Consideration on Fine Pitch WLCSP Application

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Considerations on fine pitch WLCSP application

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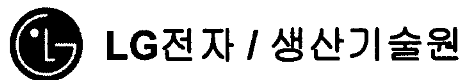


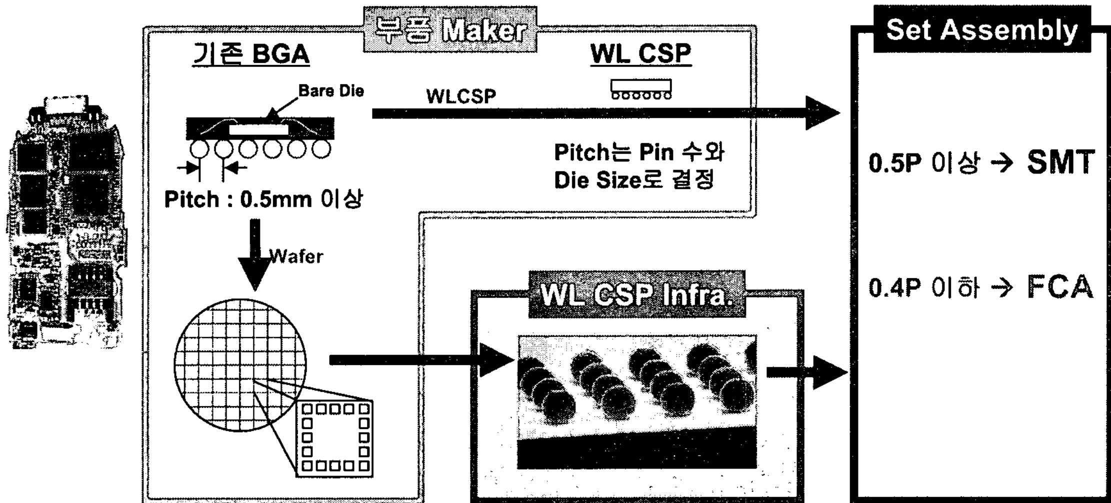
Contents

- WLCSP 적용 개요
- Fine Pitch FCA 공정 개발
- Mobile Phone 적용 사례
- Summary

WLCSP Application Concept

Fine Pitch WLCSP 적용 개요

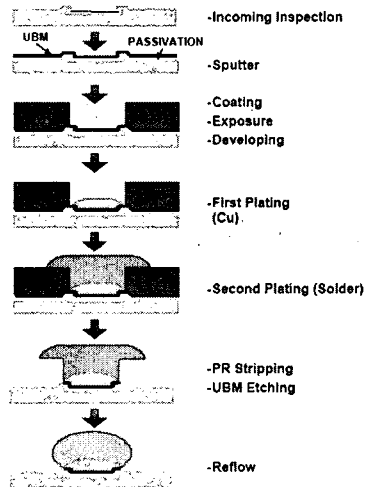
▶관점 • Set Maker
• Mobile Product

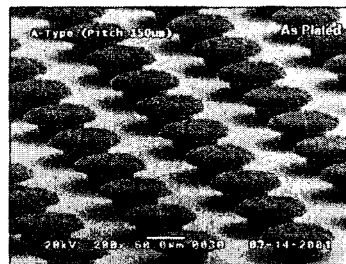


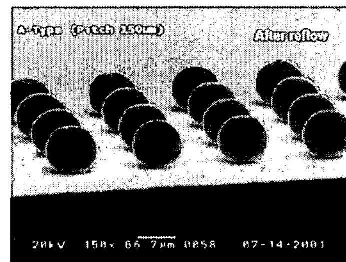
WLCSP Application Concept

Solder Bumped Flip Chip

Solder Bump - Process flow -

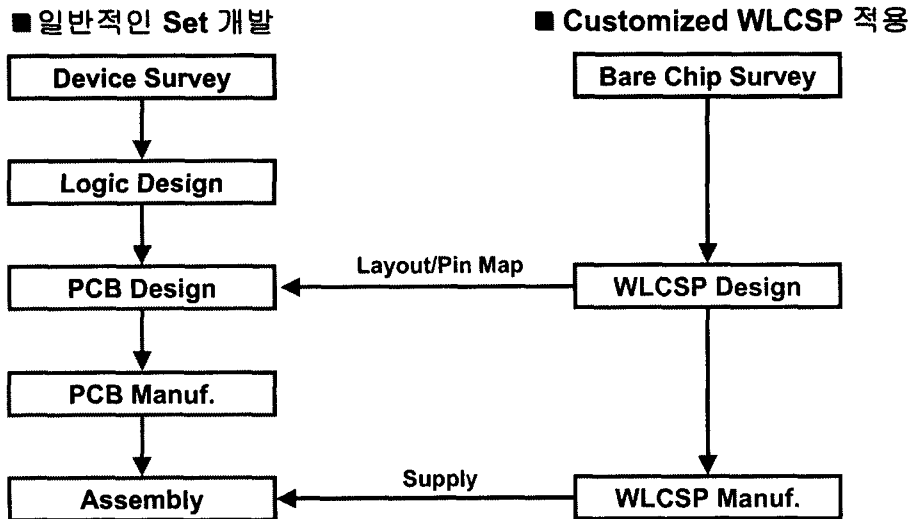






WLCSP Application Concept

WLCSP 제품 적용 Procedure



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WLCSP Application Concept

WLCSP 적용 시 검토 항목

1. Device Selection
   - Effect : Cost, Design Flexibility, Size, Thickness...
   - Wafer : In-house IC, Maker IC
   - Life Cycle
2. Package Design
   - Package Type, Pitch, Ball Array
   - Pattern Design : Critical Net(Analog/Digital), Signal Integrity
   - Mechanical Reliability
   - Production Capability
3. Packaging
   - Infrastructure
   - Pb-free
   - Test Capability
4. PCB
   - Via (Laser, Laser Filled Via, Bump Via)
   - Minimum L/S, Via Dia. Clearance, Tolerance
   - Surface Treatment (Au, OSP)
5. Production
   - Line Facility
   - Inspection Method/Machine
   - Repair Method
   - N2 Soldering (500PPM under)

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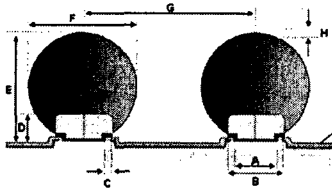
Fine Pitch FCA 공정 개발

Test Chip Design

■ Bump Spec.



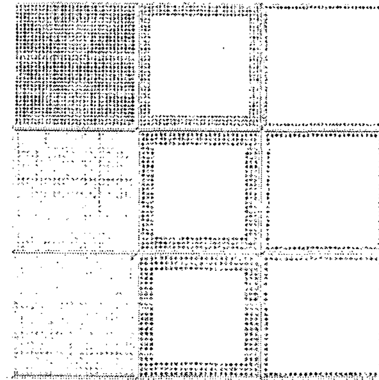
• Bumping Pitch : 150~200㎛
• Bump Height : 70~100㎛

■ Test Die Layout

P:150㎛

P:180㎛

P:200㎛



• Daisy Chain
• 1, 3-Peripheral, Full Grid

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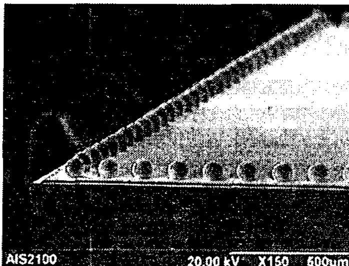
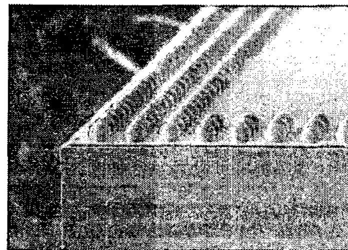
Fine Pitch FCA 공정 개발

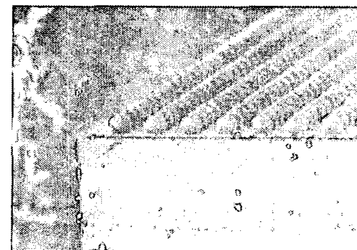
Test Chip Manufacturing



1- Peripheral
P: 150, 180, 200㎛



3- Peripheral
P: 150, 180, 200㎛



Full Grid
P: 150, 180, 200㎛

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Fine Pitch FCA 공정 개발

PCB Technology

		LX-BUMP	B^2iT	PALAP	AGSP	SAVIA	ALIVH
Lay-up Structure		Cu Bump	Ag Paste Bump	Ag Paste	Plating+Etching Bump	Cu Paste	Cu Paste
FEATURE	Dielectric Material	FR-4, High Tg FR-4	High Tg FR-4	Thermo-plastic (LCP,PEEK)	Thermal Curable Resin	High Tg FR-4 Unclad CCL	Aramid (Non woven)
	Via Formation	Plating Bump Selective via plating	Piercing	Laser Drill(CO_2) + Silver Paste Filling	Plating + Etched Bump	M/C drill or Laser Drill(CO_2)	Laser Drill(CO_2) + Cu Paste Filling
	Connection Method	Metallurgical Interconnection	Ag Paste Interconnection	Metal paste Interconnection	Cu Plating Interconnection	Conductive paste + Cu plating	Conductive paste adhering
	CSP Pitch	0.3mm	0.4mm	0.4mm	0.4mm	0.4mm	0.4mm
	Stack Via	O	O	O	O	O	O
	All IVH	O	O	O	O	O	O
Participation State		LGE	Toshiba, Clover, Sirmtech	Denso, Ainx, NEC Noda Screen, Sowa, OKprint, Kyousha	Daiwa, Clover, Motoya, Doosan	Samsung	Matsushita, CMK
Present Step		Mass Production	Mass Production	Development	Mass Production	Development	Mass Production

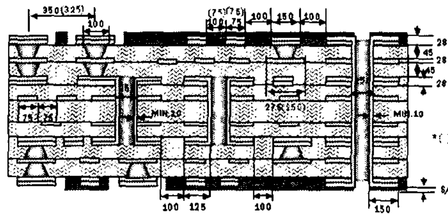
■ **Requirement**

- Ball Pitch : 150㎛
- Via Diameter : 150㎛ ↓
- Line/Spacing : 60/60㎛ ↓
- Stack Via
- Pad on Via
- Landless(Filled or Bump)

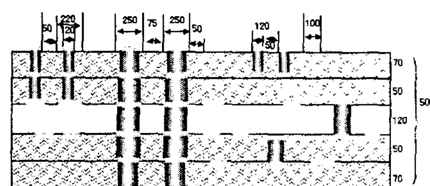
Fine Pitch FCA 공정 개발

고집적 PCB DFM

■ **Ball Pitch 0.3 이상**
→ **Laser Via**

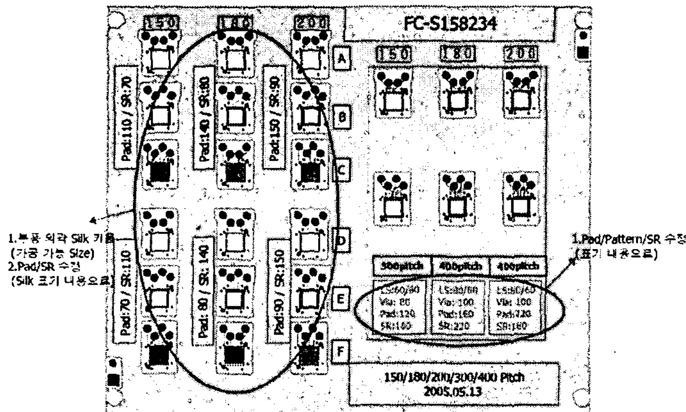


■ **Ball Pitch 0.3 이하**
→ **Bump Via**



IC Pitch	0.4	0.3	0.2	0.15
Via 구조	Laser Bump	Laser Bump	Bump	Bump
Via Dia.	150㎛	120㎛	100㎛	100㎛
Via Pitch	400㎛	300㎛	300㎛	300㎛
Pad	190㎛	140㎛	90㎛	70㎛
Line/Space	80/80㎛	60/60㎛	50/50㎛	50/50㎛
S/R 이격	50㎛	30㎛	20㎛	10㎛
표면 처리	Au	OSP	OSP	OSP

Test PCB Design

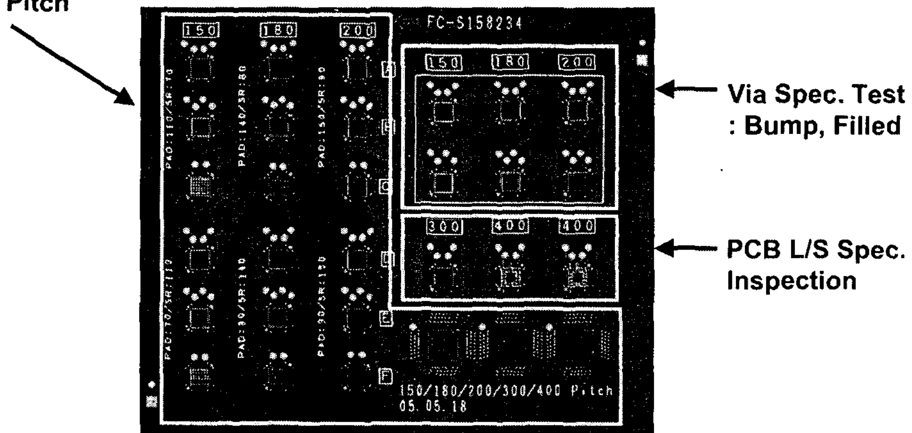


■ **Test Item**

- **Chip Interconnection**
- **PCB Delaminating**
- **Surface Insulation**
- **Joint Reliability**

Test PCB Manufacturing

Chip Interconnection Test
: 150~300㎛ Pitch



Via Spec. Test
: Bump, Filled

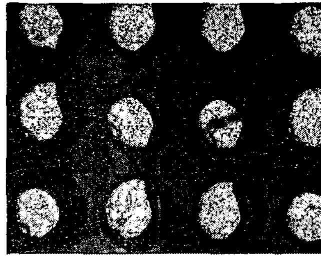
PCB L/S Spec. Inspection

Fine Pitch FCA 공정 개발

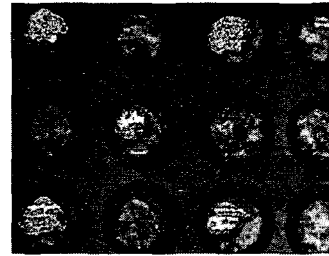
Example : PCB Failure

■ Delaminating

■ 위치 틀어짐



■ 도금 불량



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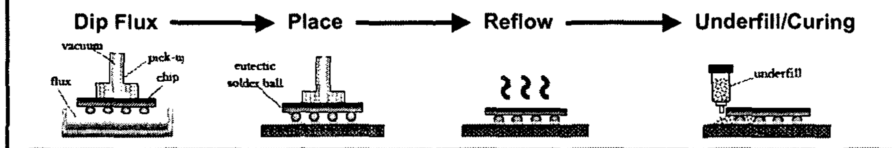
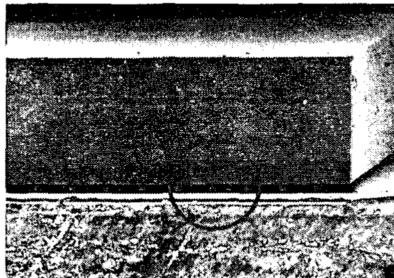
Fine Pitch FCA 공정 개발

Assembly Process

FCA(Flip Chip Attachment)

: 기존 생산 방식인 SMT를 그대로 유지하면서 Flip Chip 실장





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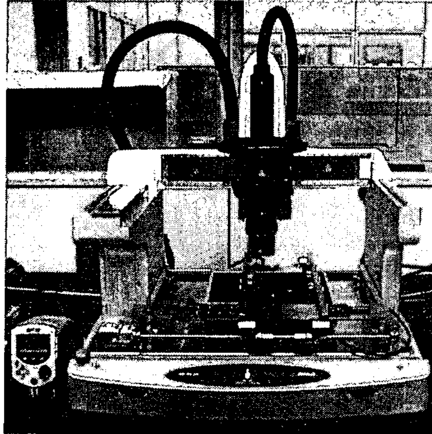
Flip Chip Assembly System



■ Test Machine

▶ **Use**

- Assembly Process Test
- Prototype
- Production Condition Test

▶ **Requirement**

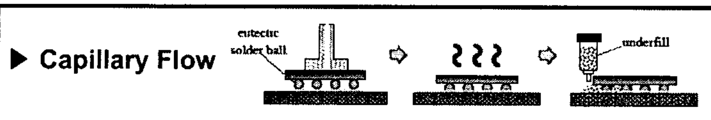
- Minimum Pitch : 100㎛

▶ **Function**

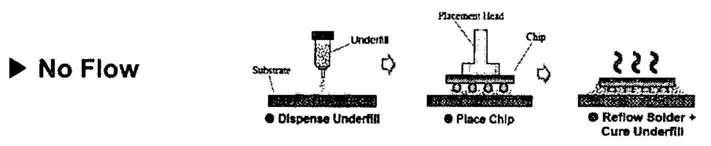
- Chip Mount, N_2 Soldering
- Chip Remove, Site-cleaning
- Dispensing(Epoxy, Solder Paste)

Underfill Process

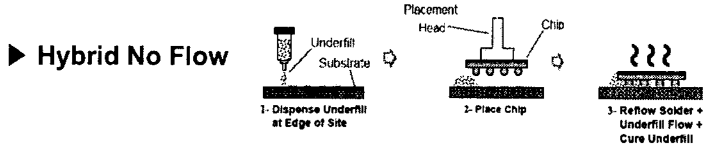
▶ **Capillary Flow**



▶ **No Flow**



▶ **Hybrid No Flow**



▶ **Pre-applied**

■ Requirement

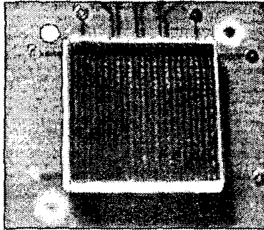
Properties	Desirable Values
Flow	> 0.5mm/s
Adhesion	> 50MPa shear force
CTE	18 ~ 30ppm/℃
Elongation	> 1%
Modulus	5 ~ 8GPa
Tg	> 130℃
Stress after cure	< 10MPa
Water pickup	< 1%
Ionic Impuries	< 10ppm
Thermal stability(1% weight loss)	> 260℃
Curing time at 160℃	< 0.5hr
Volatility during cure	< 1% weight loss
Pot life at RT	> 8hr

Fine Pitch FCA 공정 개발

Underfill / Material Selection

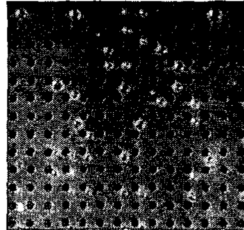
■ Flow Speed

• Glass Chip&Photo

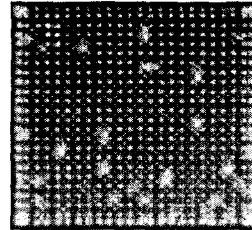


■ Void

• Glass Chip&Photo

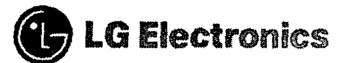


• C-SAM



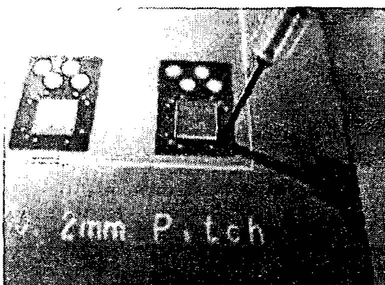
Example

Test Material	Flow Speed	Void	Repair
L	○	○	△
N	○	○	×
Z(W)	◎	○	○
Z(B)	○	○	○

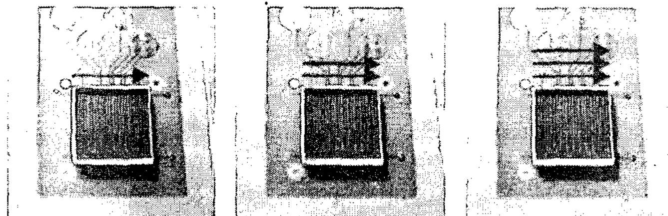


Fine Pitch FCA 공정 개발

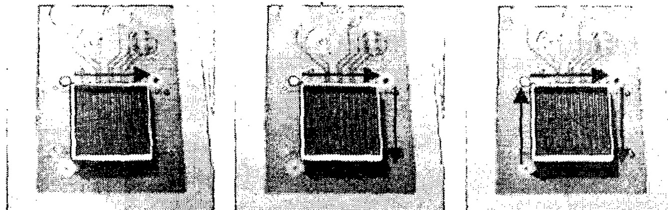
Underfill / Dispensing Test



▶ 토출량 Test



▶ 토출 Pattern Test

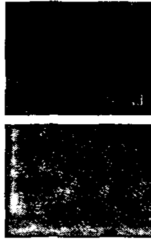


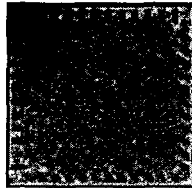
Fine Pitch FCA 공정 개발

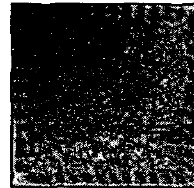
Underfill / Substrate Temperature

■ Low Temperature
: 70℃ 이하

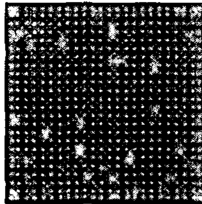
■ High Temperature
: 80℃ 이상



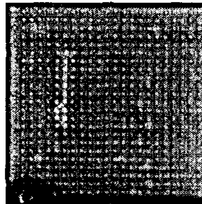




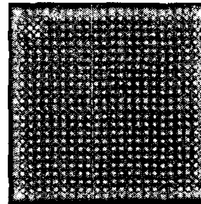
50℃



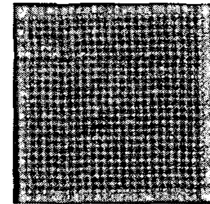
70℃



90℃



110℃



Fine Pitch FCA 공정 개발

Thermal Cycle Test

■ JEDEC Standard No.22-A104-B

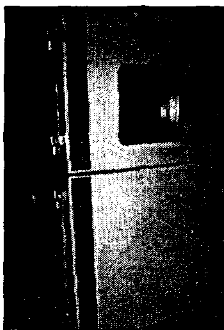
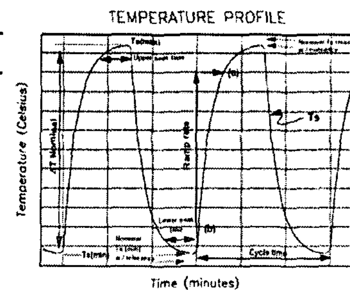


Table 1 — Temperature cycling test conditions

Test Condition*	Nominal Ts(min)(°C) with Tolerances	Nominal Ts(max)(°C) with Tolerances
A	-55(+0, -10)	+85(+10, -0)
B	-55(+0, -10)	+125(+15, -0)
C	-65(+0, -10)	+150(+15, -0)
G	-40(+0, -10)	+125(+15, -0)
H	-55(+0, -10)	+150(+15, -0)
I	-40(+0, -10)	+115(+15, -0)
J	-0(+0, -10)	+100(+15, -0)
K	-0(+0, -10)	+125(+15, -0)
L	-55(+0, -10)	+110(+15, -0)
M	-40(+0, -10)	+150(+15, -0)



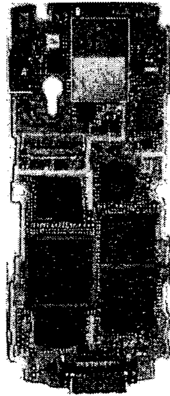
(Example : Failure Chip Count)

Cycles \ Underfill	Non-underfill	L	N	Z
100	0	0	0	0
200	1	1	0	0
300	6	10	0	0
400	4	All	0	0

Mobile Phone 적용 사례

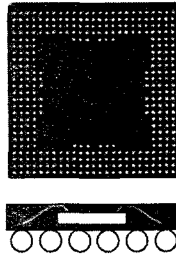
Target IC Selection

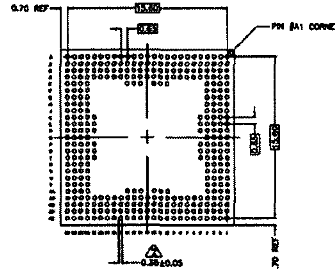
■ Mobile Phone



■ 0.65mm Pitch, 360pin BGA

- Package Size : $17x17mm^2$
- Die Size : $7.7x7.7mm^2$





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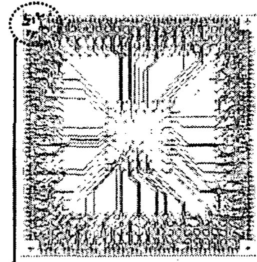
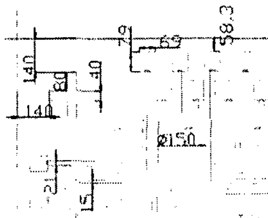
Mobile Phone 적용 사례

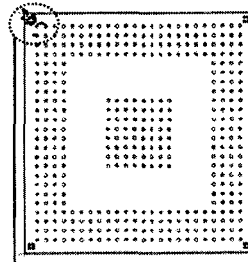
WLCSP Design

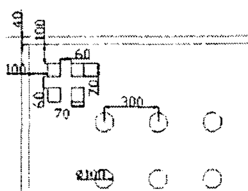
■ Pattern Layer



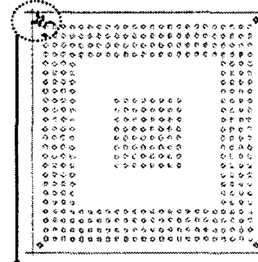


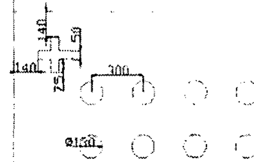
■ Passivation Layer





■ Barrier Metal Layer





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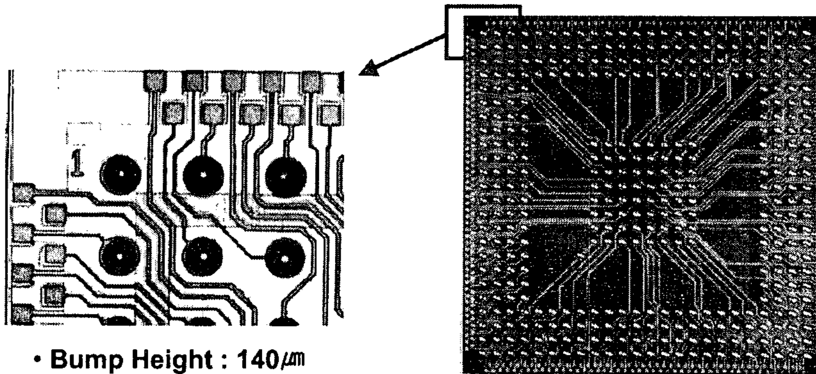
Mobile Phone 적용 사례

WLCSP Manufacturing

■ **0.3mm Pitch, 360pin WLCSP**



• **Bump Height : 140㎛**

• **Size : 7.7x7.7mm²**

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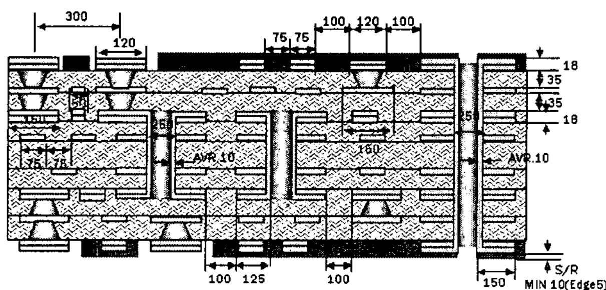
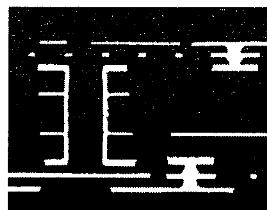
Mobile Phone 적용 사례

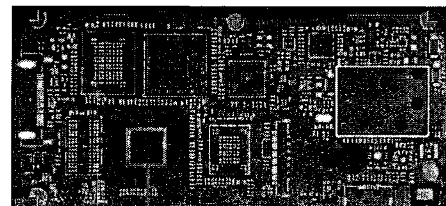
Main PCB Design

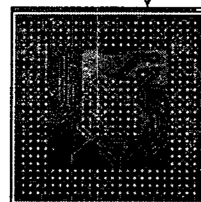
■ **PCB DFM**





■ **CAD Design**





• **Laser Filled Via**
• **L/S : 60/60㎛**
• **표면처리 : OSP**

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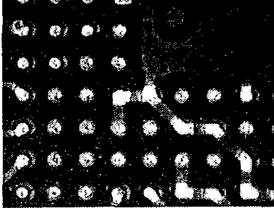
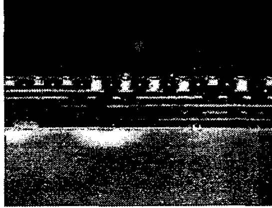
Mobile Phone 적용 사례

PCB Manufacturing

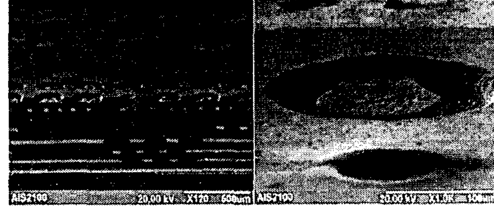
■ Top View

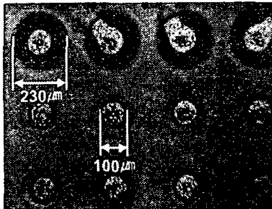


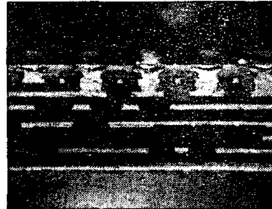
■ Cross Section

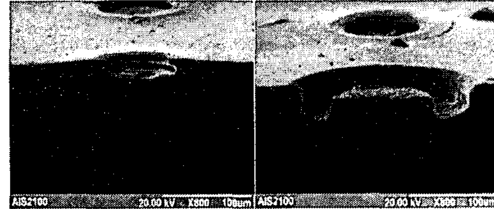


■ SEM









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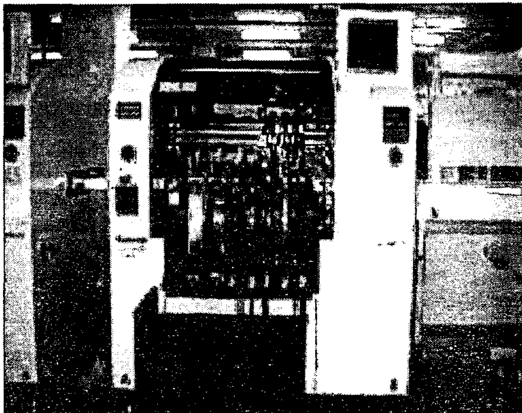
Mobile Phone 적용 사례

Assembly Line



■ **Mass Production Machine**

▶ **Use**

- Sample / Mass Production

▶ **Requirement**

- Minimum Pitch : 200㎛

▶ **Function**

- Flux Dipping & Chip Mount Module Attached
- General Chip Mount

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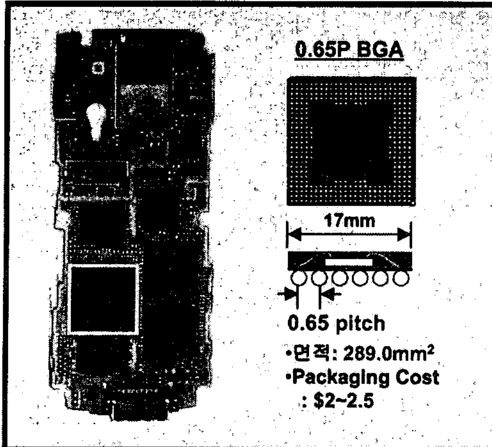
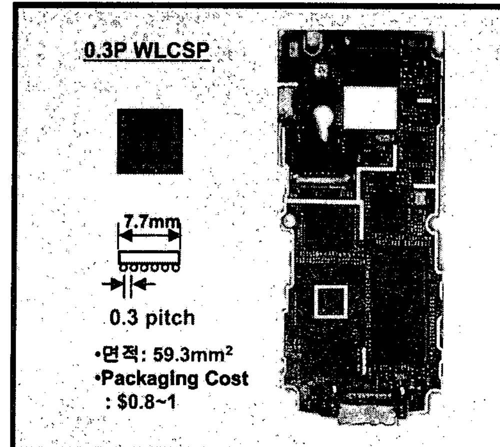
Mobile Phone 적용 사례

PCB Assembly





Summary

- 기존 단말기에 **Fine Pitch (0.3mm) WLCSP**를 개발/적용해 봄으로써 **SMT** 조립 한계로 인식되고 있는 **Pitch**인 **0.4mm**이하의 접속 기술을 검증함.

- **Set Maker** 입장에서 **Fine Pitch**를 가진 **Customized Package**를 적용할 경우, **Design** 단계에서부터 부품, 기판, 조립공법, **Infrastructure**등을 동시에 검토해야 함.

- 이동단말의 소형화/박형화 경쟁이 가속화 되는 가운데 **Package Pitch**만을 고려해 볼 때, **2006**년에는 **0.4mm Pitch**를 가진 **BGA**의 적용이 확대 될 것으로 예상되며 일부 제품에서 **0.3mm Pitch Package**의 적용도 예상됨.