

DISPENSING SPHERES IN A PREDETERMINED PATTERN

5

FIELD OF THE INVENTION

This invention relates to dispensing spheres in a predetermined pattern. This invention is particularly useful for, but not necessarily limit to, dispensing for
10 placement of solder spheres onto a substrate associated with a silicon die.

BACKGROUND ART

15

To reduce the size of packaged silicon chips, Surface Mounted Technology (SMT) has been developed. One form of SMT uses ball grid arrays. When manufacturing ball grid arrays, a pick up member is generally used to pick up
20 solder spheres and place them onto the substrate associated with a silicon die. However, manufacturing defects may result due to inadequate dispensing of the solder spheres to the pick up member.

25

In U.S. Patent 5,284,287 there is described an apparatus for manufacturing ball grid arrays which requires a container filled with solder spheres. A conventional pick up member captures spheres in the container in a predetermined pattern. Unfortunately, the
30 pick up member may not always capture all the spheres it requires to form the predetermined pattern. Furthermore, oxidation of the balls may occur due to solder spheres at the bottom of the container being unlikely to be readily captured by the pick up member. A further problem with
35 this apparatus is that the solder spheres in the container may be deformed or crushed by the pick up member.

1-0701130

Another known apparatus for manufacturing ball grid arrays uses a template located below a container filled with solder spheres. The template comprises a plurality of apertures forming a predetermined pattern for receiving spheres in the container. Underneath the template is a sliding door which is sandwiched between a substrate and the template. Upon opening the sliding door solder spheres in the apertures are allowed to drop onto the substrate. The sliding door then closes and the substrate is removed and replaced with another substrate requiring placement of solder spheres. Unfortunately, because the spheres are dropped onto the substrate accurate placement of the spheres onto the substrate does not always result. There is also no guarantee that the spheres in the container will be received by the apertures and the sliding door when closing may deform the solder spheres that are either on the substrate or in the apertures.

In U.S. Patent 5,467,913 there is described an apparatus having a template comprising a plurality of apertures defining a predetermined pattern. At each end of the template there are sphere reservoirs and the template is movable about two axes. In use movement of the template causes the spheres in the reservoir to roll across the template and be captured by the apertures. Air suction is also used in assisting capturing spheres. However, the collection of the spheres in the apertures is relatively slow and each of the apertures may not necessarily capture a sphere and therefore this apparatus may not be practical for most industrial applications.

In U.S. Patent 5,445,313 there is disclosed an apparatus that has a pick up member positionable in a reservoir of solder spheres. The spheres are attracted to apertures in the pick up member by a relatively strong suction. To assist in the spheres being attracted to the

pick up member, air is blown into the reservoir to provide agitation. The pick up member has a predetermined pattern of apertures for capturing the spheres and then subsequently dispensing the spheres onto a substrate in the predetermined pattern. Unfortunately, the strong suction may result in damage to the spheres as they impact the pick up member and the apertures may not necessarily capture a sphere for subsequent dispensing.

10

SUMMARY OF THE INVENTION

It is an aim of the invention to overcome or alleviate at least one of the problems associated with dispensing spheres in a predetermined pattern.

According to one aspect of this invention there is provided an apparatus for dispensing spheres in a predetermined pattern, said apparatus comprising:

20

a template having a plurality of apertures therein conforming to said predetermined pattern, each one of said apertures being sized and shaped to receive one or more said spheres;

25

a container moveable relative to a surface of said template and having an outlet adjacent the said surface, wherein the container in co-operation with the template surface are adapted to contain at least some of said spheres; and

30

a drive means for providing relative movement of the container across at least a portion of said surface.

35

Suitably, said outlet may be an open base region which in combination with said surface are adapted to

retain a supply of solder spheres to be transferred to said apertures.

5 Preferably, the container may be mounted such that when some of said spheres are in said container the outlet is spaced apart from the surface by a distance less than a radius of the spheres.

10 Preferably, said outlet may comprise one or more walls wherein at least one of said walls forms a plough member.

Suitably, said plough member may comprise a recess for receiving spheres and a deflector edge adjacent the template face for deflecting spheres into said recess.

15 Preferably, there may be an agitation means for agitating said spheres in said container during said relative movement.

20 Suitably, said agitation means may provide for reciprocating movement of said container relative to said template in a direction that is transverse to said relative movement, thereby relative travel between said container and said template is along an oscillatory path.

25 According to another aspect of the invention there is provided an apparatus for dispensing spheres in a predetermined pattern, said apparatus comprising:

30 a mount;

a container associated with said mount for storing a supply of said spheres, said container having an outlet adjacent a template thereunder, said template having
35 apertures therein conforming to said predetermined pattern; and

a drive means associated with said apparatus for providing relative movement of said container along at least a portion of said template, wherein during said movement said container is positioned to transfer at least one of said spheres through said outlet to a respective one of said apertures.

Preferably, said outlet may be an open base region which in combination with a surface of said template are adapted to retain a supply of solder spheres to be transferred to said apertures.

Suitably, said container and said template may be arranged to retain said spheres other than those transferred to said apertures.

Preferably, an underside of said container can be in close proximity to said template to thereby disallow said spheres other than those located in said apertures from passing therebetween.

Preferably, said container may be mounted such that when some of said spheres are in said container the outlet is spaced apart from said template by a distance less than a radius of the spheres.

Preferably, said outlet may comprise one or more walls wherein at least one of said walls forms a plough member.

Suitably, said plough member may comprise a recess for receiving spheres and a deflector edge adjacent the template face for deflecting spheres into said recess.

Suitably said apertures may have a shoulder portion for supporting a respective sphere located therein.

Suitably, said apertures may be blind. Alternatively, said apertures may provide a passage through said template. Suitably, said passage may be coupled to an air pressure variation means

5

Preferably, said air pressure variation means may be controllable to assist in location of said spheres in said apertures.

10 Suitably, said air pressure variation means may be controllable to assist in removal of said spheres in said apertures.

15 Suitably, there may be a pick up member for removing said spheres located in said apertures for transfer thereof to one or more substrates.

20 Preferably, said pick up member may comprise at least one template, said template having pick up apertures complimentary to said apertures.

25 Preferably, there may be an agitation means for agitating said spheres in said container during said relative movement.

Suitably, said agitation means may provide for reciprocating movement of said container relative to said template in a direction that is transverse to said relative movement, thereby relative travel between said container and said template is along an oscillatory path.

30

Preferably, said container may be in fluid communication with a non-oxidising gas supply.

35 Preferably, said container may comprise at least one level sensor for detecting a threshold level of spheres therein.

BRIEF DESCRIPTION OF THE DRAWINGS

5 In order that the invention may be readily understood and put into practical effect, reference will now be made to a preferred embodiment as illustrated with reference to the accompanying drawings in which:

10 FIG. 1 is a perspective view of an apparatus in accordance with the invention;

FIG. 2 is a perspective view of part of the apparatus of FIG. 1;

15 FIG. 3 is a reverse side perspective view of part of FIG. 2;

20 FIG. 4 is a perspective view illustrating a container and template of FIG. 1;

FIG. 5 is a cross-sectional view of part of the container and template of FIG. 1; and

25 FIG. 6 is a cross-sectional view of part of a pick up member and template of FIG. 1.

30 DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT OF THE INVENTION

Referring in general to Figs. 1 to 6, there is illustrated an apparatus 1 for dispensing spheres. The apparatus 1 comprises a mount 2 which has a tracks 27 to which is slidably mounted an associated sliding carriage 26 (only one of tracks 27 is illustrated). A container 3 storing a supply of solder spheres 50 has an associated

carriage mount 3a which is slidably mounted by tracks 26a to carriage 26. Hence, container 3 is movable along a longitudinal axis L and a transverse axis T.

5 The container 3 has an outlet 4 in close proximity to a surface 8 of a template 5 having a plurality of apertures 6 forming a predetermined pattern. Template 5 is releasably mounted to mount 2 by a bolts 41 and an associated clamping plate 42. Container 3 has nitrogen
10 supply inlet 33 and upper and lower sensors 34 are mounted on two opposing sides of container 3. Further, as only illustrated in Fig. 2, container 3 has a guard 61 with slots 62 that act as a limit for limiting the rate at which solder spheres 50 are available to be captured by
15 apertures 6.

 The apparatus 1 has a drive means 7 which comprises a motor 21 having an output shaft 22. Mounted to shaft 22 is a drive pulley 23 and operatively coupled to drive
20 pulley 23 is a drive belt 24. A free pulley 25 is rotatably mounted to mount 2 and engages drive belt 24 such that drive belt 24 is in alignment with longitudinal axis L of template 5. Accordingly, the drive means 7 provides relative movement between container 3 and
25 template 5 along longitudinal axis L.

 The apparatus 1 also has a pick up member 13 slidably mounted to a track assembly 14. There is also a substrate conveyor 15 for conveying substrates associated with
30 silicon dies into a position accessible by pick up member 13. The substrate conveyor 15 is known to a person skilled in the art and therefore needs no detailed description.

35 The carriage 26 is clamped to belt 24 by a clamp 24a thereby upon motor 21 turning shaft 22, movement along longitudinal axis L of both carriage 26 and container 3

will result. In alignment with longitudinal axis L is a rack 28 formed in part of track 27. The rack 28 engages a pinion 29 which is rotatably mounted to carriage 26. Extending from pinion 29 is an eccentric pin 30 which
 5 engages a slot 31 in carriage mount 3a.

At one end of track 27 there is a storage container 52 pivotally mounted about a pivot pin 53 to mount 2. A fluid actuatable ram 54 is also pivotally mounted about a
 10 pivot pin 55 to mount 2. Storage container 52 has a mounting member 56 pivotally coupled by a pivot pin 57 to an end of ram 54. There is a flap 58 pivotally mounted, by a pivot pin 59, to storage container 52 to cover an outlet of container 52. There is also a low level sensor
 15 60 mounted to detect when a reservoir of solder spheres 50 in container 52 are running low.

As illustrated specifically in Fig. 5, template 5 has a plurality of apertures 6 which form a predetermined
 20 pattern. Surface 8 of template 5 is in close proximity to an underside of outlet 4. As shown, outlet 4 is an open base region of container 3 which in combination with surface 8 retains a supply of the solder spheres 50 to be transferred to apertures 6. Each of apertures 6 comprises
 25 a shoulder portion 9 and a passage 10 through template 5 which is in communication with an air pressure variation means 11a. To achieve communication between each passage 10 and air pressure variation means 11a a communication chamber 43 is formed by a cover 44 and gasket 45
 30 arrangement coacting with a surface 46 of template 5, surface 46 being opposite to surface 8. The air pressure variation means 11a is operatively coupled to a control means 12 which is adapted to control air pressure means 11a to thereby alter air pressure in the apertures 6.

35

Located in container 3 is a reservoir of solder spheres 50. There are walls 38 at outlet 4 of container 3

(only one is shown in Fig. 5), these walls 38 form a plough member comprising a sloping recess which, as illustrated, is an elongate concave recess 39. There is also a deflector edge 40 adjacent surface 8 of template 5 for assisting in deflecting the solder spheres 50 into recess 39.

Referring specifically to Fig. 6, pick up member 13 has a pick up head 16 comprising a plate 17 with apertures 18 conforming to a predetermined pattern corresponding to the predetermined pattern on template 5. Apertures 18 have a shoulder portion 19 and a passage 20 through plate 17. Each passage 20 is in communication with an air pressure variation means 11b. To achieve communication between each passage 20 and air pressure variation means 11b, a communication chamber 47 is formed by a cover 48 and gasket 49 arrangement coacting with a surface 51 of plate 17. The air pressure variation means 11b is operatively coupled to control means 12 which is adapted to control air pressure in both apertures 6 and 18.

In use drive means 7 provides movement of container 3 relative to template 5 along longitudinal axis L. Further, during this relative movement pinion 29 (engaging rack 28) will rotate, thereby rotating eccentric pin 30 in slot 31. Consequently, container 3 will reciprocate along transverse axis T which results in container 3 traveling along an oscillatory path O. This therefore provides agitation of the spheres 50 which assists in their location in a respective one of apertures 50. The recess 39 and deflector edge 40 also assist in agitating spheres 50.

As the container 3 moves along oscillatory path O, control means 12 controls air pressure variation means 11a to provide air suction in apertures 6. This therefore assists in capturing a sphere 50 in each of apertures 6.

Further, open base region of container 3 in combination with surface 8 retain a supply of the solder spheres 50 to be transferred to apertures 6. In this regard, the distance between surface 8 and a lowermost portion of the outlet 4 (i.e. the deflector edge 40) is less than the radius of the spheres 50. Further, when the spheres 50 are located in a respective one of apertures 6 they can preferably marginally protrude above surface 8 to provide further agitation of spheres 50.

10

During a single sweep of the container 3 along oscillatory path O (e.g. from right to left) air pressure variation means provides suction to apertures 6 to assist in capturing spheres 50. Upon completion of the sweep the pick up member 13 moves into a sphere collecting position as illustrated specifically in fig 6. The control means signals the air pressure variation means 11a to cease providing air suction and also signals air pressure variation means 11b to provide air suction to apertures 18. Accordingly, the spheres 50 are transferred to apertures 18 for subsequent transfer to substrates on conveyor 15. Further, once the spheres 50 have been transferred to apertures 18, air suction provided by air pressure variation means 11b is slightly reduced to alleviate the possibility of deformation and undesirable lodging of the spheres 50 in apertures 18.

25

Once the pick up member moves away from the position illustrated in Fig. 6, the container does a reverse sweep (left to right) with air pressure variation means 11a providing suction to apertures 6. Upon completion of the reverse sweep pick up member 13 again moves to the collecting position to receive more spheres located in apertures 6.

35

If level sensors 34 detects the occurrence of a low level threshold supply of spheres 50 in container 3, then

drive means 7 moves container 3 to a position adjacent storage container 52. Ram 54 is then actuated to extend and pivot container 52 about pivot pin 53. As a result, some spheres 50 in container 58 are transferred into container 3 and transfer is regulated by pivotally mounted flap 58. Level sensors 34 detect when a sufficient supply of spheres have been transferred to container 3. Ram 52 is then actuated to retract and return container 52 from the position shown in Fig. 2 to the position shown in Fig. 1. Container 3 then returns to moving along oscillatory path 0 and transferring spheres 50 to apertures 6. Further, when spheres in container 52 are running low, the low level sensor 60 actuates a warning light (not shown) to inform an operator of apparatus 1 that more spheres 50 should be placed in container 52.

To alleviate the possibility of oxidation of spheres 50 in container 3 a non oxidising gas (such as nitrogen) is introduced into container 3 through nitrogen supply inlet 33. A similar inlet may also be provided for container 52.

Advantageously, the present invention allows for dispensing spheres 50 in a predetermined pattern and overcomes or at least alleviates the problems associated with prior art solder sphere dispensers for SMT. In this regard, movement of container 3 along oscillatory path 0 provides for transferring of spheres 50 through outlet 4 and into apertures 6. Outlet 4 in combination with surface 8 retain spheres other than those transferred to apertures 6. This is achieved without undue deforming of the spheres 50 and the oscillatory path 0, deflector edge 40 and recess 39 provides for agitation to increase the probability of all the apertures 6 capturing one of spheres 50 during a sweep of container 3.

Although the invention has been described with reference to a preferred embodiment it is to be understood that the invention is not restricted to the embodiment described herein.



WE CLAIM:

1. An apparatus for dispensing spheres in a predetermined pattern, said apparatus comprising:

a template having a plurality of apertures therein conforming to said predetermined pattern, each one of said apertures being sized and shaped to receive one or more said spheres;

a container moveable relative to a surface of said template and having an outlet adjacent the said surface, wherein the container in co-operation with the template surface are adapted to contain at least some of said spheres; and

a drive means for providing relative movement of the container across at least a portion of said surface.

2. An apparatus as claimed in claim 1, wherein said outlet is an open base region which in combination with said surface are adapted to retain a supply of solder spheres to be transferred to said apertures.

3. An apparatus as claimed in claim 2, wherein the container is mounted such that when some of said spheres are in said container the outlet is spaced apart from the surface by a distance less than a radius of the spheres.

4. An apparatus as claimed in claim 3, wherein said outlet comprises one or more walls wherein at least one of said walls forms a plough member.

5. An apparatus as claimed in claim 4, wherein said plough member comprises a recess for receiving spheres and a deflector edge adjacent the template face for deflecting spheres into said recess.



6. An apparatus as claimed in claim 1, wherein there is an agitation means for agitating said spheres in said container during said relative movement.

5

7. An apparatus as claimed in claim 6, wherein said agitation means provides for reciprocating movement of said container relative to said template in a direction that is transverse to said relative movement, thereby
10 relative travel between said container and said template is along an oscillatory path.

8. An apparatus for dispensing spheres in a predetermined pattern, said apparatus comprising:

15

a mount;

a container associated with said mount for storing a supply of said spheres, said container having an outlet
20 adjacent a template thereunder, said template having apertures therein conforming to said predetermined pattern; and

a drive means associated with said apparatus for
25 providing relative movement of said container along at least a portion of said template, wherein during said movement said container is positioned to transfer at least one of said spheres through said outlet to a respective one of said apertures.

30

9. An apparatus as claimed in claim 8, wherein said outlet is an open base region which in combination with a surface of said template are adapted to retain a supply of solder spheres to be transferred to said apertures.

35



10. An apparatus as claimed in claim 9, wherein said container and said template are arranged to retain said spheres other than those transferred to said apertures.

5 11. An apparatus as claimed in claim 10, wherein an underside of said container is in close proximity to said template to thereby disallow said spheres other than those located in said apertures from passing therebetween.

10 12. An apparatus as claimed in claim 10, wherein said container is mounted such that when some of said spheres are in said container the outlet is spaced apart from said template by a distance less than a radius of the spheres.

15

13. An apparatus as claimed in claim 8, wherein said outlet comprises one or more walls and wherein at least one of said walls forms a plough member.

20 14. An apparatus as claimed in claim 13, wherein said plough member comprises a recess for receiving spheres and a deflector edge adjacent the template face for deflecting spheres into said recess.

25 15. An apparatus as claimed in claim 8, wherein said apertures may have a shoulder portion for supporting a respective sphere located therein.

30 16. An apparatus as claimed in claim 8, wherein there is a pick up member for removing said spheres located in said apertures for transfer thereof to one or more substrates.

35 17. An apparatus as claimed in claim 8, wherein there is an agitation means for agitating said spheres in said container during said relative movement.



18. An apparatus as claimed in claim 8, wherein
said agitation means provides for reciprocating movement
of said container relative to said template in a direction
that is transverse to said relative movement, thereby
5 relative travel between said container and said template
is along an oscillatory path.

19. An apparatus as claimed in claim 8, wherein ,
said container is in fluid communication with a non-
10 oxidising gas supply.

20. An apparatus for dispensing spheres
substantially as described herein with reference to and as
illustrated by the accompanying Figs.
15