FLIP CHIP/WLP MANUFACTURING AND MARKET ANALYSIS Table of Contents		
Chapter 1	Introduction	1-1
Chapter 2	Executive Summary	2-1
Chapter 3	Flip Chip/WLP Issues and Trends	3-1
3.1	Introduction	3-1
3.2	Wafer Bumping	3-6
3.2.1	Solder Bumps	3-7
3.2.1.1	Metallurgy	3-7
3.2.1.2	Deposition Of UBM	3-11
3.2.1.3	Sputter Etching	3-12
3.2.1.4	Photolithography	3-13
3.2.1.5	Solder Deposition	3-14
3.2.1.6	Resist Strip	3-15
3.2.1.7	UBM Wet Etch	3-16
3.2.1.8	Reflow	3-16
3.2.1.9	Flux Issues	3-18
3.2.2	Gold Bumps	3-19
3.2.2.1	Bump Processing	3-19
3.2.2.2	Bonding	3-21
3.2.2.3	Coplanarity	3-25
3.2.2.4	Conductivity	3-26
3.2.2.5	Thermal Properties	3-26
3.2.2.6	Size	3-27

3.2.2.7	Reliability	3-27
3.2.2.8	Cost Issues	3-28
3.2.3	Copper Pillar Bumps	3-31
3.2.4	Copper Stud Bumping	3-35
3.2.5	C4NP	3-40
3.3	Wafer Level Packaging	3-46
3.4	Pad Redistribution	3-57
3.5	Wafer Bumping Costs	3-61
3.5.1	Wafer Redistribution And Wafer Bumping Costs	3-62
3.5.2	WLCSP Hidden Costs	3-63
3.5.3	WLCSP Cost Per Good Die	3-64
3.5.4	Wafer-Level Underfill Costs	3-65
3.6	Panel Level Packaging	3-70
Chapter 4	Lithography Issues And Trends	4-1
Chapter 4	Lithography Issues And Trends	4-1
Chapter 4 4.1	Lithography Issues And Trends Issues	4-1 4-1
-		
4.1	Issues	4-1
4.1	Issues Technical Performance	4-1
4.1 4.1.1 4.1.2	Issues Technical Performance Capital Investment	4-1 4-2 4-2
4.1.1 4.1.2 4.1.3	Issues Technical Performance Capital Investment Cost Of Consumables	4-1 4-2 4-2 4-2
4.1.1 4.1.2 4.1.3 4.1.4	Issues Technical Performance Capital Investment Cost Of Consumables Throughput	4-1 4-2 4-2 4-2 4-2
4.1 4.1.1 4.1.2 4.1.3 4.1.4 4.1.5	Issues Technical Performance Capital Investment Cost Of Consumables Throughput Ease Of Use	4-1 4-2 4-2 4-2 4-2 4-3
4.1 4.1.1 4.1.2 4.1.3 4.1.4 4.1.5 4.1.6	Issues Technical Performance Capital Investment Cost Of Consumables Throughput Ease Of Use Flexibility	4-1 4-2 4-2 4-2 4-2 4-3 4-3
4.1 4.1.1 4.1.2 4.1.3 4.1.4 4.1.5 4.1.6 4.1.7	Issues Technical Performance Capital Investment Cost Of Consumables Throughput Ease Of Use Flexibility Equipment Support	4-1 4-2 4-2 4-2 4-3 4-3
4.1 4.1.1 4.1.2 4.1.3 4.1.4 4.1.5 4.1.6 4.1.7 4.1.8	Issues Technical Performance Capital Investment Cost Of Consumables Throughput Ease Of Use Flexibility Equipment Support Resolution	4-1 4-2 4-2 4-2 4-3 4-3 4-3

4.2.1	Introduction	4-6
4.2.1.1	Reduction Steppers	4.6
4.2.1.2	Full-Field Projection	4-8
4.2.1.3	Mask Aligners	4-13
4.2.1.4	1X Steppers	4-13
4.2.1.5	2X Steppers	4-14
4.3	Competitive Technologies	4-16
4.3.1	Inkjet Printing	4-16
4.3.2	Stencil/Screen Printing	4-18
4.3.3	Electroless Metal Deposition	4-22
Chapter 5	UBM Etch Issues And Trends	5-1
5.1	Introduction	5-1
5.2	Technology Issues And Trends	5-2
5.2.1	Process Flow	5-2
5.2.2	Etch Process	5-4
5.2.3	Etch Chemistry	5-8
5.3	Batch Versus Single-Wafer Etching	5-16
Chapter 6	Metallization Issues and Trends	6-1
6.1	Introduction	6-1
6.2	Sputtering Metallization	6-3
6.2.1	Gold Bump	6-3
6.2.2	Solder Bumping	6-4
6.2.2.1	T I / Cu and TiW / Cu	6-5
6.2.2.2	Al / NiV / Cu	6-5

	T : / N : / N	
6.2.2.3	Ti/Ni(V) and TiW/Ni(V)	6-6
6.2.2.4	Cr / Cr-Cu / Cu	6-6
6.2.3	Copper Bumping	6-7
6.3	Electrodeposition	6-9
Chapter 7	Market Analysis	7-1
7.1	Market Drivers For Flip Chip And WLP	7-1
7.2	Market Opportunities	7-2
7.3	Challenges	7-6
7.4	Flip Chip Market	7-7
7.4.1	Market Dynamics	7-7
7.4.2	Market Forecast	7-15
7.5	Lithography Market	7-24
7.5.1	Aligners Vs. Steppers	7-24
7.5.2	Market Analysis	7-25
7.6	Deposition Market	7-33
	List of Tables	
3.1	Common UBM Stacks For Solder And Gold Bumping	3-8
3.2	Solder Bumping Guidelines	3-10
3.3	Gold Bumping Guidelines	3-24
3.4	Copper Bumping Guidelines	3-34
3.5	Comparison Of Solder Bumping Processes	3-43
3.6	ITRS Pin Counts For Different Applications	3-47
3.7	Pillar-WLP CSP Guidelines	3-52
3.8	Pad Redistribution Guidelines	3-59

4.1	Key Challenges For WLP Lithography	4-12
4.2	Lithography Tools By Vendor	4-15
5.1	UBM Film Etchants	5-10
5.2	Advantages Of Spin Processing	5-19
6.1	Common UBM Stacks For Gold And Solder Bumping	6-2
7.1	WLP Demand by Device (Units)	7-20
7.2	WLP Demand by Device (Wafers)	7-21
7.3	Worldwide Lithography Forecast	7-24
7.4	Cost Of Ownership Of 1x Versus 2x Steppers	7-32
7.5	Worldwide Forecast For Deposition Tools	7-34
	List of Figures	
3.1	C4 Chip Connections	3-3
3.2	Wafer Bump Technology Roadmap	3-4
3.3	Comparison Of Copper Pillar, Flip Chip, And WLP	3-5
3.4	Solder Bumping Process	3-9
3.5	Three Process Flows For Solder Bumping	3-17
3.6	Gold Bumping Process	3-23
3.7	Cost Per Gold Bumped Wafer	3-29
3.8	Copper Stud Bump	3-36
3.9	Breakdown Of Stud Bumping Costs	3-39
3.10	C4NP Process Description	3-41
3.11	Pillar-WLPCSP Process	3-51
3.12	Pad Redistribution Process	3-58
4.1	Laser-Projection Imaging	4-10
4.2	Solder Jet Technology	4-17
4.3	Principle Of Screen Printing	4-20

4.4	Principle Of Inkjet Printing	4-21
4.5	Electroless Under Bump Metallization	4-23
5.1	Electroplated Solder Bumping Process	5-3
7.1	WLP Applications	7-3
7.2	Wire Bond versus Flip Chip	7-11
7.3	Flip Chip and Wire Bond Equipment Forecast	7-13
7.4	Growth in Copper Wire Bonding	7-14
7.5	Flip Chip Market By Number of Devices	7-16
7.6	Flip Chip Market By Number of Wafers	7-17
7.7	WLP Market by Device - 2014	7-18
7.8	WLP Market by Device - 2020	7-19
7.9	Device Shipment Forecast WLP Vs Flip Chip	7-23
7.10	Device Shipment Forecast FIWLP Vs FOWLP	7-24
7.11	Historic Lithography Market Shares	7-27
7.12	Lithography Market Share Growth	7-29
7.13	ECD Market Shares	7-35
7-14	Sputtering Market Shares	7-36