Acid Copper Plating Additive for Via-filling applicable to Fine Pattern

『Top Lucina NSV』

The conventional plating bath for via-filling is based on the acid copper plating bath which contains high concentration of copper sulfate and low concentration of sulfuric acid, and has subject to the throwing power.

Especially, in case of pattern plating applied in mainly semi-additive method, uneven film thickness occurs by the size or density of pattern. The newly developed “Top Lucina NSV” can be applied to via-filing plating at the plating bath having low concentration of copper sulfate and higher concentration of sulfuric acid, which is similar to high-throwing power bath, and gains excellent throwing power. Therefore, “Top Lucina NSV” is suitable for via-filling plating on packaging board having fine pattern.

Background of Development

Recently, to apply to the trend of higher performance and miniaturization of electronics devices, higher density and thinner board are demanded to the printed wiring boards, and build-up process has been applying widely. Furthermore, in the recent build-up wiring boards, filled via which blind via-holes is filled by conductive material to apply interlayer connection and the structure called stacked via which forms filled via in direct line have been applying widely.

For formation of filled via, the filling method of conductive resin has been applying. However, for the purpose of simplification of treatment process and improvement of reliability, and as there is some restrictions in its manufacturing process in semi-additive process applying widely to manufacturing package board which requires extremely high density and high accuracy circuit formation, via-filling by plating has been applying widely.

On the other hand, acid copper plating additives to accomplish via-filling which is filled via by plating are put into the market by various chemical suppliers. We already put Top Lucina BVF and Top Lucina α into the market. Especially, Top Lucina α has been used by many clients, as it can be also applied to pattern plating and through-hole plating.

However, these via-filling plating bathes are based on decorative acid copper plating bath which contains high concentration of copper sulfate and low concentration of sulfuric acid. So, in pattern plating which has been applying mainly at semi-additive process, it has one subject which the plating film thickness becomes uneven by the size and density of patterns. This subject is suppressing the further development of high density circuit.

Under this circumstance, we treated this difficult subject and succeeded in development of new additive for via-filling having excellent throwing

Application Method

Table 1 shows the application condition and Table 2 shows the bath control method of Top Lucina NSV respectively.

Unlike to the conventional via-filling plating, Top Lucina NSV uses the bath composition of similar to high-throwing power bath which contains low concentration of copper sulfate and high concentration of sulfuric acid. Top Lucina NSV-1 contains polymer component, Top Lucina NSV-2 contains brightener component and Top Lucina NSV-3 contains leveler component respectively. By maintaining the chlorine concentration at low concentration of 6 mg/L, Top Lucina NSV bath creates both good via-filling effect and throwing power.

Table 1 : Application Condition

	Standard	Applicable Range
Copper Sulfate	100 g/L	80～120 g/L
Sulfuric Acid	180 g/L	160～200 1g/L
Chlorine Ion	6 mg/L	4～8 mg/L
Top Lucina NSV-1	4 ml/L	2～8 ml/L
Top Lucina NSV-2	0.5 ml/L	0.3～1.0 ml/L
Top Lucina NSV-3	1 ml/L	0.7～2.0 ml/L
Bath Temperature	23 ℃	20～25 ℃
Cathodic Current Density	1 A/dm^2	0.5～1.5 A/dm^2

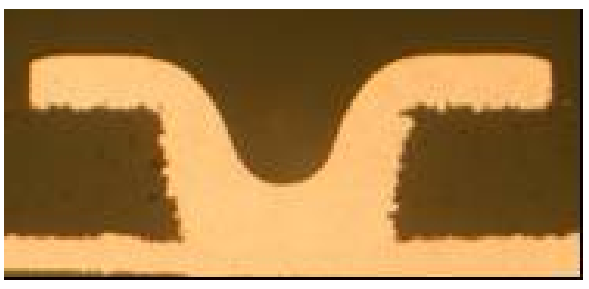
Table 2 : Bath Control Method

Control Item	Analysis Method
Copper Sulfate	Chelate Titration Method
Sulfuric Acid	Neutralization Titration Method
Chlorine Ion	Turbidity Method
Top Lucina NSV-1	CVS Analysis, DT-1 Method
Top Lucina NSV-2	CVS Analysis, LAT Method
Top Lucina NSV-3	CVS Analysis, RC Method

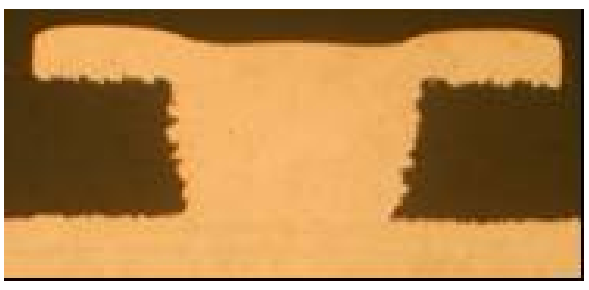
As the bath control method, we can apply the conventional analysis method, and 3 additive components can be analyzed by CVS. However, with reference to the concentration of chlorine ion, the potentiometric titration method which has been applying widely can not be used owing to too low concentration.

Filling Effect

Fig. 1 shows the comparison of filling effect between Top Lucina α and Top Lucina NSV at the same concentrations of copper sulfate and sulfuric acid. At the bath composition of copper sulfate 100 g/L and sulfuric acid 180 g/L, which is hard to obtain good filling effect for Top Lucina α, Top Lucina NSV shows good filling effect.



Top Lucina α



Top Lucina NSV

Fig.1 : Comparison of Filling Effect of Top Lucina α and Top Lucina NSV

Throwing Power

We compared the film thickness distribution of Top Lucina α and Top Lucina NSV in piece at pattern plating at the standard condition respectively. The results of them are shown in Fig. 2 and Fig. 3 respectively. In this test, we used same pattern plating board and measured the throwing power by ultra-depth geometry measurement microscope, and show in histogram.

From Fig. 2 and Fig. 3, it is clear that Top Lucina NSV has excellent throwing power.

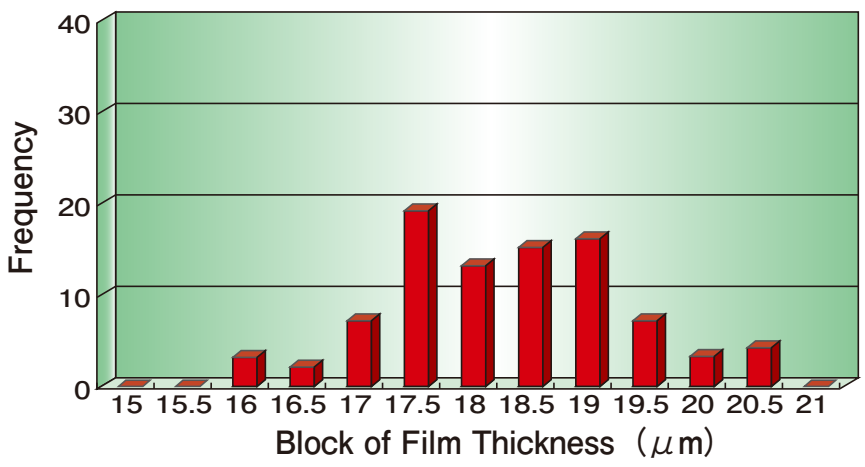


Fig.2 : Film Thickness Distribution in Piece of Pattern Plating at Standard Condition of Top Lucina α (Copper Sulfate : 200 g/L, Sulfuric Acid : 50 g/L)

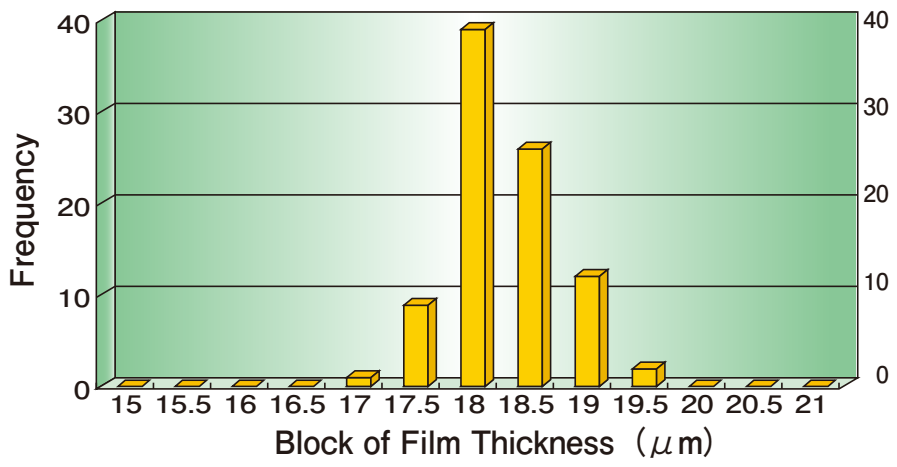


Fig.3 : Film Thickness Distribution in Piece of Pattern Plating at Standard Condition of top Lucina NSV (Copper Sulfate : 100 g/L, Sulfuric Acid : 180 g/L)

Physical Properties of Deposition Film

Table 3 shows the elongation ratio and the tensile strength of the plating film gained by changing the addition amounts of each additive.

From this result, we found that Top Lucina NSV had good elongation ratio and tensile strength at every addition amounts and showed excellent physical properties.

Table 3 : Film Physical Properties at Each Concentration of Additives

Addition Amount	Standard	NSV-1		NSV-2		NSV-3	
		1ml/L	8ml/L	0.25ml/L	1ml/L	0.5ml/L	2ml/L
Elongation Ratio (%)	22.4	22.8	24.8	21.6	22.8	23.6	23.0
Tensile Strength (N/mm^2)	301	299	286	283	289	290	301

Conclusion

To apply to the next generation packaging board, we developed additive for via-filling applicable to fine pattern named “Top Lucina NSV”. The bath composition for this additive is not based on the conventional decorative acid copper plating bath for via-filling, but accomplishes good via-filling by the bath composition of similar to high-throwing power bath.

“Top Lucina NSV” provides new type via-filling plating which has excellent throwing power, filling effect and film physical properties.

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