CIRCUIT BOARD STRUCTURE

Inventors: Cheng-Po Yu, Taoyuan County (TW); Han-Pei Huang, Taoyuan City (TW)

Correspondence Address:
NORTH AMERICA INTELLECTUAL PROPERTY CORPORATION
P.O. BOX 506
MERRIFIELD, VA 22116 (US)

Appl. No.: 12/260,096
Filed: Oct. 29, 2008

Foreign Application Priority Data
Jul. 14, 2008 (TW) 097126624

Publication Classification

Int. Cl.
H05K 1/11 (2006.01)
H05K 1/00 (2006.01)
B29C 35/08 (2006.01)
C04B 35/00 (2006.01)

U.S. Cl. 174/258, 174/266, 264/497; 264/104

ABSTRACT

A circuit board structure including a circuit board main body and an injection molded three-dimensional circuit device encapsulating at least a portion of the circuit board main body is provided. The three-dimensional circuit device includes a molded plastic body having a non-plate type, stereo structure, on which a three-dimensional pattern is also fabricated. The three-dimensional pattern is interconnected with a contact pad on the circuit board main body through a conductive via.
CIRCUIT BOARD STRUCTURE

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

The present invention relates to a circuit board structure. In particular, the present invention relates to a circuit board having a three-dimensional circuit structure and the fabrication method thereof.

[0002] 2. Description of the Prior Art

As known in the art, circuit boards are essential devices in all electronic products where circuit boards are used to bear all kinds of electronic elements such as chips, resistors or capacitors. There are many layers of wires to connect these electronic elements.

[0003] As the electronic products become smaller and thinner, in many application fields such as wireless communication, portable electronic device or automobile instrumental panel, the circuit boards are always placed in limited space in the product, or interconnected with another outer circuit boards by buses or module-connectors, such as in the automobile instrumental panels or steering wheel with electronic functions. Thus, efficiently using substrate or the surface of module shell to pattern three-dimensional circuit layout or reducing the use of buses may be more efficient to utilize the space and increase the flexibility of designing. However, on plate-type plastic or copper foil substrate, conventional circuit manufacturing technology can only form two-dimensional wire trace instead of three-dimensional pattern.

SUMMARY OF THE INVENTION

[0006] It is one objective of the present invention to provide a novel circuit board structure and a method for manufacturing a three-dimensional circuit structure in order to solve the above-mentioned prior art problems and shortcomings.

[0007] It is another objective of the present invention to provide a circuit board structure includes a circuit board main body and an injection molded three-dimensional circuit device encapsulating at least a portion of the circuit board main body. The three-dimensional circuit device includes a molded plastic body having a non-plate type, stereo structure, on which a three-dimensional pattern is fabricated. The three-dimensional pattern is interconnected with a contact pad on the circuit board main body through a conductive via.

[0008] It is still another objective of the invention to provide a method for fabricating a circuit board structure. First, a circuit board main body is provided. Second, a molded plastic body is formed by encapsulating at least a portion of the circuit board main body with injection molded material. Then, a first three-dimensional pattern is formed on the molded plastic body thereby defining a three-dimensional circuit device.

[0009] These and other objectives of the present invention will no doubt become obvious to those of ordinary skill in the art upon reading the following detailed description of the preferred embodiment that is illustrated in the various figures and drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] FIG. 1 illustrates a cross-sectional view of a circuit board structure according to an embodiment of the present invention.

[0011] FIGS. 2A to 2C illustrate a method for fabricating the circuit board structure according to an embodiment of the present invention.

[0012] FIGS. 3A to 3C illustrate another embodiment according to the present invention.

[0013] FIGS. 4A to 4B illustrate still another embodiment according to the present invention.

[0014] FIGS. 5A to 5B illustrate still another embodiment according to the present invention.

DETAILED DESCRIPTION

[0015] The present invention provides a novel circuit board structure, comprising a circuit board main body that could be rigid printed circuit board (rigid PCB), flexible printed circuit board (flexible PCB), rigid-flex composite printed circuit board (rigid-flex composite PCB) or rigid-flex combination printed circuit board (rigid-flex combination PCB). At least a portion of the circuit board main body is encapsulated by an injection molded three-dimensional circuit device. For one of the ordinary skill in the art, it is challenging and difficult to manufacture this novel circuit board which is even applicable to a wide range of technical fields such as automobile steering wheels, cellular phones or semiconductor package.

[0016] FIG. 1 illustrates a cross-sectional view of a circuit board structure according to an embodiment of the present invention. As shown in FIG. 1, the circuit board structure comprises a circuit board main body which may be a typical plate-type printed circuit board, such as a rigid printed circuit board (rigid PCB), a flexible printed circuit board (flexible PCB), a rigid-flex composite printed circuit board (rigid-flex composite PCB) or a rigid-flex combination printed circuit board (rigid-flex combination PCB). The circuit board main body comprises a core layer, for example, a Prepreg resin-containing material. A coplanar first pattern is disposed on a first side of the circuit board main body and a coplanar second pattern is disposed on a second side of the circuit board main body. Furthermore, the circuit board main body may be a two-layer board, a four-layer board or a multi-layer board, which, however, should not be seen as to limit the scope of the present invention. FIG. 1 shows an example of a two-layer board.

[0017] The present invention circuit board structure features an injection molded three-dimensional circuit device. The three-dimensional circuit device encapsulates at least a portion of the circuit board main body such as a peripheral region and the three-dimensional circuit device combines with the encapsulated portion of the circuit board main body tightly. The three-dimensional circuit device further comprises an injected molded plastic body which is non-plate, stereo type and usually contains a scratchy surface, on which at least a three-dimensional pattern is fabricated. The three-dimensional pattern is interconnected with a contact pad of the first pattern through a conductive via in the molded plastic body.

[0018] According to one embodiment of the present invention, the above-mentioned injected molded plastic body is made of plastic material comprising engineering plastic or ceramic. Specifically, the engineering plastic may be selected from a group consisting of polycarbonate (PC), acrylonitrile-butadiene-styrene copolymer (ABS copolymer), polyethylene terephthalate (PET), polybutylene terephthalate (PBT), liquid crystalline polymer (LCP), polyamide 6 (PA 6), Nylon, polyoxymethylene (POM), poly-phenylene-sulfide (PPS) and cyclic-olefin-copolymer (COC).
[0019] In addition, the plastic material further comprises catalytic particles, such as copper oxide particles, aluminum nitride particles or palladium particles. The plastic material is mixed with catalytic particles to form a laser activatable material. The catalytic particles described above may be a plurality of metal oxide particles or metallic complexes particles. In one embodiment of the present invention, the catalytic particles are selected from a group consisting of manganese, chromium, palladium, copper, aluminum and platinum.

[0020] FIGS. 2A to 2C illustrate the method for fabricating the circuit board structure 1 according to the embodiment of the present invention. First, as shown in FIG. 2A, a circuit board main body 10 is provided. The circuit board main body 10 may be a typical plate-type printed circuit board, such as a rigid PCB, a flexible PCB, a rigid-flex composite PCB or a rigid-flex combination PCB. The circuit board main body 10 comprises a core layer 11, such as a Prepreg resin-containing material. A coplanar first pattern 12 is formed on a first side 10a of the circuit board main body 10 and a coplanar second pattern 14 is formed on a second side 10b of the circuit board main body 10. It is understood that the circuit board main body 10 may be a two-layer board, a four-layer board or a multi-layer board, which, however, should not be seen as to limit the scope of the present invention. FIGS. 2A to 2C demonstrate an example of a two-layer board. Furthermore, a solder resist layer (not shown) may be provided on the first side 10a and the second side 10b of the circuit board main body 10.

[0021] As shown in FIG. 2B, at least a portion of the circuit board main body 10 is encapsulated with injection molded material, for example, by directly injecting under low injected pressure or low molded temperature, thereby forming the molded plastic body 21 that encapsulates the circuit board main body 10. The molded plastic body 21 is non-plate, stereo type and usually contains a scraggy surface. In one embodiment of the present invention, the molded plastic body 21 encapsulates at least a portion of the contact pad 12a.

[0022] As shown in FIG. 2C, a three-dimensional pattern 22 is formed on the molded plastic body 21, thereby defining a three-dimensional circuit device 20. For example, laser direct structuring (LDS) is used to activate the metal catalysts in the molded plastic body 21, after laser activation, the metallization of chemical copper is performed. Certainly, other technology, for example, microscopic integrated processing technology (MIPTEC), may also be used to form the three-dimensional pattern 22 according to the present invention. MIPTEC comprises: depositing a conductive material by chemical vapor deposition (CVD) or sputtering, then patterning the conductive material by laser and etching away the conductive material in non-metallization region, next, metallizing by chemical copper. Additionally, a conventional two-shot molding technology may be used to form the three-dimensional pattern 22 by separately injecting two different plastic materials which are activatable and non-activatable respectively, then metallizing the activatable plastic material by wet process. As described above, one approach to connecting the three-dimensional pattern 22 and the contact pad 12a involves mechanical or laser drilling and then filling with the conductive body (not shown), or directly penetrating the molded plastic body 21 by a metal conductive pillar to form a contact via. The conductive body described above may be formed by electroplating, chemical deposition or metal conductive material printing and padding.

[0023] FIGS. 3A to 3C illustrate another embodiment according to the present invention. First, as shown in FIG. 3A, a circuit board main body 100 having thereon a three-dimensional pattern 102 is provided. The circuit board main body 100 may be a plate-type printed circuit board, such as a rigid PCB, a flexible PCB, a rigid-flex composite PCB or a rigid-flex combination PCB where is already formed.

[0024] As shown in FIG. 3B, a portion or all of the circuit board main body 100 is encapsulated with the molded plastic body 121. The injection molded material is used to encapsulate at least a portion or all of the circuit board main body 100, for example, by directly injected under low injected pressure or low molded temperature, thereby forming the molded plastic body 121 that encapsulates the circuit board main body 100. The molded plastic body 121 is non-plate, stereo type and has a scraggy surface. To prevent the molded plastic body 121 from contacting some sensitive elements and in consideration of the thermal expansion coefficient, the molded plastic body 121 may comprise a cavity 121a. The suitable materials for the molded plastic body 121 are similar to the molded plastic body 21 as described in the embodiment mentioned above.

[0025] As shown in FIG. 3C, a three-dimensional pattern 122 is formed on the molded plastic body 121, defining a three-dimensional circuit device 120. Thereafter, the three-dimensional pattern 122 is electrically connected with the three-dimensional pattern 102. For example, laser direct structuring (LDS) is used to activate the metal catalysts in the molded plastic body 121, after laser activation, the metallization of chemical copper is performed. Other technology, for example, microscopic integrated processing technology (MIPTEC), may be used to form three-dimensional pattern 122. Additionally, in the present invention, the two-shot molding technology may be used to form the three-dimensional pattern 122. As described above, one approach to connecting the three-dimensional pattern 122 and three-dimensional pattern 102 involves mechanical or laser drilling and then filling with the conductive body 124, or directly penetrating the molded plastic body 122 by a metal conductive pillar to form a contact via. The conductive body described above may be formed by electroplating, chemical deposition or metal conductive material printing and padding.

[0026] According to the present invention, the combination of the molded plastic and the circuit board main body is not necessary done by injection molded technology. FIGS. 4A and 4B illustrate another embodiment according to the present invention. First, as shown in FIG. 4A, a circuit board main body 200 and a three-dimensional circuit device 220 are formed separately. The circuit board main body 200 may be a typical plate-type printed circuit board, such as a rigid PCB, a flexible PCB, a rigid-flex composite PCB, a rigid-flex combination PCB or a circuit board with a three-dimensional pattern. The circuit board main body 200 has a pattern 202 which includes contact pads 202a, 202b and 202c. The three-dimensional circuit device 220 may be made by traditional injection molded technology and contains a molded plastic body 221 which is non-plate, stereo type and with a scraggy surface on which a three-dimensional pattern 222 is formed. The three-dimensional pattern 222 comprises contact pads 222a, 222b, and 222c.

[0027] The molded plastic body 221 further comprises a slot 221a. Subsequently, one end of the circuit board main body 200 is inserted into the slot 221a to make the contact pads 222a, 222b and 222c in contact with the contact pads...
202a, 202b and 202c respectively, thereby tightly tenoning the molded plastic body and the circuit main board, as shown in Fig. 4B. While the material of the molded plastic body 221 is similar to the molded plastic body 21 in the embodiment mentioned above, it is not described herein for the sake of simplicity. The method for forming the three-dimensional patterns 222 on molded plastic body 221 is similar to the method for forming the three-dimensional patterns 122 on molded plastic body 121, which is mentioned above, thus it is not described for the sake of simplicity.

[0028] FIGS. 5A and 5B illustrate another embodiment according to the present invention. FIG. 5A illustrates a top view of the circuit board structure and FIG. 5B illustrates the cross-sectional view taken along line 1-1' of FIG. 5A. As shown in FIGS. 5A and 5B, the circuit board structure 300 comprises a substrate 302 where at least plurality of contact pads 312, pattern 314 and pattern 316 are formed on its main surface 302a. Specifically, the pattern 316 may have four rows and may be arranged in matrix or, depending on different design purposes, may be arranged in single-row, 2-row or 3-row. Specifically, the disclosure of the figures is only one example embodiment that should not be used to limit the scope of the invention.

[0029] An injection molded three-dimensional circuit device 320 is formed on the main surface 302a, which contains a center cavity 330, exposing plurality of contact pads 312. The three-dimensional circuit device 320 comprises an injection molded body 321 having a non-plate type, stereo structure. At least a three-dimensional pattern 322 and another three-dimensional pattern 322a are formed on the surface of the molded main body 321 wherein the three-dimensional pattern 322 is connected to the pattern 316 encapsulated partially by the molded plastic body 321 while the three-dimensional pattern 322a is connected to the pattern 314 encapsulated by the molded plastic body 321 through a conductive via 324 in the molded plastic body 321. Besides, in another embodiment, the edge of the molded plastic body 321 aligns with the edge of the pattern 316, which is not shown in the figures.

[0030] The material of the molded plastic body 321 is similar to the molded plastic body 21 in the embodiment mentioned above, therefore it is not described herein for the sake of simplicity. The method for forming the three-dimensional patterns 322, 322a on the molded plastic body 321 is similar to the method for forming the three-dimensional patterns 122 on molded plastic body 121, which is mentioned above, thus it is not described for the sake of simplicity.

[0031] Those skilled in the art will readily observe that numerous modifications and alterations of the device and method may be made while retaining the teachings of the invention.

What is claimed is:

1. A circuit board structure, comprising:
   a circuit board main body; and
   an injection molded three-dimensional circuit device, encapsulating at least a portion of said circuit board main body, wherein said three-dimensional circuit device includes a molded plastic body having a non-plate type, stereo structure, on which a three-dimensional pattern is fabricated, said three-dimensional pattern is interconnected with a contact pad on said circuit board main body through a conductive via.

2. The circuit board structure according to claim 1, wherein said circuit board main body includes rigid printed circuit board (rigid PCB), flexible printed circuit board (flexible PCB), rigid-flex composite printed circuit board (rigid-flex composite PCB) or rigid-flex combination printed circuit board (rigid-flex combination PCB).

3. The circuit board structure according to claim 1, wherein said circuit board main body comprises a two-layer board or a multi-layer board.

4. The circuit board structure according to claim 1, wherein said circuit board main body comprises a core layer.

5. The circuit board structure according to claim 1, wherein said molded plastic body is made of plastic material comprising engineering plastic or ceramic.

6. The circuit board structure according to claim 5, wherein said engineering plastic is selected from a group consisting of polycarbonate (PC), acrylonitrile-butadiene-styrene copolymer (ABS copolymer), polyethylene terephthalate (PET), polybutylene terephthalate (PBT), liquid crystalline polymer (LCP), polyamide 6 (PA 6), Nylon, polyoxymethylene (POM), poly-phenylene-sulfide (PPS) and cyclic olefin-co-polymer (COC).

7. The circuit board structure according to claim 5, wherein said engineering plastic comprises catalytic particles.

8. The circuit board structure according to claim 7, wherein said catalytic particles comprise copper oxide particles, aluminum nitride particles or palladium particles.

9. The circuit board structure according to claim 7, wherein said catalytic particles are selected from a group consisting of manganese, chromium, palladium, copper, aluminum and platinum.

10. The circuit board structure according to claim 1, wherein a first side of said circuit board main body has a coplanar first pattern, a second side of said circuit board main body has a coplanar second pattern.

11. The circuit board structure according to claim 10, wherein said first pattern is arranged in matrix and is partially covered by said molded plastic body.

12. The circuit board structure according to claim 10, wherein an edge of said molded plastic body aligns with an edge of said first pattern.

13. The circuit board structure according to claim 1, wherein said circuit board main body comprises a second three-dimensional pattern.

14. A method of fabricating a circuit board structure, comprising:
   providing a circuit board main body;
   forming a molded plastic body by encapsulating at least a portion of said circuit board main body with injection molded material; and
   forming a first three-dimensional pattern on said molded plastic body thereby defining a three-dimensional circuit device.

15. The method according to claim 14, wherein said molded plastic body is directly injected under low injected pressure or low molded temperature.

16. The method according to claim 14, wherein said circuit board main body includes rigid printed circuit board (rigid PCB), flexible printed circuit board (flexible PCB), rigid-flex composite printed circuit board (rigid-flex composite PCB) or rigid-flex combination printed circuit board (rigid-flex combination PCB).

17. The method according to claim 14, wherein said circuit board main body comprises a two-layer board or a multi-layer board.
18. The method according to claim 14, wherein said circuit board main body comprises a core layer.

19. The method according to claim 14, wherein said molded plastic body is made of plastic material comprising engineering plastic or ceramic.

20. The method according to claim 19, wherein said engineering plastic is selected from a group consisting of polycarbonate (PC), acrylonitrile-butadiene-styrene copolymer (ABS copolymer), polyethylene terephthalate (PET), polybutylene terephthalate (PBT), liquid crystalline polymer (LCP), polyamide 6 (PA 6), Nylon, polyoxymethylene (POM), poly-phenylene-sulfide (PPS) and cyclic-olefin-co-polymer (COC).

21. The method according to claim 19, wherein said engineering plastic comprises catalytic particles.

22. The method according to claim 21, wherein said catalytic particles comprise copper oxide particles, aluminum nitride particles or palladium particles.

23. The method according to claim 21, wherein said catalytic particles are selected from a group consisting of manganese, chromium, palladium, copper, aluminum and platinum.

24. The method according to claim 14, wherein the first side of said circuit board main body has a coplanar first pattern, the second side of said circuit board main body has a coplanar second pattern.

25. The method according to claim 24, wherein said first pattern is arranged in matrix and is partially covered by said molded plastic body.

26. The method according to claim 24, wherein an edge of said molded plastic body aligns with an edge of said first pattern.

27. The method according to claim 14, wherein said circuit board main body comprises a second three-dimensional pattern.

28. The method according to claim 14, wherein said first three-dimensional pattern is formed by laser direct structuring (LDS), microscopic integrated processing technology (MIPTEC) or two-shot molding.

* * * * *