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.

BGA packages have less coplanarity problems, have self-alignment capability, and have better yield than QFP packages

There are many kinds of ball attach technologies available, but they are all complicated in the ball attach process, and in 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 a substrate. The solder wire is then reflowed to melt solder into balls. This process has low productivity and problems with solder ball height problems.

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 contacts on contacts areas of ball grid array semiconductor devices. The semiconductor is preheated and a plurality of presolder forms are punched from a sheet of solder material directly onto contact areas on the semiconductor substrate. The substrate and solder preforms are heated to reflowed the solder to form contacts on the semiconductor substrate.

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 semiconductor device under a punch which places solder preforms on the substrate;

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Fig. 3 shows the substrate with the solder preforms;

Fig. 4 is an isometric view of the substrate with the solder forms;

Fig. 5 shows the substrate and solder balls after solder reflow;

Fig. 6 shows a solder ball attached to a substrate;

Fig. 7 shows a solder form attached to a substrate

Fig. 8 is a flow diagram of one embodiment of a process for forming and attaching solder contacts; and

Fig. 9 is flow diagram of the a second embodiment of a process to make and place the solder balls on the substrate.

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. 4) 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 is a pictorial representation showing a semiconductor substrate 16 mounted on a carrier 15, and positioned under a punch 18, having a plurality of punch die 19, and a strip or roll of solder plate 17. After semiconductor substrate 16 is positioned

under punch 18, punch 81 is activated and dies 19 punch a plurality of solder forms 20 (Fig. 3). In Fig. 3, the solder forms 20 are shown aligned on substrate 16.

Fig. 4 shows semiconductor substrate 16 with the punched-out solder forms 20 positioned over areas 21. Each of contact areas 21 may be either a via that extends into the substrate 16 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.

Prior to punching the solder sheet 17, a solder flux may be coated over each contact area 21. No flux is placed on the areas 22 between the contact areas 21. Solder forms 20 are shown as cubes or rectangular forms, but they can be any desired geometric shape.

Fig. 5 shows substrate 16 and solder balls 20a after substrate 16 and solder forms 20 have been subjected to heat to cause the solder preforms to melt and reflow. Only the contact area 21 will be wetted by the solder, and the solder surface tension will cause the melted solder forms 20 to form spheres 20a which form the contacts for the ball grid array semiconductor device.

The solder plate 17 is of uniform thickness and may be, for example, a 90/10 Sn/Pb or a 63/37 Sn/Pb composition. The thickness will be based upon the height of the contact to be used.

The basic process varies slightly depending upon the solder composition. Dependent upon the solder, the solder form may not be completely melted during reflow. A eutectic solder or flux may be placed on the substrate over the contact areas. If the solder plate is eutectic solder then a layer of flux is placed on each contact area to clean the oxidation of the contact areas. Viscosity of the flux is important when a flux is used. High viscosity flux will hold the solder form over a contact area during reflow. A solder flux with a 325-500 mesh size may be used.

After the solder forms are punched out onto the substrate contact areas, the substrate and forms are heated to cause the solder to reflow. The substrate and solder forms are heated in the range of about 150 degree C. to about 225 degree C. Time of reflow is between about 3½ minutes and 5½ minutes.

Fig. 6 is a side view of a single solder ball mounted on a substrate and Fig. 7 is a side view of a high temperature solder form. In Fig. 6, a reflowed solder ball 31 is shown which is made

from a low temperature solder. A substrate 30 with a reflowed formed solder ball 31 attached to substrate 30. There will be a solder fillet 32 around the base of the solder ball.

In Fig. 7, a high temperature punched form is used as the contact. During reflow, only the low eutectic solder has melted soldering the solder form to the contact area. The heating and reflow process may be done in a N_2 environment. Fig. 7 shows a substrate 35 with a high temperature solder form 36 attached to the substrate. A low temperature solder 37 attaches solder form 36 to substrate 35.

When forming a solder ball, the process may be as shown in Fig. 8. The substrate is prepared (45), for example by cleaning and a solder flux may be appled to the contact area on which the solder ball is to be formed and attached. The substrate is heated (46) to melt the solder flux. A preform is punched out of a solder sheet (47), for example 63/37 SnPb solder, directly onto the contact area on the substrated within a N_2 environment. The solder reflows and forms the solder ball (48).

A second embodiment of the process is shown in Fig. 9. The substrate is prepared (50) and a solder flux or paste is applied to the substrate (51) over the contact areas. A preform is punched out

of the solder sheet (52), for example 90/10 SnPb or 63/37 Sn/Pb solder composition, directly onto the substrate. The substrate is heated to cause the solder to reflow (53)forming the solder contact. The substrate is then cleaned (54).

WHAT IS CLAIMED

1. A method for forming solder contacts on contacts areas of ball grid array semiconductor devices, comprising the steps of:

pre heating a semiconductor substrate;

punching from a sheet of solder material directly onto contacts areas on a semiconductor substrate a plurality of solder forms;

reflowing the solder forms by the application of heat to form solder contacts on the semiconductor substrate.

2. The method according to claim 1, wherein the reflow of the solder is done in a H_2 atmosphere.

3. The method according to claim 1, wherein a solder flux is applied to the contact areas prior to punching the solder forms onto the substrate.

4. The method according to claim 1, wherein the substrate is preheated to a temperature in the range of 150 to 225 degree C.

5. The method according to claim 1, wherein the solder sheet is of solder selected from 63/37 Sn/Pb and 90/10 Sn/Pb solder composition.

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6. The method according to claim 1, wherein the substrate and solder forms are subjected to a reflow for a period 3½ minutes to 5½ minutes.

7. A method for forming solder contacts on contacts areas of ball grid array semiconductor devices, comprising the steps of:

applying a solder flux on contact areas of the semiconductor device substrate;

punching from a sheet of solder material directly onto contacts areas on a semiconductor substrate a plurality of solder forms;

reflowing the solder forms and solder flux by the application of heat to form solder contacts on the semiconductor substrate.

8. The method according to claim 7, wherein the substrate is preheated to a temperature in the range of 150 to 225 degree C.

9. The method according to claim 7, wherein the solder sheet is of solder selected from 63/37 Sn/Pb and 90/10 Sn/Pb solder composition.

10. The method according to claim 7, wherein the substrate and solder forms are subjected to a reflow for a period 3½ minutes to 5½ minutes.

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