

Optimization of Leveler Concentrations in Copper Via Filling for Deduction of Contamination

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Copper via filling by electroplating method became a common technology for interlayer metallization in 3D SiP(System in Packaging). [1~4] Through-chip electrodes with high aspect ratios can offer the shortest interconnection and reduce signal delay. In this study, the minimum concentration of levelers on the copper via filling was investigated. In preliminary researches, the void free copper via filling can be obtained with optimized plating conditions such as current density, current mode and additives (inhibitor, accelerator, leveler). However, reducing the use of additives is another issue for copper via filling due to the contamination problems of via with additives. The acidic copper electrolytes containing levelers were examined to investigate the deposition morphologies and filling characteristics. Three different levelers were investigated to study the effects of levelers on copper deposition. The typical electrolyte compositions are listed in table 1.

Table 1. Bath compositions for copper via filling

Bath compositions	Functions
CuSO ₄	Copper source
H ₂ SO ₄	Throwing power
PEG	Suppressor
SPS	Accelerator
JGB, DV, MV	Leveler

The effects of levelers were analyzed by several methods such as polarization plots, galvanostatic plots and surface morphologies of electroplated copper layer. Fig. 1 showed the polarization plot of copper deposition in each leveler containing electrolyte.

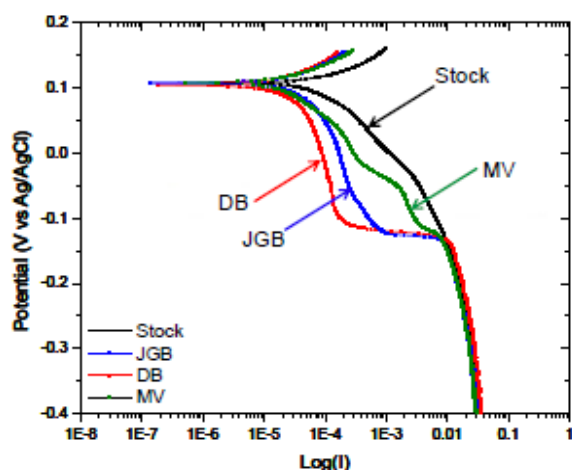


Fig. 1. Polarization plots with variation of levelers

After the electrochemical analysis, copper via filling were conducted with those levelers. Different filling morphologies were observed with variations of levelers. Defect free copper via filling was not achieved without levelers. Moreover, other experimental conditions were examined such as current density and concentrations of levelers. The optimum contents of levelers were different with

variations of levelers and bottom-up filling morphologies were achieved with proper experimental conditions. Fig. 2 shows the filling trend with leveler concentrations. The defect free filling at low concentration was achieved.

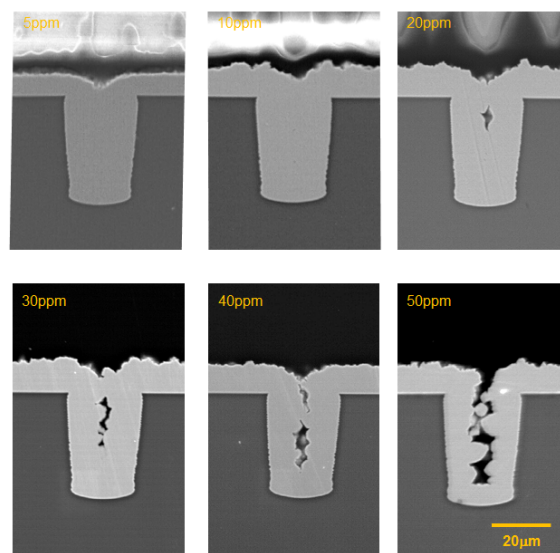


Fig. 2. Effect of JGB concentrations on via filling

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