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(54) **MULTILAYER CIRCUIT BOARD HAVING CABLE PORTION AND METHOD FOR MANUFACTURING SAME**

(57) To provide a thin multilayer flexible circuit board having cable portions drawn out of a plurality of outer layers, and a method for manufacturing the same. A multilayer flexible circuit board including a parts mounting portion having an inner-layer board 107 and outer-layer boards 106, and cable portions drawn out of at least one of the inner-layer board and outer-layer boards, wherein each of the inner-layer board and the outer-layer boards has circuits facing one another, **characterized by** each of the circuits facing one another is covered with a cover 5 formed of a cover film in common with the cable portion: and a method for manufacturing the same.

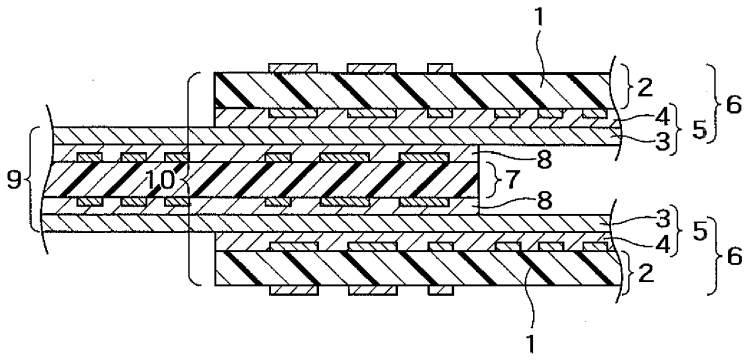


FIG. 1

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Description

Technical Field

[0001] The present invention relates to a multilayer circuit board having flexible cable portions and a method for manufacturing the same, and more specifically to a structure of a buildup-type multilayer circuit board equipped with flexible cable portions having a plurality of layers and a method for manufacturing the same.

Background Art

[0002] Figure 5 is a sectional view showing the main configuration of a conventional multilayer circuit board having cable portions drawn out of a plurality of layers. On a flexible insulating base material 101 of polyimide or the like, which is a basic material, layers to be the cable portions of a flexible circuit board 102 having circuit patterns including cable portions on both surfaces are disposed, and cover lays 105 having adhesive materials 104 on insulating films 103, such as polyimide films, are adhered onto the layers to be the cable portions to form cables for the outer-layer boards 106 and the inner-layer board 107 (refer to Patent Document 1).

[0003] The cables for the outer-layer boards 106 and the inner-layer board 107 are bonded by previously punched adhesive materials 108. For interlayer connection, through-holes penetrating all the layers, and blind via holes connecting nearby layers are used.

[0004] Aside from this, a method for manufacturing a thin multilayer flexible circuit board has also been provided (refer to Patent Document 2). This is for manufacturing a thin four-layer flexible circuit board by sharing the cover film for a flexible circuit board to become the cable portions of the inner-layer board with the base material for the outer-layer boards, that is, the flexible insulating base material.

Patent Document 1: Japanese Patent Publication No. 2-55958
Patent Document 2: Japanese Patent Laid-Open No. 5-90757

Disclosure of the Invention

[0005] Among the above-described structures, what is described in Patent Document 1 has a problem in that since the configuration of the multilayer portion 109 is complicated and thick, the requirement for thickness reduction cannot be satisfied. In addition, when perforating conducting holes upon the formation of through-holes and blind via holes, there is another problem of dealing with the generation of a large quantity of foreign matter, such as the chips of materials for each layer and smear, in the conducting holes. Specifically, there are possibilities that the desmear processing for removing foreign matter, such as the chips, becomes complicated, and the lack of desmear processing causes defective electrical connection. Also, since the number of composing material is increased, there is a problem of increase in material costs.

[0006] Also in the method described in Patent Document 2, since the formation of outer-layer cables is difficult, it is still not easy to manufacture a thin multilayer flexible circuit board.

[0007] The present invention has been made in consideration of the above-described aspects, and it is an object of the present invention to provide a multilayer flexible circuit board that can be configured to be thin even though the board has cable portions drawn out of a plurality of outer layers; and a method for manufacturing the same.

[0008] To achieve the above-described object, the present invention provides a multilayer flexible circuit board, which is the first invention; and a method for manufacturing the same, which is the second invention.

[0009] The first aspect of the present invention is a multilayer flexible circuit board including a parts mounting portion having an inner-layer board and outer-layer boards, and cable portions drawn out of at least one of the inner-layer board and outer-layer boards, wherein each of the inner-layer board and the outer-layer boards has circuits facing one another, characterized by each of the circuits facing one another is covered with a cover formed of a cover film in common with the cable portion.

[0010] The second aspect of the present invention is a method for manufacturing a multilayer flexible circuit board including a parts mounting portion having an inner-layer board and outer-layer boards laminated one another, each having a base material and conductive layers, and cable portions drawn out of at least one of the inner-layer board and outer-layer boards, wherein each of the inner-layer board and the outer-layer boards has circuits facing one another, characterized by including:

a process for preparing the inner-layer board and outer-layer boards;
a process for forming a circuit pattern having mask holes for forming conducting holes in the conductive layer in at least one of the inner-layer board and outer-layer boards;
a process for providing a cover lay on the circuit pattern;
a process for laminating the inner-layer board and outer-layer boards via adhesive materials together with the cover lay to form a multilayer circuit;
a process for removing the base material of the outer-layer boards using the mask holes;
a process for performing hole-opening processing in the inner-layer board using the mask holes to form conducting holes; and
a process for performing conducting treatment on the conducting holes to form via holes.

Brief Description of the Drawings

[0011]

Figure 1 is a side sectional view showing the configuration of an embodiment of the present invention;
Figure 2 is a process diagram showing the manufacturing process in an embodiment of the present invention;
Figure 3 is a process diagram showing the process following the process shown in Figure 2;
Figure 4 is a process diagram showing the process following the process shown in Figure 3; and
Figure 5 is a side sectional view showing the structure of a conventional multilayer circuit board.

Description of Symbols

[0012] 1 base material (flexible base material); 2 circuit board; 3 insulating film; 4 adhesive material; 5 cover lay; 6 outer-layer board (cable portion); 7 circuit board; 8 adhesive material; 9 inner-layer board (cable portion); 10 multilayer portion; 21 base material; 22, 23 copper foil; 24 conducting hole; 25 electrolytic-plated film; 26 through-hole; 27 circuit pattern; 28, 29 copper foil; 28a, 29a conformal mask; 30 double-sided copper clad laminate; 31, 31a, 31b conducting hole; 32 unnecessary adhesive material; 33 via hole; 34 step via hole; 35 skip via hole; 36 outer-layer circuit pattern; 37 multilayer circuit board; 101 base material; 102 double-sided circuit board; 103 insulating film; 104 adhesive material; 105 cover lay; 106 outer-layer board (cable); 107 inner-layer board (cable); 108 adhesive material; 109 multilayer portion

Best Mode for Carrying Out the Invention

[0013] The embodiment of the present invention will be described below referring to the attached drawings.

Embodiment 1

[0014] Figure 1 is a sectional view showing the structure of a multilayer flexible circuit board being Embodiment 1 of the present invention. This shows circuit boards 2 where circuit patterns including cable portions are formed on flexible insulating base materials 1, which are base materials. The circuit boards 2 are used as outer-layer boards.

[0015] Next, cover lays 5 wherein an adhesive material 4 is overlaid on each of insulating films 3, such as polyimide, are adhered onto either upper or lower surfaces, shown in the drawing, of the circuit boards 2. Thereby, two outer-layer boards 6 having cables composed of circuit boards 2 and cover lays 5 are prepared.

[0016] On the other hand, a double-sided inner-layer board 9 having circuit patterns on the upper and lower surfaces, shown in the drawing, of the base material is prepared. Then, in the state wherein cover lays 5 are inserted, the outer-layer boards 6 are adhered onto both surfaces, shown in the drawing, of the inner-layer board 9.

[0017] Previously punched adhesives 8 are adhered onto the inner-layer board 9, and the insulating films 3 of the cover lays 5 are adhered by the adhesives 8 to form the cover lays 5. Then, the outer-layer boards 6 are continuously joined to the inner-layer board 9 by the cover lays 3. Thereby, the multilayer portion wherein the outer-layer boards 6 and the inner-layer board 9 are laminated is configured to be thin.

[0018] The portions drawn out of both the outer-layer boards 6 and the inner-layer board 9 are used as flexible cables, and the portions are drawn out of at least one of the outer-layer boards 6 and the inner-layer board 9.

Method for manufacturing Embodiment 1

[0019] Figure 2 is process diagrams showing part of processes in the method for manufacturing Embodiment 1 shown in Figure 1. In Figure 2 (1), a conductive hole 24 is formed using an NC drill or the like in a base material 21 composed of a flexible insulating material, such as polyimide, of a thickness of for example, 25 μm having copper foils 22 and 23 of thickness of 8 μm on the both surfaces, which is called a double-sided copper clad laminate. Thereby, the inner-layer board 9 is formed.

[0020] Then, conducting treatment and subsequent electrolytic plating treatment are performed on the conductive hole 24 opened in the base material 21 to form an electrolytic-plated film 25 of about 10 μm, and an interlayer conducting path is formed. Thereby, a penetrating conductive hole 26 is formed.

[0021] Furthermore, circuit patterns on the both surfaces are subjected to a series of processes, such as resist layer formation, exposure, development, etching, and resist layer peeling using a photo fabrication method to form circuit patterns 27. Thereby, a double-sided inner-layer board 9 is formed.

[0022] Next, in Figure 2 (2), conformal masks 28a and 29a are formed on what is called a double-sided copper clad laminate 30 having copper foils 28 and 29 of a thickness of 12 μm on the both surfaces of a base material 1. This is performed using the above-described photo fabrication method to form circuit patterns on the copper foils 28 and 29.

[0023] At this time, since the alignment of the copper foils 28 and 29 are performed on the flat material, the alignment accuracy can be easily secured without being affected by the elongation and shrinkage of the material. As required, an exposing machine that can perform highly accurate alignment may be used. A roughening treatment for improving adhesion to the adhesive material may also be carried out.

[0024] On the other hand, what is called a cover lay 5 having an adhesive material 4, such as acryl and epoxy of a thickness of 15 μm on an insulating film 3, which is a polyimide film of a thickness of for example, 12 μm is

prepared. Then, the cover lay 5 is adhered onto the inner-layer side of the buildup layer of the multilayer circuit board using a vacuum press, a laminator, or the like. Thereby, the outer-layer boards 6 with the cover lays 5 can be obtained.

[0025] Next, as shown in Figure 2 (3), adhesive materials 8 for laminating the outer-layer boards 6 on the inner-layer board 7 are aligned. The adhesive materials 8 are previously punched. Then, the outer-layer boards 6 with the cover lays 5 and the inner-layer board 7 are laminated with intervening adhesive materials 8 by the vacuum press or the like to form a multilayer circuit.

[0026] As the adhesive material, a material with little runoff, such as a low-flow type prepreg and a bonding sheet, is preferred. The thickness of the adhesive material 8 is preferably about 15 μm.

[0027] Figure 3 (4) shows a process for etching off the base materials 1 using the conformal masks 28a. In this process, the base materials 1 of the outer-layer boards 6 on the portions of the conductive holes 31 and the inner-layer boards 9 are removed.

[0028] As a resin etchant, a solution containing an alkali metal, an amine compound and water is preferred. By using such a resin etchant, the polyimide film of the base material 1, which is the flexible insulating base material can be selectively removed, and the adhesive material 4 of acryl, epoxy, or the like is little affected. Therefore, the polyimide film of the base material 1 to be removed can be subjected to resin etching without the shortage of etching.

[0029] When the resin etchant is used, a polyimide film for the base material 1 of the outer-layer boards 6 obtained by the polycondensation of pyromellitic dianhydride and aromatic diamine having high etching rate (for example, Kapton manufactured by du Pont and Apical manufactured by Kaneka Corporation) is preferred.

[0030] For the insulating film 3 of the base material 21 for the inner-layer board 9 and the cover lay 5, a polyimide film obtained by the polycondensation of biphenyl tetracarbonic dianhidride and diaminobenzene (for example, Upilex manufactured by Ube Industries, Ltd.) is preferred.

[0031] Furthermore, for the insulating film 3 of the base material 21 for the inner-layer board 7 and the cover lay 5, a resin film having high resistance to the above-described resin etchant, such as aramid resin may be used instead of polyimide.

[0032] In Figure 3 (5), step via holes and skip via holes are formed in the cover lays 5 and the adhesive materials 8 exposed from the conductive holes 31 processed in resin etching.

[0033] At locations to form these holes, laser processing is performed using previously prepared conformal masks 28a and 29a to form three kinds of conductive holes 31, 31a and 31b. The laser method may be selected from UV-YAG laser, carbon dioxide laser, excimer laser or the like.

[0034] The diameters of respective conductive holes 31, 31a and 31b are determined as follows: Firstly, the diameter of the conductive holes 31 is determined to be 50 μm, because when polyimide of a thickness of 25 μm is used for the base material 1, conductive holes having a diameter of 50 μm can be fabricated, and the plating thickness required for securing reliability is about 10 μm.

[0035] For conductive holes 31a and 31b, no thickness-adding plating of 10 μm or more resulting in increase in the thickness of the conductive layers is required from the second layer to the fifth layer of the layers composing outer-layer boards 6, and the thickness of the conductive layers can be reduced. For this reason, the thickness of the adhesive materials 4 and 8 required for filling can be reduced, and reliability can be secured even if the plating is relatively thin.

[0036] As the hole diameter that can secure reliability when plating thickness is about 15 to 20 μm, if the upper hole diameter is 150 μm and the lower hole diameter is 150 μm in the conductive holes 31a, minute wirings can be formed and the degree of integration can also be improved. Further, desmear treatment and conduction treatment for performing the interlayer connection by electrolytic plating are carried out. For processing using a conformal mask, a direct laser method may also be combined. When the direct laser method is used, the thickness of the copper foil is preferably 20 μm or less.

[0037] In addition, unnecessary adhesive materials 32 on the inner-layer board 9 can also be removed by laser processing. The kind of laser used in this case is preferably excimer laser, which excels in processing accuracy in the depth direction.

[0038] If carbon dioxide laser or UV-YAG laser is used from the point of view of productivity, the energy outputs and the numbers of shots of the laser are controlled for the accurate processing in the depth direction. This processing is preferably carried out under conditions different from the conditions for processing conductive holes.

[0039] Particularly when carbon dioxide laser is used, highly accurate processing in the depth direction is difficult to carry out. Therefore, it is preferable to leave remaining films having a thickness of about 5 μm, and simultaneously remove unnecessary matter using desmear process to remove remaining films and smear on the bottoms of conductive holes. The desmear process is performed using plasma and permanganic acid.

[0040] However, when requirement for bending is not so strict, such as cables bent only when assembling into the device, it is not required to remove unnecessary adhesive materials adhered onto the outer-layer board. In this case, it is preferable to prevent the adhesion of foreign matter produced by various shields, such as silver shield films and paste, to the exposed adhesive materials so as not to cause contamination.

[0041] In the process shown in Figure 4, the multilayer circuit base material having conductive holes 31, 31a and 31b is subjected to electrolytic plating of about 15 to 20 μm to achieve interlayer conduction. By these processes,

skip via holes 35 obtained from conductive holes 31 can be formed, and the interlayer conduction of all the circuits from the outer-layer boards to the inner-layer board in the buildup board can be achieved. Also in these processes, a multilayer circuit base material wherein interlayer conduction has been completed is obtained.

[0042] When through-holes for mounting inserting parts or the like is required, through-holes may be formed using an NC drill or the like at the time of forming conductive holes, and the through-holes may also be simultaneously formed at the time of via hole plating.

[0043] Furthermore, circuit patterns 36 for the outer-layer boards are formed using a normal photo fabrication method. At this time, plating layers deposited on the cover films 3 located in the inner-layer side of the laminated board are also removed, if any.

[0044] Thereafter, by performing surface treatment, such as solder plating, nickel plating and gold plating, on the surface of the board, and performing the formation and shape processing of a photo solder resist layer as required, a multilayer circuit board 37 having cables drawn out of the outer-layer boards 6 and the inner-layer board 7 can be formed.

[0045] To the processes shown in Figure 2 (1) to Figure 4, the role-to-role method can be applied, and further improvement of productivity can be expected. In addition to high-density mounting, examples wherein a multilayer circuit board having cable portions in the inner-layer board and the outer-layer board include the followings.

[0046] The multilayer flexible circuit board enabling high-density mounting for digital video cameras can mount a CSP (chip size package), and requires cables that are repeatedly bent and cables from other layers to be bent when assembled in the housing.

[0047] In the present invention, the requirements can be fully satisfied by using cables in the outer-layer board 6 as cables for repeated bending, and using cables in the inner-layer board 7 in combination as cables from other layers to be bent when assembled in the housing.

[0048] According to the present invention, as described, since the circuit provided on one of the base materials of the outer-layer boards and the inner-layer board of which cable portions can be drawn out composes the multilayer flexible circuit board coated by the cover common to the cable portions, the laminate structure can be simplified, and the multilayer flexible circuit board having a reduced thickness can be provided. In addition, since material costs can be reduced, the cost reduction effect can be obtained.

[0049] As a result of simplifying the board structure, the method for manufacturing a multilayer flexible circuit board wherein manufacturing processes are simplified can be provided. When via holes for connecting the outer-layer boards to the inner-layer board, since mask holes for forming conductive holes in the circuit pattern are provided, and the conductive holes are formed using the mask holes, highly reliable conductive holes integrated with the circuit pattern can be obtained.

Claims

1. A multilayer flexible circuit board comprising a parts mounting portion having an inner-layer board and outer-layer boards, and cable portions drawn out of at least one of said inner-layer board and outer-layer boards, wherein each of said inner-layer board and said outer-layer boards has circuits facing one another, **characterized by**
each of said circuits facing one another is covered with a cover formed of a cover film in common with said cable portion.

2. A method for manufacturing a multilayer flexible circuit board comprising a parts mounting portion having an inner-layer board and outer-layer boards, laminated one another each having a base material and conductive layers, and cable portions drawn out of at least one of said inner-layer board and outer-layer boards, wherein each of said inner-layer board and said outer-layer boards has circuits facing one another, **characterized by** comprising:

a process for preparing said inner-layer board and outer-layer boards;
a process for forming a circuit pattern having mask holes for forming conducting holes in the conductive layer in at least one of said inner-layer board and outer-layer boards;
a process for providing a cover lay on said circuit pattern;
a process for laminating said inner-layer board and said outer-layer boards via adhesive materials together with said cover lay to form a multilayer circuit;
a process for removing the base material of said outer-layer boards using said mask holes;
a process for performing hole-opening processing in said inner-layer board using said mask holes to form conductive holes; and
a process for performing conducting treatment on said conducting holes to form via holes.

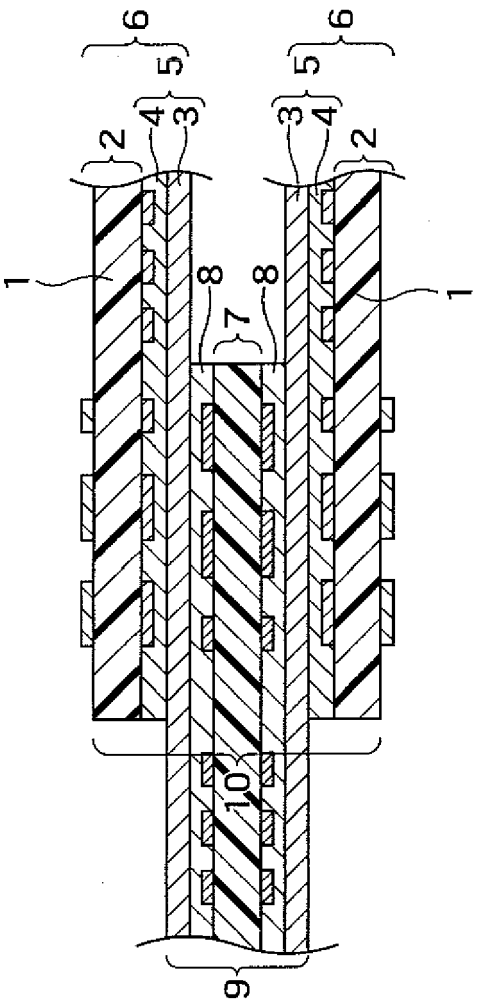


FIG. 1

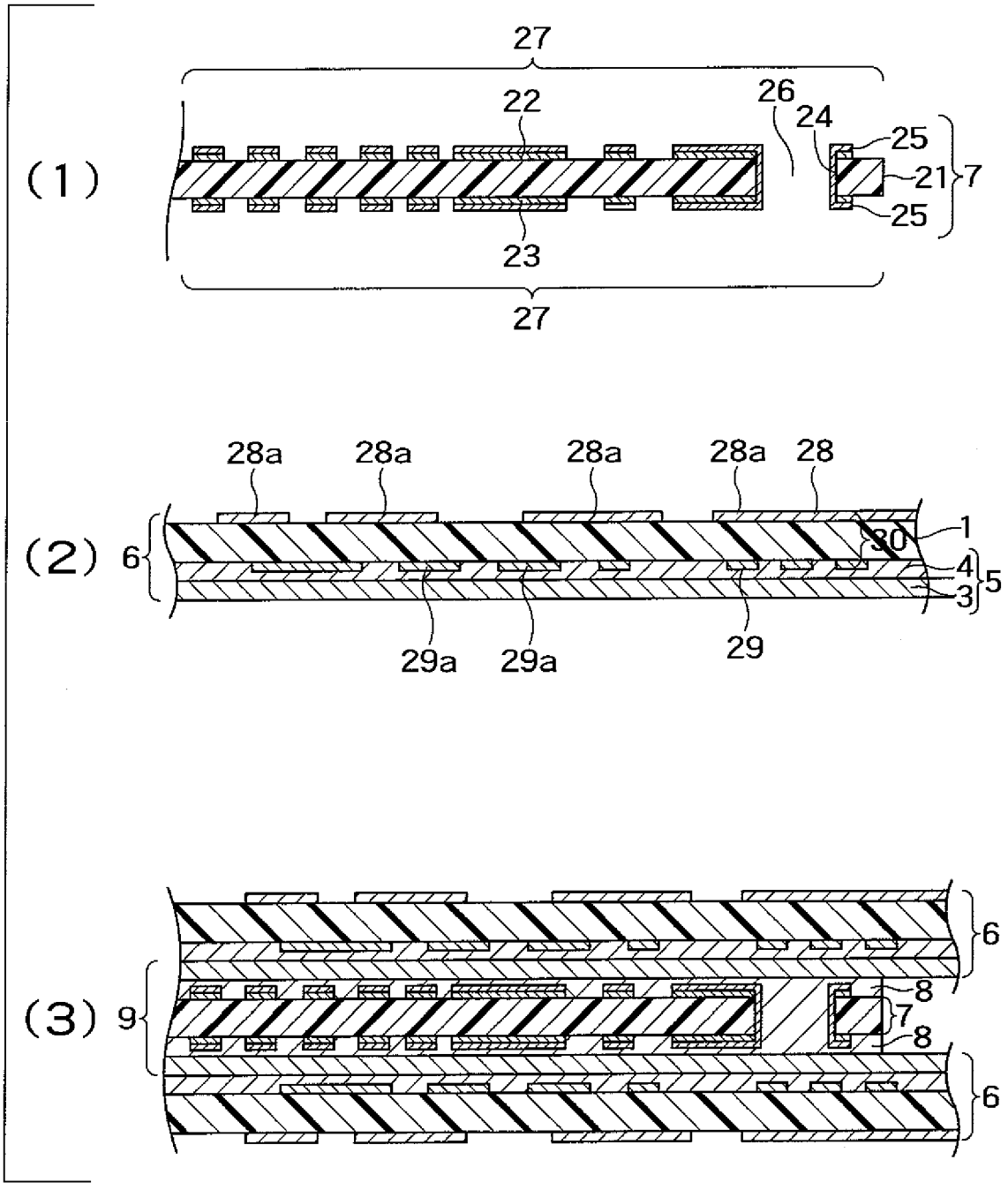

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FIG. 2

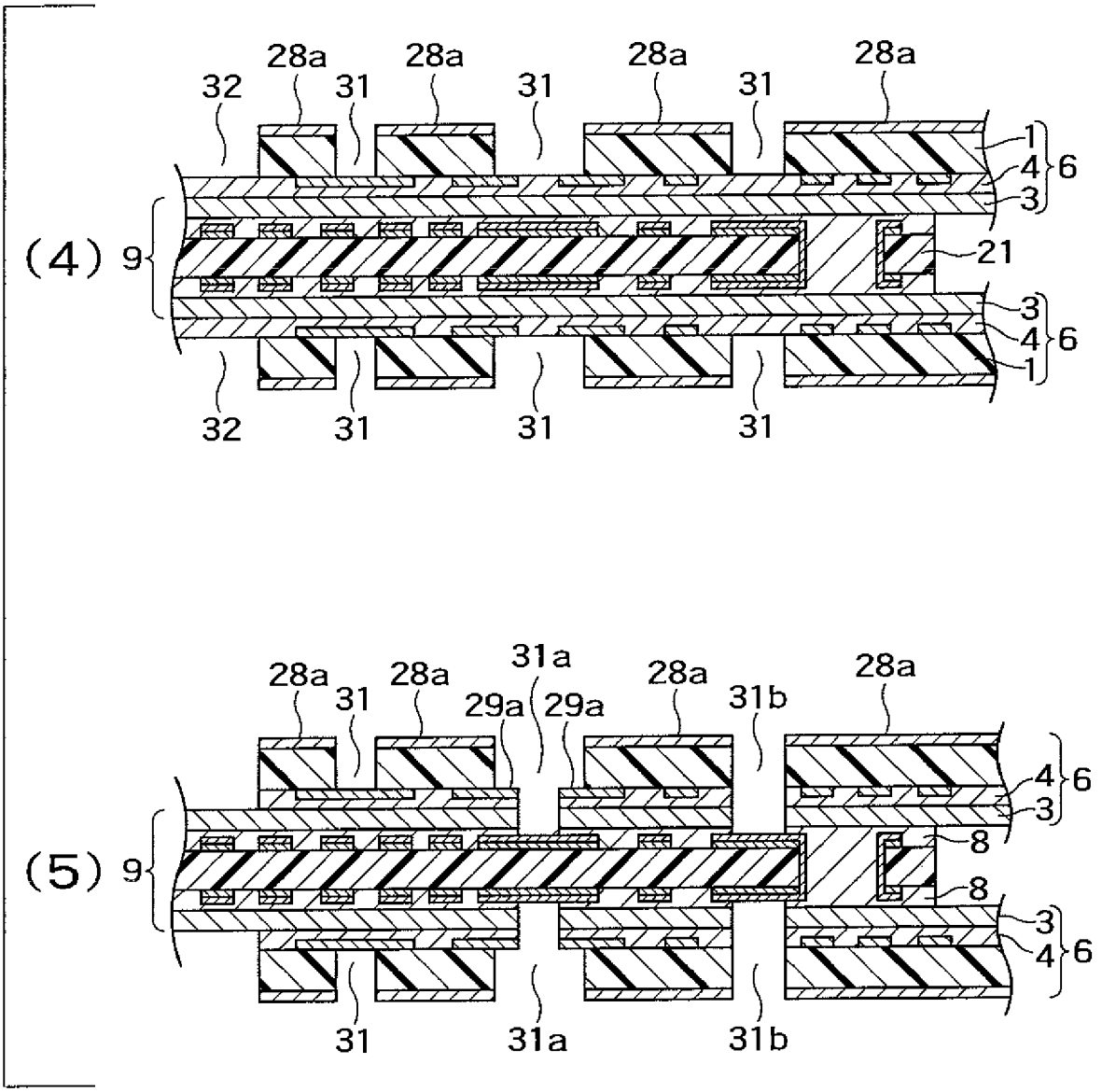

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FIG. 3

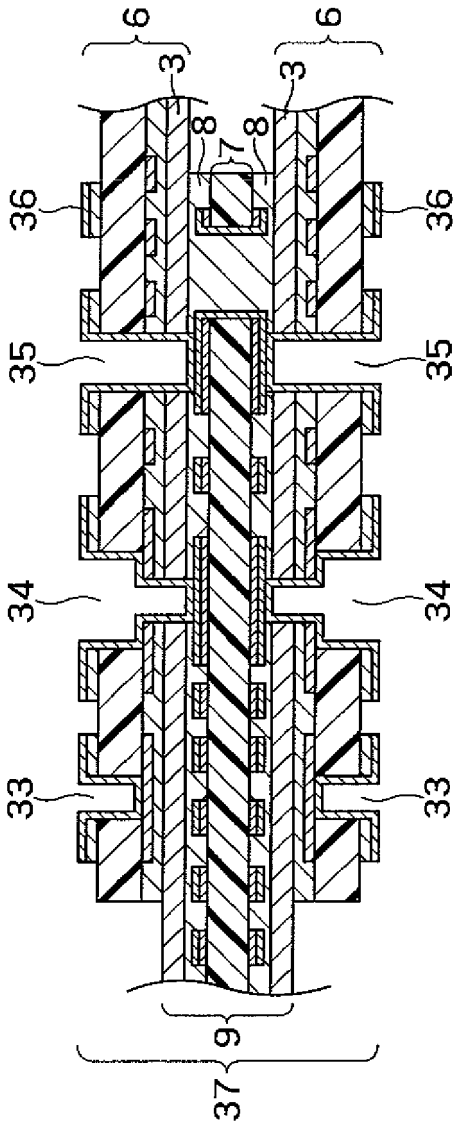


FIG. 4

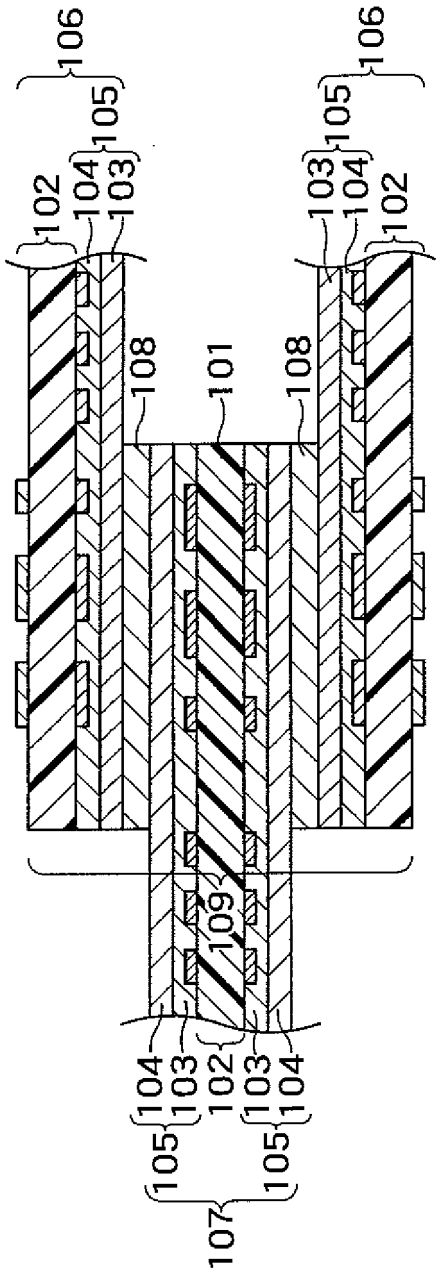


FIG. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2007/054322

A. CLASSIFICATION OF SUBJECT MATTER
H05K3/46(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H05K3/46

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2007
Kokai Jitsuyo Shinan Koho	1971-2007	Toroku Jitsuyo Shinan Koho	1994-2007

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	JP 2000-223835 A (Canon Inc.), 11 August, 2000 (11.08.00), (Family: none)	1 2
Y	JP 7-212046 A (Sharp Corp.), 11 August, 1995 (11.08.95), Figs. 2 to 4 (Family: none)	2
Y	JP 8-330734 A (Mitsubishi Gas Chemical Co., Inc.), 13 December, 1996 (13.12.96), (Family: none)	2

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Date of the actual completion of the international search	Date of mailing of the international search report
21 May, 2007 (21.05.07)	29 May, 2007 (29.05.07)
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REFERENCES CITED IN THE DESCRIPTION

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- JP 5090757 A **[0004]**