

플립 칩 (Flip Chip) 기술개요 및 시장전망

MICROSCALE CO., LTD

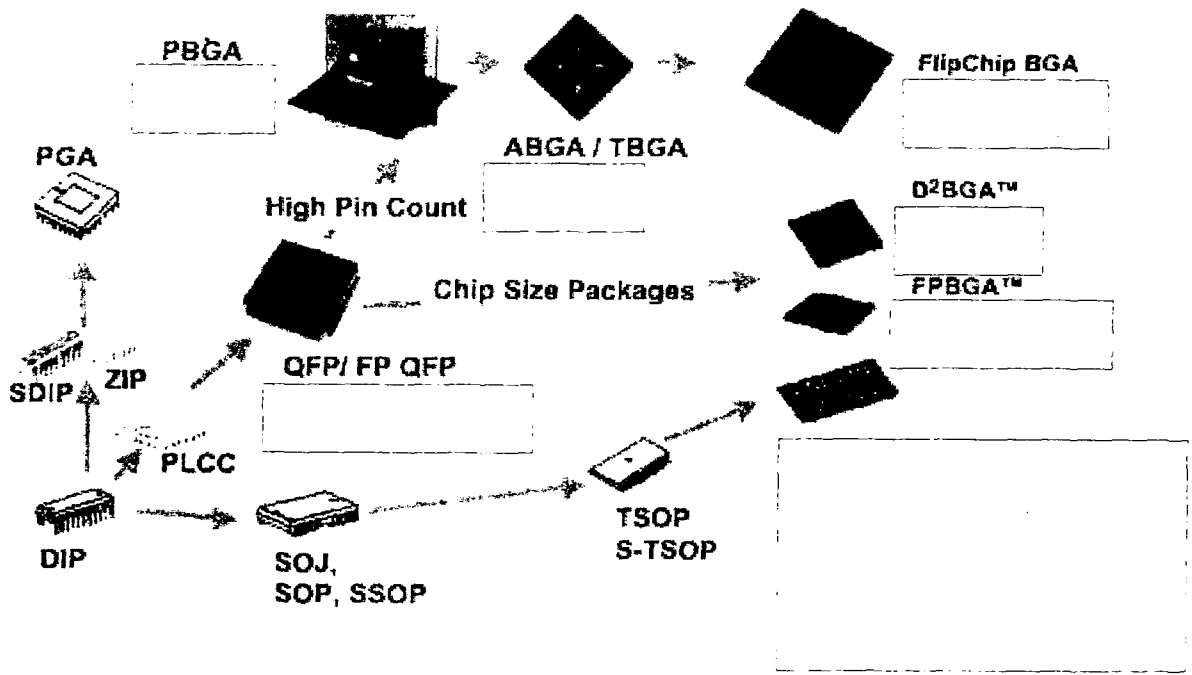
Kay S. Hwang , July 2001

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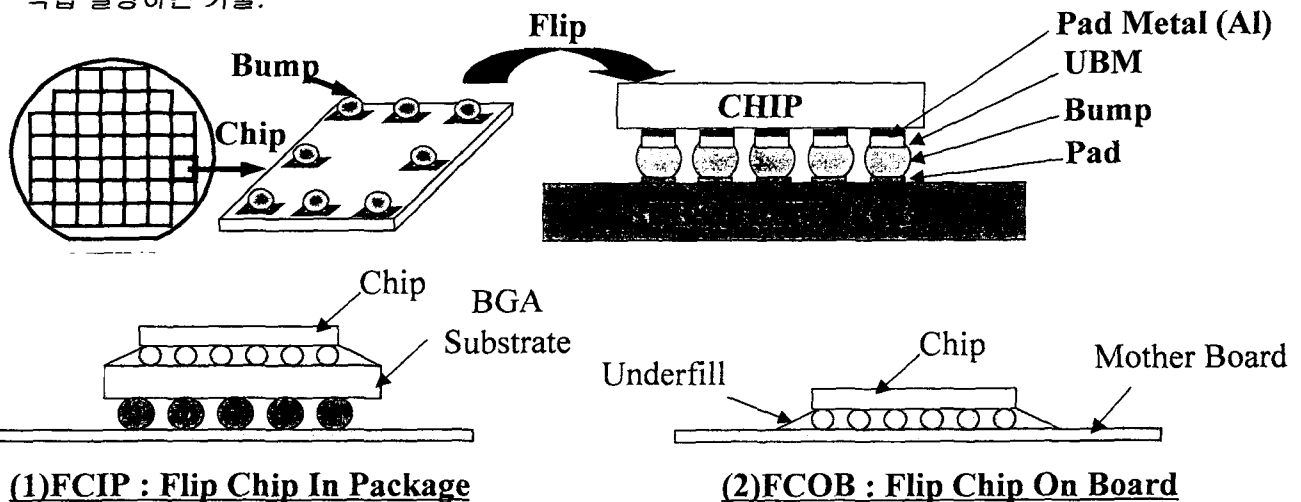
I . 반도체 Package Trend



II . Flip Chip 기술개요 및 적용

1. Flip Chip 기술정의

Wafer 및 MLB 上 Bonding PAD에 Solder(pb/sn)나 Gold(Au) 를 이용, 球形 또는 육면체 형상의 범프(bump)를 형성한 후 Chip을 뒤집어 기판(Substrate)이나 보드(Board)에 직접 실장하는 기술.



2. Flip Chip 응용분야

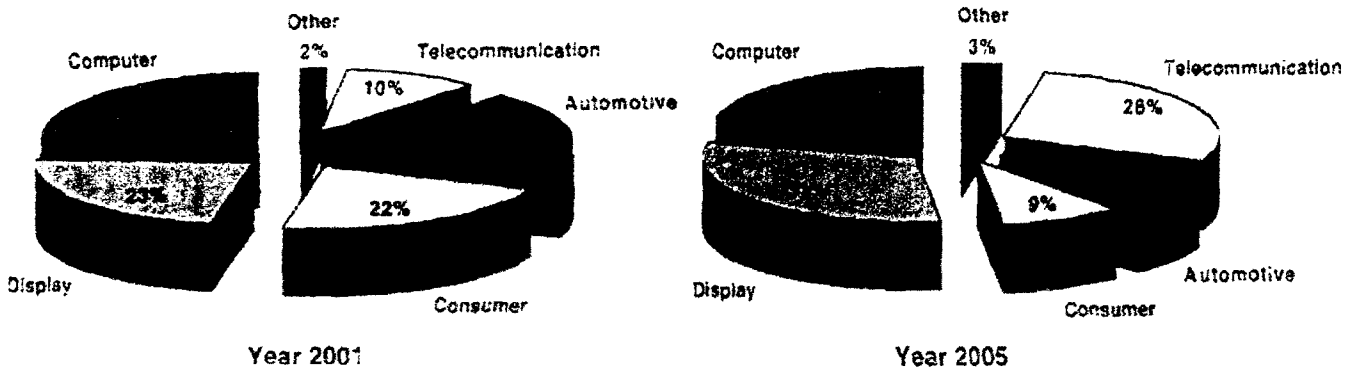
Computer	CPU, ASIC, MMU, Memory Module, Microprocessors, Chip Set, HDD...
Telecommunication	<ul style="list-style-type: none"> • Switching, network systems (switch module, router, graphics device, PLD,DSP) • Optical device (DWDM, LD module..) • Bluetooth module. • Saw device , TCXO , Crystal Oscillator...
Consumer	Camcorder, Smart Cards, RF ID, watch...
Automotive	Engine control module
Display	LCD Driver IC (LCD Monitor, Digital Camera, Notebook, PDA, Cellur phone, Palm PC)
Other	Medical (hearing aids, implanatable device)

Device	Bumps	Die Size (mm)	BumpPitch (μm)	Substrate	Body Size (mm)	PKG.
AMD microprocessor	2,000	15 x 15	226	Ceramic	50 x 50 31 x 31	CPGA CLGA
Intel microprocessor	1,000s	15 x 15	279.4	Laminate	49.5 x 49.5	PPGA
IBM switching chip	3,821	18.3 x 17.6	396 (interstitial)	Thin film/glass ceramic	127.5 x 127.5	MCM
NEC CPU	1,849	17.5 x 17.5	250	Thin film/ceramic	23 x 23	CBGA
Sun ASIC	1,000s	-	200 to 225	Laminate	45 x 45	PBGA
IBM ASIC	1,000s (1.768 signal)	18.3 x 18.3	225	Ceramic	52.5 x 52.5	CCGA
Fujitsu CPU	1,000s	-	153	Thin film/AiN	93 x 120	MCM
Motorola 603e Power PC	291	7.5 x 11	250	Ceramic	21 x 21	CBGA
Motorola 745 Power PC	458	6.8 x 8.2	225	Laminate	21 x 21	PBGA
Motorola 7450 Power PC	1,041	10 x 12	225	Ceramic	29 x 29	CBGA
Transmeta microprocessor	1,800	8.5 x 9.3	-	Ceramic	25 x 32	CBGA
Seagate preamp(HDD)	52	2.5 x 4.5	178 (peripheral)	Flex circuit	-	COF
IBM preamp (HDD)	48	2.8 x 3.7	229(2-row peripheral)	Flex circuit	-	COF
Matsushita RF device	38	-	114(peripheral)	LTCC	-	BGA
Medical	50	5 x 5	250	Ceramic	-	MCP
Automotive ECU	120	5 x 5	250	ceramic	-	MCP

3. Flip Chip 시장

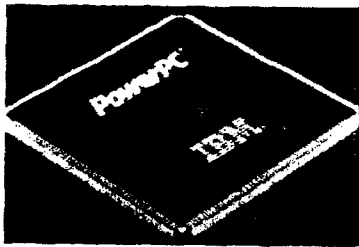
(Millions of units)

	2000	2001	2002	2003	2004	2005
Computer	288	360	539	783	1,017	1,250
Telecommunication	72	144	283	609	1,057	1,632
Consumer	13	31	71	131	214	370
Automotive	301	328	351	395	460	540
Display		195	365	525	760	1,375
Other	14	33	37	45	51	63
Total	1,095	2,075	2,075	2,945	4,370	5,825



(Source :Techsearch International 2001)

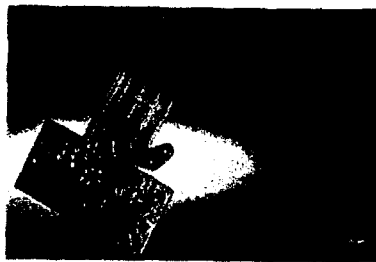
Computer



Single Chip Ceramic Package with Flip Chip Assembly (IBM CPU)



Flip Chip on Single Chip Laminate Package (LSI CPU)



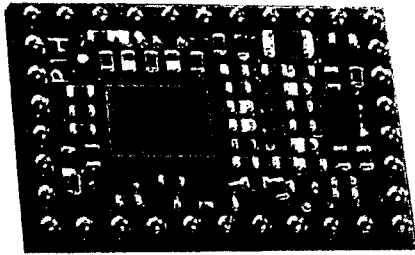
Flip Chip Device for HDD (Saturn)



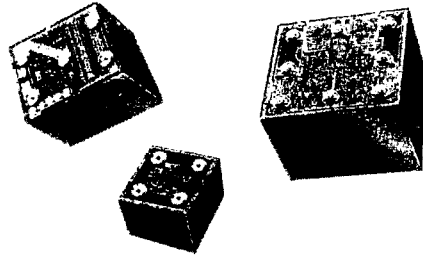
IBM SRAM

(Source: Roadmap of Packaging Technology, Techsearch International 2001)

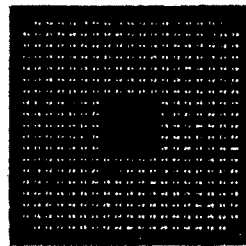
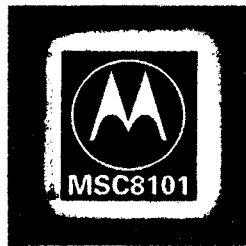
Telecommunication



Ericsson's Bluetooth module



National Semiconductor's μ SMD for Voltage regulators

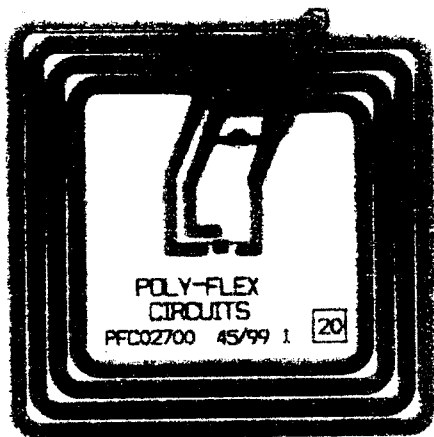


Motorola's Flip Chip PBGA for DSP

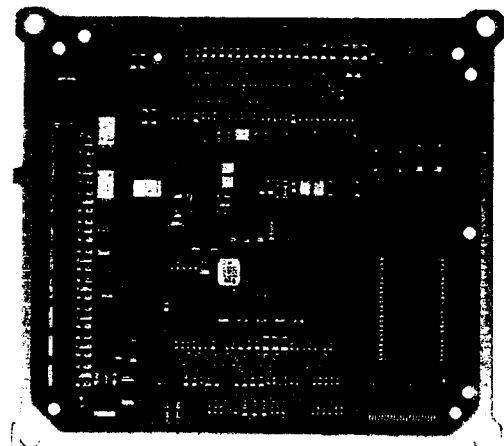
(Source: Techsearch International 2001)

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Smart Label, RF Tag and Automotive



RFID Tag (Poly-Flex Circuits)



Automotive
Delphi's Engine Control Module

(Source: Techsearch International 2001)

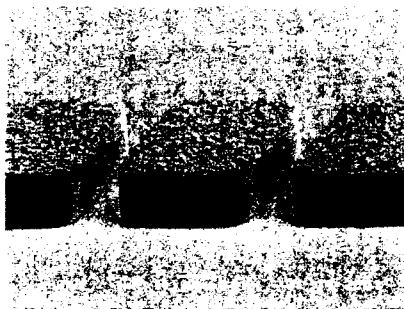
III. Bumping 기술의 구분

1. 솔더 범프 : PbSn, AgSnCu, AuSn, etc.
 - 스크린 프린팅, 전해도금방식, 솔더 Evaporation
2. 무전해 도금 범프 : Ni/Au, Ni/Au위 Solder Paste
 - 무전해 도금 후 ACF, ACA, NCP 등 이용한 접착 혹은 무전해 범프위에 솔더 페이스트로 스크린 프린팅 실시
3. Polymer Bump : Polymer + metal particle
 - 스크린 프린팅 방식
4. Stud bump : Au, Cu, Pd, etc.
 - 주로 Au 이용 Wire Bonding 방식 유사 공정 진행 후 Ultra Sonic에 의한 Flic Chip Bonding
5. Gold bump : Au
 - Au 전해 도금 후 TAB(Tape Attach Bonding) 방식 접착(TCP) 혹은 COF, COG 접착

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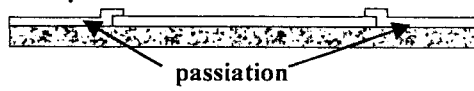
III. Au Bumping 공정 및 시장

1. 전해 Au Bump

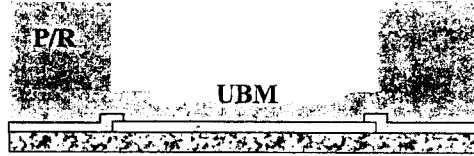


- ◆ Wafer Size : 6, 8 inch
- ◆ UBM : Ti-W/Au
- ◆ Bump Height : Nominal $18\mu\text{m} \pm 3\mu\text{m}$
- ◆ Hardness : 30 ~ 80Hv
- ◆ Bump Shear : Min. 5 grams/mil²
- ◆ Electrical testing and packaging available for LCD Driver IC

2. 전해 Au Bumping 공정

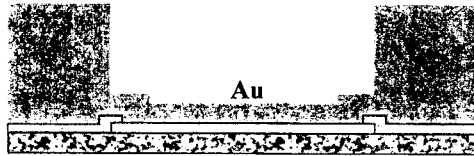


- Passivated wafer

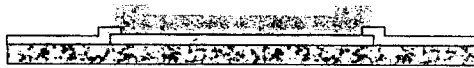


-UBM Sputtering

-Thick P/R Patterning



- Electroplating Au



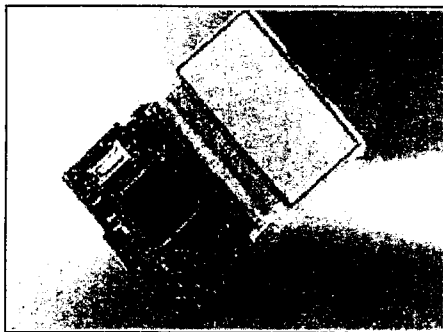
-Thick P/R Strip

- Remove UBM

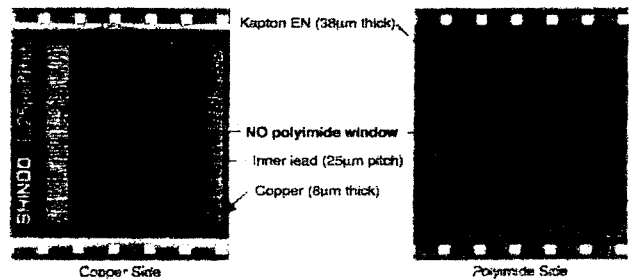
(Source :Microscale Confidential)

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Display



Display: TFT-LCD
EL, PDP



Shindo's COF

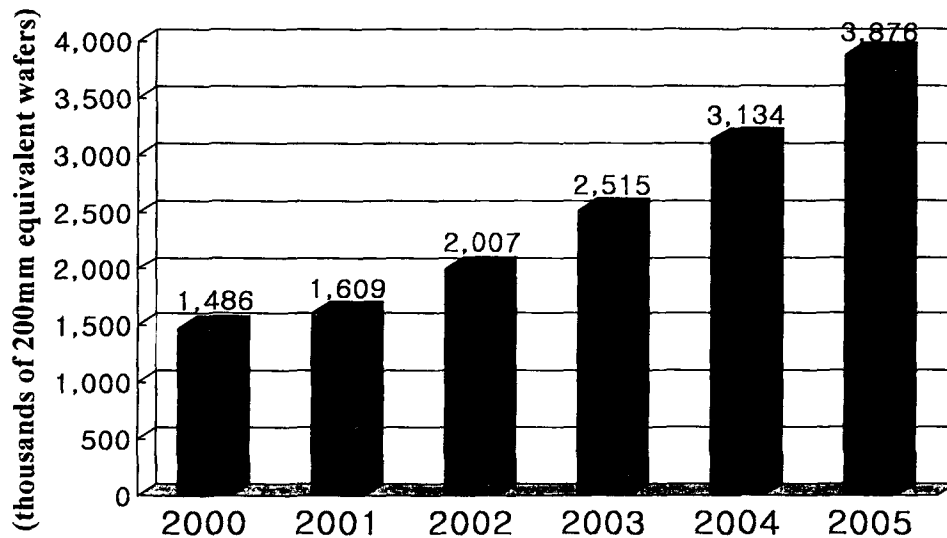


Display with driver COF

(Source: Techsearch International 2001)

3. 전해 Au Bumping 시장

Gold Bumping	2000	2001	2002	2003	2004	2005
Millions of devices	1,327	1,432	1,788	2,245	2,802	3,465
Thousands of 200mm equivalent wafers	1,486	1,609	2,007	2,515	3,134	3,876

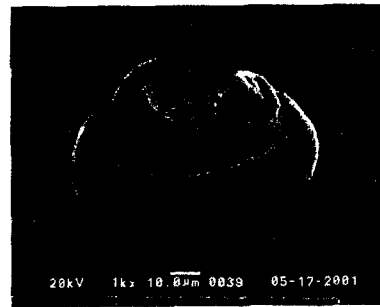
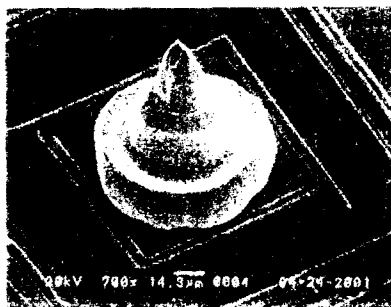


(Source :Techsearch International 2001)

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V. Stud Bumping 공정 및 시장

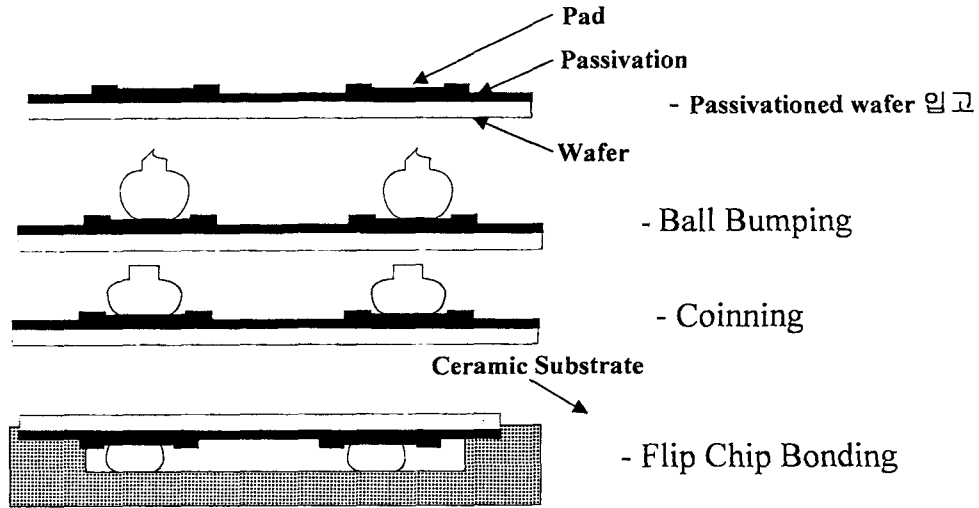
1. Au Stud Bumping



- ◆ Wafer Size : 4 , 6 inch
- ◆ Bump Size : Nominal $80\mu\text{m} \pm 5\mu\text{m}$
- ◆ Bump Height :
 - Single mode (Nominal $70\mu\text{m} \pm 10\mu\text{m}$)
 - Double mode (Nominal $40\mu\text{m} \pm 5\mu\text{m}$)
- ◆ Direct flip chip packaging available for SAW Filter, TCXO, or Oscillator

(Source :Microscale Confidential)

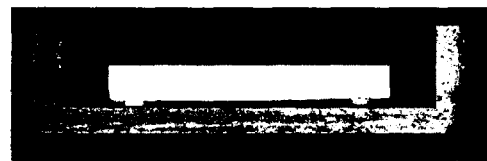
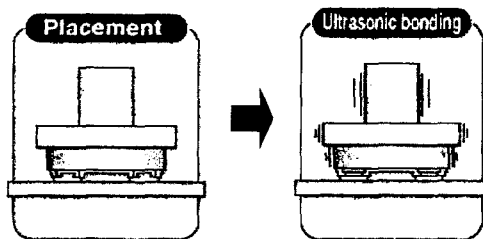
2. Au Stud Bumping 공정



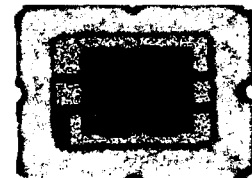
(Source :Microscale Confidential)

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3. Au Stud Flip Chip Bonding



Cross section of flip chip

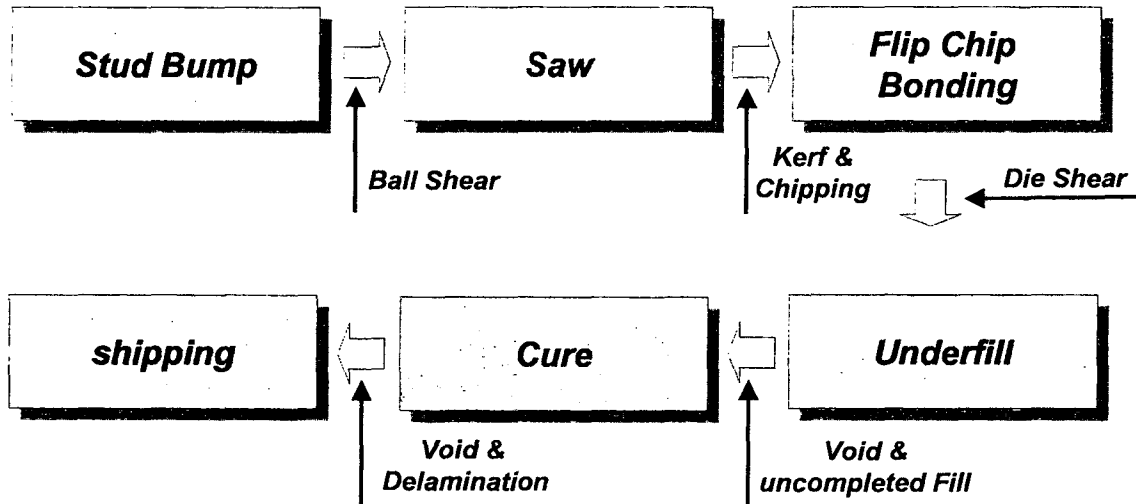


Top view of flip chip

- Wafer Size : 4 , 6 inch
- Wafer Type : Si, LN/LT, GaAs, etc
- Substrate : Ceramic
- Bump Height : 15- 25 μm
- Flip Chip Bonding Method
: ThermoSonic Direct Flip Chip
- Capability : 700 kpcs/month
- Applications : SAW Filter, TCXO, VCO, etc

(Source :Microscale Confidential)

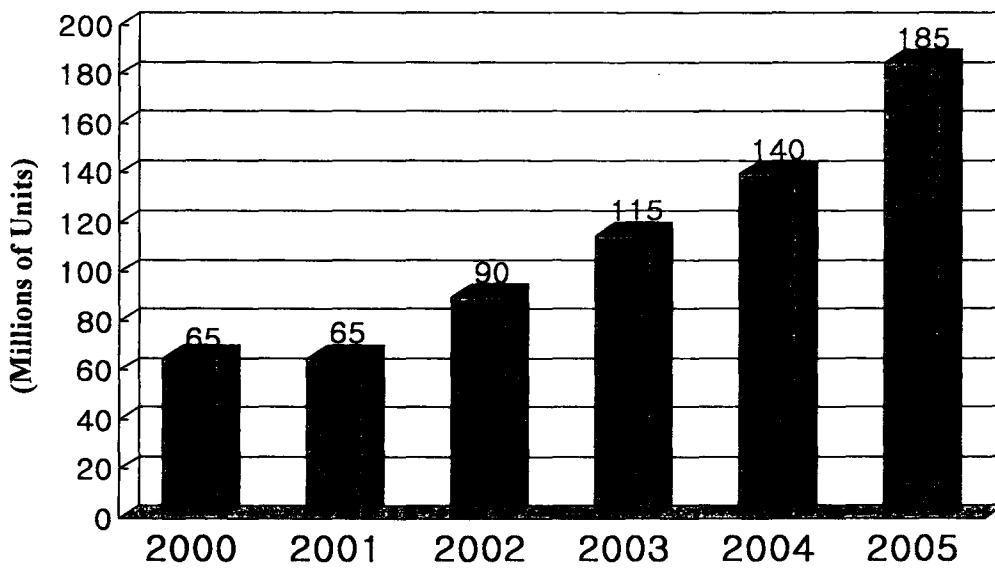
4. Au Stud Bump & Direct Flip Chip Bonding 공정



(Source :Microscale Confidential)

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5. Au Stud Bumping 시장



(Source :Techsearch International 2001)

VI. Solder Bumping 공정 및 시장

1. Solder Bumping



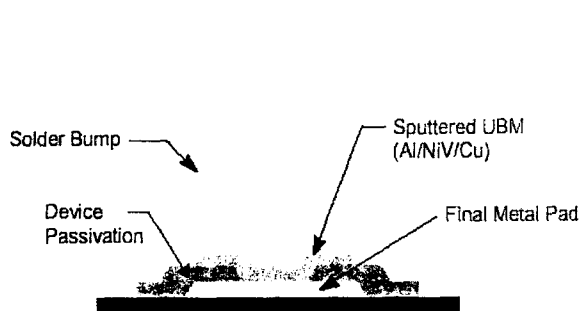
- Substrate : Wafer (6, 8 inch)/PCB
- Solder Composition
 - Production : Eutectic(63Sn/37Pb)
 - Development : High lead, Low α particle, Lead free solder
- 1) Electroplated Solder Bump
 - Bump Height : Nominal $120 \mu\text{m} \pm 3 \mu\text{m}$
- 2) Screen Printed Solder Bump
 - Bump Pitch : Min. $180 \mu\text{m}$

(Source :Microscale Confidential)

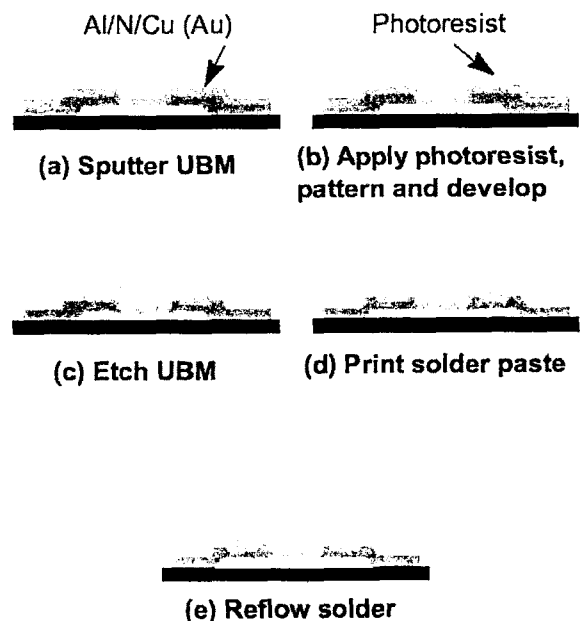
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2. Solder Bumping 공정

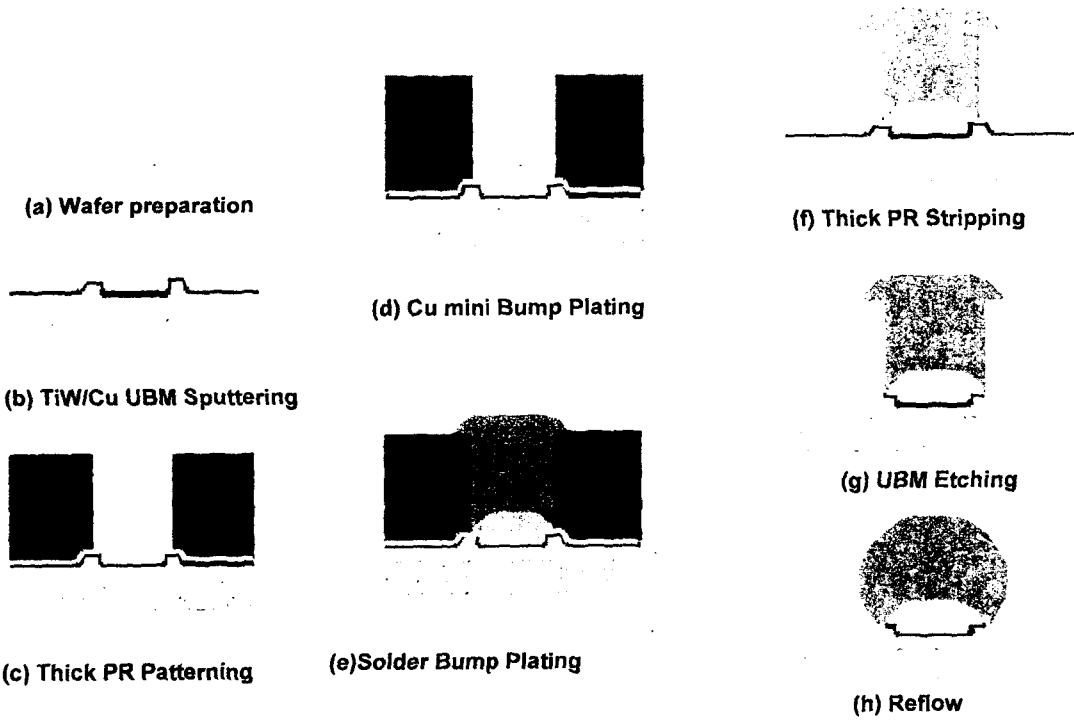
- Screen printing : 美 Flip Chip Technology 社



Cross-section of a sputtered UBM and solder paste bump.



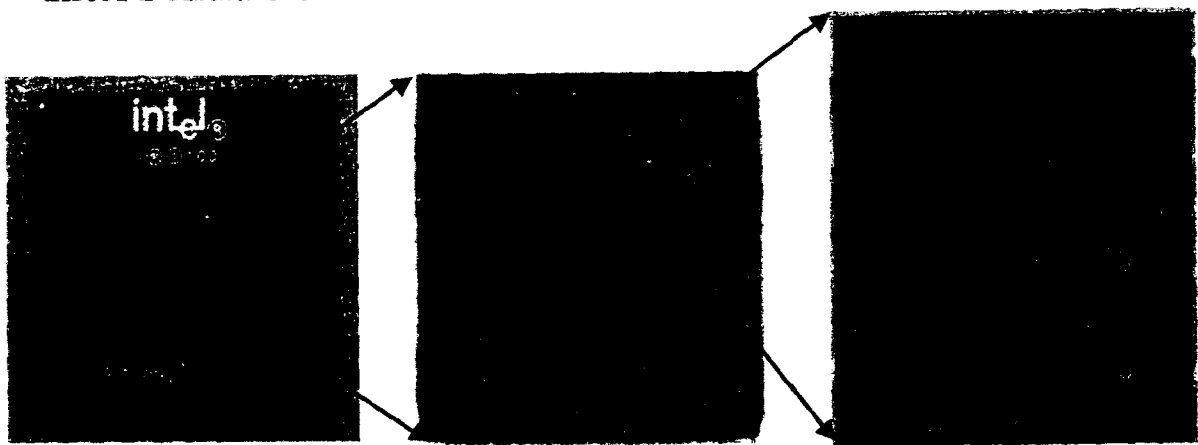
● **Electro-plating : Microscale Co. Ltd.**



(Source :Microscale Confidential)

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Intel Pentium III CPU



Top side of Package

Bottom side of CPU Chip

Package method : Flip-Chip PGA

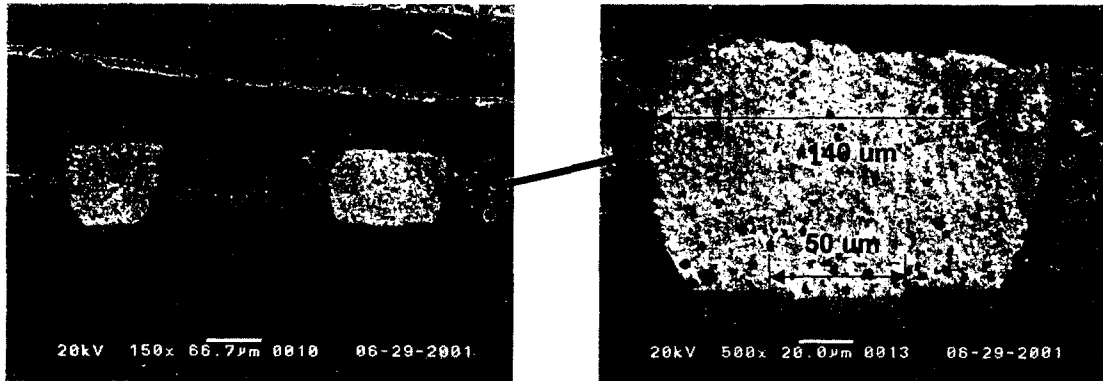
Minimum Bump pitch : 210 um

Chip Size : 13 mm x 11 mm

Number of Pads : 2103

(Source :Microscale Confidential)

Intel Pentium III CPU

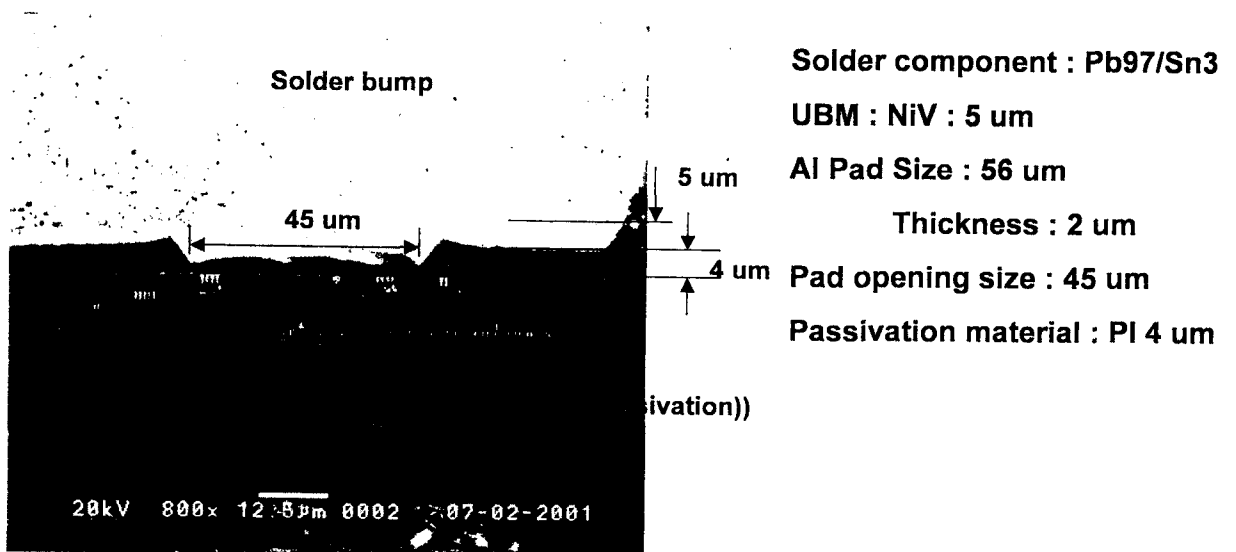


SEM images of Solder Bump

(Source :Microscale Confidential)

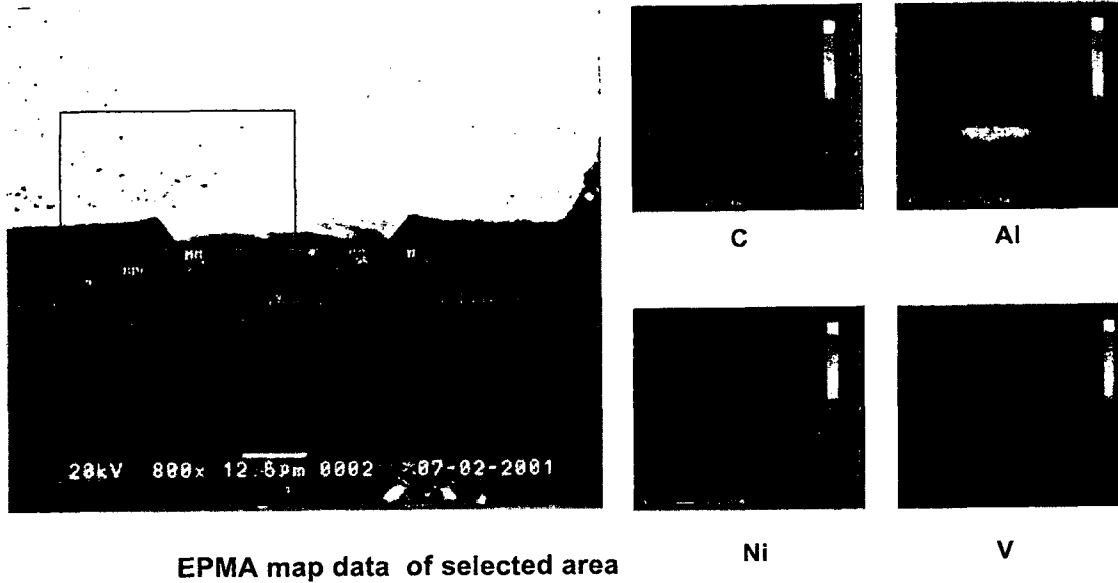
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Intel Pentium III CPU



(Source :Microscale Confidential)

Intel Pentium III CPU



(Source :Microscale Confidential)

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4. Solder Bumping 시장

◆ Demand for Solder Bumping

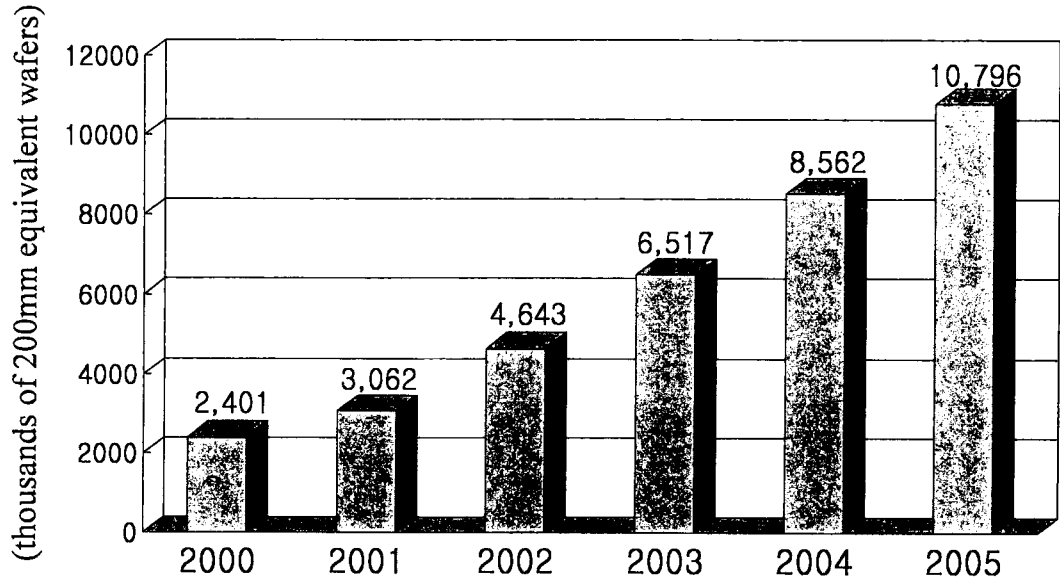
Solder Bumping	2000	2001	2002	2003	2004	2005
Millions of devices	821	1,062	1,423	2,025	2,804	3,737
Thousands of 200mm equivalent wafers	2,370	2,937	4,401	6,217	8,162	10,311

◆ Solder Bumped WLP Forecast

	2000	2001	2002	2003	2004	2005
Millions of devices	300	1,458	2,822	3,478	4,745	5,680
Thousands of 200mm equivalent wafers	31	125	242	380	480	485

(Source :Techsearch International 2001)

◆ Demand for Solder Bumped wafers (FC and WLPs)



(Source :Techsearch International 2001)

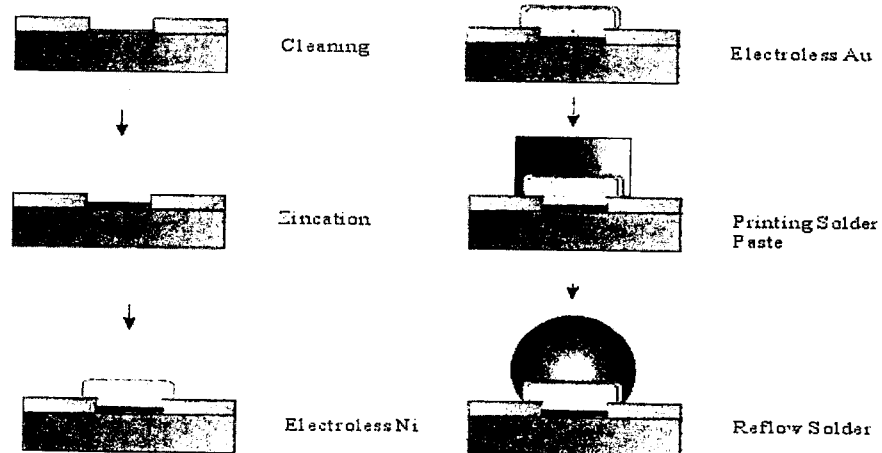
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Ⅶ 무전해 Ni/Au Bumping 공정 및 시장

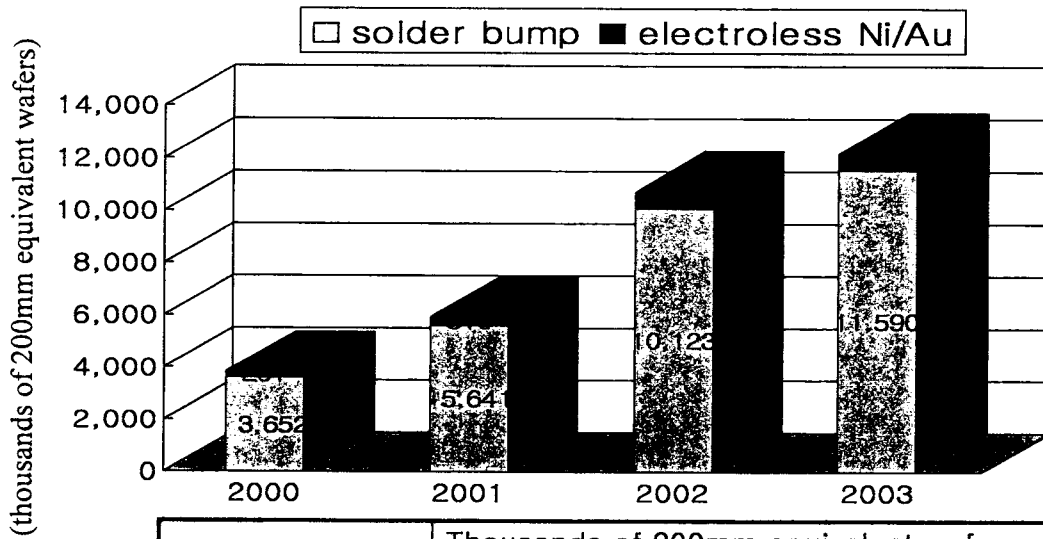
1. 무전해 Ni/Au Bump

◆ Electroless Ni/Au 및 solder Paste Screen Printing : 獨 Pactech 社

Electroless Plating Ni & Solder Paste Bumping Process



2. 무전해 Ni/Au Bump 시장



	Thousands of 200mm equivalent wafers			
	2001	2001	2002	2003
Solder Bump	3,652	5,641	10,123	11,590
Electroless Ni/Au	201	310	632	632
Total	3,853	5,951	10,755	12,222

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VIII. Flip Chip Bumping Service 사업

No.	Company	Bump Type (UBM)	Capa.(2000)(Wf / Yr)	Capa.(2001)(Wf / Yr)
1	Apack (Taiwan)	Screened Solder (Cr / Cu)	96,000	96,000 (solder)
2	Aptos Corp. (Taiwan, USA)	Plated gold (TiW/Au)	60,000 (gold), 60,000 (solder)	60,000 (gold) 60,000 (solder)
3	ASE (Taiwan)	Solder (Al / Ni / Cu)	-	315,000 (solder)
4	Casio (Japan)	Plated gold (TiW/Au) Solder (Ti / Cu / Ni)	2,400,000 (gold) 36,000 (solder)	2,760,000 (gold) 78,000 (solder)
5	Chipbond (Taiwan)	Plated gold(TiW/Au) Solder (TiW / Cu)	540,000 (gold) 60,000 (solder)	675,000 (gold) 105,000 (solder)
6	Citizen Watch (Japan)	Solder(Cr / Cu)	84,000 (solder)	84,000 (solder)
7	EM Microelectronics (Swiss)	Plated gold(TiW/Au) Solder (TiW / Cu)	150,000 (gold)	150,000 (gold)
8	Fujitsu Tohoku Electronics (Japan)	Solder(Ti/Ni)	96,000 (solder)	120,000(solder)

(Source : Techsearch International 2001)

No.	Company	Bump Type (UBM)	Capa.(2000)(Wf /Yr)	Capa.(2001)(Wf / Yr)
9	Fupo(Taiwan)	Plated gold (TiW/Au) Solder (TiW / Cu)	240,000 (gold, solder)	580,000 (gold, solder)
10	IC Interconnect (USA)	Screened solder (Electroless Ni / Au)	150,000	150,000
11	K&S Flip Chip Div.(USA)	Solder (Al / NiV / Cu)	288,000 (solder)	360,000 (Solder)
12	MEGIC (Taiwan)	Plated gold(TiW/Au)	120,000	360,000(gold), 30,000(solder)
13	MicroFab Technology (Singapore)	Plated gold (TiW/Au)	-	180,000(gold, solder)
14	Microscale (Korea)	Plated gold (TiW/Au) Solder (Plated, Screened)	-	20,000(gold, solder)
15	Pac Tech (Germany,Japan,USA)	Screened solder (Electroless Ni / Au)	150,000	345,000
16	SPIL (Taiwan)	Solder (Al / NiV / Cu)	-	120,000(solder)
17	Unitive (Taiwan,USA)	Solder(Cr/CrCu/Cu , Ti/Cu/Ni)	160,000(solder)	290,000(solder), 36,000(gold)

(Source :Techsearch International 2001)

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IX. Flip Chip 및 Bumping 기술발전 추이

1. 솔더범핑 공정기술의 발전경향

- 저가 공정요구 : Evaporation > Electro-Plating > Screen Printing, 무전해 도금
- 환경보호 운동관련 Lead Free Solder 개발 추이
- 고신뢰성 Low- α 요구

2. LCD용 Au 범프의 수요증가 및 적용분야 확장

- PC Monitor의 TFT LCD 액정 화면화, PDA, 유기 EL 등 적용분야 확대
- 휴대전화기 화면의 Color 화 : 흑백 > 흑백 대형화면 > 4 Gray제품 > Color 화면
- 8 inch Color STN 의 급증, 8 inch wafer의 300 um 공정 처리 기술

3. CPU, DSP 등의 대용량, 고속처리 기능요구에 따른 주변 메모리, Chip Set의 플립칩 화경향

4. 무선통신용 Passive 소자, 모듈의 고속, 고주파 기능 요구에 따른 플립칩 확장

- SAW Filter, TCXO, RF Module 등
- Smart Label, RFID TAG 등의 수요 증가

(Source :Microscale Confidential)