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METHOD OF FABRICATING PRINTED WIRING BOARD

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

The present invention relates to a method of fabricating a printed wiring board, particularly to a method of fabricating a printed wiring board having a slot for a bonding wire for connecting with a semiconductor chip at its central portion.

DESCRIPTION OF THE RELATED ART

Explaining an example of a method of fabricating such a printed wiring board, conventionally, a printed wiring board is fabricated by using a so-to-speak copper-clad glass epoxy resin substrate in which a copper coating is formed on a surface of glass epoxy resin. Such a copper-clad glass epoxy resin substrate used as a material for a printed wiring board, is provided by a method in which a copper foil previously coated with an adhesive agent on a bonding face thereof is pasted on a so-to-speak glass epoxy resin board produced by impregnating epoxy resin to glass fabrics or a method in which glass epoxy resin prepreg and a copper foil are subjected to thermal compression bonding.

A copper foil used as a copper coating layer formed on this kind of a copper-clad glass epoxy resin substrate is a so-to-speak electrolytic copper foil and generally, an electrolytic copper foil having a thickness of about 9 μm to 35 μm constitutes is mainly used.

However, as a printed wiring board has been used widely in apparatus for civil use such as television sets and cameras and various kinds of industrial apparatus such as computers, high density wiring has

been requested, as a result, thin wall formation of a copper coating layer has been requested in order to accurately form fine circuits. Therefore, according to the copper-clad glass epoxy resin substrate, in accordance with the thin wall formation of the copper coating layer, there has been progressed a development of forming a copper coating by electroless plating. Further, as a method of fabricating a printed wiring board by using such a copper-clad glass epoxy resin substrate, semi additive process or subtractive process has generally been used.

The former semi additive process is a process in which a conductor circuit is formed further on the copper coating layer on the copper-clad glass epoxy resin substrate by plating and specifically, a metal coating formed on the copper-clad glass epoxy resin substrate is made to constitute a first metal layer and a plating resist layer is formed thereon by a predetermined pattern.

In this case, a thickness of the plating resist layer is made to be equal or larger than a thickness of a circuit formed on the first metal layer by a plating process. Successively, a plate coating (second metal layer) is formed on the metal coating (first metal layer) exposed among intermediate portions of the pattern of the plating resist layer by an electric plating process. Thereafter, the plating resist layer is exfoliated, a face of the metal coating (first metal layer) is exposed and the exposed metal coating (first metal layer) is removed by etching with the electrically-plated coating (second metal layer) as a mask to thereby form the conductor circuit.

Further, the latter subtractive process is a process in which a

conductor circuit is formed by dissolving to remove a copper coating layer from the copper-clad glass epoxy resin substrate and specifically, an etching resist layer is provided on the copper coating formed on the copper-clad glass epoxy resin substrate and is formed in a pattern indicating a region necessary for the circuit. Successively, a conductor circuit pattern is formed by dissolving to remove the exposed metal coating region and thereafter, the resist layer is exfoliated to thereby fabricate a printed wiring board.

According to the printed wiring board provided by these processes, in comparison with a conventional printed wiring board prepared by using the copper-clad glass epoxy resin substrate fabricated by the copper foil as its material, wirings having a high density can be constituted.

Further, the following processing is carried out thereafter on a conductor circuit portion of the printed wiring board prepared as described above.

That is, after roughening the conductor circuit portion in order to promote adhesion thereof with a solder resist, provided later, the solder resist is coated or laminated, a bump pad portion is exposed at a central portion by exposing and developing the solder resist layer, the resist layer remaining at a surrounding portion is thermally hardened and thereafter, the bump pad portion is electrically plated.

Further, the printed wiring board formed as described above is provided with a shape as shown in Fig. 5. The printed wiring board is constructed by a constitution in which bump pads 14 for connecting to

electrode pads 13 of a semiconductor chip 12 are aligned in arrays at peripheral portions of a printed wiring board 11 and the electrode pads 13 of the semiconductor chip 12 are connected to the bump pads 14 by bonding wires 15 as illustrated in Fig. 6. Further, there is constituted a semiconductor package of PBGA molding the printed wiring board 11 and the semiconductor chips 12 connected as described above by a resin 16 or TBGA integrating tape substrate on which the wiring is provided and the semiconductor chips 12 by a cover plate, as required.

However, according to the conventional printed wiring board arranged with the bump pads aligned in arrays at the peripheral portions of the printed wiring substrate, there is constructed the structure in which the electrode pads of the semiconductor chip are connected to the bump pads at the peripheral portions of the printed wiring substrate by the bonding wires and accordingly, a wiring length of the bonding wires is obliged to prolong and accordingly, the conventional printed wiring board cannot deal with a conductor circuit having a higher density or high frequency which is requested in recent years so far as such a structure is constructed. Hence, in order to shorten the wiring length, there has been proposed a printed wiring board constituted by perforating a slot at a central portion of a printed wiring substrate by a router bit and in the meantime, arranging bump pads at vicinities of the slot and passing bonding wires for connecting to electrode pads of semiconductor chips to the slot.

According to the printed wiring board of this style, the conductor circuit is formed by the semi additive process or the subtractive process

by using the copper-clad glass epoxy resin substrate, successively, a surface treatment is carried out on the conductor circuit by electric plating and thereafter, the slot is perforated at the central portion of the substrate by the router bit.

However, when the slot is perforated by the router bit, cut burr is produced at a pattern of a wiring portion provided at the central portion for electric plating. When the burr is large, the printed wiring board is obliged to abandon as a failed product and when the burr is small, the burr must be removed by vacuum suction or the like. Therefore, time and labor are required in operation, the product yield is deteriorated and the production efficiency is lowered. Further, when the burr is not completely removed assumedly, there is a drawback of posing a problem of shortcircuit among wirings and further improvement has been desired.

SUMMARY OF THE INVENTION

Therefore, it is an object of the invention to provide a method of fabricating a printed wiring board which is a method of fabricating a printed wiring board perforated with a slot at its central portion by a router bit and in which in perforating the slot, occurrence of cut burr is prevented at a pattern of a wiring portion for electric plating, occurrence of exfoliation of wiring is also prevented, the product yield is promoted and the operational efficiency is improved.

In order to achieve the above-described object, according to an aspect of the invention, in a method of fabricating a printed wiring board by forming a conductor circuit by patterning a metal coating formed on a surface of an insulating substrate, successively subjecting the conductor

circuit to a surface treatment by electric plating and thereafter perforating a slot for bonding wires for connecting to a semiconductor chip at a central portion of the substrate by a router bit, a pattern of a wiring portion for the electric plating at a location for perforating the slot is formed to be inclined to constitute an acute angle relative to a face orthogonal to a moving direction of the router bit, preferably, an acute angle of 15° or more and a width of the wiring portion for the electric plating is constituted to be $90\text{ }\mu\text{m}$ or more, preferably, $120\text{ }\mu\text{m}$ or more.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a plane view of a printed wiring board fabricated by the invention;

Fig. 2 is a view showing a situation of perforating a slot by a router bit in one perforating step according to the invention;

Fig. 3 is a view showing a situation of reciprocating and perforating a slot by a router bit according to the invention;

Fig. 4 is an outline sectional view of PBGA fabricated by using an embodiment of a printed wiring board according to the invention;

Fig. 5 is a plane view of a conventional printed wiring board; and

Fig. 6 is an outline sectional view of PBGA fabricated by using the printed wiring board according to a conventional technology.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

According to the invention, in addition to a general copper-clad glass epoxy resin substrate, a copper-clad glass epoxy resin substrate formed with a conductor circuit by using the above-described semi additive process, subtractive process or full additive process can also be

used.

That is, in forming or prior to forming a metal coating by electroless plating, there is used palladium, silver or an alloy including these is used on a surface of the copper-clad glass epoxy resin as a plating catalyst.

Further, when the conductor circuit is formed by using the semi additive process or the subtractive process, after forming the metal coating on the surface of the glass epoxy resin by a plating process using the catalyst, a portion of the metal coating is removed by etching to thereby form the conductor circuit on the surface of the glass-epoxy resin.

Further, when the conductor circuit is formed by using the full additive process, the metal coating is formed on the surface of the glass epoxy resin and adsorbed with the catalyst and exposed among intermediary portions of the circuit after removing a plating resist layer.

Further, a conductor circuit portion formed on an insulating substrate in this way is roughened by, for example, chemical polishing, buffing or jet scrubbing (abrasive grain blowing) in order to promote adhesion with solder resist, provided later. Successively, after coating a solder resist over the entire surface of the printed wiring board by coating or laminating, the solder resist layer is removed by exposing and developing to thereby expose a bump pad portion at a central portion of the substrate. Successively, after thermally hardening a solder resist layer remaining at peripheral portions of the printed wiring board, Ni-Au or Au plating is carried out on the exposed bump pad portion by electric plating process.

Although the printed wiring board shown in Fig. 1 can be fabricated by perforating a slot at a central portion of the printed wiring board formed in this way by a router bit and arranging bump pads at vicinities of the slot, in perforating the slot, a pattern of a wiring portion provided at the central portion of the substrate for electric plating needs to cut by the router bit and in this case, a consideration must be given to sufficiently preventing the occurrence of cut burr.

Hence, the inventors have carried out various research in order to prevent the occurrence of cut burr in cutting the pattern of the wiring portion for electric plating by the router bit. As a result, the inventors have completed the invention by finding out that not only the occurrence of burr but also exfoliation of wirings can be efficiently prevented by constituting a constant angle in respect of the pattern of the wiring portion and making a wiring width equal to or larger than a predetermined width.

That is, it has been found that occurrence of burr is significantly reduced when a pattern 7 of a wiring portion for electric plating formed on a printed wiring board 1 is formed such that an angle γ relative to a face β orthogonal to a moving direction α of a router bit 8 is previously constituted to incline by an acute angle, preferably, an acute angle of 15° or more, further preferably, about 30° as shown in Fig. 2. In other words, the reason of making the angle γ of the pattern of the wiring portion relative to the face β orthogonal to the moving direction α of the router bit 8 15° or more, is that when the angle γ is made to be less than 15° or an obtuse angle, an amount of burr produced by the router bit 8

becomes significantly large. Further, although the larger the angle γ relative to the face β orthogonal to the moving direction α of the router bit 8, the more preferable, there is a restriction on the width of the sheet and therefore, the upper limit is at least about 60° .

Further, it has been found that according to the wiring pattern, when the width of the wiring portion is less than $90\text{ }\mu\text{m}$, not only exfoliation of wirings in fabrication but also burr caused by the exfoliation of wirings is also occurred. That is, the exfoliation of wirings in fabrication can be prevented in the case of the wiring portion for electric plating having a width of $90\text{ }\mu\text{m}$ or more, preferably, $120\text{ }\mu\text{m}$ or more.

Further, it is preferable to make the width of the wiring portion $200\text{ }\mu\text{m}$ or less in consideration of a request for higher density formation although the width differs depending on dimensions of the substrate of the wiring.

Generally, according to the perforating operation by the router bit 8, in accordance with the width or the length of a slot 9, there are a case in which the perforating operation is carried out by cutting both side faces of the slot in the moving direction α of the bit 8 while rotating the bit 8 in one direction as shown in Fig. 2 above, and a case in which one side face 9-1 of the slot 9 is cut to perforate in the moving direction α of the bit 8 while rotating the bit 8 in one direction, successively, at a stage at which cutting of a predetermined length of the slot 9 has finished, the moving direction α of the bit 8 is switched to a reverse direction and the bit 8 is moved in a moving direction α' and other side face 9-2 of the slot

9 is cut to perforate to thereby form the desired slot 9 as shown in Fig. 3. In either of the cases, it is important to cut the slot such that the angle γ relative to the face β orthogonal to the moving direction α of the router bit 8 becomes an acute angle.

Further, in the latter case, the width of the slot 9 can be widened without using the router bit 8 having a different diameter by increasing the number of times of reciprocal movement by repeating the operation of switching the moving direction α as required. Further, kinds of the router bit 8 used, a rotational number, inserting and discharging speed, feed speed and the like of the router bit 8 are not particularly limited but preferable ones can be selected in accordance with the shape of the slot 9 to be perforated.

According to a printed wiring board perforated with the slot 9 at its central portion in this way and arranged with bump pads 4 at vicinities of the slot 9, the bump pads 4 and electrode pads 3 of a semiconductor chip 2 are connected by bonding wires 5 as shown in Fig. 4. Further, there can also be constituted a semiconductor package of PBGA produced by molding the printed wiring board 1 and the semiconductor chip 2 which are connected to each other by a resin 6 or TBGA produced by integrating the printed wiring board 1 and the semiconductor chip 2 by a cover plate as required.

(Embodiments)

Next, an explanation will be given of embodiments according to the invention along with comparative examples.

A dry film type photoresist "AQ2559" (commercial name) made by

Asahi Chemical Industry is uniformly laminated by a thickness of 25 μm on a surface of a copper-clad glass epoxy resin substrate having a thickness of 200 μm provided with a copper foil of 18 μm . Thereafter, a photomask patterned such that both of a circuit width and a circuit interval are 40 μm is mounted on the photoresist layer, ultraviolet ray of 60 mJ/cm^2 is irradiated thereon and successively, the substrate is developed, washed by water and dried to thereby prepare a printed writing board formed with a conductor circuit.

Next, after roughening the conductor circuit portion by blowing abrasive grains having a particle diameter of 100 μm , a solder resist "PSR4000AUS" (commercial name) made by Taiyo Ink is coated thereon by a thickness of 30 μm , successively, the solder resist is dissolved to be removed by exposure and development to thereby expose a bump pad portion at a central portion thereof, further, the solder resist remaining at peripheral portions is thermally hardened by a drying furnace.

Successively, there are carried out electric plating operation and perforating operation by a router bit in respect of a pattern of a wiring portion for the electric plating while varying a pattern width of the wiring portion and the angle (γ) relative to a face orthogonal to a moving direction of the router bit as shown in Table 1. An occurrence state of burr is shown in Table 1 and an occurrence state of exfoliation of wiring is shown in Table 2.

Further, perforating conditions by the router bit are as follows.

(1) Router bit: bit made by Union Tool

(2) Spindle Speed of bit: 38000 rpm (rotated in the clockwise

direction)

(3) Z axis advance: 100 mm/min

(4) Feed speed of bit: 350 to 400 mm/min (bit is moved only in one direction)

(5) Width and length of slot: 1.0 mmW × 10.00 mmL

[Table 1]

Pattern width of wiring portion (μm)	Angle γ (°)				
	-30	-15	0	+15	+30
70	×	○	○	○	◎
90	×	○	○	○	◎
115	×	×	○	◎	◎
130	×	×	×	◎	◎

◎: No occurrence of burr

○: Almost no occurrence of burr

×: Occurrence of burr

As is apparent from Table 1, even when the pattern width of the wiring portion is varied, in the case in which the angle (γ) relative to the face orthogonal to the moving direction of the router bit is inclined to be 15° or more, occurrence of burr can be prevented and particularly, burr does not occur at an inclination of 30°.

[Table 2]

Pattern width of wiring portion (μm)	Angle γ (°)				
	-30	-15	0	+15	+30
70	×	×	×	×	○
90	×	×	×	○	◎
115	◎	◎	◎	◎	◎
130	◎	◎	◎	◎	◎

- ◎: No exfoliation of wiring
- : Almost no exfoliation of wiring
- ×: Exfoliation of wiring

As is apparent from Table 2, when the pattern width of the wiring portion is made to be 90 μm or more, exfoliation of wiring can be prevented and particularly, exfoliation of wiring does not occur in the case of the pattern width of 120 μm or more.

It is known from the results shown in Table 1 and Table 2 that conditions of no occurrence of burr and no exfoliation of wiring are constituted by forming the wiring pattern of the wiring portion for electric plating to be inclined to constitute an acute angle of 15° or more relative to the face orthogonal to the moving direction of the router bit and making the width of the wiring portion 90 μm or more.

As has been described, there can be provided a method of fabricating a printed wiring board which is a method of fabricating a printed wiring board by perforating a slot by a router bit and in which in cutting a pattern of a wiring portion for electric plating by the router bit, occurrence of burr is prevented, occurrence of exfoliation of wiring is also prevented, the product yield is promoted and the operational efficiency is improved.



What is claimed is:

1. A method of fabricating a printed wiring board comprising the steps of:

forming a conductor circuit by patterning a metal coating formed on a surface of an insulating substrate;

subjecting the conductor circuit to a surface treatment by electric plating; and

perforating a slot for bonding wires for connecting to a semiconductor chip at a central portion of the substrate by a router bit;

wherein a pattern of a wiring portion for the electric plating at a location for perforating the slot is formed to be inclined to constitute an acute angle relative to a face orthogonal to a moving direction of the router bit.

2. The method of fabricating a printed wiring board according to Claim 1:

wherein the pattern of the wiring portion for the electric plating is formed to be inclined to constitute an acute angle of 15° or more relative to the face orthogonal to the moving direction of the router bit.

3. The method of fabricating a printed wiring board according to Claim 1 or 2:

wherein a width of the wiring portion for the electric plating is made to be 90 μm or more.