High throwing power nickel electroplating and its application

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Introduction

One of drawbacks of nickel electroplating is low or poor throwing power. A Nickel electroplating solution with high throwing power has been developed and its benefits are discussed in this paper. The presentation specifically reports on the application of nickel plating to printed circuit boards with solder mask or photo resist.

Experimental

Throwing power is measured with a Haring-Blum Cell at distance ratio of 1:5 between two cathodes and an anode, plating at 2A for 30minutes. Throwing power (T.P.) is shown as follows.

$$T.P.(\%)=100(5 - M)/5 + M - 2$$

Where M is the ratio of the weight of the deposited metals on cathodes.

Results

The T.P. of various nickel plating solutions are shown in Table 1. The T.P. of a nickel bath which contains low nickel metal concentration and very high concentration of conductivity salts and contains no chelating agent of nickel ion was excellent. The T.P. of a Watts type bath with a nickel concentration of 12g/L and nickel ion chelated with a citrate was not good.

The optimum plating conditions of the high T.P. nickel plating bath are shown in Table 2.

Properties of the nickel deposits of high T.P. sulfate and halide baths are shown in Table 3 as well as comparisons to the Watts type and nickel sulfamate baths. The T.P. of the high T.P. halide bath is considered superior as exhibited in Table 1, but the color of the surface deposit is brownish and it is not good for actual use.

Lift-off of solder mask was recognized with nickel solutions containing sodium or potassium ion and with a Woods nickel bath containing hydrochloric acid which was cathodically electrolyzed (Table 4). But no lift-off was recognized with a Watts type, nickel sulfamate bath or nickel bath containing 1M conductivity salt (except sodium or potassium ions) which was electrolyzed.

The roughness of deposit from the high T.P. sulfate bath is uniform and greater than that of the Watts type and nickel sulfamate baths, and the color of the surface of the deposit is uniform and gold wire bondability is excellent when gold plating is deposited on it. The deposit from the high T.P. sulfate bath has been used as an underlayer of precious metal electroplating , tin or solder electroplating.

Summary

A Nickel electroplating bath with high throwing power is prepared by using low nickel concentration, very high concentration of conductivity salts and proper plating conditions. It is concluded that lift-off of solder mask or photo resist on copper substrate (PWB's) after the nickel plating is dependent on the composition of the nickel plating solution.

The high throwing power nickel plating solution has been used for about 10 years for nickel plating of ceramic IC packages, tip capacitors, lead frames, and PWB's.

Bath type	Ni(g/L) in bath	Throwing Power(%)
Watts type bath	73	6
Low Ni Watts type	12	6
Ni sulfamate bath	73	8
Ni chelated bath(pH 4.3)	24	-11
High T.P. sulfate bath	12	30
High T.P. halide bath	12	50

Table 1. Throwing power of Ni baths [1)]
T.P.; Throwing Power

Bath pH	4.4
Bath temperature	55° C
Cathode current density	1A/dm^2
Agitation	Cathode rocking; 1m/min.

Table 2. Standard plating condition of high T.P. nickel plating baths[1,2,4)]

Bath	Hardness (Hv)	Stress (Kg/mm^2)	Ductility (mm)
Watts type	241	42	5
Ni sulfamate	280	-7	6
High T.P sulfate	213	16	8
High T.P. halide	278	44	6

Table 3. Properties of nickel deposits

Cathodic current density;1A/dm^2, Ductility; Erichsen Test (bent distance; mm).

Test solution	Dipping	Cathodic Electrolysis
Alkaline cleaner (contained Na ion)	－	＋
Ni bath contained 1M Na or K ion as conductivity salt	－	＋
1M Na or K ion + boric acid	－	＋
Woods Ni bath (Ni chloride 100g/L+HCL 100g/L)	－	＋
Watts type bath	－	－
Ni sulfamate bath	－	－
Ni bath contained 1M conductivity salt except Na or K ion	－	－

Table 4. Lift-off of solder mask or photo resist on copper substrate.
(＋ ; lift-off, － ; no lift-off)

References

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