METHOD OF FORMING BALL GRID ARRAY CONTACTS

FIELD OF THE INVENTION

This invention relates to semiconductor devices, and more particularly to a method of forming Ball Grid Array contacts on semiconductor devices.

BACKGROUND OF THE INVENTION

The density of the integrate circuits has been increasing over the past years to meet the higher performance required of the integrated circuits. Package size is getting smaller and smaller to meet the same high performance requirement resulting in higher pin density for the package. Higher pin density requires finer pitch of I/O connecting leads. Ball Grid Array packages meet the higher density pin requirements and are being used to replace current Quad Flat Package (QFP) due to the advantages of the BGA over the traditional QFP package.

There are many kinds of ball attach technologies available, but they are all complicated in the ball attach process, and using them it is hard to get uniform balls on the substrate.

One example of ball attach process is the use of a dispensing machine to dispense solder paste on the substrate directly. Since the deposited solder paste may vary in volume, each solder ball may have a different metal content. It is hard to control the solder ball height. The productivity of dispensing method is lower, but the major issue is the short ball height.

Another process is the attachment of preformed balls. There are two methods, one for plastic packages, and one for ceramic packages. A Eutectic solder ball is used for plastic BGA packages and a high temp solder ball is used for ceramic BGA packages.

In another process, a solder wire bond is used to form BGA balls. A wire bonder is to bond solder wire on the lead pads of substrate. The solder wire is then reflowed to melt solder into balls. This process has low productivity and problems with low solder ball height.

A punch metal pellet Ball attachment process is another common method used to form the balls on a BGA package Visual inspection system must be used to ensure 100% ball placement.

Each of the above processes does not ensure uniform ball height or size, and does not ensure that a ball is placed at each desired place on the semiconductor package.

SUMMARY OF THE INVENTION

The invention is a method for forming solder contact balls for a ball grid array semiconductor device. A sheet of solder is etched or stamped to form an array of solder preforms. The array of preforms is placed over a substrate on which solder balls are to be electrically connected to contact areas. The array of preforms is aligned on the substrate, one preform over a contact area. The substrate and preforms are heated to cause the solder to reflow such that the surface tension of the reflowed solder of each preform forms a solder ball over a contact area.

The technical advance represented by the invention as well as the objects thereof will become apparent from the following description of a preferred embodiment of the invention when

considered in conjunction with the accompanying drawings, and the novel features set forth in the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 shows a semiconductor device with ball grid array contacts;

Fig. 2 shows a solder sheet used to make preforms;

Fig. 3 shows a preform made from a solder sheet;

Fig. 4 is an isometric view of the solder preforms;

Fig. 5 is as second embodiment of the solder preforms;

Fig. 6 shows the preforms aligned on a substrate; and

Fig. 7 shows the solder balls formed from the preforms.

Fig. 8 is a flow diagram of the process of forming solder balls.

DESCRIPTION OF A PREFERRED EMBODIMENT

Fig. 1 shows a semiconductor device 10 which includes the substrate 11 and an array of solder ball contacts 12. Each solder ball is attached to a contact point (see Fig. 6) under the solder ball. The contact point may be either a via that extends into the substrate 11 to contact an element on the semiconductor chip, or may be a conductor on the substrate that interconnects with other circuitry or a contact pad on the semiconductor device.

Fig. 2 shows a solder sheet 13 used in making a plurality of preforms. Solder sheet is of a uniform thickness of a sufficient size to cover the substrate 11.

Fig. 3 shows an array 9 of a plurality of connected preforms 14 that have been formed from sheet 13. Each preform 14 has connecting tabs 15, 16, 17 and 18 extending from four sides, interconnecting the preforms 14. The dimensions "d" are such that the center C of each preform is over a position at which a solder ball contact is to be formed.

Fig. 4 is an isometric illustration of the preform array 9 of Fig. 3. It should be noted that the preforms are of uniform thickness, each having the same volume of solder as the other preforms.

Fig. 5 is an alternate embodiment of the preform array 9 of Fig. 4. A cut or indention 20 is made midway between each preform on the connecting tabs 15, 16, 17 and 18. Indention 20 improves the separation process during the formation of the solder ball from the preform.

Fig. 6 shows the array 9 of preforms 14 positioned on substrate 30. Each preform 14 is positioned over a contact area 14a (shown in dashed lines) to which a solder ball contact is to be electrically attached. Each contact area 14a may have a solder flux deposited thereon to provide wetting between the contact area and the solder ball. The non-contact area around each contact 14a is non-conducting and non-wetting to solder.

In the process, after array 9 has been positioned on substrate 30 such that each preform 14 is over a contact area 14a, the array 9 and substrate are brought to a temperature sufficient to cause the solder preforms 14 to melt. The solder reflows such that a portion of each connecting tabs 15, 16, 17 and 18 melts and flows into an adjacent body of solder which is formed from a preform 14. The surface tension of the molten solder causes the solder mass of each preform 14 to form a ball.

Fig. 7 shows the solder balls 32 formed on and attached to a contact area on substrate 30. Each solder ball size is controlled by the flat pattern of preform 14. Since each preform 14 is the same as the other preforms 14, the size of each formed ball will be the same, and since the solder ball is formed over a contact area, each ball is connected in a desired place. The surface of the

substrate is non-conductive and not solder wetable except at the contact areas. This aids in the formation of the solder balls and ensures that each solder ball is electrically attached on a contact point.

Fig. 8 is process flow diagram for forming the solder ball contacts by solder reflow. The array of preforms is formed from a sheet of solder (40). The array of preforms is placed on the substrate on which the solder ball contacts are to be formed (41). The array of preforms is aligned on the semiconductor substrate (42). Thereafter, the substrate and aligned preforms are heated to cause the solder to reflow and to form solder balls (43).

WHAT IS CLAIMED

1. A method for forming solder contact balls for a ball grid array semiconductor device, comprising the steps of:

forming a sheet of solder to form an array of solder preforms;

placing the array of preforms over a substrate on which solder balls are to be electrically connected to contact areas;

aligning the preforms, one each over a contact area; and

heating the substrate and preforms to cause the solder to reflow such that the surface tension of the reflowed solder of each preform forms a solder ball over a contact area.

2. The method according to claim 1, wherein the volume of each solder ball is controlled by controlling the geometry of the solder form.

3. The method according to claim 1, wherein each solder preform in an array is the same size as other preforms in the array.

4. The method according to claim 1, wherein each preform is joined to other preforms in the array by tabs, and each tab has an indention extending partially through the tab.

5. The method according to claim 1, wherein each preform is connected to other preforms by tab, and each solder ball is made up of solder in the preform and a portion of tabs adjacent to the preform.

6. The method according to claim 1, including the step of applying a solder flux to the contact area prior to aligning the preforms over the contact areas.

7. A method for forming solder contact balls for a ball grid array semiconductor device, comprising the steps of:

forming a sheet of solder to form an array of solder preforms, each preform in the array interconnected to at least two other preforms in the array by tabs;

placing the array of preforms over a substrate on which solder balls are to be electrically connected to contact areas;

aligning the preforms, one each over a contact area; and

heating the substrate and preforms to cause the solder to reflow such that the surface tension of the reflowed solder of each preform forms a solder ball over a contact area.

8. The method according to claim 7, wherein the volume of each solder ball is controlled by controlling the geometry of the solder form.

9. The method according to claim 7, wherein each solder preform in an array is the same size as other preforms in the array.

10. The method according to claim 7, wherein each tab has an indention extending partially through the tab.

11. The method according to claim 7, wherein each preform is connected to other preforms by tab, and each solder ball is made up of solder in the preform and a portion of tabs adjacent to the preform.

12. The method according to claim 7, including the step of applying a solder flux to the contact area prior to aligning the preforms over the contact areas.