14nm Chip Package Interaction (CPI) Technology Development

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INTRODUCTION

Exponential Growth of Computing for 110 years

Moore’s Law: number of transistors doubled every 18 months
* More layers to improve layout density
* Degrade interconnect RC delay
Solution →

Lower resistivity conductor: Cu

Lower dielectric constant materials: Low-k or Ultra low k

• Lower modulus
• Lower mechanical strength
Chip Package Interaction (CPI)
-Key for reliability and devices integration

Diagram: Tree with branches labeled BEOL, C4 bump, CPI, Package, and Reliability.
CPI Test Vehicle Configuration

* Full 14nm BEOL stacks
* 14nm BEOL design rules
* 14nm BEOL process and ELK material
* Large die size to cover all the products possible
* CPI macro structures to cover high CPI risk area as much as possible
* CPI macro structures are sensitive enough to reflect the changes during tests
* Same bump pitch and bump alloy
* Same substrate BOM
* Same assembly process
Results and discussion

1. FBEOL review

Single passivation

Dual passivation on Al pad
2. Bump pitch effect and bump selection

CPI Risk:
Cu pillar > SnAg

Selection: SnAg with 140um bump pitch
3. Assembly development

Most CPI TV:
* Tight bump pitch at periphery area
* Large bump pitch at center area
Good for CPI, can’t be used for assembly development

Uniformed bump pitch
No UF voids and anomaly after assembly
No solder bridging
4. Crack stop effect

Crack Stop:
* Protect the micro-cracks propagation
* Critical to ELK BEOL

\[ G < G_{\text{crackstop}} \]

CSAM image of Corner delamination
FIB X-section of the corner delamination
5. CPI qualification summary

Reliability test condition and summary

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CSAM image after ATC test, no white bumps observed
Summary

* Dual passivation of FBEOL applied to improve CPI reliability

* CPI reliability of 140um bump pitch with SnAg bump evaluated

* Assembly of 140um bump pitch with SnAg developed

* Crack stops effect of CPI reliability assessed

* Wider crack stops applied to improve CPI reliability margin

* 14nm CPI technology qualification completed and passed
Thank You!