

**TEHCET**

Electronics Materials Information



# 2023-2024 CMR™ ELECTRONIC GASES

## Bulk & Specialty Gases

**Prepared By:**

Jonas Sundqvist, PhD

**TEHCET CA LLC**

11622 El Camino Real #100

San Diego, CA 92130

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

[info@TEHCET.com](mailto:info@TEHCET.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 & Assoc. Prof. in Chemistry at Linköping University, Sweden — 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 equipment, 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 Techet, 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. He is the Co-Chair of the annual Critical Materials Conference organized by TECHCET LLC CA.



**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>	<b>3 SEMICONDUCTOR INDUSTRY MARKET STATUS &amp; OUTLOOK</b>	<b>35</b>
1.1 ELECTRONIC GAS MARKET – HISTORICAL AND 5-YEAR FORECAST	14	3.1 WORLDWIDE ECONOMY	36
1.2 MARKET DRIVERS FOR THE SPECIALTY GAS MARKET	15	3.1.1 SEMICONDUCTOR INDUSTRIES TIES TO THE GLOBAL ECONOMY	38
1.2.1 SPECIALTY GAS MARKET: 5-YEAR SUPPLY & DEMAND	16	3.1.2 SEMICONDUCTOR SALES GROWTH	39
1.3 MARKET TRENDS	17	3.1.3 TAIWAN MONTHLY SALES TRENDS	40
1.4 TECHNOLOGY TRENDS– DEVICE ROADMAP	21	3.1.4 UNCERTAINTY ABOUNDS ESPECIALLY FOR 2023 - SLOWER TO NEGATIVE SEMICONDUCTOR REVENUE GROWTH EXPECTED	41
1.4.1 TECHNOLOGY TRENDS – DEVICE SEGMENT OPPORTUNITIES	22	3.2 CHIPS SALES BY ELECTRONIC GOODS SEGMENT	42
1.5 COMPETITIVE LANDSCAPE– ELECTRONIC GAS MARKET SHARE	23	3.2.1 SMARTPHONES	43
1.6 SUPPLY CAPACITY AND DEMAND, INVESTMENTS	24	3.2.2 PC UNIT SHIPMENTS	44
1.7 EHS AND LOGISTIC ISSUES– GREEN HOUSE GASES FROM LOGIC PRODUCTION	25	3.2.3 SERVERS / IT MARKET	47
1.8 MARKET ASSESSMENT SUMMARY	28	3.3 SEMICONDUCTOR FABRICATION GROWTH & EXPANSION	48
<b>2 SCOPE, PURPOSE AND METHODOLOGY</b>	<b>30</b>	3.3.1 FAB EXPANSION ANNOUNCEMENT SUMMARY	49
2.1 SCOPE	31	3.3.2 WW FAB EXPANSION DRIVING GROWTH	51
2.2 PURPOSE	32	3.3.3 EQUIPMENT SPENDING TRENDS	52
2.3 METHODOLOGY	33	3.3.4 TECHNOLOGY ROADMAPS	53
2.4 OVERVIEW OF OTHER TECHCET CMR™ REPORTS	34	3.3.5 FAB INVESTMENT ASSESSMENT	54
		3.4 POLICY & TRADE TRENDS AND IMPACT	55

# TABLE OF CONTENTS

3.5 SEMICONDUCTOR MATERIALS OVERVIEW	56	4.3.4 MARKET TRENDS– WAFER STARTS DRAM	79
3.5.1 COULD MATERIALS CAPACITY LIMIT CHIP PRODUCTION SCHEDULES?	57	4.3.5 MARKET TRENDS– WAFER STARTS NAND	81
3.5.2 LOGISTICS ISSUES EASED DOWN	58	4.3.6 DEPOSITION PROCESS BY DEVICE TYPE AND MATERIAL– AN OVERVIEW	84
3.5.3 TECHCET WAFER STARTS FORECAST THROUGH 2027	59	4.3.7 ETCH PROCESS BY DEVICE TYPE– ATOMIC LAYER ETCHING ALE	86
3.5.4 TECHCET'S MATERIAL FORECAST	60	4.3.8 SUMMARY OF TECHNICAL TRENDS AND OPPORTUNITIES	92
<b>4 ELECTRONIC GASES MARKET TRENDS</b>	<b>61</b>	4.4 REGIONAL TRENDS	93
4.1 MARKET TRENDS DRIVING THE ELECTRONIC GAS BUSINESS	62	4.4.1 REGIONAL TRENDS – LINDE	94
4.2 SUPPLY CAPACITY AND DEMAND, INVESTMENTS	64	4.4.2 REGIONAL TRENDS– AIR LIQUIDE	95
4.2.1 WF6 DEMAND DRIVERS	67	4.4.3 REGIONAL TRENDS– AIR PRODUCTS	96
4.2.2 WF6 MARKET DEMAND	68	4.4.5 REGIONAL TRENDS– TAIYO NIPPON SANO	97
4.2.3 WF6 MARKET DEMAND– MO ALD IP FILING	70	4.4.6 REGIONAL TRENDS– KOREA	98
4.2.4 WF6 MARKET DEMAND	71	4.4.7 REGIONAL TRENDS– JAPAN	99
4.3 TECHNICAL DRIVERS / MATERIAL CHANGES AND TRANSITIONS	72	4.4.8 REGIONAL TRENDS– JAPAN & KOREA	100
4.3.1 GENERAL TREND LAST DECADE GOING FROM PVD & LPCVD TO PECVD	73	4.3.15 REGIONAL TRENDS– CHINA	101
4.3.2 MARKET TRENDS BY DEVICE TYPE AND NODE – ADVANCED DEVICES	74	4.4.9 REGIONAL TRENDS – RUSSIA	102
4.3.3 MARKET TRENDS– ADVANCED LOGIC	75	4.4.10 REGIONAL TRENDS– USA	103
		4.5 GENERAL COMMENTS ON SPECIFICATIONS AND PURITY	106
		4.6 ELECTRONIC GAS SUPPLY CHAIN RISK FACTORS	107

# TABLE OF CONTENTS

4.6.1 GEOPOLITICAL RISKS	108	5.4.6 DRAFT CALCULATION TRANSPORT: CHINA VS UKRAINE	124
4.6.2 RUSSIA RISKS	109	5.5 SUSTAINABLE SEMICONDUCTOR PROCESSES AND MANUFACTURING TECHNOLOGIES	125
4.6.3 SUPPLY CHAIN RISKS– RAW MATERIAL PRICING	110	5.6 HELIUM – SUSTAINABLE PRODUCTION – GREEN HELIUM	126
4.6.4 LOGISTICS	111	5.7 HELIUM – SUSTAINABLE PRODUCTION – GREEN HELIUM	127
4.7 MARKET TRENDS ASSESSMENT	112	5.8 NF3 REPLACEMENT: F2 GAS	128
<b>5 EHS AND SUSTAINABILITY ISSUES</b>	<b>113</b>	5.8.1 FLUORINATED GAS REGULATIONS	129
5.1 EHS AND LOGISTIC ISSUES– GREEN HOUSE GASES FROM SEMICONDUCTOR PRODUCTION	114	5.8.2 FLUORINATED GAS REGULATIONS, CONTINUED	130
5.1.2 EHS AND LOGISTIC ISSUES– GREEN HOUSE GASES FROM SEMICONDUCTOR PRODUCTION, CONTINUED	115	5.8.3 LINDE F-GAS INSTALLATION	131
5.2 EHS AND LOGISTICS ISSUES	116	5.8.4 ENVIRONMENT REGULATION RISK– IMPLEMENTED TREATIES AND PROTOCOLS	132
5.3 EHS AND LOGISTIC ISSUE – GREEN HOUSE GASES FROM SEMICONDUCTOR PRODUCTION	117	<b>6 ELECTRONIC GASES MARKET STATISTICS &amp; FORECASTS</b>	<b>133</b>
5.4 EHS AND LOGISTIC ISSUES– GREEN HOUSE GASES FROM AIR GASES (NEON)	118	6.1 ELECTRONIC GAS MARKET– HISTORICAL AND 5-YEAR FORECAST	134
5.4.1 ASU ENERGY CONSUMPTION - GHG EMISSIONS	119	6.1.1 INDUSTRIAL GAS MARKET	135
5.4.2 ASU ENERGY CONSUMPTION - GHG EMISSIONS	120	6.1.2 ELECTRONIC GAS MA	136
5.4.3 CARBON FOOTPRINT OF SHIFTING NEON SUPPLY FROM UKRAINE TO CHINA	121	6.1.3 SUPPLIER LIST, FINANCIALS AND PROFILES	137
5.4.4 CARBON FOOTPRINT OF NEON PRODUCTION	122	6.1.4 MARKET DRIVERS FOR THE SPECIALTY GAS MARKET	138
5.4.5 CARBON FOOTPRINT OF NEON SHIPPING IN GAS ISO CONTAINER	123	6.2 SPECIALTY GAS MARKET: 5-YEAR SUPPLY & DEMAND RKET SHARE	139
		6.2.1 HE 5-YEAR SUPPLY & DEMAND	140

# TABLE OF CONTENTS

6.2.1 HE 5-YEAR SUPPLY & DEMAND, CONTINUED	141	<b>7 SUB TIER MATERIAL SUPPLY CHAIN</b>	<b>161</b>
6.2.2 NE 5-YEAR SUPPLY & DEMAND	142	7.1 SALES CHANNELS	162
6.2.3 NEON	143	7.2 LOGISTICS REQUIREMENTS	163
6.2.4 XE 5-YEAR SUPPLY & DEMAND	144	7.2.1 SUB-TIER SUPPLY-CHAIN: TUNGSTEN DISRUPTIONS	164
6.2.5 NF3 5-YEAR SUPPLY & DEMAND	146	7.3 SUB-TIER SUPPLY-CHAIN M&A ACTIVITY	166
6.2.6 TUNGSTEN HEXAFLUORIDE 5-YEAR SUPPLY & DEMAND	147	7.4 SUB-TIER SUPPLY-CHAIN EHS AND LOGISTICS ISSUES	167
6.3 M&A ACTIVITIES	148	7.5 SUB-TIER SUPPLY-CHAIN PRICING TRENDS	168
6.4 NEW PLANTS	149	7.6 SUB-TIER SUPPLY-CHAIN TECHCET ANALYST ASSESSMENT	169
6.4.1 NEW PLANTS, LINDE EXPANSIONS 2023	152	<b>8 SUPPLIER PROFILES</b>	<b>170</b>
6.4.2 NEW PLANTS, AIR LIQUIDE EXPANSIONS 2022/2023	153	AIR LIQUIDE	
6.4.3 NIHON SUO HOLDING CO., LTD. TO INCREASE DIBORANE CAPACITY	154	AIR PRODUCTS	
6.5 SUPPLIER PLANT CLOSURES	155	AIR WATER	
6.5.1 NEW ENTRANTS– SK MATERIALS, SHOWA DENKO SEEK JOINT ENTRY INTO US SEMICONDUCTOR GAS MARKET	156	CRYOIN ENGINEERING	
6.5.2 NEW ENTRANTS– RESONAC	157	DUPONT	
6.5.3 NEW ENTRANTS– NEON, CHINA	158	And 20+ more...	
6.6 PRICING TRENDS	159		
6.7 GAS SUPPLY ASSESSMENT	160		

# TABLE OF CONTENTS

<b>9 APPENDIX</b>	<b>287</b>
9.1 GASES USED BY MULTIPLE INDUSTRIES	288
9.1.1 SPECIALTY GAS INDUSTRY MATRIX	289
9.1.2 GASES USED FOR SEMICONDUCTOR DEVICE MANUFACTURING	290
9.1.3 GASES USED IN THE DISPLAY INDUSTRY	291
9.2 SUPPLIER LISTING BY GAS TYPE	294
9.2.1 HYDRIDES	295
9.2.2 SILICON PRECURSORS (SILANES)	296
9.2.3 ETCHANTS/CHAMBER CLEAN	297
9.2.4 DEPOSITION/MISC	298
9.2.5 BULK GASES	299
9.3 ETCH GAS ROADMAPS	300
9.3.1 ETCH ROADMAPS 1 OF 3	301
9.3.2 ETCH ROADMAPS 2 OF 3	302
9.3.3 ETCH ROADMAPS 3 OF 3	303



# FIGURES & TABLES

## FIGURES

FIGURE 1: ELECTRONIC GAS MARKET	14	FIGURE 17: SEMICONDUCTOR AUTOMOTIVE PRODUCTION	46
FIGURE 2: ELECTRONIC GAS MARKET SEGMENTATION	15	FIGURE 18: TSMC PHOENIX INVESTMENT ESTIMATED WILL BE US \$40 B	48
FIGURE 3: TECHCET WAFER START FORECAST BY NODE	17	FIGURE 19: CHIP EXPANSIONS 2022-2027 US\$366 B	49
FIGURE 4: TECHNOLOGY ROADMAP DEVICES	21	FIGURE 20: SEMICONDUCTOR CHIP MANUFACTURING REGIONS OF THE WORLD	51
FIGURE 5: TOTAL ELECTRONIC GAS MARKET SHARE 2021, US\$6,3 BILLION	23	FIGURE 21: GLOBAL TOTAL EQUIPMENT SPENDING BY SEGMENT (US\$ B)	52
FIGURE 6: AIR GAS BOILING POINT	25	FIGURE 22: OVERVIEW OF ADVANCED LOGIC DEVICE TECHNOLOGY ROADMAP	53
FIGURE 7: COMPARISON OF CO2 EMISSIONS FROM VARIOUS TRANSPORTATION MODES	26	FIGURE 23: INTEL OHIO PLANT SITE FEB. 2023 AND ARTIST RENDERING (ON BOTTOM)	54
FIGURE 8: OCEAN CONTAINER PRICE INDEX - JULY '20 TO MARCH '23	27	FIGURE 24: EUROPE CHIP EXPANSION UPSIDE	57
FIGURE 9: GLOBAL ECONOMY AND THE ELECTRONICS SUPPLY CHAIN (2022)	38	FIGURE 25: PORT OF LA	58
FIGURE 10: WORLDWIDE SEMICONDUCTOR SALES	39	FIGURE 26: TECHCET WAFER START FORECAST BY NODE SEGMENTS**	59
FIGURE 11: TECHCET'S TAIWAN SEMICONDUCTOR INDUSTRY INDEX (TTSI)*	40	FIGURE 27: GLOBAL SEMICONDUCTOR MATERIALS OUTLOOK	60
FIGURE 12: 2023 SEMICONDUCTOR INDUSTRY REVENUE GROWTH FORECASTS	41	FIGURE 28: 2D PHASE OF BORON AS POSSIBLE FUTURE TRANSISTOR CHANNEL	66
FIGURE 13: 2022 SEMICONDUCTOR CHIP APPLICATIONS	42	FIGURE 29: 3DNAND MARKET SHARE 2022	67
FIGURE 14: MOBILE PHONE SHIPMENTS WW ESTIMATES	43	FIGURE 30: 3DNAND STRUCTURE	68
FIGURE 15: WORLDWIDE PC AND TABLET FORECAST	44	FIGURE 31: MO PRECURSORS	69
FIGURE 16: ELECTRIFICATION TREND BY WORLD REGION	45	FIGURE 32: PATENT FAMILIES FILED FOR MOLYBDENUM ALD IN THE MEMORY SPACE.	70

# FIGURES & TABLES

FIGURE 33: WAFER START FORECAST SHOWING TWO TIMING SCENARIOS WHERE MO COULD BE INTRODUCED (MILLIONS OF 200 MM EQUIVALENT / YEAR)	71	FIGURE 49: DEP - ALE STI FILL AND RECESS ETCH	90
FIGURE 34: 3D DEVICE ARCHITECTURES	73	FIGURE 50: PLASMA AND THERMAL ALE PROCESSES	91
FIGURE 35: FORECASTS – WAFER STARTS 2021 TO 2027	74	FIGURE 51: AIR LIQUIDE FINANCIALS (ANNUAL REPORT 2022 PENDING)	95
FIGURE 36: FORECASTS – WAFER STARTS LOGIC 300 MM	75	FIGURE 52: KOREA 2021 NEON IMPORTS	98
FIGURE 37: SAMSUNG START 3 NM PILOT RAMP USING GAA-FET TECHNOLOGY JUNE 2022	76	FIGURE 53: RESONAC BUSINESS SEGMENT REVENUE 2022	99
FIGURE 38: IMEC 2022 LOGIC ROADMAP	77	FIGURE 54: TOTAL HELIUM PRODUCTION 160 MILLION M3	102
FIGURE 39: APPLIED MATERIALS CENTURA PATTERN SHAPING CLUSTER	78	FIGURE 55: FLUORSPAR PRICE IN US 2014-2022	110
FIGURE 40: FORECASTS – WAFER STARTS DRAM 300 MM	79	FIGURE 56: OCEAN CONTAINER PRICE INDEX - JULY '20 TO MARCH '23	111
FIGURE 41: IP FILING IN THE FIELD OF 3DRAM IS ACCELERATING	80	FIGURE 57: CO2 EMISSIONS CONTRIBUTIONS WITHIN A CHIP FAB	114
FIGURE 42: FORECASTS – WAFER STARTS NAND 300 MM	81	FIGURE 58: GLOBAL WARMING IMPACT FROM VARIOUS PROCESS GASES	115
FIGURE 43: PATHWAYS FOR CONTINUED 3D NAND SCALING	82	FIGURE 59: TOTAL EMISSIONS AND ENERGY USE PROJECTION PER LOGIC NODE	116
FIGURE 44: 3DNAND SCALING FROM 1 STACK TO 4 STACKS	83	FIGURE 60: CO2EQ OUTPUT FROM ETCH GASES	117
FIGURE 45: SELECTIVE W LOWERS RESISTANCE	85	FIGURE 61: AIR SEPARATION UNIT FLOW CHART	118
FIGURE 46: FINFET/GAA TRANSITION	86	FIGURE 62: AIR GAS BOILING POINT	119
FIGURE 47: SELECTIVITY IMPROVEMENT WITH ALE	87	FIGURE 63: CARBON GENERATION FROM AIR SEPARATION PROCESSES	120
FIGURE 48: ALD AND ALE ROADMAPS OF INTEL, TSMC AND SAMSUNG	88	FIGURE 64: COMPARISON OF CO2 EMISSIONS FROM VARIOUS TRANSPORTATION MODES	123

# FIGURES & TABLES

FIGURE 65: F2 AND NF3 ACTIVATION	128	FIGURE 82: HE MATERIALS SUPPLIER TIER STRUCTURE	162
FIGURE 66: ELECTRONIC GAS MARKET	134	FIGURE 83: TUNGSTEN USE BY INDUSTRY (TEHCET ESTIMATE)	165
FIGURE 67: TOTAL INDUSTRIAL GAS MARKET 2021, US\$97 BILLION	135	FIGURE 84: ELECTRONIC SPECIALTY GASES	293
FIGURE 68: TOTAL ELECTRONIC GAS MARKET 2021, US\$6,3 BILLION	136	FIGURE 85: BULK GASES	293
FIGURE 69: ELECTRONIC GAS MARKET SEGMENTATION	138	<b>TABLES</b>	
FIGURE 70: HE WW SUPPLY AND DEMAND	140	TABLE 1: SPECIALTY AND BULK GAS REVENUE 2022, 2027	14
FIGURE 71: 2027 HELIUM SUPPLY	141	TABLE 2: ELECTRONIC GAS MARKET GROWTH RATES BY END MARKET	15
FIGURE 72: TOTAL NEON DEMAND VS. SUPPLY	142	TABLE 3: 5-YEAR SPECIALTY GAS SUPPLY & DEMAND	16
FIGURE 73: KOREA 2021 NEON IMPORTS	143	TABLE 4: GAS TRENDS AND OPPORTUNITIES BY DEVICE TYPE & PROCESS TECHNOLOGY	22
FIGURE 74: TOTAL XENON DEMAND VS. SUPPLY (MILLION LITERS/YR)	144	TABLE 5: GLOBAL GDP AND SEMICONDUCTOR REVENUES*	36
FIGURE 75: TOTAL KRYPTON DEMAND VS. SUPPLY (MILLION LITERS/YR)	145	TABLE 6: IMF ECONOMIC OUTLOOK*	37
FIGURE 76: NF3 SUPPLY/DEMAND	146	TABLE 7: DATA CENTER SYSTEMS AND COMMUNICATION SERVICES MARKET SPENDING 2022	47
FIGURE 77: AWF6 FORECAST	147	TABLE 8: OVERVIEW OF DEPOSITION PROCESSES BY DEVICE TYPE AND MATERIAL	84
FIGURE 78: HARDMASK SCHEMATIC	154	TABLE 9: ETCH GASES SUMMARY TABLE	91
FIGURE 79: LATEST SITUATION MAP IN UKRAINE, SHOWING TAKEN MAURIUPOL BUT ODESSA STILL FREE	155	TABLE 10: GAS TRENDS AND OPPORTUNITIES BY DEVICE TYPE	92
FIGURE 80: RESONAC BUSINESS SEGMENT REVENUE 2022	157	TABLE 11: LINDE FINANCIALS AND REGIONAL SALES	94
FIGURE 81: RARE GAS PRICE ESCALATION	159		

# FIGURES & TABLES

TABLE 12: AIR PRODUCTS REGIONAL FINANCIALS	96	TABLE 27: ETCHANT GAS SUPPLIERS	297
TABLE 13: TAIYO NIPPON SANZO REGIONAL FINANCIALS	97	TABLE 28: DEPOSITION/MISC. GAS SUPPLIERS	298
TABLE 14: ESTIMATED SUPPLY CHAIN SUPPLIER RANKING	104	TABLE 29: BULK GAS SUPPLIERS	299
TABLE 15: REGIONAL SUMMARY OF GAS MARKET	105	TABLE 30: ETCH ROADMAPS	301
TABLE 16: CO2 EMISSIONS PER TONS SHIPPED BY OCEAN, TRUCK OR RAIL	124	TABLE 31: ETCH ROADMAPS	302
TABLE 17: GAS GWP AND ATMOSPHERIC LIFETIME	128	TABLE 32: ETCH ROADMAPS	303
TABLE 18: ELECTRONIC GAS MARKET SIZE AND GROWTH	134		
TABLE 19: TOTAL REVENUE 2022 COMPARED TO 2021 OF MAJOR GAS COMPANIES AND GAS SUPPLIERS	137		
TABLE 20: ELECTRONIC GAS MARKET GROWTH RATES BY END MARKET	138		
TABLE 21: 5-YEAR SPECIALTY GAS SUPPLY & DEMAND	139		
TABLE 22: M&A ACTIVITIES	148		
TABLE 23: SPECIALTY GAS INDUSTRY MATRIX	289		
TABLE 24: GASES USED IN FPD MANUFACTURING	292		
TABLE 25: HYDRIDE GAS SUPPLIERS	295		
TABLE 26: SILICON PRECURSOR SUPPLIERS	296		

# 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:

TEHCET's Critical Materials Reports™	
1	CMP Consumables (Pads & Slurry)
2	CMP Equipment Ancillaries (Conditioners, Filters, etc.)
3	CVD /ALD Hi K Precursors
4	CVD DIELECTRIC Precursors
5	Equipment Components – Quartz
6	Equipment Components – Silicon
7	Equipment Components – SiC/Ceramics
8	Gases - Electronic Specialty, Bulk & Rare Gases
9	Metal Plating Chemicals
10	Photoresists, Ancillaries & Extension Materials
11	Sputtering Targets
12	Wafers: Silicon, SOI
13	SiC Wafers & Manufacturing
14	Wet Chemicals / Specialty Cleans
15	Special Reports: Impact of US Expansions on Wet Chemicals Supply Chains