

**TECHCET**

Electronics Materials Information



# 2022 CMR™ ELECTRONIC GASES

## Bulk & Specialty Gases

**Prepared By:**

Jonas Sundqvist, PhD

**TECHCET CA LLC**

11622 El Camino Real #100

San Diego, CA 92130

[www.TECHCET.com](http://www.TECHCET.com)

[info@TECHCET.com](mailto:info@TECHCET.com)

## 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.

## ANALYST BIOGRAPHY

- Jonas Sundqvist, Ph.D. – Sr. Technology Analyst of TECHCET— covers Electronic Gases and ALD & CVD precursors and related technologies, and the co-chair of the Annual Critical Materials Council (CMC) Conference. His over 20 years of work experience includes Group Leader of the Thin-Film Technologies Group at The Fraunhofer Institute for Ceramic Technologies and Systems (IKTS) in Germany, Clean Room Operations Manager for Lund Nano Lab, Lund University in Sweden and Group Leader of the ALD & High-k devices group at Fraunhofer's Center Nanoelectronic Technologies (CNT) in Germany, which included 28nm node work for GLOBALFOUNDRIES Fab1.
- Previously, at Infineon Memory Development Centre (MDC), he developed high-k and metal nitride ALD processes, and at Qimonda, he was a materials manager focused on the ALD/CVD precursors supply-chain. He holds a Ph.D. and an M.S. in inorganic chemistry from Uppsala University, Sweden & Institute for Micromanufacturing, Louisiana Tech, USA, a B.S. in electrical and electronics engineering from Lars Kagg, and nine patents and 40 related scientific publications.
- Jonas Sundqvist is on the Scientific Committee for AVS ALD and has co-chaired ALD2016 Dublin Ireland, and the annual EFDS ALD for Industry Workshop in Germany.



**Jonas Sundqvist, Ph.D.**

Sr. Technology Analyst of TECHCET,  
Electronic Gases and ALD & CVD

# TABLE OF CONTENTS

<b>1 EXECUTIVE SUMMARY</b>	<b>13</b>	2.3 METHODOLOGY	31
1.1 ELECTRONIC GAS MARKET – HISTORICAL AND 5-YEAR FORECAST	14	2.4 OVERVIEW OF OTHER TECHCET CMR™ REPORTS	32
1.2 MARKET DRIVERS FOR THE SPECIALTY GAS MARKET	15	<b>3 SEMICONDUCTOR INDUSTRY MARKET STATUS &amp; OUTLOOK</b>	<b>33</b>
1.2.1 SPECIALTY GAS MARKET: 5-YEAR SUPPLY & DEMAND	16	3.1 WORLDWIDE ECONOMY	34
1.3 MARKET TRENDS	17	3.1.1 SEMICONDUCTOR INDUSTRIES TIES TO THE GLOBAL ECONOMY	36
1.4 TECHNOLOGY TRENDS- DEVICE ROADMAP	20	3.1.2 SEMICONDUCTOR SALES GROWTH	37
1.4.1 TECHNOLOGY TRENDS- DEVICE SEGMENT OPPORTUNITIES	21	3.1.3 TAIWAN MONTHLY SALES TRENDS	38
1.5 COMPETITIVE LANDSCAPE- ELECTRONIC GAS MARKET SHARE	22	3.2 ELECTRONIC GOODS MARKET	39
1.6 SUPPLY CAPACITY AND DEMAND, INVESTMENTS	23	3.2.1 SMARTPHONES	40
1.7 EHS AND LOGISTIC ISSUES – GREEN HOUSE GASES FROM SEMICONDUCTOR PRODUCTION	24	3.2.2 PC UNIT SHIPMENTS	41
1.7.1 EHS AND LOGISTIC ISSUES – GREEN HOUSE GASES FROM LOGIC PRODUCTION	25	3.2.1.1 ELECTRIC VEHICLE (EV) MARKET TRENDS	42
1.8 MARKET ASSESSMENT SUMMARY	26	3.2.1.2 INCREASE IN SEMICONDUCTOR CONTENT FOR AUTOS	43
<b>2 SCOPE, PURPOSE AND METHODOLOGY</b>	<b>28</b>	3.2.2 SERVERS / IT MARKET	44
2.1 SCOPE	29	3.3 SEMICONDUCTOR FABRICATION GROWTH & EXPANSION	45
2.2 PURPOSE	30	3.3.1 FAB EXPANSION ANNOUNCEMENT SUMMARY	46
		3.3.2 WW FAB EXPANSION DRIVING GROWTH	47
		3.3.3 EQUIPMENT SPENDING TRENDS	48

# TABLE OF CONTENTS

3.3.4 TECHNOLOGY ROADMAPS	49	4.2.2 WF6 DEMAND DRIVERS	72
3.3.5 FAB INVESTMENT ASSESSMENT	50	4.2.3 WF6 MARKET DEMAND	73
3.4 POLICY & TRADE TRENDS AND IMPACT	51	4.3 TECHNICAL DRIVERS / MATERIAL CHANGES AND TRANSITIONS	74
3.4.1 POLICY AND TRADE ISSUES	52	4.3.1 GENERAL TREND LAST DECADE GOING FROM PVD & LPCVD TO PECVD	75
3.5 SEMICONDUCTOR MATERIALS OUTLOOK	53	4.3.2 DEVICE ROADMAP	76
3.5.1 COULD MATERIALS CAPACITY LIMIT CHIP PRODUCTION SCHEDULES?	54	4.3.3 LEADING EDGE DEVICE ARCHITECTURE	77
3.5.2 CONTINUED LOGISTICS ISSUES PLAGUE THE WESTERN WORLD	55	4.3.4 LEADING EDGE LOGIC ROADMAP	78
3.5.3 TECHCET WAFER STARTS FORECAST THROUGH 2026	56	4.3.5 DEPOSITION PROCESS BY DEVICE TYPE AND MATERIAL— AN OVERVIEW	79
3.5.4 TECHCET WAFER START FORECAST	57	4.3.6 DEPOSITION PROCESS BY DEVICE TYPE AND MATERIAL— AN OVERVIEW, continued	80
3.5.5 TECHCET'S MATERIALS FORECAST	58	4.3.7 SUMMARY OF DEVICE SEGMENT TRENDS AND OPPORTUNITIES	81
<b>4 ELECTRONIC GASES MARKET TREND</b>	<b>59</b>	4.3.8 REGIONAL TRENDS – LINDE	82
4.1 MARKET TRENDS DRIVING THE ELECTRONIC GAS BUSINESS	60	4.3.9 REGIONAL TRENDS – AIR LIQUIDE	83
4.1.1 MARKET TRENDS – WAFER STARTS	62	4.3.10 REGIONAL TRENDS – AIR PRODUCTS	86
4.1.2 MARKET TRENDS – WAFER STARTS LOGIC	63	4.3.11 REGIONAL TRENDS – TAIYO NIPPON SANO	87
4.1.3 MARKET TRENDS – WAFER STARTS DRAM	64	4.3.12 REGIONAL TRENDS – KOREA	88
4.1.4 MARKET TRENDS – WAFER STARTS NAND	65	4.3.13 REGIONAL TRENDS – CHINA	89
4.2 SUPPLY CAPACITY AND DEMAND, INVESTMENTS	66	4.4 US SPEC GAS FOCUS & SEGMENTATION	90
4.2.1 WF6 MARKET DEMAND	69		

# TABLE OF CONTENTS

4.4.1 US GROWTH FOLLOWS WAFER STARTS	91	4.5.5 EHS AND LOGISTIC ISSUES – SUSTAINABLE SEMICONDUCTOR TECHNOLOGIES AND SYSTEMS (SSTS) RESEARCH PROGRAM	105
4.4.2 SPEC GAS APPLICATIONS (FOCUS ON US MARKET)	92	4.5.6 NF3 REPLACEMENT F2 GAS	106
4.4.3 THE US MARKETS ARE GENERALLY SMALL FOR THE CF GASES OF INTEREST BUT EXHIBIT HEALTHY GROWTH.	93	4.5.6.1 FLUORINATED GAS REGULATIONS	107
4.4.4 THE US MARKET SIZE & GROWTH FOR SPECIALTY GASES OF INTEREST ALSO SMALL BUT SHOWING HEALTHY GROWTH, CONTINUED	94	4.5.6.2 FLUORINATED GAS REGULATIONS	108
4.4.5 US MARKET DEPOSITION AND ETCH GASES OPPORTUNITIES	95	4.5.6.3 LINDE F-GAS INSTALLATION	109
4.4.6 US TAM IN DOLLARS FOR INDIVIDUAL ETCH GASES— UPSIDE FORECAST VS. ORIGINAL MODEL	96	4.6 GENERAL COMMENTS ON SPECIFICATIONS AND PURITY	110
4.4.7 US HAS A FRAGMENTED SUPPLY CHAIN	97	4.7 ELECTRONIC GAS SUPPLY CHAIN RISK FACTORS	111
4.4.8 US SPEC GAS SUMMARY	98	4.7.1 GEOPOLITICAL RISKS	112
4.4.9 SUMMARY OF OTHER REGIONAL SPECIALTY GAS ISSUES	99	4.7.2 RUSSIA RISKS	113
4.5 EHS AND LOGISTIC ISSUES – TUNGSTEN	100	4.7.3 NATIONAL GOVERNMENT FINANCIAL SUPPORT	114
4.5.1 EHS AND LOGISTIC ISSUES – TUNGSTEN	101	4.7.4 ENVIRONMENT REGULATION RISK	115
4.5.2 EHS AND LOGISTIC ISSUES – RUTHENIUM	102	4.7.5 ENVIRONMENT REGULATION RISK — IMPLEMENTED TREATIES AND PROTOCOLS	116
4.5.3 EHS AND LOGISTIC ISSUES – GREEN HOUSE GASES FROM SEMICONDUCTOR PRODUCTION	103	4.7.6 SUPPLY CHAIN RISKS — RAW MATERIAL PRICING	117
4.5.4 EHS AND LOGISTIC ISSUES – GREEN HOUSE GASES FROM LOGIC PRODUCTION	104	4.7.7 LOGISTICS	118
		4.7.7.1 VOLUMES OF FREIGHT CONTAINERS	119
		4.7.8 IMPORT ACTIVITY & ASSOCIATED RISKS (EXAMPLE US IMPORTS)	120

# TABLE OF CONTENTS

4.8 MARKET TREND ASSESSMENT	121	5.6.1 NEW ENTRANTS - NIHON SOSO (JPN) – DIBORANE IN ASIA	143
<b>5 SEGMENT MARKET STATISTICS &amp; FORECASTS</b>	<b>122</b>	5.6.2 NEW ENTRANTS – NATA CHEMICALS	144
5.1 ELECTRONIC GAS MARKET – HISTORICAL AND 5-YEAR FORECAST	123	5.7 PRICING TRENDS	145
5.1.1 INDUSTRIAL GAS MARKET	124	5.8 PROCESS TOOLS SEGMENTED BY DEPOSITION METHOD	146
5.1.2 ELECTRONIC GAS MARKET SHARE	125	5.8.1 WFE DEPOSITION ASSESSMENT	147
5.1.3 SUPPLIER LIST, FINANCIALS AND PROFILES	126	5.9 CHANGES AND SHIFTS IN THE HE MARKET	148
5.1.4 MARKET DRIVERS FOR THE SPECIALTY GAS MARKET	127	5.9.1 RUSSIA WAR ESCALATES, PUTTING A DAMPER ON HE SUPPLY	149
5.2 SPECIALTY GAS MARKET: 5-YEAR SUPPLY & DEMAND	128	5.9.2 MARKET SIZE AND GROWTH 5-YEAR HELIUM SUPPLY & DEMAND (COMPRESSED GAS)	150
5.2.1 HE 5-YEAR SUPPLY & DEMAND	129	5.10 GAS SUPPLY ASSESSMENT	151
5.2.2 NE 5-YEAR SUPPLY & DEMAND	130	<b>6 SUB TIER MATERIAL SUPPLY CHAIN</b>	<b>152</b>
5.2.3 XE 5-YEAR SUPPLY & DEMAND	132	6.1 SALES CHANNELS	153
5.2.4 NF3 5-YEAR SUPPLY & DEMAND	134	6.2 LOGISTICS REQUIREMENTS	154
5.2.5 TUNGSTEN HEXAFLUORIDE 5-YEAR SUPPLY & DEMAND	135	6.2.1 SUB-TIER SUPPLY-CHAIN: TUNGSTEN DISRUPTIONS	155
5.3 M&A ACTIVITIES	136	6.3 SUB-TIER SUPPLY-CHAIN M&A ACTIVITY	157
5.4 NEW PLANTS	137	6.4 SUB-TIER SUPPLY-CHAIN EHS AND LOGISTICS ISSUES	158
5.4.1 NIHON SUO HOLDING CO., LTD. TO INCREASE DIBORANE CAPACITY	140	6.5 SUB-TIER SUPPLY-CHAIN PRICING TRENDS	159
5.5 SUPPLIER PLANT CLOSURES	141	6.6 SUB-TIER SUPPLY-CHAIN TECHCET ANALYST ASSESSMENT	160
5.6 NEW ENTRANTS - EUROPE CHINA ELECTRONIC MATERIALS (CHINA)	142		

# TABLE OF CONTENTS

## 7 SUPPLIER PROFILES

ADEKA Corporation  
Air Liquide  
AZmax Co., Ltd  
DNF Co., Ltd  
Entegris  
Epivalence  
Gelest – Mitsubishi Chemicals  
Hansol Chemical  
H.C. Starck  
Kojundo Chemical Laboratory  
...and many more

161

## 8 APPENDIX

272

8.1 GASES USED BY MULTIPLE INDUSTRIES	273
8.1.1 SPECIALTY GAS INDUSTRY MATRIX	274
8.1.2 GASES USED FOR SEMICONDUCTOR DEVICE MANUFACTURING	275
8.1.3 GASES USED IN THE DISPLAY INDUSTRY	276
8.2 SUPPLIER LISTING BY GAS TYPE	278
8.2.1 HYDRIDES	279
8.2.2 SILICON PRECURSORS (SILANES)	280
8.2.3 ETCHANTS/CHAMBER CLEAN	281
8.2.4 DEPOSITION/MISC	282
8.2.5 BULK GASES	283
8.3 ETCH GAS ROADMAPS	284
8.3.1 ETCH ROADMAPS 1 OF 3	285
8.3.2 ETCH ROADMAPS 2 OF 3	286
8.3.3 ETCH ROADMAPS 3 OF 3	287



# FIGURES & TABLES

## FIGURES

FIGURE 1: ELECTRONIC GAS MARKET	14	FIGURE 17: CHIP EXPANSIONS 2021-2026 > US\$460 B	46
FIGURE 2: ELECTRONIC GAS MARKET SEGMENTATION	15	FIGURE 18: SEMICONDUCTOR CHIP MANUFACTURING REGIONS OF THE WORLD	47
FIGURE 3: TECHCET WAFER START FORECAST BY NODE	17	FIGURE 19: 3-MONTH AVERAGE SEMICONDUCTOR EQUIPMENT BILLINGS	48
FIGURE 4: TECHNOLOGY ROADMAP DEVICES	20	FIGURE 20: OVERVIEW OF DEVICE TECHNOLOGY ROADMAP	49
FIGURE 5: TOTAL ELECTRONIC GAS MARKET SHARE 2021, US\$6,3 BILLION	22	FIGURE 21: EUROPE CHIP EXPANSION UPSIDE	54
FIGURE 6: CO2EQ OUTPUT FROM ETCH GASES (SOURCE: IMEC)	24	FIGURE 22: TECHCET WAFER START FORECAST BY NODE	56
FIGURE 7: TOTAL EMISSIONS AND ENERGY USE PROJECTION PER LOGIC NODE	25	FIGURE 23: TECHCET WAFER START FORECAST BY LOGIC NODE	57
FIGURE 8: GLOBAL ECONOMY AND THE ELECTRONICS SUPPLY CHAIN (2021)	36	FIGURE 24: GLOBAL SEMICONDUCTOR MATERIALS OUTLOOK	58
FIGURE 9: WORLDWIDE SEMICONDUCTOR SALES	27	FIGURE 25: FORECASTS – WAFER STARTS 2018 TO 2026	62
FIGURE 10: TECHCET'S TAIWAN SEMICONDUCTOR INDUSTRY INDEX*	38	FIGURE 26: FORECASTS – WAFER STARTS LOGIC 300 MM	63
FIGURE 11: SEMICONDUCTOR CHIP APPLICATIONS	39	FIGURE 27: ANNUAL WAFER DRAM STARTS (MILLIONS OF 200MM EQUIVALENT / YEAR)	64
FIGURE 12: MOBILE PHONE SHIPMENTS WW ESTIMATES	40	FIGURE 28: ANNUAL NAND WAFER STARTS (MILLIONS OF 200MM EQUIVALENT / YEAR)	65
FIGURE 13: WORLDWIDE PC AND TABLET FORECAST, 2021, Q3	41	FIGURE 29: 3DNAND STRUCTURE	69
FIGURE 14: GLOBAL EV TRENDS	42	FIGURE 30: MO PRECURSORS	70
FIGURE 15: SEMICONDUCTOR SPEND PER VEHICLE TYPE	43	FIGURE 31: AMPOULE TECH REQUIREMENTS	71
FIGURE 16: TSMC CONSTRUCTION SITE IN ARIZONA.	45	FIGURE 32: 3DNAND WAFER START FORECAST SHOWING USAGE OF W & MO TRANSITION	72

# FIGURES & TABLES

FIGURE 33: WAFER START FORECAST SHOWING TWO TIMING SCENARIOS WHERE MO COULD BE INTRODUCED (MILLIONS OF 200MM EQUIVALENT / YEAR)	73	FIGURE 49: TOTAL EMISSIONS AND ENERGY USE PROJECTION PER LOGIC NODE	104
FIGURE 34: ALD FOR PHOTOLITHOGRAPHY IP	74	FIGURE 50: F2 AND NF3 ACTIVATION	106
FIGURE 35: 3D DEVICE ARCHITECTURES	75	FIGURE 51: CHINA SPOT PRICES OF KEY RAW MATERIALS	117
FIGURE 36: DEVICE TECHNOLOGY ROADMAPS	76	FIGURE 52: PORT TRAFFIC LA AND LONG BEACH	118
FIGURE 37: IMEC 2021 LOGIC ROADMAP	77	FIGURE 53: CONTAINER FREIGHT PRICE IN USD	118
FIGURE 38: SCALING AND LITHOGRAPHY TRENDS	78	FIGURE 54: POLA CONTAINER VOLUMES	119
FIGURE 39: FINFET/GAA TRANSITION	79	FIGURE 55: ELECTRONIC GAS MARKET	123
FIGURE 40: AIR LIQUIDE REGIONAL FINANCIALS	83	FIGURE 56: TOTAL INDUSTRIAL GAS MARKET 2021, US\$97 BILLION	124
FIGURE 41: AIR LIQUIDE REGIONAL FINANCIALS	84	FIGURE 57: TOTAL ELECTRONIC GAS MARKET 2021, US\$6,3 BILLION	125
FIGURE 42: AIR LIQUIDE REGIONAL FINANCIALS	85	FIGURE 58: ELECTRONIC GAS MARKET SEGMENTATION	127
FIGURE 43: WAFER START UPSIDE FROM US FAB EXPANSION	91	FIGURE 59: HE WW SUPPLY AND DEMAND	129
FIGURE 44: US REGIONAL 5-YEAR GROWTH FORECASTS FOR C4F6, C4F8, CH3F AND CH2F2	93	FIGURE 60: 2026 HE MARKET SHARE - WW REGIONS	130
FIGURE 45: US REGIONAL 5-YEAR FORECASTS FOR CL2, BCL3, HBR	94	FIGURE 61: TOTAL NEON DEMAND VS. SUPPLY	131
FIGURE 46 : US REGIONAL 5-YEAR FORECASTS FOR WF6 & NF3	95	FIGURE 62: TOTAL XENON DEMAND VS. SUPPLY (MILLION LITERS/YR)	132
FIGURE 47: WAFER START UPSIDE FROM US FAB EXPANSION	96	FIGURE 63: TOTAL KRYPTON DEMAND VS. SUPPLY (MILLION LITERS/YR)	133
FIGURE 48: CO2EQ OUTPUT FROM ETCH GASES (SOURCE: IMEC)	103	FIGURE 64: NF3 SUPPLY/DEMAND	134
		FIGURE 65: WF6 FORECAST	135

# FIGURES & TABLES

FIGURE 66: HARDMASK SCHEMATIC	140
FIGURE 67: LATEST SITUATION MAP IN UKRAINE, SHOWING TAKEN MAURIUPOL BUT ODESSA STILL FREE	141
FIGURE 68: ECEM PRODUCT OFFERINGS	142
FIGURE 69: NIHON SOSO ELECTRONICS GAS BUSINESS IN ASIA	143
FIGURE 70: NATA CHEMICALS FACILITIES	144
FIGURE 71: COMPRESSED NEON PRICE ESCALATION	145
FIGURE 72: DEPOSITION SEGMENTS (USD BILLION)	146
FIGURE 73: HELIUM ELECTRONICS MARKET DEMAND BASED ON APPLICATIONS ~16% (CONSERVATIVE) TO 19% (UPSIDE) IN MCM	150
FIGURE 74: HE MATERIALS SUPPLIER TIER STRUCTURE	153
FIGURE 75: TUNGSTEN USE BY INDUSTRY (TEHCET ESTIMATE 2020)	155
FIGURE 76: ELECTRONIC SPECIALTY GASES	277
FIGURE 77: BULK GASES	277

## TABLES

TABLE 1: ELECTRONIC GAS MARKET SIZE AND GROWTH	14
TABLE 2: ELECTRONIC GAS MARKET GROWTH RATES BY END MARKET	15
TABLE 3: 5-YEAR SPECIALTY GAS SUPPLY & DEMAND	16
TABLE 4: GAS TRENDS AND OPPORTUNITIES BY DEVICE TYPE & PROCESS TECHNOLOGY	21
TABLE 5: GLOBAL GDP AND SEMICONDUCTOR REVENUES*	34
TABLE 6: IMF ECONOMIC OUTLOOK*	35
TABLE 7: DATA CENTER SYSTEMS AND COMMUNICATION SERVICES FORECAST 2021	44
TABLE 8: OVERVIEW OF DEPOSITION PROCESSES BY DEVICE TYPE AND MATERIAL	79
TABLE 9: GAS TRENDS AND OPPORTUNITIES BY DEVICE TYPE	81
TABLE 10: LINDE FINANCIALS AND REGIONAL SALES	82
TABLE 11: AIR PRODUCTS REGIONAL FINANCIALS	86
TABLE 12: TAIYO NIPPON SANZO REGIONAL FINANCIALS	87
TABLE 13: GAS SEGMENTATION GROUPS/DEFINITIONS	90
TABLE 14: GASES OF INTEREST AND APPLICATIONS	92

# FIGURES & TABLES

TABLE 15: C4F6, C4F8, CH2F2, CHF3, CAGRS (2021-2025)	93	TABLE 32: SILICON PRECURSOR SUPPLIERS	280
TABLE 16: CL2, BCL3, HBR, CAGRS (2021-2025)	94	TABLE 33: ETCHANT GAS SUPPLIERS	281
TABLE 17: WF6 AND NF3 FORECAST AND CAGRS (2021-2025)	95	TABLE 34: DEPOSITION/MISC. GAS SUPPLIERS	282
TABLE 18: US TAM UPSIDE FOR WF6 AND NF3 (M\$USD)	96	TABLE 35: BULK GAS SUPPLIERS	283
TABLE 19: ESTIMATED SUPPLY CHAIN SUPPLIER RANKING	97	TABLE 36: ETCH ROADMAPS	285
TABLE 20: REGIONAL SUMMARY OF GAS MARKET	99	TABLE 37: ETCH ROADMAPS	286
TABLE 21: GAS GWP AND ATMOSPHERIC LIFETIME	106	TABLE 38: ETCH ROADMAPS	287
TABLE 22: IMPORT ACTIVITY OCTOBER 2020 THROUGH MAY 2021	120		
TABLE 23: ELECTRONIC GAS MARKET SIZE AND GROWTH	123		
TABLE 24: TOTAL REVENUE 2021 OF MAJOR GAS COMPANIES AND GAS SUPPLIERS	126		
TABLE 25: ELECTRONIC GAS MARKET GROWTH RATES BY END MARKET	127		
TABLE 26: 5-YEAR SPECIALTY GAS SUPPLY & DEMAND	128		
TABLE 27: M&A ACTIVITIES	136		
TABLE 28: EQUIPMENT MARKET SIZE (US\$ B)	146		
TABLE 29: SPECIALTY GAS INDUSTRY MATRIX	274		
TABLE 30: GASES USED IN FPD MANUFACTURING	276		
TABLE 31: HYDRIDE GAS SUPPLIERS	279		

# 2

## SCOPE, PURPOSE AND METHODOLOGY

## 2.1 SCOPE

- This report covers the electronic gas 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>
- One of the challenges that the gas companies encounter is profitability due to the timing of investments and industry downturns for large installations like Air Separation Units (ASUs) and Semiconductor fabs. In the meantime, new suppliers are emerging in the China market to support the "Made in China" program backed by the government. When these suppliers gain in capability and capacity, their influence could dramatically impact the gas supply chain in the next 3+ years.

## 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

- 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.



## 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 2022 can be found at [www.techcet.com](http://www.techcet.com) and are listed in the table below:

	<b>Critical Materials Reports™</b>
1	<b>CMP Pads and Slurry</b>
2	<b>Electronic Gases</b>
3	<b>Photoresist</b>
4	<b>Precursors - Dielectric Precursors</b>
5	<b>Precursors - Hi K / ALD CVD Metal Precursors</b>
6	<b>Silicon Wafers</b>
7	<b>Specialty Cleaning Chems / Wet Chems</b>
8	<b>Metal Chemicals</b>
9	<b>Targets</b>
10	<b>Equipment Components – Quartz</b>
11	<b>Equipment Components – Ceramics/SiC</b>
12	<b>Equipment Components- Si parts</b>
	<b><i>Special Reports</i></b>
13	<b>Impact of US Chip Expansions</b>
14	<b>Impact of European Chip Expansions</b>