



Semiconductor Materials Information

Gases

For Semiconductor Device Processing

A Techcet Group Critical Materials Report

Prepared by
Maggie Y.M. Lee and
Lita Shon-Roy
Techcet Group, LLC*
2009

* www.techcet.com

Lshonroy@techcet.com

Ph: 858-259-9077

Table of Contents

	Page #
1 HIGHLIGHTS	5
1.1 Market.....	5
1.2 Supply.....	5
1.3 Suppliers.....	6
1.4 Specialty Gas Highlights	6
2 INTRODUCTION	7
2.1 Definition of Bulk and Specialty	7
2.2 Drivers of Competitiveness	7
3 THE MARKET	8
3.1 Regional Share.....	11
3.2 Supplier Market Share	12
3.3 Supplier Regional Market Standing	16
4 SUPPLIERS AND SPECIALIZATION.....	17
5 SUPPLY CHAIN-LINKS.....	19
5.1 Role of distributor.....	19
6 FUTURE GAS PURITY REQUIREMENTS.....	22
6.1 Bulk Gases.....	22
6.2 Specialty Gases.....	25
6.3 Susceptability to In-line Contamination.....	30
7 STATISTICAL PROCESS / QUALITY CONTROL	32
7.1 Ship-to-Control Standard.....	32
8 SPECIALTY GASES FOR EXPANDING SOLAR MARKET	34
8.1 Gas Usage in Solar Cell Manufacturing.....	37
8.2 Silane (SiH ₄).....	37
8.3 Hydrogen Chloride (HCl).....	42
8.4 Nitrogen Trifluoride (NF ₃)	42
9 ENVIRONMENTAL CONCERNS AFFECTING GAS UTILIZATION	45
9.1 Future Requirements	46
9.2 PFC emissions reduction	49
9.2.1 Alternative Chemistries and Process Optimization	51
9.2.2 Abatement and Recycling.....	53
9.2.3 Carbon Trading.....	54
10 SUPPLY ALERT	55
10.1 HCl Supply Issues	55
10.2 Helium	57
10.2.1 Helium Costs Continue to Rise.....	59
10.2.2 Present and Future Helium Production.....	60
10.2.3 New Helium Plants	61
10.3 Silane	64
10.3.1 Silane Shortage	65

10.3.2 Price Increases and Production Expansion News	67
10.3.3 Shipping Logistics	69
10.4 Argon	70
11 GAS SUPPLIERS' 2007–2009 NEWS AND ACTIVITIES.....	71
11.1 Air Products and Chemicals (AP)	71
11.2 Air Liquide (AL)	81
11.3 Linde Group (LG).....	88
11.4 Praxair (PRAX)	96
11.5 Taiyo Nippon Sanso Corporation (TNSC)/ Matheson Tri-Gas (MTG)	103

Appendices

Appendix A: List of Abbreviations.....	110
Appendix B: Drivers of Industry Growth (from 2008 Gases Report)	2
Appendix C: Specialty Gas Applications as a Percent of Total Revenues	3
Appendix D: Updates on REACH and the Reduction of Perfluorocarbon Emissions	4
Appendix E: PFOS Reduction	6

Figures

Figure 1: Electronics Process Gas Market Revenues / Forecast — \$2.74 B	5
Figure 2: Electronic Gas Market Revenues	9
Figure 3: Percentage Change in Worldwide Semiconductor Sales, 2007–2009	10
Figure 4: Yr-Yr Change in Operating Income of Top 5 Gas Companies.....	10
Figure 5: Regional Sales — Electronic Gases 2008	11
Figure 6: Bulk and Specialty Electronic Gas Market Shares.....	13
Figure 7: Bulk Electronic Gas Market Shares	14
Figure 8: Specialty Electronic Gas Market Shares	15
Figure 9: Market Shares by Total Company Revenues	15
Figure 10: WW Silane Demand from Polysilicon and Device Manufacturers.....	38
Figure 11: Silane Producer Market Share.....	38
Figure 12: Silane Supply Chain for Solar Cell Fabrication	41
Figure 13: NF ₃ Producer Market Share	43
Figure 14: He Supply vs. Demand.....	64

Figure 15: Supply vs. Demand — a Silane Glut Coming.....	65
Figure A1: Specialty Gases by Percent of Total Revenues	3
Figure A2: PFOS Mass Balance, WSC Baseline 2005.....	7

Tables

Table 1: Regional Market Leaders.....	16
Table 2: Producers for Selected Gases.....	21
Table 3: ITRS 2007/2008 Impurity Limits for Bulk Gases; 68nm ≥ DRAM ½ pitch ≥ 25nm; 2007–2015	23
Table 4: ITRS 2007/2008 Impurity Limits for Lithography and Critical Metrology Purge Gases (ppbv); 68nm ≥ DRAM ½ pitch ≥ 25nm; 2007–2015	25
Table 5: ITRS 2007/2008 Impurity Limits for Specialty Gases.....	27
Table 6: Atmospheric Lifetimes and Global Working Potentials of Select Greenhouse Gases.....	46
Table 7: ITRS 2007 EHS Chemical Restrictions Table.....	48
Table 8: World Production and Reserves of Helium	58
Table 9: Crude Helium Pricing	60
Table 10: Source/Supply Relationships	61
Table 11: New Helium Extraction Plants	62

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.