

WIRING BOARD AND PROCESS FOR PRODUCING THE SAME

1 BACKGROUND OF THE INVENTION

This invention relates to a wiring board excellent in connection reliability and a process for producing the same.

5 A wiring board usually has a plurality of circuit conductors, and through-holes having metallized inner walls in portions necessary for connecting individual layers when the circuit conductors are formed on a plurality of layers.

10 Such a wiring board is mainly produced by a subtractive process or an additive process. The subtractive process comprises drilling or punching holes in an insulating substrate having conductors on the whole surfaces for connection on necessary portions,
15 forming a metal on inner walls of the holes and the surface conductors by electroless plating or electrical plating, covering portions necessary for circuits with an etching resist, and removing exposed metal by etching to produce a wiring board. On the other hand, the
20 additive process comprises drilling or punching holes on necessary portions for connection in an insulating plate, forming a plating resist so as to expose inner walls of the holes and portions necessary for forming circuits, and forming a metal on the inner walls of
25 holes and the portions necessary for forming circuits.

1 Further, Japanese Patent Examined Publication
(JP-B) No. 50-40466 discloses a process as shown in
Figs. 6(A) to 6(D) comprising forming conductor circuits
3 on surfaces of an insulating substrate 1 (Fig. 6(A)),
5 covering the surfaces thereof with protective films
15 (Fig. 6(B)), drilling a hole 12 in the insulating
substrate together with the circuit conductors (Fig.
6(C)), and forming a metal layer 14 on the inner wall
of the hole 12 by electroless plating (Fig. 6(D)).

10 Still further, Japanese Patent Unexamined
Publication (JP-A) No. 61-176193 discloses a process as
shown in Figs. 7(A) to 7(E) comprising removing a
conductor in a size of through-hole diameter from
portions 18 of a circuit conductor 3 on a front side
15 necessary for connecting to a circuit of back side of
a double-sided copper-clad laminate 17 (Fig. 7(A) and
retaining a conductor on the back side corresponding
to the connecting portions 18 to form patterns in
desired form (Fig. 7(B)), forming a plating resist 25
20 on both sides (Fig. 7(C)), irradiating the connecting
portions 18 on the front side with a laser light until
the conductor of the circuit conductor 3 of the back
side is exposed and removing the plating resist around
the connecting portions 18 with the laser light (Fig.
25 7(D)), and forming an electroless plated film 24 on
the inner walls of the holes and around the surface
portions thereof together with the exposed portions of
the circuit conductor 3 of the back side to produce

1 a wiring board (Fig. 7(E)).

According to known subtractive processes and additive processes, since drilling or punching of through-holes is carried out at an initial stage of the
5 production processes, fabricating conditions in the later steps for conductor circuits to be connected with the through-holes are remarkably limited in order to maintain the relation to the through-holes constant. For example, when a pattern called as a land which
10 connects a through-hole and a circuit conductor is formed on a photomask which is a means for forming an etching resist, there must be taken into consideration expansion and contraction of the photomask and the insulating substrate used therein as well as an error
15 of register at the time of working.

This becomes also a limiting factor in the formation of through-holes and a resist for electroless plating in the additive process.

Such a problem of hole positions in the
20 subtractive processes and the additive processes does not take place in the process of the above-mentioned JP-B 50-40466. But, in recent wiring boards having a high wiring density, finer circuit conductors are also required. Thus, when such wiring boards are produced by
25 the process of JP-B 50-40466, since the connecting area between a through-hole and a circuit conductor portion is small, break of circuits due to thermal stress readily takes place, which could not be expected from

known wiring boards have low wiring density and results in producing a problem of lowering in connection reliability.

Further, when a laser light is used for forming holes as JP-A-61-176193, the problem of connection
5 reliability and wiring density can be solved. But in the production of multi-layer wiring boards, there arise various problems in that it is necessary to laminate a plurality of double-sided wiring boards thus treated, to form holes necessary for connection and to make inner
10 walls of through-holes electroconductive, an apparatus for forming holes at desired locations using a laser light is expensive, and the like.

Summary of the Invention

The objects of the present invention are to
15 provide a wiring board excellent in connection reliability and high in wiring density and a process for producing such a wiring board economically and easily, in spite of the number of laminated wiring layers.

According to one aspect of the present
20 invention, there is provided a wiring board comprising an insulating substrate, circuit conductors formed on each side of the insulating substrate, at least one first hole formed through the insulating substrate, a circuit hole conductor formed on the whole inner wall of the hole and
25 extending over a part of the surface of the insulating substrate around the hole in the range of 0.01 mm to 0.5 mm from the rim of the hole, electrical connection thus being provided between the inner wall of the hole and the portion of the hole conductor over the part of the
30 surface of the substrate surrounding said hole, at least one second hole formed through the insulating substrate and the circuit conductors formed on the insulating substrate, and a circuit hole conductor formed on the whole inner wall of the second hole and on the part of the
35 circuit conductors formed on the insulating substrate around the said second hole in the range of 0.01 mm to

0.5 mm from the rim of the hole, electrical connection thus being provided between the inner wall of said second hole and the part of the circuit conductors surrounding said second hole, the circuit hole conductor on the inner
5 wall of the first hole and on the substrate about said first hole having been formed simultaneously with the circuit hole conductor formed on the inner wall of the second hole and on the part of the circuit conductor surrounding said second hole.

10 A second aspect of the invention provides a wiring board comprising an inner circuit board and insulating boards laminated on both surfaces of the inner circuit board, inner circuits being provided by circuit
15 conductors provided on the outer surfaces of the inner circuit board, circuit conductors provided on the outer exposed surfaces of the insulating boards, at least one first hole formed through the insulating boards and the
20 inner circuit board, at least one second hole formed through the insulating boards, the inner circuit board, and the circuit conductors on the insulating boards, at least one circuit hole conductor being formed on the whole
25 inner wall of the or each first hole to extend over a part of the surfaces of the insulating boards around the hole in the range of 0.01 mm to 0.5 mm from the rim of the
30 hole, and at least one circuit hole conductor being formed on the whole inner wall of the or each second hole to extend over parts of the surfaces of the circuit
conductors formed on the insulating boards in the range of 0.01 mm to 0.5 mm from the rim of the hole to provide an
35 electrical connection between the inner wall of the or each said second hole and the circuit conductors formed on the insulating boards around said second hole, the circuit hole conductor on the inner wall of the first hole and on the substrate about said first hole having been formed
simultaneously with the circuit hole conductor formed on the inner wall of the second hole and on the part of the

circuit conductor surrounding said second hole.

A third aspect of the invention provides a process of producing the wiring board of the first aspect which comprises

5 a step of forming desired circuit conductors on both surfaces of an insulating substrate,

a step of forming a protective film on the whole of the surfaces of the insulating substrate having the circuit conductors thereon,

10 a step of drilling or punching at least one said first hole and at least one said second hole through the insulating substrate,

a step of removing the protective film from around each of the first and second holes in the range of
15 0.01 mm to 0.5 mm from the rim of the hole,

a step of forming a circuit conductor on the whole inner wall of the or each first hole to extend over part of surface of the insulating substrate around the hole in the range of 0.01 mm to 0.5 mm from the rim of the
20 hole and simultaneously forming a circuit conductor on the whole inner wall of the or each second hole to extend over part of the circuit conductors formed on the insulating substrate around the hole in the range of 0.01 mm to 0.5 mm from the rim of the hole, thus to provide an
25 electrical connection between the inner wall of said second hole and the circuit conductor surrounding such hole, and

a step of removing the rest of the protective film.

30 A fourth aspect of the present invention provides a process for producing the wiring board of the second aspect, which comprises

a step of forming inner circuits on both surfaces of an insulating substrate to make an inner
35 circuit board,

a step of providing insulating boards on both surfaces of the inner circuit board and forming desired circuit conductors on the exposed surfaces of the

5 insulating boards,

a step of forming a protective film on the whole surfaces of the insulating boards having the circuit conductors,

a step of drilling or punching at least one said
10 first hole and at least one said second hole through the insulating and the inner circuit boards,

a step of removing the protective film around the first and second holes in the range of 0.01 mm to 0.5 mm from the rim of the hole,

5 a step of simultaneously forming circuit hole conductors on the inner walls of the first and second hole and the portions about said holes from which the protective film has been removed in the above step, and
a step of removing the rest of the protective film.

10 Brief Description of the Drawings

Figure 1 is a cross-sectional view of one example of the wiring boards of the present invention.

15 Figures 2(A) to 2(F) are cross-sectional views explaining one example of the processes of the present invention.

Figure 3 is a cross-sectional view of another example of the wiring boards of the present invention.

20 Figures 4(A) to 4(G) are cross-sectional views explaining another example of the processes of the present invention.

Figure 5 is a cross-sectional view of a further example of the wiring boards of the present invention.

Figures 6(A) to 6(D) are cross-sectional views explaining one example of known processes.

25 Figures 7(A) to 7(E) are cross-sectional views explaining another example of known processes.

Description of the Preferred Embodiments

Figures 1 to 5 of the drawings illustrate the provision of a wiring board having a structure
30 characterised by having enlarged connecting areas between through-holes and circuit conductors and different connecting structures, and the provision of a process for producing such a wiring board characterised by fabricating circuit conductors first, drilling or punching through-
35 holes, and forming conductors on the whole inner walls of the through-holes and around portions of the through-holes

in connection in different structures.

The present invention is explained referring to the drawings.

- 5 As shown in Figure 1, the wiring board of the present invention comprises an insulating substrate 1, a plurality of circuit conductors 3 formed on both sides of the insulating substrate, a plurality of first holes (a) 2a at desired portions through only the insulating
- 10 substrate 1, a plurality of second holes (b) 2b at desired portions through the insulating substrate 1 and the circuit conductors 3, a plurality of circuit hole conductors (a) 4a formed on the whole inner walls of the holes (a) 2a and a part of surfaces of the insulating
- 15 substrate around the holes (a) 2a in connection with the inner wall of holes (a) 2a, and a plurality of circuit hole conductors (b) 4b formed on the whole inner walls of the holes (b) 2b and a part of the circuit conductors 3 formed on the insulating substrate 1 around the holes (b)
- 20 in connection with the inner wall of holes (b) 2b. The important thing is that the wiring board has both holes (a) and holes (b) having different electrical connection structures.

Such a wiring board can be produced by the

1 following process comprising:

1-A: a step of forming a plurality of desired circuit conductors 3 on surfaces of the insulating film 1 (Fig. 2(A)),

5 1-B: a step of forming a protective film 5 on the whole surfaces of the insulating substrate 1 having the circuit conductors 3 (Fig. 2(B)),

1-C: a step of drilling or punching the holes (a) 2a and the holes (b) 2b (Fig. 2(C)),

10 1-D: a step of removing the protective film 5 around the holes (a) and the holes (b) in the desired range (Fig. 2(D)),

1-E: a step of forming conductors (a) 4a and conductors (b) 4b on the whole inner walls of the holes (a) 2a and holes (b) 2b and the portions from which the protective film 5 has been removed in the step 1-D (Fig. 2(E)), and

1-F: a step of removing the rest of the protective film 5 (Fig. 2(F)).

20 In the process of the present invention, it is a very surprising thing to produce a wiring board having holes (a) and holes (b) with different electrical connection structures easily and economically.

In the wiring board mentioned above, it is possible to use an insulating substrate 1 and an inner circuit board 10 having a plurality of insulating boards 11 and a plurality of inner circuits 12 in place of the insulating substrate 1. In such a case, the wiring

1 board takes a structure as shown in Fig. 3 comprising
 an inner circuit board 10 having inner circuits 12,
 insulating boards 11 formed on both sides of inner
 circuit board, circuit conductors 3 formed on individual
 5 surfaces of the insulating boards 11, at least one first hole
 (a) 2a formed at a desired portion of the insulating
 substrate 1 through the insulating boards 11 and the
 inner circuit board 10, at least one second hole (b) 2b formed
 at a desired portion of the insulating substrate 1
 10 through the insulating boards 11, the inner circuit
 board 10, and the circuit conductors 3, at least one circuit
 hole conductor (a) 4a formed on the whole inner wall
 of the hole (a) 2a and a part of surfaces of the
 insulating boards 11 in connection with the inner wall
 15 of the hole (a) 2a, and at least one circuit hole conductor
 (b) 4b formed on the whole inner wall of the hole (b)
 2b and a part of the surfaces of the circuit conductors
 3 formed on the insulating boards 11 in connection with
 the inner wall of the hole (b) 2b.

20 Such a wiring board can be produced by the
 following process comprising:

2-A: a step of forming inner circuits 12 on surfaces
 of an insulating substrate 1 to make an inner circuit
 board 10 (Fig. 4(A)),

25 2-B: a step of forming insulating boards 11 on
 surfaces of the inner circuit board 10 and forming
 desired circuit conductors 3 on surfaces of the insulat-
 ing boards 11 (Fig. 4(B)),

1 2-C: a step of forming a protective film 5 on the whole surfaces of the insulating boards 11 having the circuit conductors 3 (Fig. 4(C)),

 2-D: a step of drilling or punching at least one
5 hole (a) 2a and at least one hole (b) 2b (Fig. 4(D)),

 2-E: a step of removing the protective film 5 around the hole (a) 2a and the hole (b) 2b in a desired range (Fig. 4(E)),

 2-F: a step of forming a circuit conductor (a) 4a
10 and a circuit conductor (b) 4b on the whole inner walls of the hole (a) 2a and hole (b) 2b and the portions from which the protective film has been removed in the step 2-E (Fig. 4(F)), and

 2-G: a step of removing the rest of the protective
15 film 5 (Fig. 4(G)).

 As the protective film 5 used in the step 1-B or 2-C, there can be used liquid, powdery or film-like conventional resins such as acrylic resins, polyester resins, polyethylenes, polypropylenes, polyvinyl
20 chlorides, polytetrafluoroethylenes, etc.

 The protective film 5 can be form by a conventional method such as roll coating, curtain coating, dip coating, fluidized bed coating, or laminating.

 It is possible to use a composite film obtained
25 by laminating two or more films having different solubilities for one kind of a removing solution as the protective film 5. In such a case, when a film having a higher solubility is placed near the insulating

- 1 substrate 1, holes are formed by the step 1-C or 2-D,
and the resulting substrate is dipped in or sprayed with
a removing solution, the protective film around the
holes can easily be removed selectively as shown in
5 Fig. 5. Such a protective film 5 is a combination of
an acrylate resin film 21 and a polyester resin film 22.

As an agent for selectively removing the
acrylate resin, there can be used trichloroethane,
trichloroethylene, methylene chloride, etc.

- 10 A composite structure of acrylate resin and
polyester resin can be available commercially under a
name of Resist Film PHT 347 for electroless plating
(mfd. by Hitachi Chemical Co., Ltd.).

- Removal of the protective film 5 around the
15 holes (a) 2a and the holes (b) 2b in the desired range
can be carried out chemically using the removing agent
(or solution) mentioned above or mechanically by
jetting water containing abrasive grains.

- The range of the removal of the protective
20 film 5 is such that the contacting area is given between
the insulating substrate 1 or the insulating board 11
and the conductor (a) 4a, and the connecting area
between the conductor (b) 4b and the circuit conductor
3 are sufficiently large. When the range is 0.01 mm or more,
25 the connection reliability becomes the same or higher
compared with that obtained by a known subtractive
process. In order to keep the distance between the
circuit conductor 3 and a neighboring circuit conductor

1 sufficient and not too narrow, the range of 0.5 mm
or less is required.

In the case of a multi-layer wiring board
according to the present invention, there can be obtained
5 the following advantages compared with a known method
wherein only one kind of hole (a) or (b) is present.
That is, the circuit conductor (a) 4a can directly
connect the inner circuit 12 with an electronic part,
and the circuit conductor (b) 4b can connect the inner
10 circuit 12 with the surface circuit 3 and an electronic
part. When only the circuit conductor (a) is formed
according to a known process, it is necessary to place
a small conductor (pad) on a surface of the insulating
board 11 for connection. In contrast, according to the
15 present invention, since the circuit conductor (b) 4b
is simultaneously formed together with the circuit
conductor (a) 4a, the use of such a pad is not necessary,
which results in making the wiring density higher due to
the vacant space of the pad.

20 The circuit conductors (a) and (b) 4a and
4b can be formed by a method of coating an electro-
conductive ink or a method of depositing a metal by
electroless plating. As the metal, the use of copper,
nickel, etc. having higher electroconductivity is
25 preferable. Further, electroless plating is more
preferable.

As the insulating substrate or board, there

1 can be used conventional ones such as glass cloth
impregnated with an epoxy resin, paper/epoxy resin,
glass composite/epoxy resin (glass composite containing
glass short fibers), paper/phenol resin, etc.

5 According to the present invention, the wiring
board has a structure wherein the connecting area
between through-holes and circuit conductors extends
not only to the cross-section of through-hole portion
of the circuit conductor but also to the circuit
10 conductor of through-hole portion, so that the connecting
area becomes larger compared with the known one.
Further, the use of pads which are used in known wiring
boards is not necessary on portions wherein the fixing
of electronic parts is only aimed at and connection of
15 the electronic parts and circuit conductors is not
necessary, or portions only connected with inner circuits
in multi-layer circuits. Therefore, the wiring design
of circuit conductors becomes easy.

 Further, in the process for producing the
20 wiring board of the present invention, since drilling
or punching of holes can be conducted after forming all
the circuit conductors, the steps can be simplified.
In addition, it is not necessary to consider an error
for adjusting the hole location at the time of fabricat-
25 ing circuits.

 The present invention is illustrated by way
of the following Examples.

1 Example 1

As an insulating substrate, a copper-clad laminate MCL-E-67 (mfd. by Hitachi Chemical Co., Ltd.) wherein glass cloth was impregnated with epoxy resin was used. On both sides of the insulating substrate, an ultraviolet curing type etching resist acrylic resin film (PHT 864, a trade name, mfd. by Hitachi Chemical Co., Ltd.) was laminated, followed by adhesion of a photomask transmitting light in a desired pattern on the etching resist film. After irradiating ultraviolet rays and development to form a desired etching pattern, an etching solution of cupric chloride was sprayed to remove unnecessary copper foils by etching for forming the desired circuit conductors.

15 Then, a composite resist for electroless plating (PHT 347, a trade name, mfd. by Hitachi Chemical Co., Ltd.) comprising an acrylate resin film and a polyester resin film was laminated on the surfaces of circuit conductor formed laminate using a vacuum laminator, followed by drilling through-holes 2a and 2b as shown in Fig. 1 at desired positions using a drilling machine.

The surfaces of the drilled laminate were polished by jetting water containing abrasive grains of 240 mesh and at the same time the plating resist was removed from peripheries of the holes in the range of 0.05 mm in average from the brim of holes.

After seeding a catalyst (PdCl_2) in the holes,

1 treatment with an electroless copper plating solution
(CC-41, a trade name, mfd. by Hitachi Chemical Co.,
Ltd.) was conducted to deposit copper in an average
thickness of 0.04 mm.

5 Then, the electroless plating resist was
removed by dipping in methylene chloride at 40°C for
40 seconds to produce a wiring board.

Example 2

As an insulating substrate, a copper-clad
10 laminate MCL-E-168 (mfd. by Hitachi Chemical Co., Ltd.)
wherein glass cloth was impregnated with epoxy resin
containing a catalyst for electroless copper plating
was used. On both sides of the insulating substrate,
an ultraviolet curing type etching resist (acrylic
15 resin, PHT 864, mfd. by Hitachi Chemical Co., Ltd.) was
laminated, followed by adhesion of a photomask trans-
mitting light in a desired pattern on the etching resist
film. After irradiating ultraviolet rays and develop-
ment to form a desired etching pattern, an etching
20 solution of cupric chloride was sprayed to remove
unnecessary copper foils by etching for forming the
desired circuit conductors.

Then, an electroless plating resist PHT 347
(a trade name, mfd. by Hitachi Chemical Co., Ltd.) was
25 laminated on the surfaces of circuit conductor formed
laminate, followed by drilling of through-holes 2a and
2b as shown in Fig. 1 at desired positions using

- 1 a drilling machine.

The surfaces of the drilled laminate were sprayed with methylene chloride at room temperature for 30 seconds to remove the acrylate resin portion of the electroless plating resist PHT 347 in the range of 0.05 mm in average from the brim of holes by dissoltuion.

After treatment with an electroless copper solution (CC-41, a trade name, mfd. by Hitachi Chemical Co., Ltd.), copper was deposited in average thickness of 0.04 mm, followed by removal of the electroless plating resist by dipping in methylene chloride at 40°C for 40 seconds to produce a wiring board.

Example 3

An inner circuit board was prepared as follows.

- 15 A copper-clad laminate MCL-E-168 (a trade name, mfd. by Hitachi Chemical Co., Ltd.) wherein glass cloth was impregnated with epoxy resin containing a catalyst for electroless copper plating was used. On both sides of the inner circuit board, an ultraviolet curing type etching resist PHT 864 (mfd. by Hitachi Chemical Co., Ltd.) was laminated, followed by adhesion of a photomask transmitting light in a desired pattern on the etching resist film. After irradiating ultraviolet rays and development to form a desired etching pattern, an etching solution of cupric chloride was sprayed to remove unnecessary copper foils by etching for forming the desired circuit conductors. Three resulting
- 20
- 25

- 1 laminates were laminated alternately with prepregs
GE 168N (a trade name, mfd. by Hitachi Chemical Co.,
Ltd.) wherein glass cloth was impregnated with epoxy
resin containing a catalyst for electroless copper
5 plating, followed by heating and pressing to make the
laminated layers into one body.

Then, an electroless plating resist PHT 347
(a trade name, mfd. by Hitachi Chemical Co., Ltd.) was
laminated on the surfaces of the resulting inner circuit
10 board using a vacuum laminator, followed by drilling
of through-holes (a) 2a and (b) 2b as shown in Fig.
4(D) at desired positions using a drilling machine.

The surfaces of the drilled laminate were
sprayed with methylene chloride at room temperature for
15 30 seconds to remove the acrylate resin portion of the
electroless plating resist PHT 347 in the range of 0.05
mm in average from the brim of holes by dissolution.

After treatment with an electroless copper
solution (CC-41, a trade name, mfd. by Hitachi Chemical
20 Co., Ltd.), copper was deposited in average thickness
of 0.04 mm, followed by removal of the electroless
plating resist by dipping in methylene chloride at 40°C
for 40 seconds to produce a wiring board.

Example 4

25 As an insulating substrate, a copper-clad
laminate MCL-E-67 (mfd. by Hitachi Chemical Co., Ltd.)
wherein glass cloth was impregnated with an epoxy resin

1 was used. On both sides of the insulating substrates,
an ultraviolet curing type etching resist film PHT 864
(mfd. by Hitachi Chemical Co., Ltd.) was laminated,
followed by adhesion of a photomask transmitting light
5 in a desired pattern on the etching resist film. After
irradiating ultraviolet rays and development to form
a desired etching pattern, an etching solution of
cupric chloride was sprayed to remove unnecessary
copper foils by etching for forming the desired circuit
10 conductors.

Then, a polypropylene pressure-sensitive
adhesive film was adhered to the surfaces of circuit
conductor formed laminate with heating and pressing,
followed by drilling through-holes (a) 2a and (b) 2b as
15 shown in Fig. 1 at desired positions using a drilling
machine.

The surfaces of the drilled laminate were
polished by jetting water containing adhesive grains
of 240 mesh and at the same time the plating resist was
20 removed from peripheries of the holes in the range of
0.05 mm in average from the brim of holes.

After seeding a catalyst (PdCl_2) in the holes,
treatment with an electroless copper plating solution
(CC-41, a trade name, mfd. by Hitachi Chemical Co.,
25 Ltd.) was conducted to deposit copper in an average
thickness of 0.04 mm.

Then, the polypropylene pressure-sensitive
adhesive film was peeled using a polishing apparatus

- 1 to produce a wiring board.

Comparative Example 1

As an insulating substrate, a copper-clad laminate MCL-E-67 (mfd. by Hitachi Chemical Co., Ltd.)
5 wherein glass cloth was impregnated with epoxy resin was used. On both sides of the insulating substrate, an ultraviolet curing type etching resist film PHT 864 (mfd. by Hitachi Chemical Co., Ltd.) was laminated, followed by adhesion of a photomask transmitting light
10 in a desired pattern on the etching resist film. After irradiating ultraviolet rays and development to form a desired etching pattern, an etching solution of cupric chloride was sprayed to remove unnecessary copper foils by etching for forming the desired circuit
15 conductors.

Then, a resist for electroless plating (PHT 347, a trade name, mfd. by Hitachi Chemical Co., Ltd.) was laminated on the surfaces of circuit conductor formed laminate using a vacuum laminator, followed by
20 drilling through-holes at desired positions using a drilling machine.

After seeding a catalyst (PdCl_2) in the through-holes without removing the plating resist around the through-holes, treatment with an electroless
25 copper plating solution (CC-41, a trade name, mfd. by Hitachi Chemical Co., Ltd.) was conducted to deposit copper in an average thickness of 0.04 mm.

1 Then, the electroless plating resist was removed by dipping in methylene chloride at 40°C for 40 seconds to produce a wiring board.

5 The wiring boards thus produced in Examples 1 to 4 and Comparative Example 1 were subjected to a test for examining connection reliability according to MIL-STD-107 by conducting a heating-cooling repeating test (one cycle: 120°C, 30 minutes → room temperature, 5 minutes → -65°C, 30 minutes → room temperature, 5
10 minutes)

 The results are shown in Table 1, wherein numbers of repetition of the heating and cooling until breakage of wiring are shown.

Table 1

Example No.	Number of repetition of heating and cooling
Example 1	1020
" 2	1300
" 3	1400
" 4	1050
Comparative Example 1	320

15 As explained above, according to the present invention, wiring boards with excellent connection reliability and high wiring density can be obtained.



23.

C L A I M S

1. A wiring board comprising an insulating substrate, circuit conductors formed on each side of the insulating substrate, at least one first hole formed
5 through the insulating substrate, a circuit hole conductor formed on the whole inner wall of the hole and extending over a part of the surface of the insulating substrate around the hole in the range of 0.01 mm to 0.5 mm from the rim of the hole, electrical connection thus being provided
10 between the inner wall of the hole and the portion of the hole conductor over the part of the surface of the substrate surrounding said hole, at least one second hole formed through the insulating substrate and the circuit conductors formed on the insulating substrate, and a
15 circuit hole conductor formed on the whole inner wall of the second hole and on the part of the circuit conductors formed on the insulating substrate around the said second hole in the range of 0.01 mm to 0.5 mm from the rim of the hole, electrical connection thus being provided between
20 the inner wall of said second hole and the part of the circuit conductors surrounding said second hole, the circuit hole conductor on the inner wall of the first hole and on the substrate about said first hole having been formed simultaneously with the circuit hole conductor
25 formed on the inner wall of the second hole and on the part of the circuit conductor surrounding said second hole.

2. A process of producing the wiring board of claim 1, which comprises
30 a step of forming desired circuit conductors on both surfaces of an insulating substrate,
a step of forming a protective film on the whole of the surfaces of the insulating substrate having the circuit conductors thereon,
35 a step of drilling or punching at least one said first hole and at least one said second hole through the



insulating substrate,

a step of removing the protective film from around each of the first and second holes in the range of 0.01 mm to 0.5 mm from the rim of the hole,

- 5 a step of forming a circuit conductor on the whole inner wall of the or each first hole to extend over part of surface of the insulating substrate around the hole in the range of 0.01 mm to 0.5 mm from the rim of the hole and simultaneously forming a circuit conductor on the
- 10 whole inner wall of the or each second hole to extend over part of the circuit conductors formed on the insulating substrate around the hole in the range of 0.01 mm to 0.5 mm from the rim of the hole, thus to provide an electrical connection between the inner wall of said second hole and
- 15 the circuit conductor surrounding such hole, and a step of removing the rest of the protective film.

3. A wiring board comprising an inner circuit board and insulating boards laminated on both surfaces of
- 20 the inner circuit board, inner circuits being provided by circuit conductors provided on the outer surfaces of the inner circuit board, circuit conductors provided on the outer exposed surfaces of the insulating boards, at least one first hole formed through the insulating boards and
- 25 the inner circuit board, at least one second hole formed through the insulating boards, the inner circuit board, and the circuit conductors on the insulating boards, at least one circuit hole conductor being formed on the whole inner wall of the or each first hole to extend over a part
- 30 of the surfaces of the insulating boards around the hole in the range of 0.01 mm to 0.5 mm from the rim of the hole, and at least one circuit hole conductor being formed on the whole inner wall of the or each second hole to extend over parts of the surfaces of the circuit
- 35 conductors formed on the insulating boards in the range of 0.01 mm to 0.5 mm from the rim of the hole to provide an



electrical connection between the inner wall of the or each said second hole and the circuit conductors formed on the insulating boards around said second hole, the circuit hole conductor on the inner wall of the first hole and on the substrate about said first hole having been formed simultaneously with the circuit hole conductor formed on the inner wall of the second hole and on the part of the circuit conductor surrounding said second hole.

4. A process of producing the wiring board of claim 3, which comprises

a step of forming inner circuits on both surfaces of an insulating substrate to make an inner circuit board,

a step of providing insulating boards on both surfaces of the inner circuit board and forming desired circuit conductors on the exposed surfaces of the insulating boards,

a step of forming a protective film on the whole surfaces of the insulating boards having the circuit conductors,

a step of drilling or punching at least one said first hole and at least one said second hole through the insulating and the inner circuit boards,

a step of removing the protective film around the first and second holes in the range of 0.01 mm to 0.5 mm from the rim of the hole,

a step of simultaneously forming circuit hole conductors on the inner walls of the first and second hole and the portions about said holes from which the protective film has been removed in the above step, and

a step of removing the rest of the protective film.

5. A process according to claim 2 or 4, wherein the protective film is a composite film comprising two or more films having different solubilities for a removing solution.



26.

6. A process according to claim 2, 4 or 5, wherein the circuit hole conductors are formed by electroless plating.

7. A wiring board according to claim 1 or 3 and
5 constructed and arranged substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

8. A process of producing a wiring board according to claim 2 or 4 and substantially as hereinbefore
10 described with reference to the accompanying drawings.
