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(54) **PRINTED CIRCUIT BOARD AND MANUFACTURING METHOD THEREOF**

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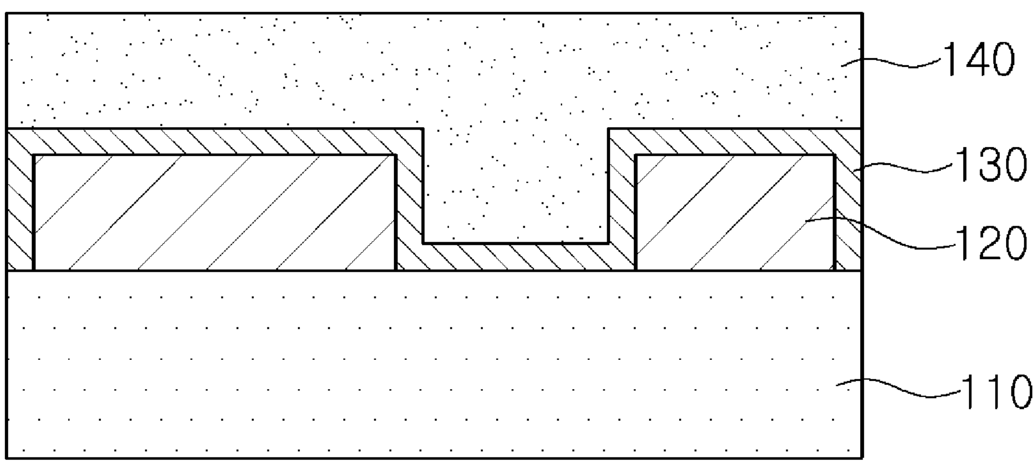
(57) **ABSTRACT**

There are provided a printed circuit board and a manufacturing method thereof. The printed circuit board (PCB) includes an adhesive film disposed between an insulating layer and a circuit pattern, wherein the adhesive film includes poly(glycidyl methacrylate). The printed circuit board may include the adhesive film between the circuit pattern and the insulating layer, and thus, adhesive strength may be increased, while having a low roughness value, a fine circuit pattern may be formed, and reliability thereof may be enhanced.



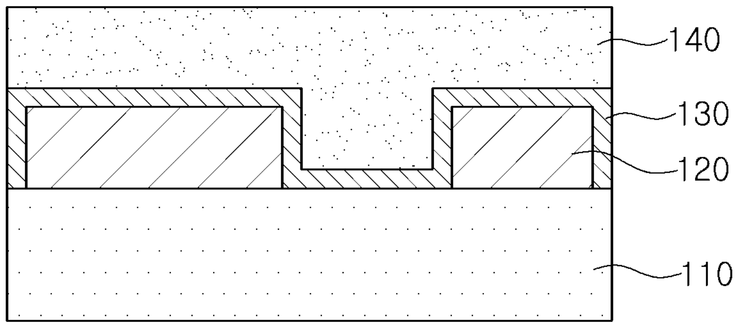


FIG. 1

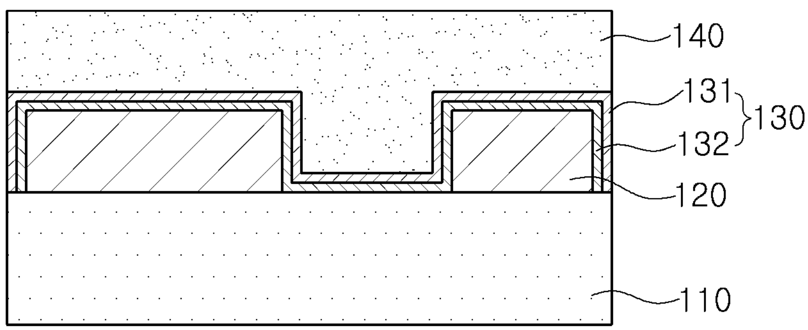


FIG. 2

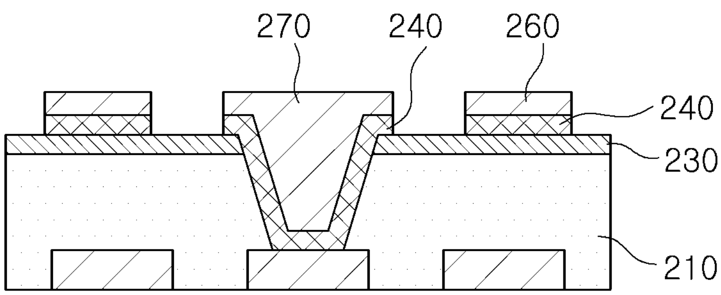


FIG. 3

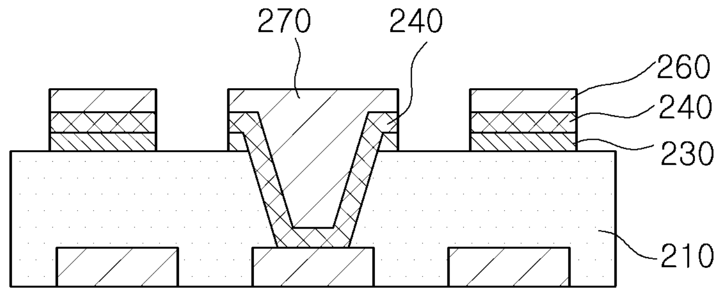


FIG. 4

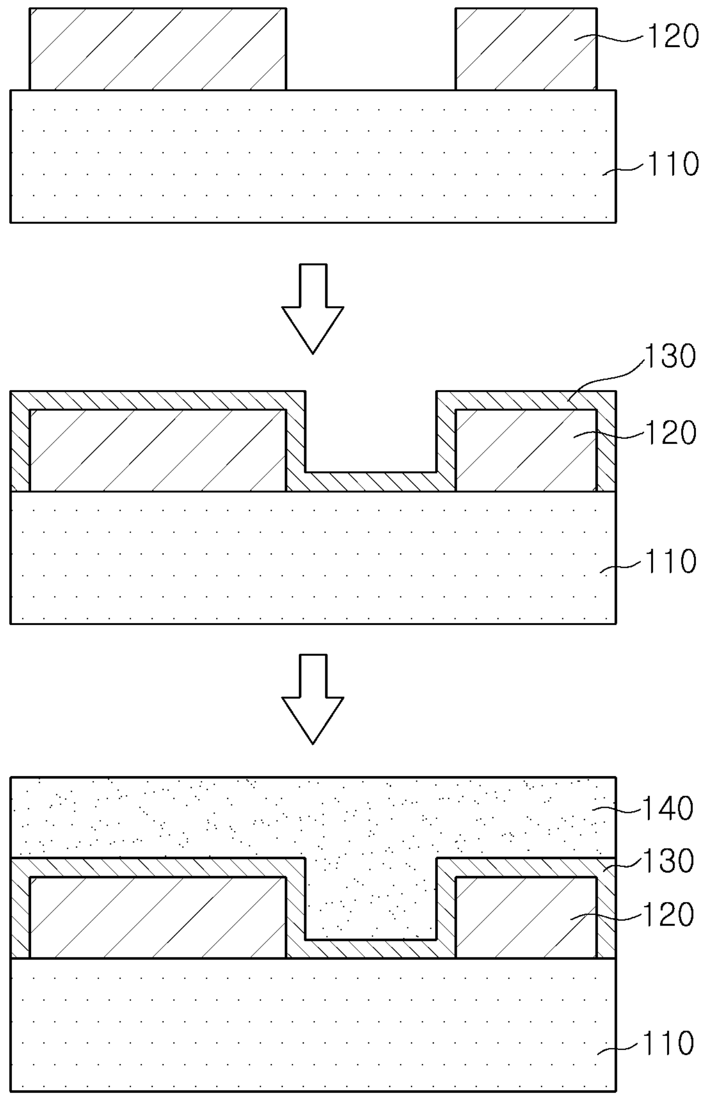


FIG. 5

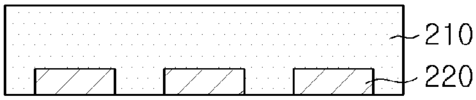


FIG. 6A

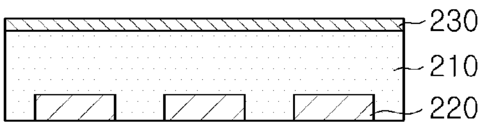


FIG. 6B

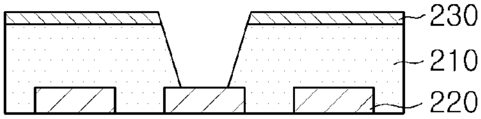


FIG. 6C

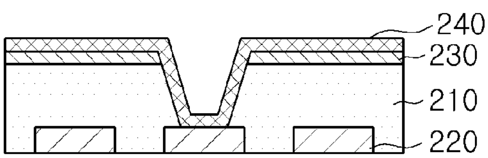


FIG. 6D

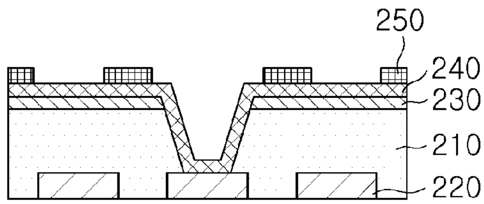


FIG. 6E

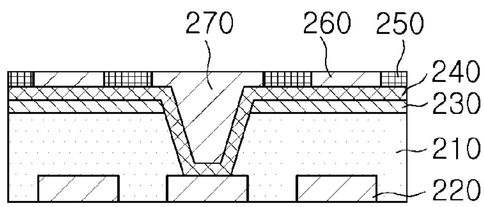


FIG. 6F

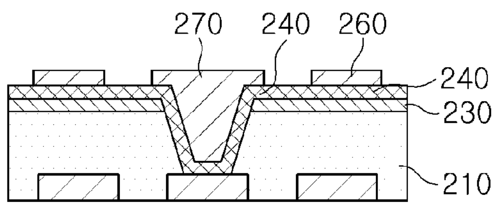


FIG. 6G

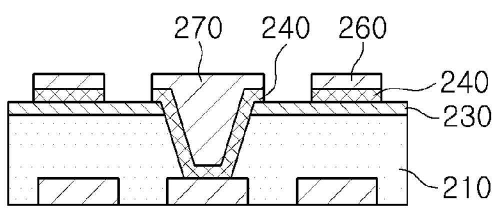


FIG. 6H

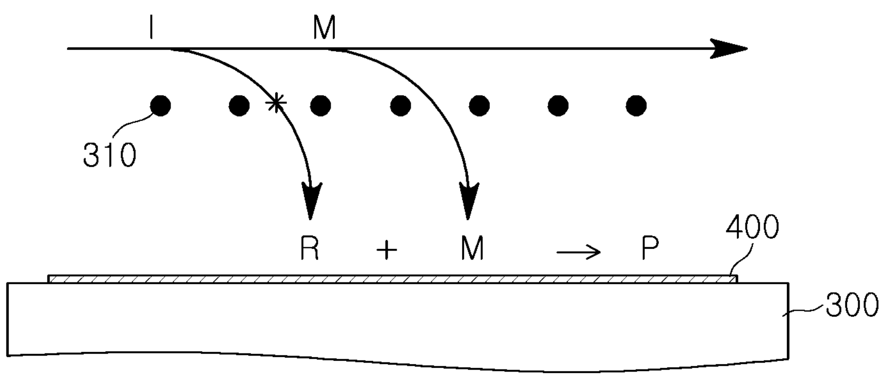


FIG. 7

PRINTED CIRCUIT BOARD AND MANUFACTURING METHOD THEREOF

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims the benefit of Korean Patent Application No. 10-2014-0017989 filed on Feb. 17, 2014, with the Korean Intellectual Property Office, the disclosure of which is incorporated herein by reference.

BACKGROUND

[0002] The present disclosure relates to a printed circuit board and a manufacturing method thereof.

[0003] In general, a printed circuit board (PCB) is formed by forming wiring patterns with copper foil on one or both surfaces of a board formed of various thermosetting synthetic resins, fixedly disposing integrated circuits (ICs) or electronic components on the board, implementing electrical connections therebetween, and coating the board with an insulator.

[0004] The recent development of the electronics industry has triggered growing demand for multifunctional, lighter, thinner, shorter, and smaller electronic components, and in line therewith, printed circuit boards (PCBs) on which electronic components are mounted have also come to be required to have high density wiring patterns and to be thinned.

[0005] In particular, in manufacturing a PCB, in an additive method or a semi-additive process (SAP) method, an insulating layer formed of a resin is desmeared to have increased roughness and is subsequently plated, or a copper circuit is subjected to a roughening treatment and coated with a resin to secure adhesive strength between the resin and the plated layer.

[0006] However, a PCB manufactured in such a manner has too high a degree of roughness to form a fine circuit and involves a great deal of loss in signal transmissions.

[0007] In order to overcome the shortcomings, the manufacturing of boards having a low degree of roughness has been attempted, but such boards may have a low degree of adhesive strength between a resin and a circuit due to low degree of roughness, degrading reliability.

[0008] To resolve the drawbacks, Patent Document 1 proposes methods for securing a high degree of adhesive strength with a low degree of roughness using an adhesive or a tin plating solution.

[0009] However, these methods employ a wet process with an adhesive, a tin plating solution, or the like, increasing process costs and causing the need for periodical solution management.

RELATED ART DOCUMENT

(Patent Document 1) Korean Patent Laid-Open Publication No. 2010-0050422

SUMMARY

[0010] An exemplary embodiment in the present disclosure may provide a printed circuit board (PCB) in which an adhesive film is provided to increase adhesive strength between an insulator and a circuit pattern, thus obtaining high interlayer adhesive strength with a low degree of roughness, and a manufacturing method thereof.

[0011] According to an exemplary embodiment in the present disclosure, a printed circuit board (PCB) may include: an adhesive film formed between an insulating layer and a circuit pattern, wherein the adhesive film includes poly(glycidyl methacrylate).

[0012] The adhesive film may include one or more of an amine-based polymer, an imidazole-based polymer, and a pyridine-based polymer.

[0013] The adhesive film may further include an aromatic compound.

[0014] The aromatic compound may be one or more selected from the group consisting of divinyl benzene, styrene, and ethyl benzene.

[0015] The adhesive film may be formed by bonding poly (glycidyl methacrylate) to the insulating layer.

[0016] The adhesive film may be formed by bonding one or more of an amine-based polymer, an imidazole-based polymer, and a pyridine-based polymer to the circuit pattern.

[0017] According to an exemplary embodiment in the present disclosure, a printed circuit board (PCB) may include: an adhesive film formed between an insulating layer and a circuit pattern, wherein the adhesive film includes a plurality of layers, and at least one of the plurality of layers forming the adhesive film includes poly(glycidyl methacrylate).

[0018] The adhesive film may include a first adhesive layer and a second adhesive layer, and the first adhesive layer may include poly(glycidyl methacrylate) while the second adhesive layer may include one or more of an amine-based polymer, an imidazole-based polymer, and a pyridine-based polymer.

[0019] The first adhesive layer may be adhesively formed on the insulating layer.

[0020] The second adhesive layer may be adhesively formed on the circuit pattern.

[0021] The first adhesive layer may further include an aromatic compound.

[0022] The aromatic compound may be one or more selected from the group consisting of divinyl benzene, styrene, and ethyl benzene.

[0023] According to an exemplary embodiment in the present disclosure, a method of manufacturing a printed circuit board (PCB) may include: forming an adhesive film between an insulating layer and a circuit pattern, wherein the adhesive film includes poly(glycidyl methacrylate).

[0024] The forming of an adhesive film may include: forming a circuit pattern on the insulating layer; forming the adhesive film on the insulating layer with the circuit pattern formed thereon; and forming an upper insulating layer on the adhesive film.

[0025] The upper insulating layer may include a solder resist (SR) layer.

[0026] The forming of an adhesive film may include: forming the adhesive film on the insulating layer; forming a copper plating layer on the adhesive film; and performing a patterning process on the copper plating layer to form a circuit pattern.

[0027] The adhesive film may be formed by performing one or more processes selected from the group consisting of chemical vapor deposition (CVD), initiated chemical vapor deposition (iCVD), and spin coating.

[0028] The adhesive film may include a first adhesive layer and a second adhesive layer, and the first adhesive layer may include poly(glycidyl methacrylate) while the second adhesive layer may include one or more of an amine-based polymer, an imidazole-based polymer, and a pyridine-based polymer.

[0029] The first adhesive layer may be adhesively formed on the insulating layer, while the second adhesive layer may be adhesively formed on the circuit pattern.

[0030] The first adhesive layer may further include an aromatic compound.

BRIEF DESCRIPTION OF DRAWINGS

[0031] The above and other aspects, features and other advantages of the present disclosure will be more clearly understood from the following detailed description taken in conjunction with the accompanying drawings, in which:

[0032] FIG. **1** is a cross-sectional view illustrating a printed circuit board (PCB) according to an exemplary embodiment of the present disclosure;

[0033] FIG. **2** is a cross-sectional view illustrating a PCB according to an exemplary embodiment of the present disclosure;

[0034] FIG. **3** is a cross-sectional view illustrating a PCB according to another exemplary embodiment of the present disclosure;

[0035] FIG. **4** is a cross-sectional view illustrating a PCB according to another exemplary embodiment of the present disclosure;

[0036] FIG. **5** is a cross-sectional view illustrating sequential processes in a method of manufacturing a PCB according to the exemplary embodiment of FIGS. **1** and **2**;

[0037] FIGS. **6**A through **6**H are cross-sectional views illustrating sequential processes in a method of manufacturing a PCB according to the exemplary embodiment of FIGS. **3** and **4**; and

[0038] FIG. **7** is a view illustrating a process of forming an adhesive film according to an exemplary embodiment of the present disclosure.

DETAILED DESCRIPTION

[0039] Hereinafter, embodiments in the present disclosure will be described in detail with reference to the accompanying drawings. The disclosure may, however, be embodied in many different forms and should not be construed as being limited to the embodiments set forth herein. Rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the disclosure to those skilled in the art. In the drawings, the shapes and dimensions of elements may be exaggerated for clarity, and the same reference numerals will be used throughout to designate the same or like elements.

[0040] Printed Circuit Board

[0041] FIGS. **1** and **2** are cross-sectional views illustrating a printed circuit board (PCB) according to an exemplary embodiment of the present disclosure.

[0042] Referring to FIG. **1**, a PCB according to an exemplary embodiment of the present disclosure includes an adhesive film **130** formed between an insulating layer **140** and a circuit pattern **120**. The adhesive film **130** includes poly (glycidyl methacrylate).

[0043] With this structure, adhesive strength with respect to the circuit pattern **120** and the insulating layer **140** may be increased without a roughening process such as in the related art.

[0044] The adhesive film **130** may further include one or more of an amine-based polymer, an imidazole-based polymer, and a pyridine-based polymer.

[0045] The adhesive film **130** may further include an aromatic compound, and the aromatic compound may be one or more selected from the group consisting of divinyl benzene, styrene, and ethyl benzene.

[0046] The poly(glycidyl methacrylate) of the adhesive film **130** may be adhesively formed on the insulating layer **140**, and one or more of an amine-based polymer, an imidazole-based polymer, and an pyridine-based polymer of the adhesive film **130** may be adhesively formed on the circuit pattern **120**, whereby adhesive strength of both sides between heterogeneous interfaces may be increased.

[0047] Referring to FIG. **2**, the adhesive film **130** according to an exemplary embodiment of the present disclosure may include a plurality of layers. For example, the adhesive film **130** may include a first adhesive layer **131** and a second adhesive layer **132**.

[0048] At least one layer forming the adhesive film **130** may include poly(glycidyl methacrylate).

[0049] For example, the first adhesive layer **131** may include poly(glycidyl methacrylate), while the second adhesive layer **132** may include one or more of an amine-based polymer, an imidazole-based polymer, and a pyridine-based polymer.

[0050] The first adhesive layer **131** may further include an aromatic compound, and the aromatic compound may be one or more selected from the group consisting of divinyl benzene, styrene, and ethyl benzene.

[0051] The first adhesive layer **131** may be adhesively formed on the insulating layer **140** while the second adhesive layer **132** may be adhesively formed on the circuit pattern **120**, and thus, adhesive strength of both sides between heterogeneous interfaces may be increased.

[0052] FIGS. **3** and **4** are cross-sectional views illustrating a PCB according to another exemplary embodiment of the present disclosure.

[0053] As in the exemplary embodiments of FIGS. **1** and **2**, in the exemplary embodiments of FIGS. **3** and **4**, an adhesive film is formed between an insulating layer and a circuit pattern. However, the exemplary embodiments of FIGS. **1** and **2** have a structure in which the insulating layer is stacked on the circuit pattern, while the exemplary embodiments of FIGS. **3** and **4** have a structure in which a circuit pattern is formed on an insulating layer.

[0054] Referring to FIG. **3**, an adhesive film **230** is formed on an insulating layer **210**, and circuit patterns **240** and **260** are formed on the adhesive film **230**. The circuit patterns **240** and **260** may be formed by sequentially stacking an electroless copper plating layer **240** and an electro-copper plating layer **260**. Vias **240** and **270** electrically connecting the upper and lower circuit patterns **240** and **260** may also be formed of an electroless copper plating layer **240** and an electro-copper plating layer **270**.

[0055] Thus, since the insulating layer **210** and the circuit patterns **240** and **260** are bonded by the adhesive film **230**, although surface roughness of the insulating layer **210** is low, sufficient adhesion may be secured.

[0056] As in the exemplary embodiments of FIGS. **1** and **2**, the adhesive film **230** may include a first adhesive layer adhered to the insulating layer **210** and a second adhesive layer adhered to the circuit patterns **240** and **260**. The first adhesive layer may include poly(glycidyl methacrylate), while the second adhesive layer may include one or more of an amine-based polymer, an imidazole-based polymer, and a pyridine-based polymer.

[0057] The exemplary embodiment of FIG. **4** is identical to the exemplary embodiment of FIG. **3**, except that the adhesive film **230** is formed only on the portions of the circuit patterns **240** and **260**, and thus, a detailed description thereof will be omitted.

[0058] Method of Manufacturing PCB

[0059] FIG. **5** is a cross-sectional view illustrating sequential processes in a method of manufacturing a PCB according to the exemplary embodiment of FIGS. **1** and **2**.

[0060] Referring to FIG. **5**, after a circuit pattern **120** is formed on an insulating layer **110**, an adhesive film **130** may be formed on the insulating layer **110** with the circuit pattern **120** formed thereon. The adhesive film **130** may have a thickness ranging from 0.01 μm to 1 μm.

[0061] The adhesive film **130** may include poly(glycidyl methacrylate) and may further include one or more of an amine-based polymer, an imidazole-based polymer, and a pyridine-based polymer. The adhesive film **130** may further include an aromatic compound, and the aromatic compound may be one or more selected from the group consisting of divinyl benzene, styrene, and ethyl benzene.

[0062] Here, the adhesive film **130** may be formed by bonding a film containing one or more of an amine-based polymer, an imidazole-based polymer, and a pyridine-based polymer bonded so as to be adjacent to the circuit pattern **120** and forming a film containing poly(glycidyl methacrylate) thereon.

[0063] An upper insulating layer **140** may be formed on an upper surface of the adhesive film **130**. The upper insulating layer **140** may be, for example, a solder resist (SR) layer.

[0064] The adhesive film **130** may increase adhesive strength with respect to the circuit pattern **120** using one of more of an amine-based polymer, an imidazole-based polymer, and a pyridine-based polymer and adhesive strength with respect to the upper insulating layer **140** using poly (glycidyl methacrylate).

[0065] Thus, since the PCB having the adhesive film **130** according to an exemplary embodiment of the present disclosure has increased adhesive strength with respect to the circuit pattern **120** and the upper insulating layer **140**, reliability thereof may be enhanced.

[0066] FIGS. **6**A through **6**H are cross-sectional views illustrating sequential processes in a method of manufacturing a PCB according to the exemplary embodiment of FIGS. **3** and **4**.

[0067] Referring to FIG. **6**, after an insulating layer **210** is provided (process **6**A), an adhesive film **230** may be formed on the insulating layer **210** (process **6**B). The adhesive film **230** may have a thickness ranging from 0.01 μm to 1 μm.

[0068] The adhesive film **230** may include poly(glycidyl methacrylate) and may further include one or more of an amine-based polymer, an imidazole-based polymer, and a pyridine-based polymer. The adhesive film **230** may further include an aromatic compound, and the aromatic compound may be one or more selected from the group consisting of divinyl benzene, styrene, and ethyl benzene.

[0069] Here, the adhesive film **230** may be formed by first bonding a film containing poly(glycidyl methacrylate) to the insulating layer **210** and forming a film containing one or more of an amine-based polymer, an imidazole-based polymer, and a pyridine-based polymer thereon.

[0070] After forming the adhesive film **230**, a via hole may be formed with a laser (process **6**C). The via hole exposes a lower circuit pattern **220**. Thereafter, electroless copper plating is performed to form an electroless copper plating layer **240** on the adhesive film **230** and within the via hole (process **6**D).

[0071] The copper plating layer **240** may undergo a patterning process including lithography and etching process so as to be changed to a fine circuit pattern.

[0072] Namely, a patterned plated resist **250** is attached to the electroless copper plating layer **240** (process **6**E), and electro-plating is performed thereon to form an electro-plated layer **260** (process **6**F). Thereafter, the plated resist **250** is removed (process **6**G) and the electroless copper plating layer **240** is etched to form a fine circuit pattern (process **6**H). Thereafter, a process of removing the adhesive film **230** formed in a region other than the circuit pattern may be further performed (please refer to FIG. **4**).

[0073] The adhesive film **230** may have low roughness (Ra) value of, for example, 0.1 μm or less, for example, while increasing adhesive strength with respect to the electroless copper plating layer **240**, thus contributing to forming the electroless copper plating layer **240** as a fine circuit pattern.

[0074] Thus, the method of manufacturing a PCB according to an exemplary embodiment of the present disclosure may provide a PCB having a fine circuit pattern using the adhesive film **230** having enhanced adhesive strength with respect to the copper plating layer **250**, while having a low roughness value.

[0075] The adhesive films **130** and **230** according to an exemplary embodiment of the present disclosure may be formed by performing one or more processes selected from the group consisting of chemical vapor deposition (CVD), initiated chemical vapor deposition (iCVD), and spin coating.

[0076] FIG. **7** is a view illustrating a process of forming an adhesive film according to an exemplary embodiment of the present disclosure.

[0077] Referring to FIG. **7**, according to the iCVD method, a polymer thin film P may be formed through vapor polymerization in which polymerization and film forming process are simultaneously performed by vaporizing a monomer M of polymer constituting the adhesive film within a chamber. Through the iCVD, the initiator I and the monomer M may be vaporized and chain-polymerized in a vapor phase using a free radical R, whereby the polymer thin film P may be deposited on a surface of a board **300** including a circuit pattern or an insulating layer.

[0078] When the initiator I and the monomer M are simply mixed, polymerization does not occur, but when the initiator I is decomposed by a filament **310** having a high temperature positioned within the iCVD chamber to generate the radical R, the monomer M is activated to cause chain-polymerization.

[0079] As the initiator I, peroxide such as tert-butylperoxide (TBPO), tert-amyl peroxide (TAPO), or the like, is largely used. The initiator I, a volatile material having a boiling point of about 110° C., may be thermally decomposed at about 150° C.

[0080] Thus, when the high temperature filament **310** used in the iCVD chamber is maintained at about 200° C. to 250° C., chain polymerization may be easily induced. Here, the temperature of the filament **310** is sufficiently high to thermally decompose the initiator I of the peroxide, but most organic substances including the monomer M used in the iCVD are not thermally decomposed at such a temperature.

[0081] The free radical R formed by decomposing the initiator I may be delivered to the monomer M to cause chain polymerization to form the polymer P. The polymer P formed thusly may be deposited on the board **300** maintained at a low temperature to form an adhesive film **400**.

[0082] In a spin coating method, an adhesive film solution for forming an adhesive film may be applied dropwise to a surface of a board installed in a spin coater.

[0083] Thereafter, through rotary force of the spin coater in which the board is installed, the adhesive film solution may be applied to the entirety of the board including the circuit pattern or the insulating layer formed thereon.

[0084] Subsequently, the applied adhesive film solution is cured so a volatile organic solvent is volatized to be removed, an adhesive film may be formed on the board including a circuit pattern and an insulating layer.

[0085] The adhesive film **130** according to an exemplary embodiment of the present disclosure may include a plurality of layers. For example, the adhesive film **130** may include a first adhesive layer **131** and a second adhesive layer **132**.

[0086] At least one of the plurality of layers forming the adhesive film **130** may include poly(glycidyl methacrylate).

[0087] For example, the first adhesive layer **131** may include poly(glycidyl methacrylate) while the second adhesive layer **132** may include one or more of an amine-based polymer, an imidazole-based polymer, and a pyridine-based polymer.

[0088] The first adhesive layer **131** may further include an aromatic compound, and the aromatic compound may be one or more selected from the group consisting of divinyl benzene, styrene, and ethyl benzene.

[0089] Here, the first adhesive layer **131** may be adhesively formed on the insulating layer **140**, while the second adhesive layer **132** may be adhesively formed on the circuit pattern **120**. Thus, adhesive strength of both sides between heterogeneous interfaces may be increased.

[0090] As set forth above, the PCB according to exemplary embodiments of the present disclosure includes an adhesive film between a circuit pattern and an insulating layer, and thus, adhesive strength may be increased, while having a low roughness value, a fine circuit pattern may be formed, and reliability thereof may be enhanced.

[0091] While exemplary embodiments have been shown and described above, it will be apparent to those skilled in the art that modifications and variations could be made without departing from the spirit and scope of the present disclosure as defined by the appended claims.

What is claimed is:

1. A printed circuit board (PCB) comprising an adhesive film disposed between an insulating layer and a circuit pattern,
wherein the adhesive film includes poly(glycidyl methacrylate).

2. The printed circuit board of claim **1**, wherein the adhesive film includes one or more of an amine-based polymer, an imidazole-based polymer, and a pyridine-based polymer.

3. The printed circuit board of claim **1**, wherein the adhesive film further includes an aromatic compound.

4. The printed circuit board of claim **3**, wherein the aromatic compound is one or more selected from the group consisting of divinyl benzene, styrene, and ethyl benzene.

5. The printed circuit board of claim **1**, wherein the adhesive film is formed by bonding poly(glycidyl methacrylate) to the insulating layer.

6. The printed circuit board of claim **2**, wherein the adhesive film is formed by bonding one or more of an amine-based polymer, an imidazole-based polymer, and a pyridine-based polymer to the circuit pattern.

7. A printed circuit board (PCB) comprising an adhesive film formed between an insulating layer and a circuit pattern,
wherein the adhesive film includes a plurality of layers, and at least one of the plurality of layers forming the adhesive film includes poly(glycidyl methacrylate).

8. The printed circuit board of claim **7**, wherein the adhesive film includes a first adhesive layer and a second adhesive layer, and the first adhesive layer includes poly(glycidyl methacrylate) while the second adhesive layer includes one or more of an amine-based polymer, an imidazole-based polymer, and a pyridine-based polymer.

9. The printed circuit board of claim **8**, wherein the first adhesive layer is adhesively formed on the insulating layer.

10. The printed circuit board of claim **8**, wherein the second adhesive layer is adhesively formed on the circuit pattern.

11. The printed circuit board of claim **8**, wherein the first adhesive layer further includes an aromatic compound.

12. The printed circuit board of claim **11**, wherein the aromatic compound is one or more selected from the group consisting of divinyl benzene, styrene, and ethyl benzene.

13. A method of manufacturing a printed circuit board (PCB), the method comprising forming an adhesive film between an insulating layer and a circuit pattern,
wherein the adhesive film includes poly(glycidyl methacrylate).

14. The method of claim **13**, wherein the forming of an adhesive film includes:
forming a circuit pattern on the insulating film;
forming the adhesive film on the insulating layer with the circuit pattern formed thereon; and
forming an upper insulating layer on the adhesive film.

15. The method of claim **14**, wherein the upper insulating layer includes a solder resist (SR) layer.

16. The method of claim **13**, wherein the forming of an adhesive film includes:
forming the adhesive film on the insulating layer;
forming a copper plating layer on the adhesive film; and
performing a patterning process on the copper plating layer to form a circuit pattern.

17. The method of claim **13**, wherein the adhesive film is formed by performing one or more processes selected from the group consisting of chemical vapor deposition (CVD), initiated chemical vapor deposition (iCVD), and spin coating.

18. The method of claim **13**, wherein the adhesive film includes a first adhesive layer and a second adhesive layer, and the first adhesive layer includes poly(glycidyl methacrylate) while the second adhesive layer includes one or more of an amine-based polymer, an imidazole-based polymer, and a pyridine-based polymer.

19. The method of claim **18**, wherein the first adhesive layer is adhesively formed on the insulating layer, while the second adhesive layer is adhesively formed on the circuit pattern.

20. The method of claim **18**, wherein the first adhesive layer further includes an aromatic compound.

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