

SILICON PARTS

SUPPLY-CHAIN & MARKET ANALYSIS
A CRITICAL MATERIALS REPORT™

**Prepared By: Allan Wiesnoski, Sr. Analyst
and Shaoyan Luo, Jr. Analyst**

TEHCET CA LLC

11622 El Camino Real #100

San Diego, CA 92130

www.TEHCET.com

info@TEHCET.com

The logo for TEHCET, featuring the word "TEHCET" in a bold, white, sans-serif font. The letters are set against a blue, pill-shaped background with a slight gradient and a drop shadow effect.

Electronics Materials Information

RESEARCH 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.

READER'S NOTE

This report represents the interpretation and analysis of information generally available to the public or released by responsible agencies or individuals. Data was obtained from sources considered reliable. However, accuracy or completeness is not guaranteed.

Allan Wiesnoski – Sr Analyst of TECHCET in charge of market analysis of Silicon Parts Components. He has worked in the semiconductor industry for more than 30 years as an expert in etch and deposition applications and business development. Before TECHCET he was Aixtron's Sr. Group Manager focused on their deposition tool product line, providing direction on manufacturing and development to meet customer requirements. He was Co-Founder and VP of Product Development of PlasmaSi, which was acquired by Aixtron. Prior to PlasmaSi, he worked at Mattson Technology, where he oversaw Etch Systems Strategic Marketing, and at LAM Research where he developed and tested various etch processes as their Sr. Etch Process Engineer. He holds a BS in Chemical Engineering from University of California at San Diego and has co-authored multiple patents and publications on etch and deposition technology.



Shaoyan(Yan) Luo – Jr.Analyst of TECHCET in charge of identification of economic trends, market research and forecast modeling. She is tri-lingual in English, Chinese and Korean and works to support the Company's customers from Far East to West. She has a B.S. degree in Mathematics/Economics from the University of California at San Diego.



TABLE OF CONTENTS

1 EXECUTIVE SUMMARY	10	3.2 ELECTRONIC GOODS MARKET	29
1.1 OVERVIEW OF THE GLOBAL SEMICONDUCTOR MARKET	11	3.2.1 SMARTPHONES	30
1.2 OVERVIEW OF THE 2020 SILICON PARTS MARKET	12	3.2.2 PC UNIT SHIPMENTS	31
1.3 OVERVIEW OF POLYSILICON & SILICON INGOTS	13	3.2.3 AUTOMOTIVE SALES	32
1.4 TOP 3 CONCERNS ABOUT SUPPLY AVAILABILITY	14	3.2.3.1 AUTOMOTIVE SALES AND IMPACT ON SEMICONDUCTOR SALES	33
1.5 TOP 3 OPPORTUNITIES FOR GROWTH IN THE INDUSTRY	15	3.2.3.2 ELECTRIC VEHICLE (EV) MARKET TRENDS	34
2 SCOPE, PURPOSE AND METHODOLOGY	16	3.2.3.3 INCREASE IN SEMICONDUCTOR CONTENT FOR AUTOS	35
2.1 SCOPE	17	3.2.3.4 SEMICONDUCTOR CONTENT BY AUTOMOTIVE ELECTRONIC SYSTEM	36
2.2 PURPOSE	18	3.2.4 SERVERS / IT	37
2.3 METHODOLOGY	19	3.2.4.1 SERVERS / IT, CONTINUED – FORECASTS	38
2.4 OVERVIEW OF OTHER TECHCET CMR™ REPORTS	20	3.3 SEMICONDUCTOR FABRICATION GROWTH & EXPANSION	39
3 SEMICONDUCTOR INDUSTRY MARKET OUTLOOK	21	3.3.1 EQUIPMENT SPENDING TRENDS	40
3.0 SEMICONDUCTOR INDUSTRY STATUS & OUTLOOK	22	3.3.2 RECENT INVESTMENT AND FAB/PLANT EXPANSION ACTIVITY	42
3.1 SEMICONDUCTOR INDUSTRY TIED TO WORLDWIDE ECONOMY	23	3.4 POLICY & TRADE TRENDS AND IMPACT	44
3.1.1 SEMICONDUCTOR INDUSTRIES TIES TO THE GLOBAL ECONOMY	25	3.4.1 POLICY AND TRADE ISSUES	45
3.1.2 SEMICONDUCTOR SALES GROWTH	26	3.4.2 U.S. CHIPS ACT	47
3.1.3 TAIWAN MONTHLY SALES TRENDS	27	3.4.3 OTHER SEMICONDUCTOR FUNDING ACTIVITY	48
3.1.4 SEMICONDUCTOR UNITS AND WAFER SHIPMENT GROWTH FORECAST	28		

TABLE OF CONTENTS

3.4.4 OVERALL CHINA MARKET TRENDS	49	4.7.1 SUB-TIER SUPPLY-CHAIN: SILICON PARTS NEW ENTRANTS – OCI	66
3.5 SEMICONDUCTOR MATERIALS OUTLOOK	51	4.8 MATERIAL TRENDS FOR THE LEADING-EDGE	67
3.5.1 TECHCET WAFER START FORECAST	52	4.9 TRENDS/IMPACT/STATUS OF LEGACY MATERIALS, 5G	68
3.5.2 SEMICONDUCTOR – LEADING EDGE NODE GROWTH	53	4.10 REGIONAL TRENDS/DRIVERS	69
3.5.3 WAFER STARTS OTHER DEVICES	54	4.11 GLOBAL TRANSPORTATION TRENDS	70
3.5.4 SEMICONDUCTOR MATERIALS MARKET FORECAST	55	5 MARKET LANDSCAPE (FABRICATORS)	71
4 SILICON PARTS MARKET TRENDS	56	5.1 MATERIALS MARKET SIZE & FORECAST	72
4.1 SILICON PARTS MARKET SIZE AND FORECAST	57	5.1.1 MATERIALS MARKET SIZE & FORECAST, CONTINUED	73
4.2 MARKET TRENDS OVERVIEW	58	5.1.2 MATERIALS MARKET SIZE & FORECAST, CONTINUED	74
4.3 SILICON PARTS APPLICATIONS	59	5.2 FABRICATION - SILICON PARTS FABRICATORS BY REGION	75
4.3.1 LARGE VS. SMALL DIAMETER PARTS –CAPITAL EXPENDITURE OF FAB EQUIPMENT	60	5.2.1 FABRICATION - SILICON PARTS FABRICATORS BY REGION, CONTINUED	76
4.3.2 200MM EQUIPMENT MARKET TRENDS	61	5.3 FABRICATION - SILICON PARTS FABRICATORS MARKET SHARE	77
4.4 NON-SEMICONDUCTOR APPLICATIONS SHARING SI PARTS SUPPLY-CHAIN	62	5.3.1 FABRICATION - SILICON PARTS FABRICATORS MARKET SHARE, CONTINUED	78
4.5 TECHNOLOGY TRENDS - SILICON PARTS VS. SILICON CARBIDE	63	5.4 TOP 3 OEMS – LAM RESEARCH, TEL, AMAT: LAM RESEARCH	79
4.6 TRADE ISSUES - TARIFFS AND CHINA	64	5.4.1 TOP 3 OEMS – LAM RESEARCH, TEL, AMAT: LAM RESEARCH	80
4.7 SUB-TIER SUPPLY-CHAIN: DISTRIBUTIONS – REC SILICON	65	5.4.2 TOP 3 OEMS – LAM RESEARCH, TEL, AMAT	81
		5.4.3 TOP 3 OEMS – LAM RESEARCH, TEL, AMAT	82

TABLE OF CONTENTS

5.5 2020 SILICON FABRICATOR MARKET SHARE BY SUPPLIER	83	6.2.2 CHINA SILICON INGOT MANUFACTURER – THINKONSEMI	100
5.5.1 2020 SILICON FABRICATOR MARKET SHARE BY SUPPLIER, CONTINUED	84	6.2.3 SILICON INGOT - HISTORICAL PRICES 2002~2019	101
5.5.2 2020 SILICON FABRICATOR MARKET SHARE BY SUPPLIER, ANALYSIS	85	6.4 SUPPLY CHAIN DISRUPTIONS/CONSTRAINTS	102
5.5.3 2020 SILICON FABRICATOR BY REGION, CONTINUED	86	6.4.1 SUPPLY CHAIN DISRUPTIONS/CONSTRAINTS, CONTINUED	103
5.6 FAB EQUIPMENT SPENDING 2016 ~ 2022	87	6.5 OTHER INDUSTRIAL USES	104
5.6.1 FAB EQUIPMENT SPENDING BY REGION	88	7 TECHCET ANALYST ASSESSMENT	105
5.7 SUPPLIERS ACTIVITY - M&A ACTIVITY	89	7.1 BENEFITS OF SILICON AS A MATERIAL FOR EQUIPMENT PARTS	106
5.7.1 SUPPLIERS ACTIVITY - NEW PLANTS/NEW ENTRANTS	90	7.1.1 BENEFITS OF SILICON AS A MATERIAL FOR EQUIPMENT PARTS, CONTINUED	107
5.7.2 SUPPLIERS ACTIVITY - NEW PLANTS/NEW ENTRANTS, CONTINUED	91	7.2 TECHCET ANALYST ASSESSMENT	108
5.7.3 SUPPLIERS ACTIVITY - RECENTLY CLOSED PLANTS OR "TO BE" CLOSED PLANTS	92	7.2.1 TECHCET ANALYST ASSESSMENT, CONTINUED	109
6 SUB-TIER MATERIAL SUPPLY CHAIN	93	8 SUPPLIER PROFILES	110
6.1 RAW MATERIAL SOURCE AND STATUS - POLYSILICON	94	8.1 2020 SILICON FABRICATOR MARKET SHARE BY SUPPLIER: SILFEX	111
6.1.1 RAW MATERIAL SOURCE AND STATUS - POLYSILICON, CONTINUED	95	8.1.2 2020 SILICON FABRICATOR MARKET SHARE BY SUPPLIER: SILFEX, CONTINUED	112
6.1.2 RAW MATERIAL SOURCE AND STATUS - POLYSILICON, ANALYSIS	96	8.2 2020 SILICON FABRICATOR MARKET SHARE BY SUPPLIER: BULLEN ULTRASONICS	113
6.1.3 RAW MATERIAL SOURCE AND STATUS - POLYSILICON, ANALYSIS, CONTINUED	97	8.3 2020 SILICON FABRICATOR MARKET SHARE BY SUPPLIER: HANA MATERIALS	114
6.2 BASE MATERIAL – SILICON INGOT	98	8.4 2020 SILICON FABRICATOR MARKET SHARE BY SUPPLIER: WORLDEX	115
6.2.1 BASE MATERIAL - SILICON INGOT MANUFACTURERS/SUPPLIERS	99		

TABLE OF CONTENTS

FIGURES

FIGURE 1: GLOBAL ECONOMY AND THE ELECTRONICS SUPPLY CHAIN (2020)	25	FIGURE 17: CHINA IC MARKET AND PRODUCTION TRENDS	49
FIGURE 2: WORLDWIDE SEMICONDUCTOR SALES	26	FIGURE 18: 300MM WAFER STARTS	53
FIGURE 3: WORLDWIDE SEMICONDUCTOR SALES (TSMC, UMC, VIS, ASE, CHIPMOS, KYEC)	27	FIGURE 19: > 32NM NODE LOGIC DEVICES GROWTH FORECAST (200MM EQUIV.)	54
FIGURE 4: SEMICONDUCTOR WAFER AREA SHIPMENTS	28	FIGURE 20: GLOBAL SEMICONDUCTOR MATERIALS HISTORY & FORECAST	55
FIGURE 5: SEMICONDUCTOR CHIP APPLICATIONS	29	FIGURE 21: SILICON PARTS FROM SILFEX	56
FIGURE 6: MOBILE PHONE SHIPMENTS WW ESTIMATES	30	FIGURE 22: 2020 SILICON PARTS BY EQUIVALENT WAFER SIZE	59
FIGURE 7: PC NOTEBOOK SHIPMENTS	31	FIGURE 23: 2018 SILICON PARTS BY EQUIVALENT WAFER SIZE	59
FIGURE 8 : U.S. AUTOMOTIVE SALES	32	FIGURE 24: TSMC FOUNDRY FACILITY	60
FIGURE 9: MONTHLY AUTOMOTIVE SALES TRENDS	33	FIGURE 25: USED APPLIED MATERIALS 200MM EQUIPMENT	61
FIGURE 10: GLOBAL EV TRENDS	34	FIGURE 26: AMOLED MATERIAL REVENUES - TV & MOBILE (M USD)	62
FIGURE 11: SEMICONDUCTOR SPEND PER VEHICLE TYPE.	35	FIGURE 27: POLYSILICON PLANT IN MOSES LAKE	65
FIGURE 12: SEMICONDUCTOR CONTENT BY AUTOMOTIVE APPLICATION.	36	FIGURE 28: PRICING TREND IN POLYSILICON PROVIDED BY OCI	66
FIGURE 13: AMAZON SERVER FARM	37	FIGURE 29: INCREASING DEGREE OF DIFFICULTIES WITH NODAL TRANSITIONS	67
FIGURE 14: SEMICONDUCTOR REVENUE GROWTH FORECASTS (AS OF MARCH 2020)	39	FIGURE 30: CONGESTION AT PORT OF LONG BEACH	70
FIGURE 15: CAPITAL SPENDING TRENDS BY TECHNOLOGY NODE.	40	FIGURE 31: 2020 SILICON FABRICATED PARTS REVENUES AND FORECAST ESTIMATES (M USD)	72
FIGURE 16: OVERVIEW OF LOGIC ROADMAP TRENDS	41	FIGURE 32: 2020 SILICON FABRICATED PARTS REVENUES AND FORECAST ESTIMATES (M USD)	73

TABLE OF CONTENTS

FIGURE 33: 2020 SILICON PARTS CONSUMPTION BY END USE LOCATION ESTIMATE	75
FIGURE 34: 2020 ETCH EQUIPMENT MARKET SHARE	77
FIGURE 35: GLOBAL ETCH EQUIPMENT MARKET SIZE (B USD)	78
FIGURE 36: LAM RESEARCH'S NEW PLASMA ETCHING SYSTEM FOR CHIPMAKING PROCESS	79
FIGURE 37: LAM RESEARCH VS. APPLIED MATERIALS BUSINESS SEGMENT REVENUES (M USD)	82
FIGURE 38: 2020 SILICON FABRICATOR MARKET SHARE BY SUPPLIER	83
FIGURE 39: PROJECTED HIGH-VOLUME FABs STARTING CONSTRUCTION	86
FIGURE 40: FAB EQUIPMENT SPENDING	87
FIGURE 41: 2020 FAB EQUIPMENT SPENDING (BILLION USD)	88
FIGURE 42: POLYSILICON DEMAND SEMICONDUCTOR VS. SOLAR	95
FIGURE 43: SI PARTS SUPPLIERS THAT SELL SILICON INGOT FOR SILICON PARTS FABRICATION	99
FIGURE 44: THINKONSEMI 550MM SILICON WAFER (2020)	100
FIGURE 45: 2020~2019 AVERAGE POLYSILICON SPOT MARKET PRICE (\$/KG)	101
FIGURE 46: FERROTEC WAFER CLEANING ROOM	106

TABLES

TABLE 1: GLOBAL GDP AND SEMICONDUCTOR REVENUES*	23
TABLE 2: WORLD BANK ECONOMIC OUTLOOK*	24
TABLE 3: DATA CENTER SYSTEMS AND COMMUNICATION SERVICES FORECAST 2021.	38
TABLE 4: DEVICE MAKER INVESTMENT ACTIVITY	42
TABLE 5: DEVICE MAKER INVESTMENT ACTIVITY, CONTINUED	43
TABLE 6: US CHIPS ACT PROVISIONS	47
TABLE 7: 2020 SILICON FABRICATOR MARKET SHARE BY SUPPLIER	84
TABLE 8: RAW MATERIAL SOURCE AND STATUS	97

2 SCOPE, PURPOSE AND METHODOLOGY

2.1 SCOPE

This Critical Materials Report™ primarily focuses on the markets of silicon parts used in semiconductor process equipment, including silicon base materials and silicon equipment components for wafer process tools used for semiconductor device manufacturing. These parts are considered consumables, given that they are eventually require replacing after repeated use. Details on the supply-chain from high purity poly-silicon, base material manufacturers, and silicon fabricators are provided.

2.2 PURPOSE

This report aims to provide an overview to the above scope silicon material and parts supply chain, serving the semiconductor industry. The report includes information on the market landscape of silicon parts suppliers in addition to their dependency on raw materials. This information about this critical material is essential in the running of the semiconductor wafer fabs across the world. The goal is to annually (or bi-annually) track the state of the industry; the health of the supply and demand; to pinpoint any shortcomings or issues faced by the industry; and to provide a guidance for purchasing and industry quality improvement decisions. Business and technical trends relating to changes in the semiconductor industry are also provided to help the reader understand the drivers behind the silicon parts market. We hope to provide a dialog and feedback opportunities for related stakeholders to fine-tune and better manage the supply ups and downs.

2.3 METHODOLOGY

We track micro-economic and macro-economic trends pertaining to the semiconductor industry and track overall industry trend and needs, equipment supply and demand situation, deduction towards the silicon material requirement, and supplier/fabricators situation one by one. From this vantage point, we check the suppliers/fabricators and the base material company information, and then the raw materials market information. Included in our work is an analysis of public information, website information, supplier interviews, supplier surveys, supplier peer-data cross-checking, and reference comparison. In addition, we conduct a material base usage calculation with respect to a demand and supply micro-economic analysis. We then conduct a forward and backward sweep of the forecast until data is in sync. In the meantime, for the data points that are missing, we use past historic, forward-looking data, and peer data so to extrapolate from three different levels of cross-checking. This provides us an estimation based on judgment from industry experience. Information provided was generated through a combination of primary and secondary market research supported by TECHCET's database of market information on semiconductor equipment consumables and process materials.