WAFER LEVEL PROCESS FORMATION OF A POLYMER ISOLATED CHIP SCALE PACKAGE
Outline

- Small Silicon CSP device
- Assembly Issue
- Polymer Isolation Process Module
- Experimental Results
- Conclusion
- Q & A
• 2 Lead Chip Scale Package 0201/01005 sized devices

• 100% of the CSP area is the silicon

• Using a 01005 sized CSP device occupies less board area compared to the same sized die built in a plastic molded package
Small CSP package

- More than Two Thousand 01005 parts able to fit on top of a dime
- Dime thicker than six 01005 parts

Dime Diameter: 17.91 mm
Dime Thickness: 1.35 mm
ASSEMBLY SHORT ISSUE

Solder Bridge on the CSP end (CSP tilted at the end)

Solder Bridge on CSP side (CSP tilted to one side)

Short/Leakage contributing factors
• Short Bump Height (Low Profile)
• Solder Paste Proximity to CSP Edge
• Solder Stencil to Pad Alignment
• CSP placement accuracy and tilt

Excess Solder (Short between bare silicon die sidewall and the PCB pad)
SOLDER SHORT ISSUE

0201 CSP Tilt (Sidewall Bridging)

Close up image of sidewall Solder Bridging

Short causes assembly rework and added cost
• About 70% of a 0201/01005 CSP area is available for silicon circuits
• Area lost due from the saw street region
• Silicon removed from the saw street & replaced with a polymer
• No lost in silicon real estate area with the addition of the polymer isolation
• Polymer Isolation on silicon sidewall prevents the assembly short issue
• Polymer on the backside prevents short to the silicon backside
PROCESS FLOW

1) Trench Mask
2) Silicon Etch
3) Polymer Coat

Silicon Wafer FEOL
Redistribution
Solder Bump
Bond to Carrier
Wafer Background

Polymer Isolation
Carrier Removal
Wafer Probe
Laser Mark
CSP Singulation

Tape and Reel
Process Flow (Brief)

1) Mount Wafer to Carrier Substrate
2) Silicon Wafer Backgrind
3) Scribe line Silicon Trench Mask
4) Silicon Trench Etch
   Suitable for products that have Test Structures and Dummy Fill in the Scribe Line region.

5) Resist Clean
Final Probe done after carrier removal
Screen out dies damaged from defects at Silicon Etch Module
Silicon Etch Alignment

Alignment Feature
- IR Camera (Stepper)

Develop Inspection (IR Scope)
- Check Pattern Alignment
- Product & Misalignment Structure
- CD Measure

Silicon Etch Space to Front side active Silicon Devices (7.5 um)
Alignment is important

After Silicon Plasma Etch
- Wafer Probe done after Silicon Plasma Etch Module
- Reject dies that may be Damaged from the silicon etch
Cross Sections

0201 Sized Polymer Isolated CSP (0.200 mm Thick)

01005 Sized Polymer Isolated CSP (0.170 mm Thick)
Experimental Results
Mechanical Strength
Reliability
Mechanical Strength
3 Point Bend Test Setup

Setup

Load
Span
Support
Support

Load At Breakage
Displacement

Force (Load) vs Displacement Curve (Example)

Loading Tool
Sample (Package)

CSP

Cross Section

Load vs Displacement Curve (Example)
CSP Thickness:
Bare Silicon: 270 um
Polymer Isolated: 200 um
Mechanical Strength
Silicon Fracture Stress

\[ \sigma_{\text{max}} = \frac{3 \times F_{\text{break}} \times L_{\text{span}}}{2 \times W \times T^2} \]

Silicon Fracture Stress Increase
- Poly Isolation
- Plasma Etch Silicon Street
Plasma Silicon Etch Scribe

Silicon

Traditional Mechanical Dicing Saw

Polymer Isolated CSP With Plasma Silicon Etch

Polymer

Silicon Edge
<table>
<thead>
<tr>
<th>Board Level Test</th>
<th>Condition</th>
<th>Read Point</th>
<th>Rej/sample size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Board Assembly Yield</td>
<td>Mount on Board &amp; Test</td>
<td>Test After Mount</td>
<td>0/1180</td>
</tr>
<tr>
<td>Highly Accelerated Stress Test (HAST)</td>
<td>Temp= +130°C, RH=85%, 18.8 psig, biased</td>
<td>96 hr</td>
<td>0/270</td>
</tr>
<tr>
<td>Temperature Cycle</td>
<td>T = -65°C to 150°C</td>
<td>1000 cycles</td>
<td>0/270</td>
</tr>
</tbody>
</table>
Polymer Intact After HAST
Black & White X-Ray of CSP after HAST Reliability
Black & White/Color X-Ray of CSP after HAST Reliability
Polymer Sidewall Isolation

No Leakage to substrate due to Polymer Isolation on sidewalls
Even if solder extends to the scribe and along the sidewall
CONCLUSION

A 5-side polymer 0201/01005 CSP requires the bulk silicon to be thinned down to maintain the low profile final package thickness.

- Thinner silicon decreases the mechanical strength
- Improve silicon strength with silicon plasma etch instead of mechanical diamond saw

Polymer Isolated 0201/01005 sized CSP key points:

- Polymer Sidewall Isolation eliminates assembly solder shorts to the silicon
- Wafer Level Polymer Process Module integrated into standard CSP Flow
- Carrier provides mechanical support during polymer formation module after the wafer is thinned to <100um
- Backside Silicon Street Etch suitable for scribe lines that contain test structures and dummy fill
- 27% better mechanical strength than typical bare silicon CSP (Silicon Plasma Etch and polymer isolation)
- Industrial Temp Cycle Performance (> 1000 cycles 150C to -65C)
- Polymer Isolation still intact after HAST (96 hr)
- Qualified for Production
Thank You!

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