

Method of Plating Miniature Parts

BACKGROUND OF THE INVENTION

Field of the Invention

5 The present invention relates to a method of plating miniature parts, and more particularly though not exclusively, it relates to a method of plating miniature parts while supplying horizontal and vertical swing motions to a container containing the miniature parts to be plated.

10 Description of the Background Art

For example, a multilayer ceramic capacitor is provided with external electrodes on both longitudinal ends thereof. In order to form such external electrodes, silver paste, for example, is generally applied onto
15 prescribed positions of a chip for defining the multilayer ceramic capacitor, and baked. However, since silver is oxidizable and solder-leachable, surface layers of tin or nickel are formed on substrate layers containing silver such as the silver paste. These surface layers are often
20 formed by plating.

In order to efficiently plate miniature electronic parts such as the aforementioned multilayer ceramic capacitors or miniature parts other than electronic parts, a plurality of parts to be plated are generally
25 individually introduced into a proper container, which in

turn is dipped in a plating bath for simultaneously plating the plurality of parts. In such a plating method, the container is provided with a cathode or serves as a cathode itself, while an anode is arranged in an appropriate position of the plating bath. Thus, the parts are plated in the container when the same are electrically connected with the cathode. In order to promote such electric connection between the parts and the cathode, the container contains a plurality of steel balls in addition to the parts.

In the aforementioned plating method, the parts and the steel balls contained in the container are properly stirred during plating, so that the respective parts are uniformly plated. Barrel plating is known as a method of plating a number of miniature parts while stirring the same. In such barrel plating, a container called a barrel, which is prepared from a net in the form of a hexagonal pole, is employed to contain a plurality of parts to be plated and steel balls. The container is dipped in a plating bath so that its central axis is horizontally directed, and rotated about the central axis. Thus, the parts and the steel balls contained in the container are stirred.

In the aforementioned barrel plating method, however, the parts and the steel balls are not necessarily

uniformly stirred. Among such parts and steel balls, those in regions close to the wall surfaces of the container tend to remain in such regions, and relatively hardly change places with those in other regions.

5 Consequently, it is difficult to uniformly plate the parts, while two or more parts and/or steel balls may be plated in sticking states.

Fig. 1 shows a plating apparatus 1, which has been proposed in order to solve this problem. Referring to
10 Fig. 1, a container 2 which is formed by a net, for example, contains a plurality of miniature parts 3 to be plated and a plurality of steel balls 4. The parts 3 such as multilayer ceramic capacitors, for example, are provided on both ends thereof with external electrodes 5.
15 The container 2 is positioned in a plating vessel 7 containing a plating solution 6.

In order to stir the parts 3 and the steel balls 4, this container 2 is coupled to a vibrating head 9 through a coupling rod 8. The vibrating head 9 supplies the
20 container 2 with a reciprocating angular motion in a small angular range about the coupling rod 8, i.e., a horizontal swing motion as shown by arrow 10, thereby stirring the parts 3 and the steel balls 4. In order to upset the parts 3 in such a stirring state, the container 2 is
25 provided with a baffle 11.

In the plating apparatus 1 shown in Fig. 1, however, the parts 3 and the steel balls 4 may be caught in a cavity, which is inevitably defined between the baffle 11 and the wall surface of the container 2. Thus, specific
5 ones of the parts 3 may remain in such a cavity while the other ones are being plated, leading to dispersion in thickness of plating films which are formed on the parts 3 upon completion of plating.

Fig. 2 shows another plating apparatus 12, which can
10 solve the aforementioned problem. This plating apparatus 12 comprises a container 13 which is provided with no baffle.

Referring to Fig. 2, the plating apparatus 12 comprises a swing motion generating part 14. A motor 15
15 is mounted on the swing motion generating part 14, while an eccentric load 17 is mounted on a rotary shaft 16 of the motor 15. The swing motion generating part 14 is contained in a fixed housing 18, and held through a plurality of springs 19 with respect to the housing 18.

20 A container 13 is coupled to the swing motion generating part 14 through a coupling rod 21 extending through a hole 20 which is provided in the housing 18. When the eccentric load 17 is rotated following rotation of the motor 15, therefore, the swing motion generating
25 part 14, being held through the springs 19 with respect to

the housing 18, makes horizontal and vertical swing motions, which are transmitted to the container 13 through the coupling rod 21.

5 The container 13 contains a plurality of miniature parts 3 such as multilayer ceramic capacitors, for example, and a plurality of steel balls 4. This container 13 is positioned in a plating vessel 23 containing a plating solution 22.

10 Fig. 3 is a plan view showing the container 13, which is integrally formed of resin with the coupling rod 21. A plurality of holes 25 and 26 are provided on a bottom wall 24 of the container 13. Nets 27 are fitted in the holes 25 respectively, to allow passage of the plating solution 22 while preventing falling of the parts 3 and the steel
15 balls 4 from the container 13. On the other hand, cathode members 28 are fitted in the holes 26 respectively. As shown in Fig. 2, the cathode members 28 are connected with lead wires 29, which are wired through the interior of the hollow coupling rod 21.

20 Fig. 4 shows a flow locus 30 formed by the parts 3 and the steel balls 4 when the parts 3 are plated in the container 13 of the plating apparatus 12. Thus, the parts 3 and the steel balls 4 are sufficiently stirred in the container 13 along the flow locus 30, so that the
25 respective parts 3 can be uniformly plated.

When the parts 3 are plated in the plating apparatus 12, however, the parts 3 may be separated from the steel balls 4 as shown in Fig. 5, such that the steel balls 4 can apply no action on the parts 3. More specifically, the parts 3 tend to gather on the central portion of the container 13, while the steel balls 4 tend to gather on the outer peripheral side of the container 13. Thus, it may be difficult to uniformly plate the respective parts 3 even by the plating apparatus 12.

10 The inventors have investigated the cause for the phenomenon shown in Fig. 5, to infer that this phenomenon may be caused by difference in specific gravity between the parts 3 and the steel balls 4. The specific gravity of the parts 3 such as multilayer ceramic capacitors is 3 to 6, 15 while that of the steel balls 4 is about 8. On the basis of such difference in specific gravity, it is inferred that the parts 3 gather on the central portion of the container 13 due to the smaller specific gravity, while the steel balls 4 gather on the outer peripheral side of the 20 container 13 due to the larger specific gravity.

SUMMARY OF THE INVENTION

Accordingly, the present invention aims to overcome at least some of the abovementioned problems.

According to the present invention, there is provided 25 a method of plating miniature parts, the method comprising: providing a container for containing a plurality of miniature parts to be plated, said container comprising a cathode electrode; providing a plurality of electrically

conductive bodies for promoting electrical connection between said miniature parts, being contained in said container, and said electrode; providing a plurality of electrically insulating bodies being larger in volume than
5 said miniature parts; introducing said miniature parts, said conductive bodies and said insulating bodies into said container; positioning said container in a plating vessel containing a plating solution; providing an anode electrode in contact with said plating solution; applying
10 reciprocating horizontal and vertical angular motions to said container positioned in said plating vessel and passing an electrical current between said electrodes via the plating solution.

Therefore, it is possible to introduce the insulating
15 bodies between the respective ones of the parts and the electrically conductive bodies which are preferably steel balls, while the insulating bodies can be vibrated by the reciprocating horizontal and vertical angular motions supplied from the container. Thus, it is possible to
20 sufficiently stir the parts and the conductive bodies, thereby uniformly plating the parts.

Preferably, the conductive bodies have the largest specific gravity among the parts, the conductive bodies and the insulating bodies while the parts and the insulating
25 bodies are substantially identical in specific gravity to each other.

The embodiment described hereinafter is effectively applied to plating of electronic parts such as multilayer

ceramic capacitors each comprising a plurality of external electrodes on its outer surfaces. The external electrodes comprise substrate layers, and surface layers which are formed by plating.

- 5 The insulating bodies preferably having spherical shapes and are more preferably formed of alumina, or by metal bodies covered with silicone resin.

The above and further features of the present invention are set forth with particularity in the appended
10 claims and should become clearer from consideration of the following detailed description of an embodiment of the invention given with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

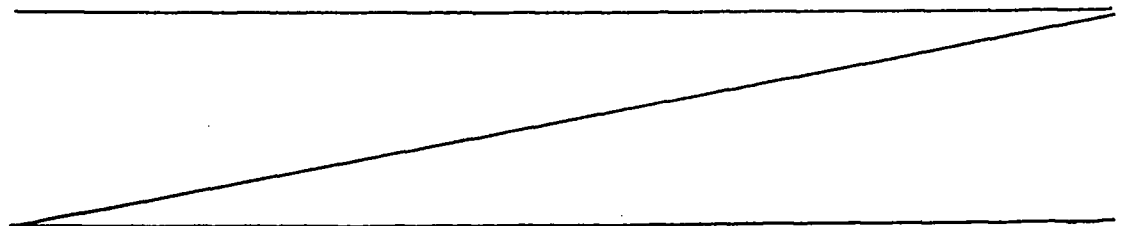
- 15 Fig. 1 is an illustrative sectional view showing a conventional plating apparatus 1;

Fig. 2 is an illustrative sectional view showing another conventional plating apparatus 12;

- 20 Fig. 3 is a plan view of a container 13 shown in Fig. 2;

Fig. 4 is an illustrative plan view showing a flow locus 30 of parts 3 and steel balls 4 in the container 13 shown in Fig. 2;

Fig. 5 is an illustrative sectional view showing the



container 13, for illustrating a problem in a plating method which is carried out with the plating apparatus 12 shown in Fig 2;

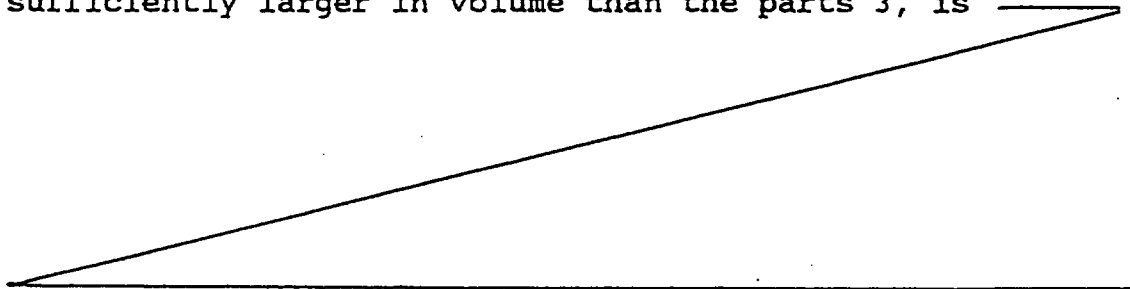
Fig. 6 is a sectional view corresponding to Fig. 2, for illustrating a plating method embodying the present invention; and

Fig. 7 is a sectional view for illustrating movements of parts 3, steel balls 4 and insulating bodies 31 which are made in a container 13 by the plating method shown in Fig. 6.

DETAILED DESCRIPTION OF THE EMBODIMENT

Fig. 6 shows a plating apparatus 12, which is substantially similar to that shown in Fig. 2. This plating apparatus 12 is adapted to carry out a plating method embodying the present invention. Referring to Fig. 6, elements corresponding to those shown in Fig. 2 are denoted by similar reference numerals. As to the structure of the plating apparatus 12 shown in Fig. 6, refer to the above description with reference to Figs. 2 to 4.

Referring to Fig. 6, a container 13 contains a plurality of insulating bodies 31, in addition to a plurality of miniature parts 3 and a plurality of steel balls 4. The number of insulating bodies 31, which are sufficiently larger in volume than the parts 3, is



properly decided in consideration of the dimensions of the container 13, the stirring state of the parts 3, and the like. The insulating bodies 31 are preferably formed by balls of alumina, or iron balls which are covered with
5 silicone resin. The insulating bodies 31 are not restricted to the aforementioned spherical shapes, but the same may have polygonal shapes.

The miniature parts 3, such as multilayer ceramic capacitors provided with external electrodes 5, for
10 example, may have lengths of several mm to not more than 1 mm along the longest edges. Such multilayer ceramic capacitors generally have specific gravity of 3 to 6. On the other hand, the steel balls 4 have diameters of about 0.7 to 1.2 mm and specific gravity of about 8, while the
15 insulating bodies 31 have diameters of 10 to 15 mm and specific gravity of 3 to 6. Thus, the insulating bodies 31 are larger in volume than the respective parts 3. Among the parts 3, the steel balls 4 and the insulating bodies 31, the steel balls 4 have the largest specific
20 gravity, while the parts 3 and the insulating bodies 31 are substantially identical in specific gravity to each other.

Referring to Fig. 7, the parts 3, the steel balls 4 and the insulating bodies 31 flow along the flow locus 30
25 shown in Fig. 4, when the container 13 is supplied with

horizontal and vertical swing motions. At this time, the insulating bodies 31 are introduced between the parts 3 and the steel balls 4, which tend to gather independently of each other. Further, the insulating bodies 31 which are
5 vibrated by the swing motions of the container 13 stir the parts 3 and the steel balls 4. Thus, the parts 3 and the steel balls 4 appropriately flow along the flow locus 30 shown in Fig. 4, to be properly mixed with each other. Particularly in this embodiment, the insulating bodies 31
10 being substantially identical in specific gravity to the parts 3 apply larger actions on the parts 3, which tend to gather on the central portion of the container 13 as shown in Fig. 5.

Thus, the parts 3 are electrically connected with
15 cathode members 28 directly or through the steel balls 4 with a certain probability, whereby plating films are formed to define surface layers of external electrodes 5.

Although the present invention has been described by reference to a specific embodiment, it is to be clearly
20 understood that the same is by way of illustration and example only and is not to be taken by way of limitation, the scope of the present invention being determined only by the terms of the appended claims.



CLAIMS:

1. A method of plating miniature parts, the method comprising:

5 providing a container for containing a plurality of miniature parts to be plated, said container comprising a cathode electrode;

10 providing a plurality of electrically conductive bodies for promoting electrical connection between said miniature parts, being contained in said container, and said electrode;

providing a plurality of electrically insulating bodies being larger in volume than said miniature parts;

introducing said miniature parts, said conductive bodies and said insulating bodies into said container;

15 positioning said container in a plating vessel containing a plating solution;

providing an anode electrode in contact with said plating solution;

20 applying reciprocating horizontal and vertical angular motions to said container positioned in said plating vessel and passing an electrical current between said electrodes via the plating solution.

2. A plating method in accordance with claim 1, wherein said conductive bodies have the largest specific gravity among said miniature parts, said conductive
25 bodies and said insulating bodies, said miniature parts and said insulating bodies being substantially identical



in specific gravity to each other.

3. A plating method in accordance with claim 1 or 2,
wherein said miniature parts are electronic parts each
provided on its outer surfaces with a plurality of
5 external electrodes comprising substrate layers and
surface layers, said surface layers being formed by
plating.

4. A plating method in accordance with claim 3,
wherein said electronic parts are multilayer ceramic
10 capacitors.

5. A plating method in accordance with any preceding
claim, wherein said insulating bodies have spherical
shapes.

6. A plating method in accordance with any preceding
15 claim, wherein said insulating bodies are made of
alumina.

7. A plating method in accordance with any of claims
1 to 5, wherein said insulating bodies are formed by
metal bodies being covered with silicone resin.

20 8. A plating method in accordance with any preceding
claim wherein said conductive bodies comprise steel
balls.



9. A method substantially as described herein with reference to Figure 6 and 7 of the accompanying drawings.