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OPTIMIZATION OF THROUGH-HOLE PLATING METHOD FOR PROTOTYPING

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Anotace:
This paper deals with optimizing of copper plating process for manufacturing of small amount of printed circuit boards. This treatise describe problematic of copper plating based on reverse pulse. Main discussed procedure in this paper is activation of printed circuit board surface for conformal copper plated surface of through holes.

Tento článek se zabývá optimalizovaným procesem pokovení mědí pro prototypovou výrobu desek plošných spojů. Toto pojednání popisuje problematiku pokovení mědí s využitím reverzně pulsního proudu. Hlavní cast procesu o níž pojednává tento dokument je aktivace povrchu desek plošných spojů pro rovnoměrné pokovení mědí povrch průchozích otvorů v deskách plošných spojů.

INTRODUCTION

Nowadays, many methods are used for through-hole copper plating in the series production and in the prototyping. Copper plating can be made by method of direct current plating, pulse plating or reverse pulse plating. For smaller production and smaller holes diameters is commonly used pulse or reverse pulse plating [1,2]. "Switchable reverse pulse plating producing more uniform copper plating for difficult aspect ratios and smaller holes. Reverse pulse plating is also very useful for small holes on high density PCBs and improves production reliability during soldering. Reverse pulse plating uses precisely controlled reverse pulses to remove excess material during the plating process. [3]" Sometimes is difficult to obtain sufficient results from common used processes due to influence on the many parameters. One parameter is preparation of holes surface before copper plating. For activation of surface can be used a few special chemical solutions (for example solution of copper sulfate, calcium hypophosphite and ammonium hydroxide [4]), but principle is simple. Homogenously activate/cover surface of plated holes.

This paper deals with innovative method of copper plating, mainly part of preparation of sample surface for plating. Method is based on reverse pulse plating and the main innovation is on usage of lower ambient pressure during activation of surface. In the case of plating the copper with the aid of electrical energy is needed to the surface of the drilled holes to first prepare / activate the electric copper plating. This process is crucial in terms of the creation and uniform conformal layers that allow adhesion and growth of the copper layer. [3]

METHODOLOGY

Chapter methodology describe methods, equipment and materials, which will be used for verification of new principles described in the next part.

Innovative methods in through-hole plating

As was mentioned in the beginning of this paper, during activation of non-conducting surface (drilled holes) can be helpful some additional parts of this process. One innovation in the process is addition lower pressure for better leak of activator to smaller holes. It is well known fact, already low vacuum decrease surface tension of liquids and causes expansion of gasses. It allows, air trapped in smaller holes, go outside and activator solution go inside. [5]

Other concept is using ultrasound transferred to the test vehicle. "An ultrasonic wave is reflected when it strikes an interface between materials with different speeds of sound (acoustic impedance). Furthermore, an interface between materials with a larger difference in acoustic impedance reflects ultrasonic waves more strongly and that with a smaller difference in acoustic impedance reflects them less strongly and lets part of them travel through. [6]"

The last concept is connection of previous concepts into one.

Test vehicle

Test vehicle you can see on the Fig. 1. Dimension of test coupon is 70 x 13 mm. Through holes are represented by green circles. Test pads are fabricated on the both sides of the PCB and they are connected to the VIAs. Holes diameter is in the range 0,2 – 1,5 mm. Holes with different diameters are positioned uniformly for better control of plating process. Two rows of holes with mirrored sequence to each other. Base material will be used FR4 with both sides plated 18 µm of copper.

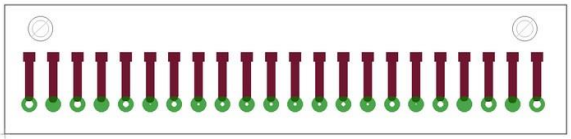

Fig. 1: Test vehicle

Equipment

Copper plating will be provided by LPKF MiniContac RS (Fig. 2). This device use reverse pulse method for plating. That method, reverse pulse copper plating, provides sufficient parameters for conformal coating of copper during plating. Innovation in this process will be vacuum chamber (Fig. 3) for activator solution, which allows activation of holes with smaller diameter than before.

Fig. 2: MiniContac RS

Fig. 3: Additional equipment – vacuum chamber

For investigation of plated holes reliability will be used current overload test method. Plated holes will be tested for hold on 1 amp. On the Fig. 4 can be seen fixture for current load measurement. Pictures on the right top corner are situated details on measurement pins. Two pins are placed from top side and two from bottom. This arrangement is due to using of pins for four-point method (two pins for current, two pins for voltage). Between top and bottom pins will be placed measured pattern of test vehicle. During test will be measured voltage/resistance of tested plated hole in the sample.

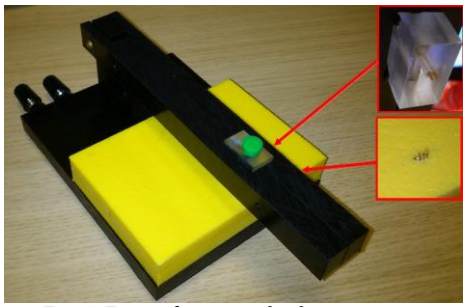

Fig. 4: Fixture for current load measurement

RESULTS

Samples were fabricated by standard method (reference sample) and optimized method with vacuum using (sample fabricated with using vacuum).

First analysis was electrical testing of resistivity. There was seen two cases of resistivity, resistivity under 0,01 Ω (plated holes) and very high resistivity (unplated holes). Defects were identified mainly for 0,2 mm diameter holes. Approximately 30 % of these small holes were unplated.

Second analysis was provided by X-Ray inspection equipment. Results are presented on the figure 5 and figure 6. On the first figure is shown unplated through hole of reference sample. Figure 6 shown right plated hole of sample fabricated with using vakuum.

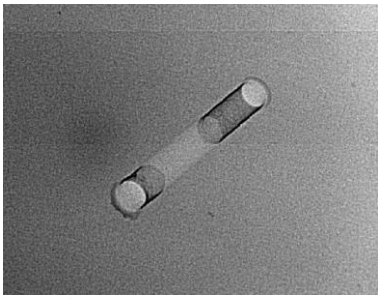

Fig. 5: Reference sample – unplated through hole

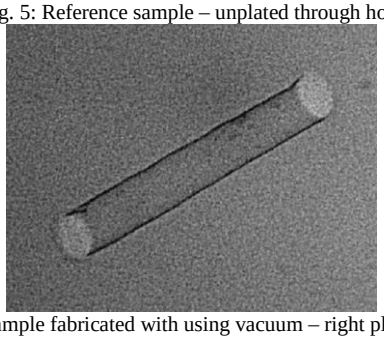

Fig. 6: Sample fabricated with using vacuum – right plated hole

CONCLUSIONS

Copper plating methods and processes are well known, but there are still some more possibilities for innovations. New additional process parameters, like low vacuum and/or ultrasound, can be very helpful in the way for reliable plated through hole on the prototypes of PCB's.

Results are shown contribution of added vacuum. This innovation helps reduce defects caused by activation process. Other described innovations in processes will be verified by experiments and results will be published.

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