

Method for producing etched circuits

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The present invention relates to a method for producing printed circuit boards having through-platings.

In structuring through-plated copper laminates, protecting the holes from the etching medium is a problem.

To solve that problem, *M. Hummel*: "Einführung in die Leiterplattentechnologie" [Introduction to printed circuit board technology], pages 98-100, Eugen G. Lenze Verlag AG (1991) proposes the "tenting technique", wherein a solid film (dry film resist) laid down over the holes like a tent acts as an etching resist. It is, however, a disadvantage of that method that annular rings of copper are produced around the through-platings, which limits the wiring density of the printed circuit board.

According to *H. Schwab*: "Electrodeposition of Photoresists for Printed Wiring Board Application", EIPC Winter Conference 1992, such annular rings can be reduced or even entirely eliminated when a positive photoresist applied by electrical immersion coating (electrodeposition) is used as the etching resist. The positive photoresists customarily used in the art require relative long light-exposure times, however. Moreover, electrical immersion coating is associated with significant technical cost.

The aim of the present invention was to develop a less costly method for structuring through-plated inner and outer layers.

It has now been found that, when a liquid negative electrodeposition-resist is used, the formation of annular rings can be significantly reduced or entirely avoided.

The present invention relates to a method for producing printed circuit boards having through-platings, which comprises the following method steps:

- (A) coating both sides of a through-plated copper laminate using a negative electrodeposition-resist;
- (B) structuring the resist coating by imagewise exposure to light, the through-platings being covered by a mask, and then developing;



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- (C) applying a metal resist by electrodeposition;
- (D) removing the crosslinked negative photoresist remaining on the laminate;
- (E) removing the bare copper by means of an etching solution; and
- (F) removing the metal resist by means of a stripper solution.

The invention is illustrated by the accompanying drawings.

Figure 1 shows a copper laminate (inner or outer layer having through-platings 3) which, in method step (A), is coated with a liquid negative photoresist by means of customary methods, for example spin-coating, immersion, knife coating, curtain pouring, screen-printing, brush application, spraying, electrostatic spraying or roller coating.

Copper laminates generally consist of an insulating substrate (1, Fig. 1), which is coated on both sides with a thin copper foil (2, Fig. 1, coating thickness about from 10 to 50 μm).

Glass-fibre-reinforced epoxy resins, especially epoxy resins provided with suitable flame protection agents, are preferably used as the insulating substrate for copper laminates (FR-4 laminates).

The laminate is preferably coated by means of roller coating or screen-printing.

Where appropriate, the solvent is subsequently removed by drying in a circulating-air oven or an infra-red oven.

The thickness of the dried photo-sensitive coating (4, Fig. 2) so applied is advantageously from 3 to 30 μm , preferably from 5 to 15 μm .

In method step (B), in accordance with known methods, the coated laminate is exposed to light through a mask corresponding to the structure to be applied, the resist composition being cured on the surface regions to be removed later.

Where appropriate, subsequent thermal curing is carried out after method step (B) for the purpose of completely crosslinking the polymers in the resist composition.

The non-crosslinked polymer is removed by treatment with a solvent, preferably water or aqueous alkali solution, in accordance with known methods (Fig. 2).

Then, in method step C, using known methods, a metal resist (5, Fig. 3) is laid down by electrodeposition on those surface regions from which the photopolymer was removed by developing.

Preferred metal resists are tin, nickel, lead, silver, gold or an alloy comprising one of those metals. Special preference is given to tin.

In method step D, the crosslinked photoresist material still remaining on the board is removed by treatment with a suitable solvent (stripping), preferably aqueous sodium hydroxide solution or potassium hydroxide solution, where appropriate at elevated temperature.

The laminate is then treated with a copper-etching solution, for example a solution of $\text{Cu}(\text{NH}_3)_4\text{Cl}_2$, KMnO_4 or $(\text{NH}_4)_2\text{S}_2\text{O}_8$, the copper surfaces that have been uncovered being completely removed (Fig. 4).

Then, in the final process step, the protected copper conductors and through-platings are cleared of metal resist. This is carried out in accordance with known methods by treatment with a suitable stripper solution that attacks and dissolves the metal of the resist but not the copper (Fig. 5). Suitable stripper solutions generally comprise dilute acids, for example hydrochloric acid or tetrafluoroboric acid.

Where appropriate, the metal resist may also be left on the copper. When tin is used as the metal resist, a heating step is preferably carried out subsequently, resulting in the tin's melting around the regions of copper, thereby enveloping them.

By this means, there is obtained a double-sided printed circuit board having through-platings which may have no, or only very small, annular rings.

Example 1:

A 0.3 mm-thick, non-structured inner layer with through-platings of 0.25 mm is coated with Probimage® 1020 (negative resist, Ciba Specialty Chemicals) by means of a roller coater.

The coating is then dried for 5 minutes at 80°C in a circulating-air oven. A resist coating thickness of 11 mm is achieved by that means. Both sides are then exposed to light through a photo-mask containing a positive image of the conductor configuration to be produced; the photo-mask covers the through-platings, which have a diameter of 0.25 mm, with a patch 0.3 mm in diameter. The light-exposure energy is 150 mJ/cm². After dissolving away (developing) the non-crosslinked coating using 1 % sodium carbonate solution in a spray developer at 2 bar, 35°C for 40 seconds, rinsing with deionised water and hot-air drying, the plate is immersed in a bath for tin electrodeposition. In the acidic tin bath, a coating about 8 mm thick is built up by cathodic deposition at the developed locations. In the next step, the photo-crosslinked Probimage® 1020 is treated with 3 % potassium hydroxide solution at 60°C in a spraying apparatus (spray pressure 3 bar) and removed from the board. The regions of copper that are uncovered are then etched away using ammoniacal copper(II) chloride solution. The board is rinsed with deionised water and, in the final step, the tin is removed using an acid stripper solution. There is obtained an inner layer which has through-platings with only small residual rings, the ring thickness being 0.025 mm. The through-platings show no sign of any etching.

CLAIMS:

1. A method for producing printed circuit boards having through-platings, which comprises the following method steps:

- (A) coating both sides of a through-plated copper laminate using a liquid, negative electrodeposition-resist;
- (B) structuring the resist coating by imagewise exposure to light, the through-platings being covered by a mask, and then developing;
- (C) applying a metal resist by electrodeposition;
- (D) removing the crosslinked negative galvanic resist remaining on the laminate;
- (E) removing the bare copper by means of an etching solution; and
- (F) removing the metal resist by means of a stripper solution.

2. A method according to claim 1, wherein in method step (A) the copper laminate is coated by means of roller coating or screen-printing.

3. A method according to claim 1, wherein tin, nickel, lead, silver, gold or an alloy comprising one of those metals is used as the metal resist in method step (C).