Panel Plate and Pattern Plate Process Optimization for Fine Line Manufacturing

Expertise
As the telecommunication devices and portable devices become more compact in size and more powerful on their function. The PCB also becomes smaller and more dense. Line width and spacing are going to be the level of 2mil on rigid PCB. Do your outer layer circuitization process is ready optimized to produce PCB with this requirements? In this article, although only simple mathematical calculations and simulation are used, it could help you to understand your situation.

Panel Plate and Pattern Plate Process

Partial Pattern Plating
It is the most common used circuitization process in China and Hong Kong. For 1mil hole wall copper finishing, typically, 0.3mil panel copper is plated and then 0.7mil pattern copper is plated after dry film process. The benefit of this process is optimized the amount of copper to be etched and the amount to be plated in pattern plate process.

Full Pattern Plating
Electrolytic copper is plated on the medium/high build electroless copper after dry film process. Minimum thickness of copper is required to be etched. However, there is a challenge on copper plating distribution on the pattern plating process.

Full Panel Plating
Right after electroless copper process, electrolytic copper is plated on the panel to the copper thickness required. The best copper thickness distribution can be achieved because of no pattern during plating. However, etching process become critical on producing fine lines.

Fine Line Capability
The dry film resolution, the etching process control and copper plating distribution are the primary factors affecting fine line capability.

The typical capabilities related to fine line capability of these processes are as below,

<table>
<thead>
<tr>
<th>Capability</th>
<th>Value</th>
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<tbody>
<tr>
<td>Dry Film Resolution -</td>
<td>Line and Space is 1.5 times of thickness</td>
</tr>
<tr>
<td>Panel Copper Distribution -</td>
<td>40% maximum to minimum point different</td>
</tr>
<tr>
<td>Pattern Copper Distribution -</td>
<td>100% maximum to minimum point different</td>
</tr>
<tr>
<td>Etch Factor of Alkaline Etching-</td>
<td>2</td>
</tr>
<tr>
<td>Etch Factor of Acidic Etching -</td>
<td>3</td>
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Based on calculation by the assumptions above, a minimum resolution capability and line width variance curves could be obtained with different pattern and panel thickness combinations.

From the curve, it could be observed that the optimum panel and pattern thickness combination for 1 mil copper thickness in hole is 0.3mil to 0.7 mil which is the most common used combination in PCB shops.

Dry film resolution is the primary factor affecting the line resolution. With 1.5mil dry film. The best resolution could be achieved is 2.25mil line and spacing. If better resolution required, thinner dry film must be used, such as 1.3mil dry film could get 1.95mil line and spacing resolution.

Theoretically, the thinner the copper is etched, the more consistency the line resolution is. However, when the panel copper is thin, more pattern copper is required. Line and space resolution will be deteriorated because of over plating.
Based on the previous assumptions, if thinner dry film is used, the best resolution could be achieved by changing the panel and pattern plate thickness ratio from 0.3 to 0.7 to 0.4 to 0.6.

**Conclusion**

There are 3 ways to get finer line and spacing, but no matter which way will be used, the thinner dry film or dry film with high resolution is the fundamental on producing fine line and spacing.

1. **Changing the pattern and panel plate thickness ratio**

   This is the simplest way almost no additional investment. As explained above, when thinner dry film is used, thinner pattern plating copper should be plated to avoid over plating.
   Since minimum panel copper is preferred, when there are isolated lines, the panel and pattern copper ratio may vary with different part numbers.

2. **Reverse pulse pattern plate with thin or no panel plate**

   Pattern distribution is the basic concern of pattern plating process. Reverse pulse pattern plate is the latest technology to enhance plating distribution. However, the compatibility between dry film and reverse pulse plating electrolyte is a question.
3. Horizontal reverse pulse full panel plate with high etch factor acidic etch process

Perhaps this is the ultimate solution to produce consistent fine lines. Without pattern plating, much thinner dry film can be used. The plating distribution will not affected by the circuitry design, but high investment cost is required for horizontal reverse pulse full panel plating machine.

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