description thereof is therefore omitted here.

When the above inspection terminates normally, the mount head 4 separated from the mask A moves to a position above the wafer 12. After the mount head 4 is positioned, the mount head 4 moves down and mounts the solder balls 9 on the wafer 12, as shown in Fig. 9. In such a manner, the mounting operation based on the pattern using the mask A corresponding to a quarter part of the wafer 12 divided into four.

Next, mounting operation on the rest quarter parts based on the rest masks B, C and D is performed in the same manner. Figs. 10 to 12 show the mounting operation based on the mask C. In the mounting operation with each of the masks B to D, the step of transferring flux to the wafer 12 is omitted because it has been already performed in the mounting operation based on the mask A. Fig. 10 is a schematic front view when solder balls are sucked by means of the mask C. Fig. 11 is a schematic front view when the suction is inspected in the same case. Fig. 12 is a schematic front view when the solder balls are mounted in the same case.

The change of a mask is performed by the movement of the masking plate 5 and the movement of the mount head 4. The mask

unit 7 having the masking plates 5 and 6 is shown in plan in Fig. 2, and shown in side in Fig. 3. The mask unit 7 is arranged so that the masking plates 5 and 6 attached to a slider 14 can be slid in the direction of arrow in Fig. 2 by means of an actuator 15.

Switching between the masks A and B and between the masks C and D is performed by the operation of the actuator 15. Switching between the masks B and C and between the masks D and A is performed by adjusting the amount of movement of the mount head 4.

According to the present invention, a mask for covering solder ball suction holes in portions where it is not necessary to mount solder balls is prepared in accordance with a workpiece with respect to a mount head in which solder ball suction holes are arranged in a matrix, so that mask is used in accordance with necessity. Accordingly, it is possible to cope with a change of a mount pattern without exchanging a suction plate or exchanging a lower end portion of the mount head itself in accordance with the mount pattern.

Further, when a plurality of masks are prepared so as to be used selectively, it is possible to cope with a larger change of a mount pattern without exchanging a suction plate or exchanging a lower end portion of the mount head itself in accordance with the mount pattern.

Moreover, when solder balls have been mounted on a wafer,

the apparatus is operated while the mask is removed from the mount head. Accordingly, it is possible to prevent the mask from interfering with the solder balls which have been mounted.

In such a manner, it is possible to cope with solder ball mounting on a large number of chips on a wafer in a lump. In addition, if the mount region is divided, it is possible to cope with mounting on the wafer in a lump.

Although the invention has been described in its preferred form with a certain degree of particularity, it is understood that the present disclosure of the preferred form can be changed in the details of construction and in the combination and arrangement of parts without departing from the spirit and the scope of the invention as hereinafter claimed.

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WHAT IS CLAIMED IS:

1. An apparatus for mounting solder balls on a wafer, comprising:

a mount head connected to a negative pressure source and provided with solder ball suction holes which are arranged in a matrix in a lower surface thereof in accordance with a wiring pattern; and

a mask for covering said solder ball suction holes in portions where it is not necessary to mount the solder balls in accordance with necessity when the solder balls are to be mounted.

2. An apparatus for mounting solder balls according to claim 1, wherein at least when solder balls have been mounted on the wafer, said apparatus is operated while said mask is removed from said mount head.

3. An apparatus for mounting solder balls according to claim 1, wherein said mask is thinner than a size of the solder balls to project over the lower surface of said mount head when the solder balls are sucked in said solder ball suction holes.

4. An apparatus for mounting solder balls on a wafer, comprising:

a mount head connected to a negative pressure source and

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provided with solder ball suction holes which are arranged in a matrix in a lower surface thereof in accordance with a wiring pattern; and

a plurality of masks for covering said solder ball suction holes in portions where it is not necessary to mount the solder balls, so that said masks are selectively used for mounting the solder balls.

5. An apparatus for mounting solder balls according to claim 4, wherein at least when solder balls have been mounted on the wafer, said apparatus is operated while said masks is removed from said mount head.

6. An apparatus for mounting solder balls according to claim 4, wherein said mask is thinner than a size of the solder balls to project over the lower surface of said mount head when the solder balls are sucked in said solder ball suction holes.

7. An apparatus for mounting solder balls according to claim 4, wherein number of said masks to be prepared is equal to number of mounting operation for every wafer.

8. A method for mounting solder balls on a wafer, comprising steps of:

preparing a mount head connected to a negative pressure

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source and provided with solder ball suction holes which are arranged in a matrix in a lower surface thereof in accordance with a wiring pattern;

covering said solder ball suction holes in a portion where it is not necessary to mount the solder balls in accordance with necessity when the solder balls are to be mounted;

sucking the solder balls in said solder ball suction holes which are not covered; and

mounting the sucked solder balls on the wafer.

9. An method for mounting solder balls according to claim 8, wherein at least when solder balls have been mounted on the wafer, said solder ball suction holes are not covered.

10. A method for mounting solder balls on a wafer, comprising steps of:

preparing a mount head connected to a negative pressure source and provided with solder ball suction holes which are arranged in a matrix in a lower surface thereof in accordance with a wiring pattern; and

selectively covering said solder ball suction holes in a plurality of portions where it is not necessary to mount the solder balls;

sucking the solder balls in said solder ball suction holes which are not covered; and

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mounting the sucked solder balls on the wafer.

11. An apparatus for mounting solder balls according to claim 10, wherein at least when solder balls have been mounted on the wafer, said solder ball suction holes are not covered.

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