

Flip Chip on Paper Leadframe Using Cu Pillar Bumps

Z. P. Wong
(APS Pte/Singapore)

Flip Chip on Paper Leadframe Using Cu Pillar Bumps

Z.P.Wang¹, Esdy Baek²

¹Advanpack Solutions Pte Ltd, Singapore

²NEPES Pte Ltd, Singapore

Content

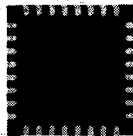
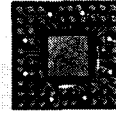
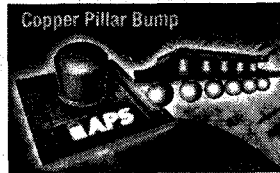
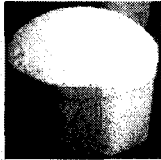
- Introduction
- Cu Pillar bumps
- Paper leadframe and its manufacturing method
- Flip chip on leadframe packaging for QFN
- Reliability
- Conclusions

INTRODUCTION



Advanpack Solutions (APS)

Platform provider for cost effective high performance electronics interconnections



- Cu-Pillar Bump Interconnect Technology
- APS Flip Chip On Leadframe Packaging
- APS Pillar CSP – Wafer Level Packaging
- APS Thermal Compression Bonding with NFU
- APS paper leadframe
- APS module technology



APS

Where Innovation Begins

INTRODUCTION



APS Flip Chip Solution

APS Flip Chip Technologies provide cost effective high performance flip chip solution

- Cu Pillar Bumps
 - Cu post with pre-determined solder tip
- Adhesive Material (P-Coat, P-Bond)
 - Underfill with fluxing capability
 - No Flow Underfill with filler to reduce CTE
 - Polymer flux for Ball Mounting
- Flip Chip Process
 - Flip Chip Placement using NFU on Maskless Substrate
 - Thermo-compression process using Filled NFU
- Substrate
 - “Paper” Leadframe providing fine pitch FCOL solution

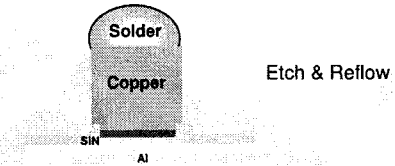
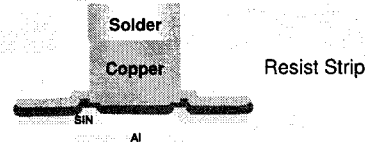
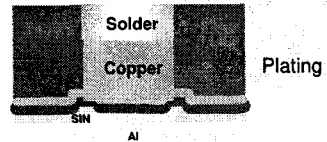
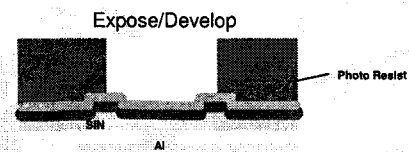
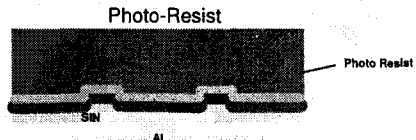
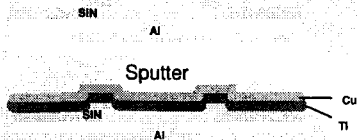
APS

Where Innovation Begins

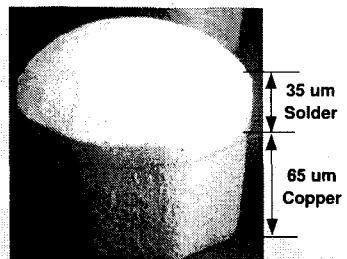
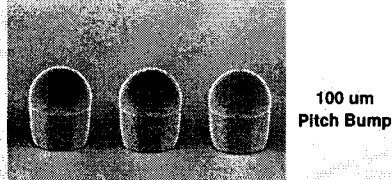
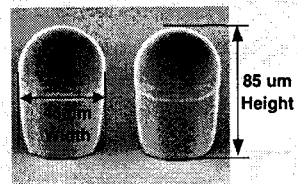
Cu Pillar Bump

Bumping Process

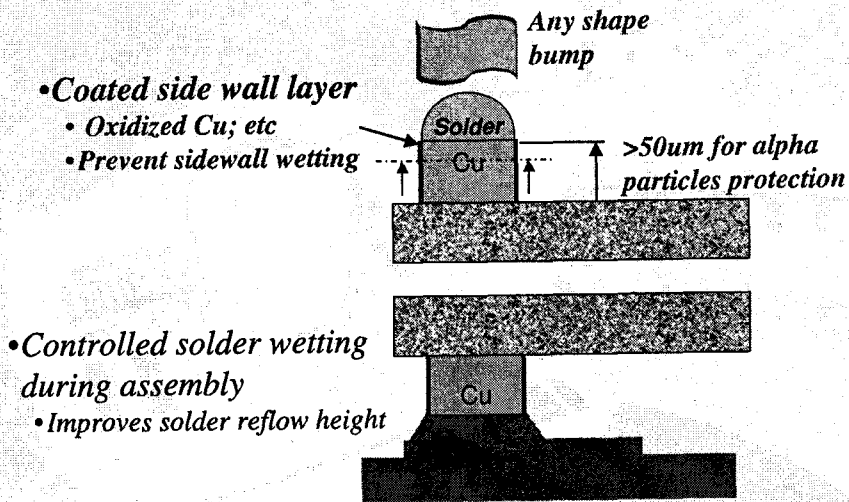
Incoming Wafer / PreClean



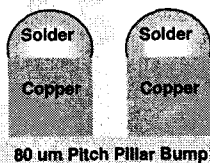
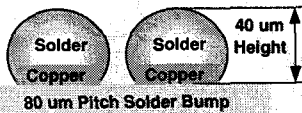
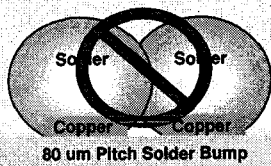
Cu Pillar Bumps



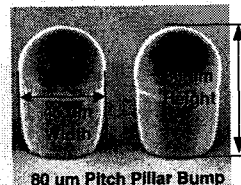
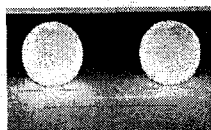
Cu Pillar Bumps



Fine Pitch Bumps

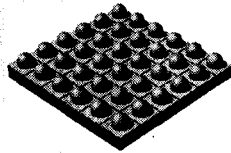


- 80 um pitch Solder Bump
 - Solder bridging will occur for solder bump with 85um Height
 - Solder bump height must be reduced to 40 um to prevent bridging
- 80 mm Pitch Copper Pillar Bump can be achieved with 80mm height because of pillar shape

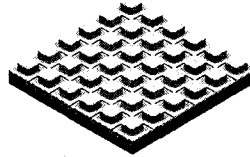


Enhancing Performance

APS ADVANPACK SOLUTIONS



Solder Ball Bump



Cu Pillar Bump

- Improved Electrical Performance
 - Higher current carrying capability
 - Low resistivity : $1.7 \mu\Omega\text{-cm}$
- Better Thermal Dissipation
 - Higher thermal conductivity
 - Flexible bump structure

APS

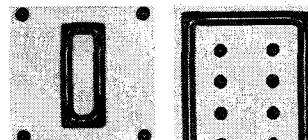
Where Innovation Begins

Unique Pillar Bar Structures

APS ADVANPACK SOLUTIONS



Bar Type Bump Structures
(capable of 1400um length)



Rectangular Bump Structures
(Internal or External Bumps)

- Bar Shaped Bumps for excellent current carrying capability
- Improved thermal performance when compared with normal solder bumps
- Rectangular shape flexibility for Faraday shielding and MEMS hermetic sealing

APS

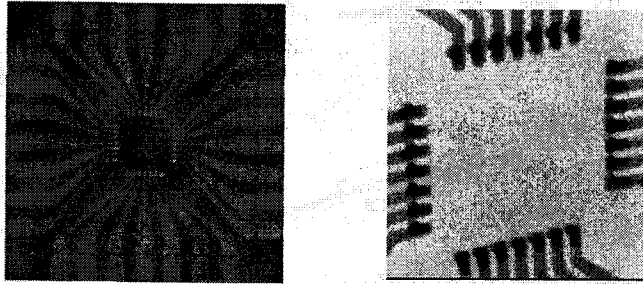
Where Innovation Begins

PAPER LEADFRAME AND ITS MANUFACTURING METHOD

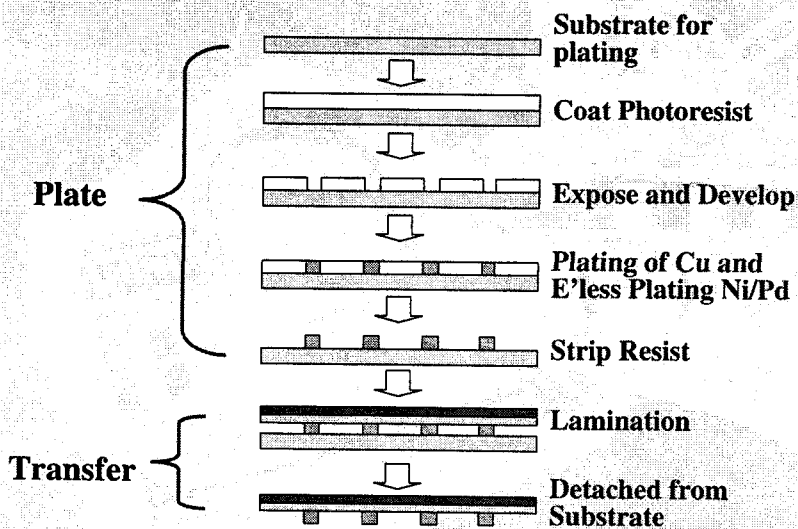


- Paper lead frame

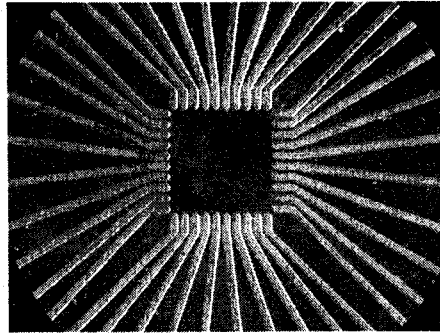
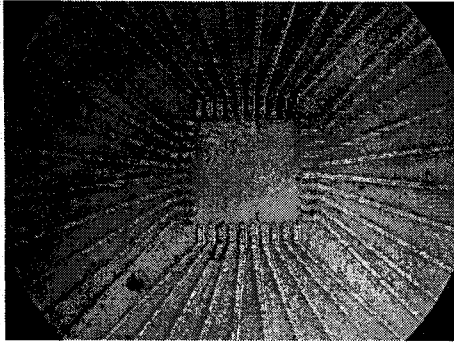
-- Lead frame with thickness around 30um



PAPER LEADFRAME MANUFACTURING METHOD

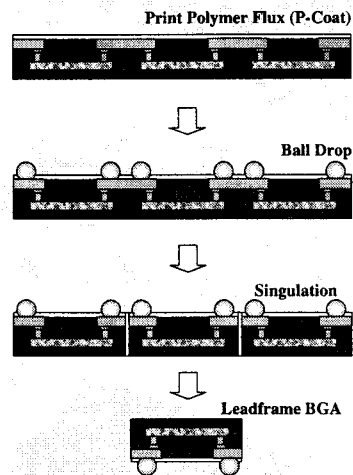
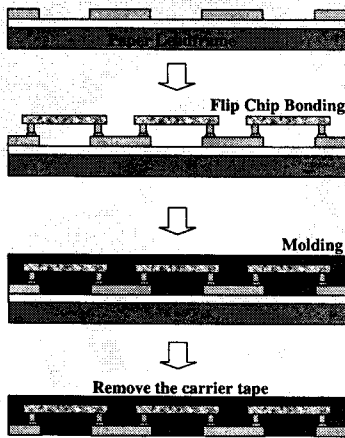
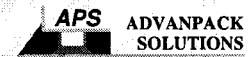


PAPER LEADFRAME



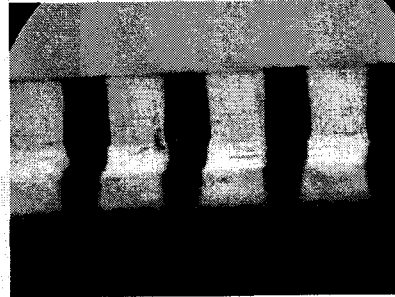
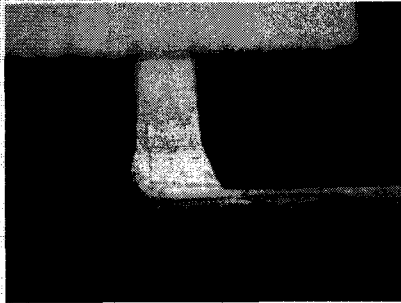
APS *Where Innovation Begins*

FLIP CHIP ON PAPER LEADFRAME

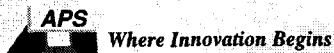


APS *Where Innovation Begins*

FLIP CHIP ON PAPER LEADFRAME



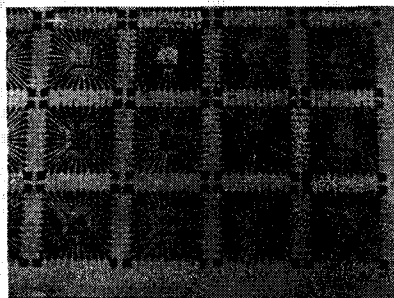
Cross-section view for Flip Chip on Paper Leadframe after molding (pitch: 80um)



FLIP CHIP ON PAPER LEADFRAME



Paper Leadframe makes fine-pitch flip-chip and fan out IO pads possible.



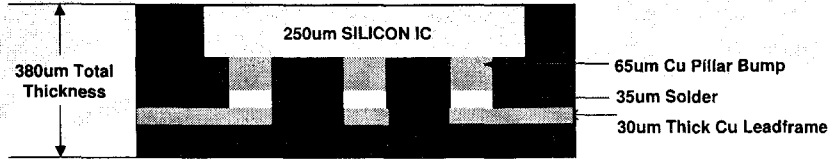
40 IOs 1x1mm Device in 5x5mm QFN package with 80µm IO (die) pitch



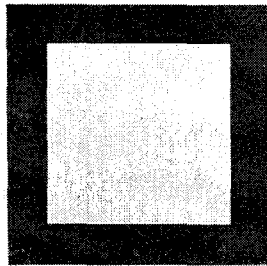
FLIP CHIP ON PAPER LEADFRAME



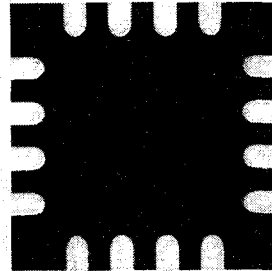
0.38 mm THICKNESS FC-QFN PILLAR BUMP CONSTRUCTION



QFN 3X3 MM 16 LEADS
TOP VIEW



QFN 3X3 MM 16 LEADS
BOTTOM VIEW



APS

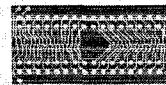
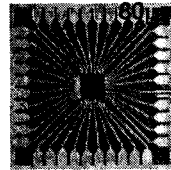
Where Innovation Begins

Paper Leadframe Possibilities



- 30 μm thick
- 80 μm Pitch – 40 μm ₂₀₀₉
- Grid Array Package
- MCM
- Ultra-Thin Package
- Stacked Package
- Selected side NiPd plating
– Improve Molding (Reliability)
- Ball dropped Package

QFN 5X5 MM 40 LEADS



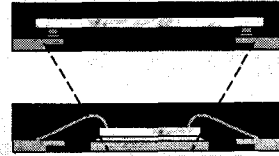
APS

Where Innovation Begins

Flip Chip Drivers to QFN Packages

APS ADVANPACK
SOLUTIONS

- Flip Chip Offers
 - Larger Die in Smaller Package
 - No wire span space required
 - Better Electrical Parasitic
 - Shorter Process Flow, thus Reduced Equipment Cost



Higher Silicon Efficiency

- Flexibility in Pillar Bumps
 - Enable Bare Cu Leadframe
 - Enhanced Thermal Performance
 - Eliminating Solder Paste Printing Process
 - Better Current Carrying Capability



APS Where Innovation Begins

Flip Chip on Leadframe with Cu Pillar Bumps

APS ADVANPACK
SOLUTIONS



- Cu Pillar Bumps can further provide
 - Higher standoff enabling normal molding compound
 - Enhanced performance with flexibility in Cu Pillar Bumps structure
 - Block Bumps in the center pad as heat sink and ground pad
- Fine Pitch Solutions
 - Paper Leadframe

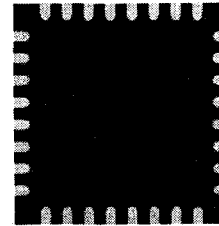
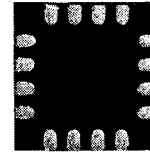
APS Where Innovation Begins

Reliability for Flip Chip on Leadframe QFN with Cu Pillar Bumps

APS ADVANPACK SOLUTIONS

0.7mm Thick QFN Package

QFN PACKAGE (mm)	3X3	3X3	5X5
Lead Count	16	16	32
Die Size (mm)	1.97X1.97	1.97X1.97	3.97X3.97
No. of Bumps	12	12	28
Package Thickness (mm)	0.70	0.70	0.70
Leadframe Type	Copper	Copper	Copper
Mold Compound	7730LC	300 B5	7730LC
Moisture Sensitivity Level	1	3	1
Reflow	3X240°C	3X240°C	3X240°C
Results	0/84	0/35	0/15
Temperature Cycles (B)			
300 cycles	0/84	0/35	0/15
500 cycles	0/84	0/35	0/15
700 cycles	0/84	0/35	0/15
1000 cycles	0/84	0/35	0/15



* Eutectic solder

APS Where Innovation Begins

Reliability for Flip Chip on Leadframe with Cu Pillar Bumps

APS ADVANPACK SOLUTIONS

Leadfree QFN 5x5

QFN PACKAGE (mm)	5X5	5X5	5X5	5X5
Lead Count	32	32	32	32
Die Size (mm)	3.97 x 3.97	3.97 x 3.97	3.97 x 3.97	3.97 x 3.97
No. of Bumps	28	28	28	28
Leadframe Type	Copper	Copper	Copper	Copper
Mold Compound	Sumitomo 7730LC	Sumitomo G770	Sumitomo 7730LC	Sumitomo G770
Moisture Sensitivity Level			1	1
Reflow			3 x 260°C	3 x 260°C
Results			0/77	0/77
Temperature Cycles (B)				
2000 cycles	0/77	0/77	0/77	0/77
2500 cycles	0/77	0/77	0/77	0/77
3000 cycles	0/67	0/77	0/77	0/77
3500 cycles	0/67	0/77	0/77	0/77
4000 cycles	0/66	0/75	0/77	0/77
5000 cycles	0/66	0/75	0/77	0/77
HTST	150°C			
500 hours	0/45	0/45		
1000 hours	0/45	0/45		

APS Where Innovation Begins

Reliability for Flip Chip on Leadframe with Cu Pillar Bumps



Lead Free Option Exceeding TCT 5000 Cycles

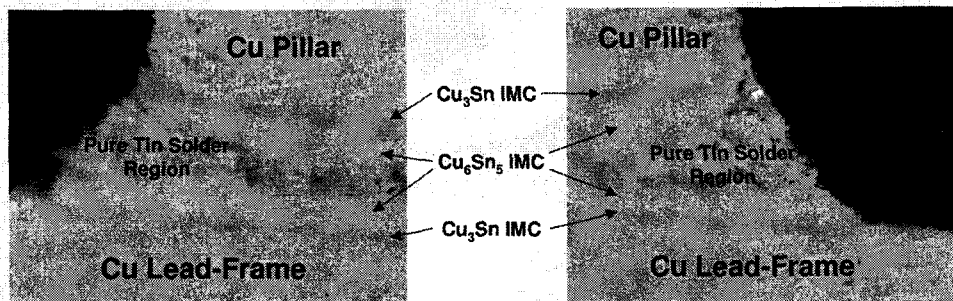
- CuSn Intermetallic growth stabilizes at 500 cycle TCT
- No whisker formation after 1000 hrs HTST



Reliability for Flip Chip on Leadframe with Cu Pillar Bumps



LEAD-FREE PILLAR BUMP BOND ON LEADFRAME



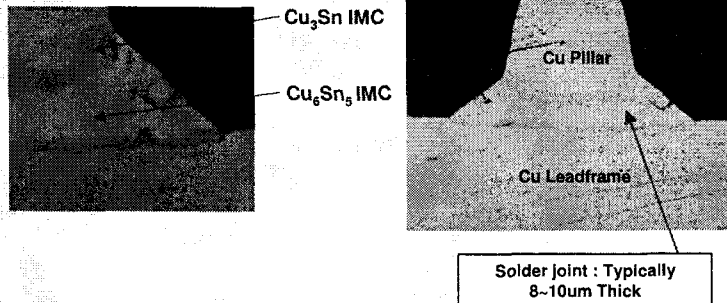
- Cross-section view of a lead-free copper pillar bump attached to QFN bare copper lead-frame
- Intermetallic Formation Stabilizes After 500 temperature cycles



Reliability for Flip Chip on Leadframe with Cu Pillar Bumps



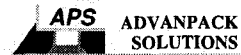
LEAD-FREE PILLAR BUMP ON LEADFRAME



- Cross-section view of a lead-free copper pillar bump attached to QFN bare copper lead-frame
- Intermetallic Formation After 1000 Hrs HTST
- No whisker issue after 1000 Hrs HTST, Passed



CONCLUSIONS



- Cu pillar bump provides a fine pitch high performance interconnection method
- The plating/transfer method for paper leadframe offers a low cost manufacturing technique for fine pitch substrate
- Paper leadframe together with Cu pillar bumps provide an excellent low cost platform for thin and high performance packages
- QFN based on flip chip on paper leadframe will be potentially low cost ultra-thin packages with high reliability

