

TABLE OF CONTENTS

1	EXECUTIVE SUMMARY	9			
1.1	MARKET GROWTH - REVENUES	10	3.2	ELECTRONIC GOODS MARKET	35
1.2	EXTENSIONS	11	3.2.1	SMART PHONES	36
1.3	TRENDS IMPACTING PRICING	12	3.2.2	PC UNIT SHIPMENTS	37
1.4	GROWTH SEGMENT -- EUV RESIST	13	3.2.3	AUTOMOTIVE SALES	38
1.5	GROWTH SEGMENT -- KRF RESIST	14	3.2.3.1	INCREASE IN SEMICONDUCTOR CONTENT FOR AUTOS	39
1.6	GROWTH SEGMENT -- NTD DEVELOP AND RINSE	15	3.2.3.2	SEMICONDUCTOR CONTENT BY AUTOMOTIVE ELECTRONIC SYSTEM	40
1.7	PHOTORESIST MARKET SHARES	16	3.2.3.3	INCREASE IN SEMICONDUCTOR CONTENT FOR AUTOS	41
1.8	NEW INDUSTRY ENTRANTS	17	3.2.3.5	SEMICONDUCTOR CONTENT BY AUTOMOTIVE ELECTRONIC SYSTEM	42
1.9	TECHNOLOGY TRENDS	18	3.2.4	SERVERS / IT	43
1.10	ANALYST ASSESSMENT	19	3.3	SEMICONDUCTOR FABRICATION GROWTH & EXPANSION	45
2	SCOPE, PURPOSE AND METHODOLOGY	21	3.3.1	SEMICONDUCTORS UNIT AND WAFER SHIPMENT GROWTH FORECAST	46
2.1	SCOPE	22	3.3.2	EQUIPMENT SPENDING TRENDS	47
2.2	PURPOSE	23	3.3.3	RECENT INVESTMENT AND FAB/PLANT EXPANSION ACTIVITY	50
2.3	METHODOLOGY	24	3.3.4	OVERALL CHINA MARKET TRENDS	52
2.4	OVERVIEW OF OTHER TECHCET CMR™ REPORTS	25	3.4	SEMICONDUCTOR INDUSTRY MARKET OUTLOOK SUMMARY	54
3	SEMICONDUCTOR INDUSTRY MARKET OUTLOOK	25	3.4.1	POLICY AND TRADE ISSUES	55
3.0	SEMICONDUCTOR INDUSTRY MARKET STATUS	27	3.4.2	U.S. CHIPS ACT	57
3.1	WORLDWIDE ECONOMY	28	3.4.3	OTHER SEMICONDUCTOR FUNDING ACTIVITY	58
3.1.1	SEMICONDUCTOR INDUSTRIES TIES TO THE GLOBAL ECONOMY	30	3.5	SEMICONDUCTOR MATERIALS OUTLOOK	59
3.1.2	SEMICONDUCTOR SALES GROWTH	31	3.5.1	LEADING EDGE NODES DRIVE MATERIALS GROWTH	60
3.1.3	TAIWAN MONTHLY SALES TRENDS	32	3.5.2	SEMICONDUCTOR PROCESS MATERIALS MARKET FORECAST	61
3.1.4	SEMICONDUCTOR INDUSTRY OUTLOOK	33	3.5.3	TEHCET FORECAST METHODOLOGY	62
3.1.5	SEMICONDUCTOR UNITS AND WAFER SHIPMENT GROWTH FORECAST	34	4	LITHOGRAPHY MATERIALS MARKET LANDSCAPE	63
			4.1	PHOTORESIST MARKET INFLUENCERS, FORECASTS & MARKET DRIVERS	64
			4.1.1	COVID-19	65
			4.1.2	TRADE RELATED CONFLICTS	67
			4.1.3	WILD FIRES	69
			4.1.4	TEXAS SNOW STORM	70

TABLE OF CONTENTS

4.2	PHOTORESIST MARKET DRIVERS, FORECAST, STATUS AND TRENDS	71	4.4.4	RINSE MATERIALS STATUS & CHALLENGES	97
4.2.1	MARKET DRIVERS	72	4.4.2.1	EDGE BEAD REMOVERS VOLUME FORECAST & TRENDS	95
4.2.2	PHOTORESIST REVENUES	73	4.4.3	PT DEVELOPER VOLUMES AND REVENUES FORECASTS	96
4.2.3	PHOTORESIST VOLUMES	74	4.4.4	RINSE MATERIALS STATUS & CHALLENGES	97
4.2.4	TOOL CAPABILITIES	75	4.5	EUV LITHOGRAPHY AND MATERIALS	98
4.2.5	PHOTORESIST MARKET TRENDS	76	4.5.1	EUV OVERVIEW	99
4.2.6	I AND G-LINE RESIST VOLUME FORECAST	77	4.5.2	EUV MATERIALS GROWTH DRIVERS & TRENDS	101
4.2.6.1	I-LINE & G-LINE TRENDS	78	4.5.3	EUV STATUS AND OVERVIEW	102
4.2.7	KRF/248NM PHOTORESIST VOLUME FORECAST	79	4.5.4	EUV PHOTOLITHOGRAPHY TRENDS	103
4.2.7.1	KRF/248NM LITHOGRAPHY & 3DNAND TRENDS	80	4.5.5	EUV PHOTORESIST PLATFORM (CURRENT AND FUTURE)	104
4.2.7.2	KRF/248NM LITHOGRAPHY & 3DNAND, CONTINUED	81	4.5.6	LIMITATIONS ON EUV PHOTORESIST GROWTH – LITHO TOOL SUPPLY	105
4.2.8	ARF/ARFI /193 NM RESIST FORECAST	82	4.5.7	A NOTE ABOUT EUV ANCILLARIES	107
4.2.8.1	ARF / 193NM VS. EUV TRENDS – OEM TOOLS	83	4.6	OTHER NEW MATERIALS FOR PATTERNING	108
4.2.9	CHINA AND RESISTS	84	4.6.1	DIRECTED SELF ASSEMBLY (DSA) HAS RENEWED ACTIVITY	109
4.2.10	EUV RESISTS VOLUME FORECAST	85	4.6.2	DSA IMPROVEMENTS REPORTED	110
4.2.10.1	EUV RESISTS REVENUE FORECAST	86	4.6.3	NANO IMPRINT LITHOGRAPHY IS CLOSE TO PRODUCTION FOR 3D NAND FLASH	111
4.3	EXTENSION MATERIALS FORECASTS, MARKET DRIVERS & ANTIREFLECTIVE COATINGS DESCRIBED	87	4.6.4	NANOIMPRINT LITHOGRAPHY (NIL) – HOW DOES IT WORK?	112
4.3.1	EXTENSION MATERIALS FORECASTS & MARKET DRIVERS	88	4.6.5	NEW PATTERNING METHODS – ASSESSMENT	113
4.3.2	KEY SUPPLIERS OF EXTENSION MATERIALS	89	4.7	EHS AND LOGISTIC ISSUES	114
4.4	ANCILLARY MATERIALS – DEVELOPER & EBR TRENDS	90	4.7.1	PFOS AND PFAS	115
4.4.1	ANCILLARY VOLUMES AND REVENUES HISTORICALLY FORECASTED ESTIMATIONS	91	5	SUPPLIER MARKET LANDSCAPE	117
4.4.1.1	NTD AND RINSE VOLUME FORECAST	92	5.1	PHOTORESIST MARKET SHARES	118
4.4.1.2	NTD AND RINSE REVENUE FORECAST	93	5.1.1	MARKET LANDSCAPE	119
4.4.2	EDGE BEAD REMOVERS VOLUME FORECAST & TRENDS	94			
4.4.2.1	EDGE BEAD REMOVERS VOLUME FORECAST & TRENDS	95			
4.4.3	PT DEVELOPER VOLUMES AND REVENUES FORECASTS	96			

TABLE OF CONTENTS

5.2	PHOTORESIST SUPPLY MARKET DYNAMICS	121
5.2.1	PHOTORESIST SUPPLIER TRENDS TO WATCH	122
5.2.2	PHOTORESIST SUPPLIER STATUS AND ACTIVITIES	123
5.2.2.1	SUPPLIER YEAR-END RESULTS & SYNOPSIS - DUPONT	124
5.2.2.2	SUPPLIER YEAR-END RESULTS & SYNOPSIS – FUJIFILM	125
5.2.2.3	SUPPLIER YEAR-END RESULTS & SYNOPSIS – JSR	126
5.2.2.4	SUPPLIER YEAR-END RESULTS & SYNOPSIS - SHIN-ETSU	127
5.2.2.5	SUPPLIER YEAR-END RESULTS & SYNOPSIS – SUMITOMO	128
5.2.2.6	SUPPLIER YEAR-END RESULTS & SYNOPSIS – TOK	129
5.2.2.7	SUPPLIER YEAR-END RESULTS & SYNOPSIS – INPRIA	130
5.2.2.8	SUPPLIER YEAR-END RESULTS & SYNOPSIS – IRRESISTIBLE MATERIALS	131
5.3	PLANT CLOSURES AND PRODUCT DISCONTINUATIONS	132
6	SUB TIER MATERIAL SUPPLY CHAIN CONSIDERATIONS	133
6.1	SUB-TIER MATERIAL SUPPLY CHAIN CONSIDERATIONS	134
6.2	SUB-TIER MATERIALS LOGISTICS ISSUES	135

7	SUPPLIER PROFILES	136
	AVANTOR	NISSAN CHEMICAL
	BASF	PHICHEM
	BREWER SCIENCE	RUIHONG
	CHANG CHUN	SACHEM
	DONGJIN CHEMICAL	SHIN-ETSU
	DUPONT	SUMITOMO
	EASTMAN	SUNTIFIC
	EVERLIGHT CHEMICAL	TOK
	FUJIFILM	YOUNGCHANG CHEMICAL
	INPRIA	ALLRESIST GESELLSCHAFT FÜR CHEMICHE
	IRRESISTABLE MATERIALS	ZEON
	JIANGSU HANTOP PHOTO-MATERIALS	JIANGSU NATA OPTOELECTRONICS
	JIANGSU NATA OPTO-ELECTRONICMATERIALS	SHANGHAI SINYANG SEMICONDUCTOR
	JSR	MATERIALS CO. LTD
	KEMPUR	
	MERCK KGAA/EMD/AZ	
	MOSES LAKE INDUSTRIES	
	APPENDIX – PHOTORESIST HISTORICAL TECH TRENDS	242
	APPENDIX – TONE DEVELOPER BACKGROUND	244
	APPENDIX – EUV TECHNOLOGY	246
	APPENDIX – ARCS & BARCS AND TARCS EXPLAINED	250
	REFERENCES	256

FIGURES & TABLES

FIGURES

FIGURE 1: PHOTORESIST REVENUES HISTORY & FORECAST ESTIMATES	10	FIGURE 21 :SEMICONDUCTOR CONTENT BY AUTOMOTIVE APPLICATION	42
FIGURE 2A AND 2B: EXTENSION MATERIALS VOLUMES & REVENUES FORECAST ESTIMATES	11	FIGURE 22: AMAZON SERVER FARM	43
FIGURE 3: EUV RESIST REVENUES	13	FIGURE 23: SEMICONDUCTOR WAFER AREA SHIPMENTS	46
FIGURE 4: EUV RESIST VOLUMES	13	FIGURE 24: 3-MONTH AVERAGE SEMICONDUCTOR EQUIPMENT BILLINGS	47
FIGURE 5: KRF PHOTORESIST REVENUES	14	FIGURE 25: CAPITAL SPENDING TRENDS BY TECHNOLOGY NODE	48
FIGURE 6: KRF PHOTORESIST VOLUME(KILOLITERS)	14	FIGURE 26: OVERVIEW OF LOGIC ROADMAP TRENDS	49
FIGURE 7: SOLVENT VOLUMES FOR NTD RINSE AND DEVELOP & FORECAST ESTIMATES	15	FIGURE 27: CHINA IC MARKET AND PRODUCTION TRENDS	52
FIGURE 8: 2020 PHOTORESIST MARKET SHARES (% OF WW REVENUES)	16	FIGURE 28 : ADVANCED NODES WAFER STARTS HISTORY & FORECAST.	60
FIGURE 9: GLOBAL ECONOMY AND THE ELECTRONICS SUPPLY CHAIN (2020)	30	FIGURE 29 :GLOBAL SEMICONDUCTOR MATERIALS OUTLOOK	61
FIGURE 10: WORLDWIDE SEMICONDUCTOR SALES	31	FIGURE 31: PHOTORESIST REVENUES FORECAST ESTIMATE BY RESIST TYPE	73
FIGURE 11: WORLDWIDE SEMICONDUCTOR SALES (TSMC, UMC, VIS, ASE, CHIPMOS, KYEC)	31	FIGURE 32: PHOTORESIST VOLUME FORECAST ESTIMATE BY DEVICE TYPE	74
FIGURE 12: SEMICONDUCTOR REVENUES 2021	32	FIGURE 33: I AND G LINE PHOTORESIST VOLUME PROJECTION 2020-2025 CAGR	75
FIGURE 13: SEMICONDUCTOR WAFER AREA SHIPMENTS	33	FIGURE 34: I AND G LINE PHOTORESIST VOLUME PROJECTION 2020-2025 CAGR 2%	79
FIGURE 14: SEMICONDUCTOR CHIP APPLICATIONS	34	FIGURE 35: BIRDS-EYE VIEW OF DC-SF CELL ARRAY	81
FIGURE 15: MOBILE PHONE SHIPMENTS WW ESTIMATES	35	FIGURE 36: 193NM PHOTORESIST VOLUME PROJECTION 2020-2025 CAGR 2% FOR ARF CAGR 16.7 FOR ARFI	82
FIGURE 16: PC NOTEBOOK SHIPMENTS	36	FIGURE 37: ASML REVENUE 193NM IMMERSION VS EUV REVENUE	83
FIGURE 17: U.S. AUTOMOTIVE SALES	37		
FIGURE 18: MONTHLY AUTOMOTIVE SALES TRENDS	38		
FIGURE 19: GLOBAL EV TRENDS	39		
FIGURE 20: SEMICONDUCTOR SPEND PER VEHICLE TYPE	40		
	41		

FIGURES & TABLES

FIGURE 30: SHRINKONOMICS OF OPTICAL LITHOGRAPHY	72
FIGURE 38: EUV (13.5NM) PHOTORESIST VOLUME PROJECTION 2020-2025 CAGR 53%	85
FIGURE 39: EUV PHOTORESIST REVENUES (US\$ MILLIONS)	86
FIGURE 40: EXTENSIONS VOLUME HISTORY & FORECAST ESTIMATES 2020-2025 FORECAST	88
FIGURE 41: SOLVENT VOLUMES FOR NTD RINSE AND DEVELOP HISTORY & FORECAST EST	92
FIGURE 42: NTD DEVELOPER AND RINSE REVENUE PROJECTED 2020-2025 (US\$ MILLIONS)	93
FIGURE 43: EBR RELATIVE VOLUMES* HISTORY & FORECAST ESTIMATE	94
FIGURE 44: EBR AND PREWET REVENUE PROJECTED 2020-2025 (US\$ MILLIONS)	95
FIGURE 45: ANCILLARY VOLUMES AND REVENUES HISTORICALLY FORECASTED ESTIMATIONS	96
FIGURE 46: EUV LAYERS EVOLUTION	101
FIGURE 47: EUV LITHOGRAPHY OPTICAL PATH (ASML TYPICAL SCANNER)	102
FIGURE 48: EUV TOOL PHOTO MEASURE AND 14NM PATTERNING DEMONSTRATION	106
FIGURE 49: REPAIR OF EUV PATTERNS	110
FIGURE 50: NANOIMPRINT PROCESS	112
FIGURE 51: 2020 PHOTORESIST MARKET SHARES (% OF WW REVENUES)	118

TABLES

TABLE 1: GLOBAL GDP AND SEMICONDUCTOR REVENUES*	28
TABLE 2: IMF WORLD ECONOMIC OUTLOOK*	29
TABLE 3: DATA CENTER SYSTEMS AND COMMUNICATION SERVICES FORECAST 2021	44
TABLE 4: RECENT INVESTMENT AND FAB/PLANT EXPANSION ACTIVITY	50
TABLE 5: US CHIPS ACT PROVISIONS	57
TABLE 6: KEY SUPPLIERS OF EXTENSION MATERIALS	89
TABLE 7: EUV PHOTORESIST PLATFORM (CURRENT AND FUTURE)	104

2 SCOPE, PURPOSE AND METHODOLOGY

2.1

SCOPE

- This report covers the lithography materials market and supply-chain for these materials used in semiconductor device fabrication. The report contains data and analysis from TECHCET's data base and Sr. Analyst experience, as well as that developed from primary and secondary market research. For more information on TECHCET Critical materials Reports™ please go to <https://TEHCET.com>
- Photoresists are defined as the spun-on photo-active resins used to capture photons in microlithographic patterning. Extensions are defined as materials that extend the resolution of photoresists including bottom anti-reflective coatings (BARC or spin-on carbon SOC) and top anti-reflective coatings (TARC), spin-on hard-masks (SOHM), adhesion layers (AL), and shrink/trim materials. Ancillaries are defined as critical materials for microlithography including edge-bead removers (EBR), strip/rinse solvents, and developers.
- Note that TECHCET does not define Post-Etch Residue Remover (PERR) chemistries as part of lithography materials, but as "Wet Chemicals / Specialty Cleaning Chemicals" as shown in the table in Section 2.4.

2.2

PURPOSE

This Critical Materials Report™ (CMR) provides focused information for supply-chain managers, process integration and R&D directors, as well as business development managers, and financial analysts. The report covers information about key suppliers, issues/trends in the material supply chain, estimates on supplier market share, and forecast for the material segments.

2.3

METHODOLOGY

TEHCET employs subject matter experts having first-hand experience within the industries which they analyze. Most of TEHCET's analysts have over 25 years of direct and relevant experience in their field. Our analysts survey the commercial and technical staff of IC manufacturers and their suppliers and conduct extensive research of literature and commerce statistics to ascertain the current and future market environment and global supply risks. Combining this data with TEHCET's proprietary, quantitative wafer forecast results in a viable long-term market forecast for a variety of process materials.

2.4

OVERVIEW OF OTHER TECHCET CMR™ REPORTS

- TEHCET produces electronic material supply chain reports each year as one of its functions for the Critical Materials Council. Reports to be published in 2019 can be found at www.techcet.com and are listed in the table below:

2021	CMR Report Schedule
1	CMP Pads and Slurry
2	Equipment Components – Quartz
3	Gases + Xeon / Neon
4	Photoresist
5	Precursors - Dielectric Precursors
6	Precursors - Hi K / ALD CVD Metal Precursors
7	Silicon Wafers
8	Specialty Cleaning Chems / Wet Chems
9	Equipment Components – Ceramics/SiC
10	Metal Chemicals
11	Targets
12	Equipment Components- Silicon 2020 version with 2021 forecast