



2018

Silicon Wafers Market & Supply-Chain

For Semiconductor Device Process Applications

a TECHCET Critical Materials Report™

Prepared by

Dean Freeman

Reviewed and Edited by L. Shon-Roy

TECHCET CA LLC

PO Box 3056

Rancho Santa Fe, CA 92067

www.TECHCET.com

info@TECHCET.com

+1-480-382-8336

ACKNOWLEDGMENTS

Thank you to all who provided input for this year's report. Most of those that participated chose to remain anonymous. Other information obtained for the preparation of this report was gleaned from industry conferences, technical experts and literature in the public domain.

RESEARCH METHODOLOGY

TECHCET employs subject matter experts having first-hand experience within the industries, which they analyze. Most of TECHCET'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 TECHCET's proprietary, quantitative wafer forecast results in a viable long-term market forecast for a variety of process materials.

READERS 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.

Table of Contents

1 Report Scope.....	7
2 Executive Summary.....	8
3 Introduction and Overview.....	9
4 Market Dynamics and Drivers.....	16
4.1 Worldwide Economy.....	16
4.2 Worldwide Economy.....	17
4.3 Electronic Goods Market.....	19
4.4 Semiconductors.....	21
4.5 Silicon's Interrelationship to Semiconductors	27
4.6 Silicon on insulator	29
4.8 Silicon Wafer Market Share.....	36
4.9 Silicon Wafer Supply Chain	39
4.10 Silicon Wafer Pricing	43
4.11 Silicon Wafer Forecast	46
5 China.....	64
6 Wafer Supplier Profiles and News.....	68
6.1 Shin-Etsu Chemical Co. Ltd. S E H (HQ Tokyo, Japan)	68
6.2 SUMCO Corp. (HQ Tokyo, Japan)	69
6.3 GlobalWafers Silicon (HQ Taiwan, China)	71
6.4 Siltronic (HQ Munich, Germany).....	72
6.5 SK Siltron (HQ Gumi, South Korea)	73
6.7 National Silicon Industry Group	75
Okmetic Ojy (HQ Vantaa, Finland) –	75
Appendix A – A Short Wafer History.....	77
The Shakeout of 200mm	79
Supply-Chain Dependencies - 300mm Historical Trends	82
Appendix B - Silicon Wafer Manufacturing Overview.....	83
B.1 Crystal Growth.....	84
B.2 Modifications	85

B.3 Value-Added Variations.....	86
Appendix C Advanced Geometry Focus Characteristics.....	89
LPD Size and Count Reduction.....	89
Wafer Flatness.....	90

List of Figures

Figure 3.1 Silicon Wafer Hierarchy.....	10
Figure 3.2 Historical Silicon Wafer Revenue	12
Figure 3.3 Wafer Forecast in MSI and Revenue	14
Figure 4.1 2017 Estimates for GDP, Electronic Goods, Semiconductors and Silicon ...	17
Figure 4.2 Japan Electronics and Information Technology Association Growth Rates Excluding Service.....	20
Figure 4.3 PC and Mobile Phone WW Device Shipments.....	21
Figure 4.4 WSTS WW Semiconductor Revenues	22
Figure 4.5 Semiconductor Unit Growth Rates 2007-2017	23
Figure 4.6 WW Semiconductor Segment Revenues	25
Figure 4.7 Relationship of Semiconductor Units to Silicon.....	28
Figure 4.8 Semiconductor vs. Silicon Correlation Factor.....	29
Figure 4.9 MSI vs. Revenue for Silicon Wafers	31
Figure 4.10 MSI Shipped by Quarter.....	33
Figure 4.11 200mm Wafer Shipments 2014-2017.....	34
Figure 4.12 300mm Wafer Shipments EPI and Polished	34
Figure 4.13 Wafer Shipments by Diameter	35
Figure 4.14 2016 Silicon Wafer Revenue Share	38
Figure 4.15 2017 Silicon Wafer Revenue Share	38
Figure 4.16 Polysilicon Market Share.....	41
Figure 4.17 Silicon Metal Pricing	42
Figure 4.18 Pricing Trend for Silicon Wafers (\$ / Sq. In.)	44
Figure 4.19 Estimated Pricing Trends for Silicon Wafers	45
Figure 4.20 Revenue per Wafer	46

Figure 4.21 Consolidated Price of Wafers.....	47
Figure 4.22 Historical MSI by Wafer Diameter	48
Figure 4.23 TECHCET Silicon(MSI) and Revenue Forecast.....	49
Figure 4.24 Dollars per Square Inch.....	50
Figure 4.25 Forecast by Wafer Diameter	51
Figure 4.26 Silicon Wafer Revenues 2006-17	52
Figure 4.27 Forecast by MSI	53
Figure 4.28 Projected 200mm Supply and Demand.....	57
Figure 4.29 Projected 300mm Wafer Supply and Demand	58
Figure 4.30 TECHCET Demand Forecast vs. Industry Announcements of Wafer Supply	61
Figure 4.31 Wafer Forecast vs. Wafer Demand	62
Figure A.1 Silicon Wafer Transition	77
Figure A.2 200mm and 300mm Event Timeline	80
Figure A.3 200mm Fab Conversion to 300 mm.....	81
Figure A.4 200mm Market History.....	83
Figure B.1 Crystal Growth Methodologies.....	85
Figure B.2 Crystal Slicing Methodologies.....	86
Figure B.3 Double-Sided Polishing Methodology	87
Figure B.4 Epitaxial Reactors for Value-Added Layer Extension	88
Figure C.1 Wafer Yield Impacts by Zone.....	91
Figure C.2 Bonded Wafer SOI Process Used by SOITEC	92
Figure C.3 Value-Added Wafer Sample Cross-Sections	93

List of Tables

Table 3.1 Capacity Expansion Plans by 2019	13
Table 4.1 WW GDP Growth by Selected Countries	17
Table 4.2 Memory Fabs (80K to 100K WSPM each by 2021).....	27
Table 4.3 Wafer Growth Rates 2014-2017.....	36
Table 4.4 Wafer Shipments by Diameter.....	36
Table 4.5 Announced Capacity Additions by Major Wafer Manufactures. WSPM.....	55
Table 4.6 Chinese and Second Tier Semiconductor Wafer Supplier Capacity Additions WSPM.....	56
Table 5.1 Chinese Semiconductor Silicon Wafer Manufacturers. Kpcs/month at Max Capacity 2018 Estimate	66
Table 6.1 Shin-Etsu Chemical Co. Ltd. Sales	69
Table 6.2 SUMCO Corp. Sales	70
Table 6.3 GlobalWafers Sales.....	71
Table 6.4 Siltronic Sales and Earnings.....	72
Table 6.5 SK Siltron Sales	73
Table 6.6 Wafer Works Sales.....	74
Table C.1 Application by Wafer Type, Simplified Overview.....	94