Stencil Technology: 2011

SMTA Carolinas Chapter & GMI
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Current Stencil Technology Summary
Processes, Materials, Capabilities, Variables

Predicting Paste Release
Opening size, Foil thickness, Technology
Fine Pitch, QFN/Flip Chip, uBGA, 01005

Stencil Coatings: Why they should help

I think in mils [0.5 mils = ~12.5 microns]
Vast majority of SMT stencils are laser cut stainless steel [SS]
- Premium grades of SS do not benefit from electro-polishing

Perhaps 10% are Nickel Electroformed

We expect these levels to continue in the short term.
- Improving stencil laser technology
- Improved stainless steel foils
- The march toward smaller and smaller openings may have slowed
How Nickel Eform Foils are Made

- Resist on mandrill is imaged with a master photoplot
- Resist pillars remain after developing
- Nickel is electroformed, atom by atom
- Ni foil is ready for QA & assembly
Predicting Good Paste Release

3.2.1.2 Area Ratio/Aspect Ratio  A general design guide for acceptable paste release is >1.0 for aspect ratio and >0.50 for area ratio but this depends on the stencil technology.

Suggested Area Ratios for Stencil Technologies

Laser Cut  minimum 0.66
Ni E Form  minimum 0.50

When the stencil separates from the board, paste release encounters a competing process: solder paste will either transfer to the pad on the board or stick to the aperture side walls. When the aperture area is greater than 0.66 of the inside aperture wall area, a complete paste transfer should occur. [for Laser Cut foils]

\[
\text{Aspect Ratio} = \frac{\text{Width of Aperture}}{\text{Thickness of Stencil}} = \frac{W}{T}
\]

\[
\text{Area Ratio} = \frac{\text{Area of Aperture}}{\text{Area of Aperture Walls}} = \frac{L \times W}{2 \times [L + W] \times T}
\]

\[
\text{Area Ratio [for BGAs]} = \frac{\text{Size of Dia or Sq}}{4 \times T}
\]
Using Area Ratio: Design & Problem Solving

Caution: the area ratios from IPC-7525A are **guidelines**, there are many, many parameters that affect paste release efficiency.

Our experience is that ratios as low as 0.60 will work well as long a premium grade of stainless steel foil is laser cut, with no need for electropolishing.
Using Area Ratio: Design & Problem Solving

<table>
<thead>
<tr>
<th>Playground</th>
<th>(try re-entering data in B,C, &amp; D)</th>
<th>(*lower yield=index&gt;higher yield)</th>
<th>Aspect Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comp</td>
<td>Stencil Thickness mil</td>
<td>Aperture Width mil</td>
<td>Aperture Length mil</td>
</tr>
<tr>
<td>ID</td>
<td>15.7 Pitch uBGA</td>
<td>6.0</td>
<td>8.5</td>
</tr>
<tr>
<td></td>
<td>4.0</td>
<td>8.5</td>
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Volumes ~20% less: rounds vs squares w/ radii

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<td>Wall Area mil²</td>
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<td>4.0</td>
<td>10.0</td>
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Using Area Ratio: Design & Problem Solving

Typically we recommend to reduce the perimeter openings by 1 mil in width & change the shape from rectangle to oblong or corner radii.

For the heat spreader, reduce area 20-50% by window paning, if possible.

Maintain 15-20 mils space between the heat spreader and the perimeter openings.
QFN Example
Although not yet widespread, 01005 chip usage is increasing.

3 mils thick SS laser cut or Ni Eform are the typical foils: Ni Eform for higher volume production, Laser for prototyping.
Tiny Chip Examples

0201, Reduced from 12 sq. to 11sq. with 1 mil radii

01005, From 10x8 rect. to 9x7 rect. with 1 mil radii
Stencil Coatings: Why they should help

- Over the last year, stencil coatings are getting a lot of press
- The theory: make the stencil bottom surface and opening walls “lack affinity” for flux and solder balls
- A more complete paste release has [2] benefits:
  1) Reduced under stencil wiping is required
  2) Fewer solder balls on the bottom surface improves gasketing and can reduce excess paste and shorts
- The coatings seem to have a long life
- MET’s early experience is positive, 1 customer, after [2] stencils has added the option for all their stencils
References

- IPC-7525A Stencil Design Guidelines
- IPC-7093 [draft] Design and Assembly Process Implementation for Bottom Termination Components
- Rosch, Franke, Lantzsch & Kleeman, Characteristics and Potentials of Nano-Coated Stencils for Stencil Printing Optimization, SMTAI, 2010
- Bill Coleman, Stencil Enabling Processes for Small Area Ratio’s, SMTAI, 2010
- MET customers, who provide feedback on our SWAGs
Any Questions

If you would like to get in touch:
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