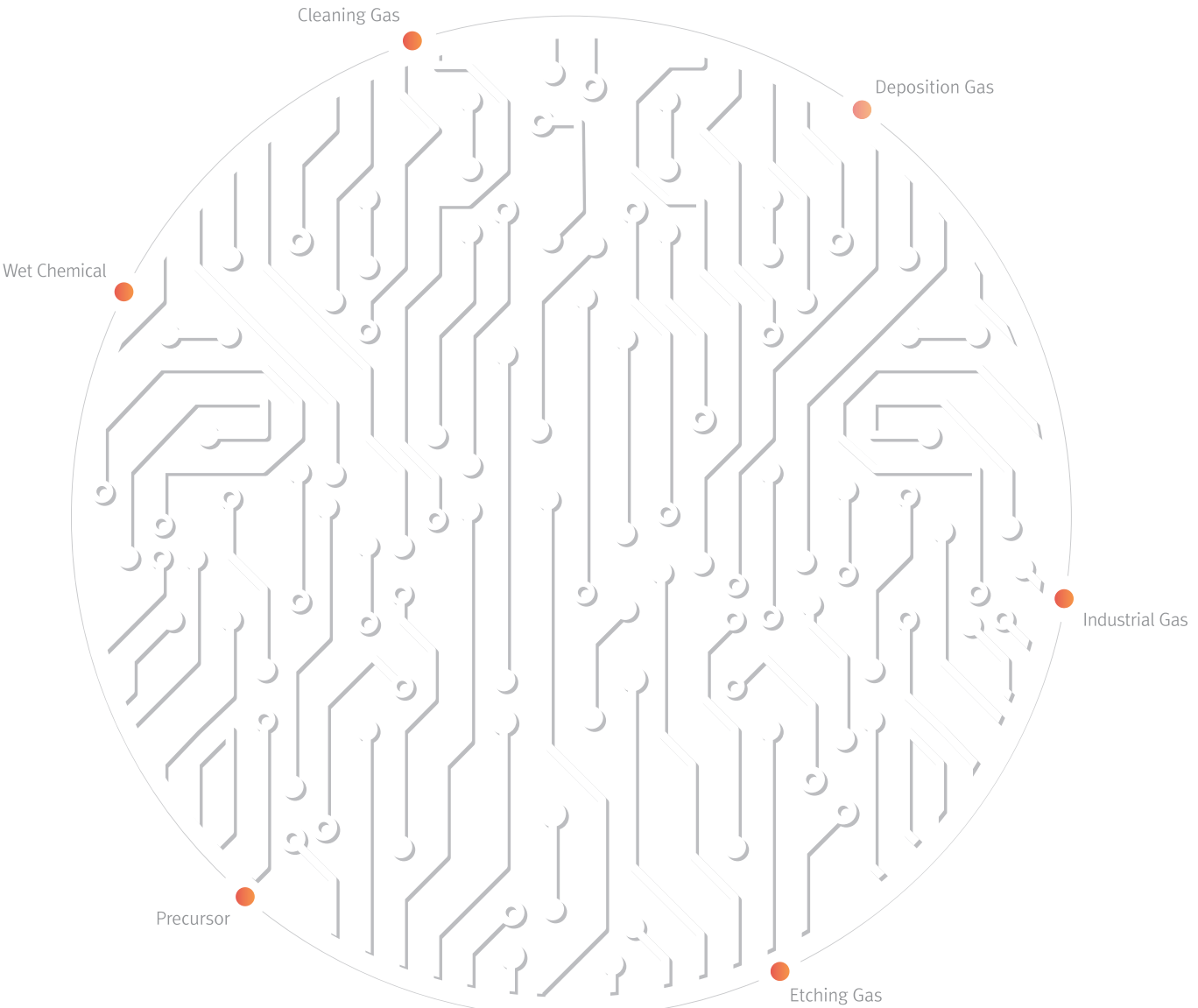
GAS & IT MATERIALS

TOTAL SOLUTION PROVIDER



SK materials

Global No.1
Total Solution Provider

GAS & IT MATERIALS

TOTAL SOLUTION PROVIDER

SK materials moves forward as a Total Solution Provider in the Gas & IT Materials industry.

SK materials

With a core focus on semiconductor materials, **SK materials** incessantly strives to become the leading total solutions provider for gas & IT materials, with its diverse portfolio of products and services aimed to create value for its customers.

Thanks to the ceaseless R&D efforts since its founding in 1982, **SK materials** was the first ever in Korea to localize Nitrogen trifluoride (NF_3) special gas in 2001.

NF_3 is a special cleaning gas that removes residues in chambers used during semiconductor manufacturing processes. **SK materials** is the unrivaled global leader in the production and sales of such gas, taking up a lion's share of over 40% of its global market share.

Our competitive edge in the special gas sector is once again showcased by our production levels of tungsten hexafluoride (WF_6) and monosilane (SiH_4), ranking world top one and two respectively, as well as our production and sales of dichlorosilane (SiH_2Cl_2) and disilane (Si_2H_6).

SK materials has its headquarters and plants in Yeongju, Gyeongsangbuk-do, and has established legal entities overseas in Taiwan and Japan in 2010, Jinjiang, China in 2011, Xian, China in 2013, and Shanghai, China in 2019. The Jinjiang entity, boasting a production capacity of 1,500 tons of nitrogen trifluoride, serves as an outpost for occupying the ever-growing Chinese market. Sales entities in Taiwan, Japan, Xian and Shanghai are supporting the company expand its influence in the global market.

With the 2016 acquisition of **SK airgas**, which produces and supplies industrial gases such as oxygen and nitrogen, **SK materials** has been growing its share in the industrial gas market via proactively responding to customer needs. We also acquired an industrial carbon dioxide (CO_2) manufacturer **Hanyu Chemical** in 2019, with an aim of securing new semiconductor materials and sharpening our competitiveness for future operations.

Furthermore, **SK trichem**, which jointly manufactures precursors with global semiconductor materials producers, and **SK showa denko**, an etching gas producer, were founded to diversify our product portfolio. This also helped expand our business scope to the materials sector, which now witnesses ever-growing demand with the proliferation of semiconductor circuit scaling and 3D NAND flashes.

As a result, **SK materials** has shown sound fiscal performance, rewriting its record in annual sales at KRW 687.3 billion (consolidated) in 2018. Since its incorporation into the SK Group in 2016, **SK materials** has been maximizing values for all stakeholders including customers and shareholders, via providing unparalleled customer service, all the while creating synergies.

The global semiconductor and display market is changing at an unprecedented pace, as IT technologies like AI, IoT, and big data further advance and new players in emerging economies like China surface. Against this backdrop, **SK materials** will revamp both its cost and quality competitiveness through ceaseless innovation in its manufacturing processes, while also actively investing in R&D of new, next-generation products.

As such, we will put forth our best efforts to secure our position as the unmatched global leader by providing tailored solutions that meet market needs even under a changing paradigm.

SK materials growing as a global top tier.

1982 ~ 2000

Frontier of the specialty gas in Korea

1982 Establishment

1998 Established Central Technology Research Center annexed to the company

1999 Listed in KOSDAQ

At a time when semiconductors were considered as an unfamiliar business area and when specialty gases used in semiconductor fabrication processes were imported, SK materials became the first Korean company which produces nitrogen trifluoride(NF_3), using our own product development capabilities.

With continuous challenges and innovation, SK materials aims to grow the company's business beyond the specialty gas market where it is the world's largest producer of nitrogen trifluoride(NF_3) and tungsten hexafluoride(WF_6), and also the second largest manufacturer of silane(SiH_4). Since SK materials expands into other industrial gases, precursors, etching gas, services, and logistics solutions, it creates even more values.

2001 ~ 2010

Preparing a foundation as a national industry through challenge and overcoming

2001 Completed 1st NF_3 Plant

2004 Completed 1st WF_6 Plant
Completed 2nd NF_3 Plant

2005 Completed 1st SiH_4 Plant

2007 Completed 3rd NF_3 Plant

2008 Completed 1st SiH_2Cl_2 Plant

2010 Completed 2nd SiH_4 Plant
Established SK materials Japan Co., Ltd. and SK materials Taiwan Co., Ltd.

2011 ~

Leaping to be a global leader in Gas & IT materials

2011 Completed 4th NF_3 Plant
Established SK materials Jiangsu Co., Ltd. in China

2012 Completed NF_3 China Plant (SK materials Jiangsu Co., Ltd.)
Completed Si_2H_6 Plant

2013 Established SK materials Xian Co., Ltd. in China

2016 Became an affiliate of SK Group
Acquired SK airgas (SK airgas Incorporated)
Established SK trichem Co., Ltd.
Completed 2th WF_6 Plant
Completed 5th NF_3 Plant

2017 Suzhou sales office open
Established SK showa denko Co., Ltd.
Completed 3th WF_6 Plant
Completed 6th NF_3 Plant

2018 Additional acquisition of SK airgas shares (100% subsidiary)
Enter High Performance Wet Chemical Products business (HSP cooperation development)

2019 Established SK materials Shanghai Co., Ltd. in China
Acquired Hanyu Chemical

SKMS

SK Management System

The SK Management System(SKMS), established in 1979, defines SK's governing philosophy and methodology, which are embodied in its management approach. SKMS has provided a foundation for SK's corporate culture through the consensus of all SK People. SK's sustained growth and consistent development to date can be largely attributed to its SKMS-based management activities and the establishment of its corporate culture.

All SK People voluntarily and willingly practice the SKMS. As a result, they contribute to corporate growth and development while achieving their own happiness at the same time.

SUPEX Quest

In order to be a happier company, SK aims for the SUPEX, or Super Excellent Levels. This is the highest goal that any person can reach, and we continuously strive to achieve these levels.

Pae-gi

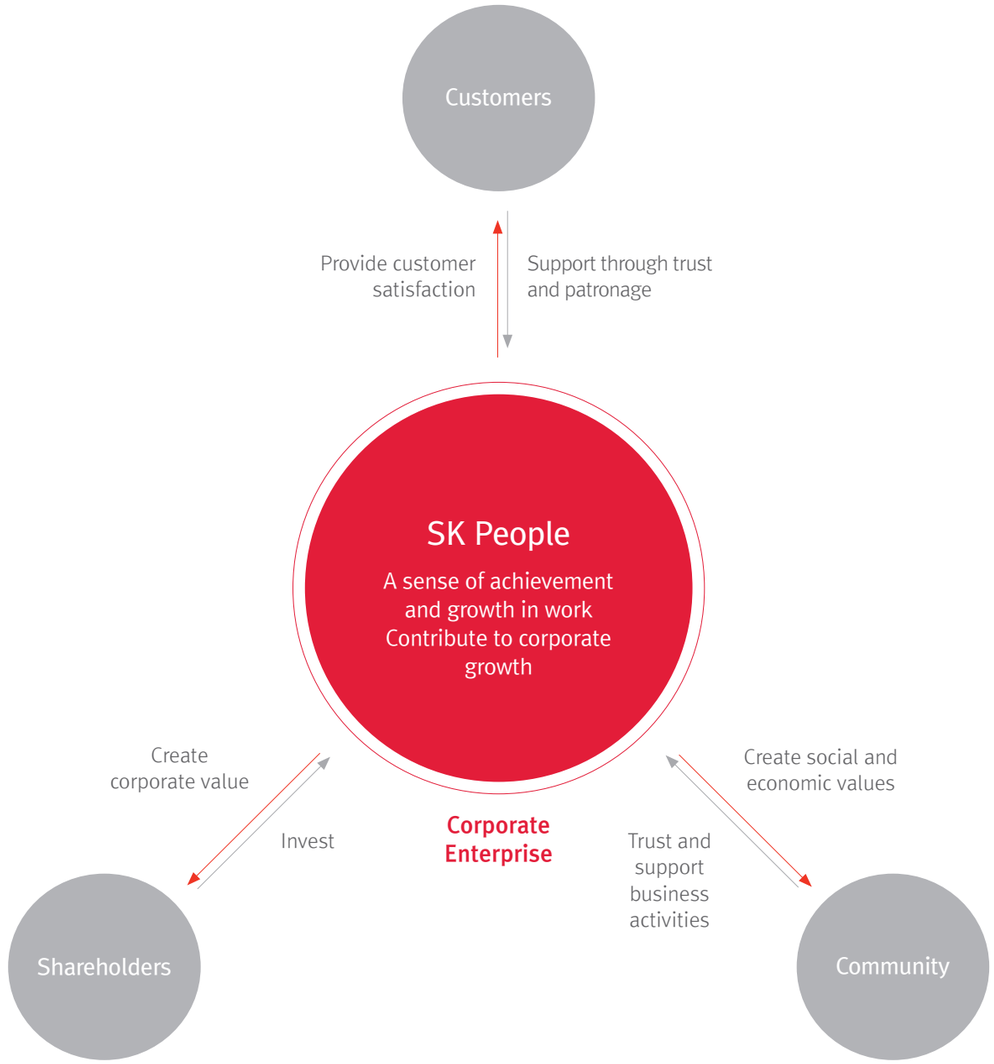
"Pae-gi" refers to a state where the brain is voluntarily and willingly engaged. People with "Pae-gi" take on and achieve higher goals, strive to develop required capabilities, and produce better performance through teamwork. SK attaches great importance to encouraging "Pae-gi," while creating the best possible environment so that they can demonstrate their capabilities to the maximum.

Voluntary and Willing Brain Engagement (VWBE)

SK is fully aware that its employees are the focus of the management and the pursuit of SUPEX can only be realized when employees give their best. We believe that this will be attained by our employees engaging in the "Voluntarily & Willingly Brain Engagement (VWBE)" strategy.

Happiness of Stakeholders

SK believes that its mission is to create greater happiness for its numerous stakeholders. The ultimate goal that we pursue is being happy by making those around us happy.



Global No.1

Total Solution Provider

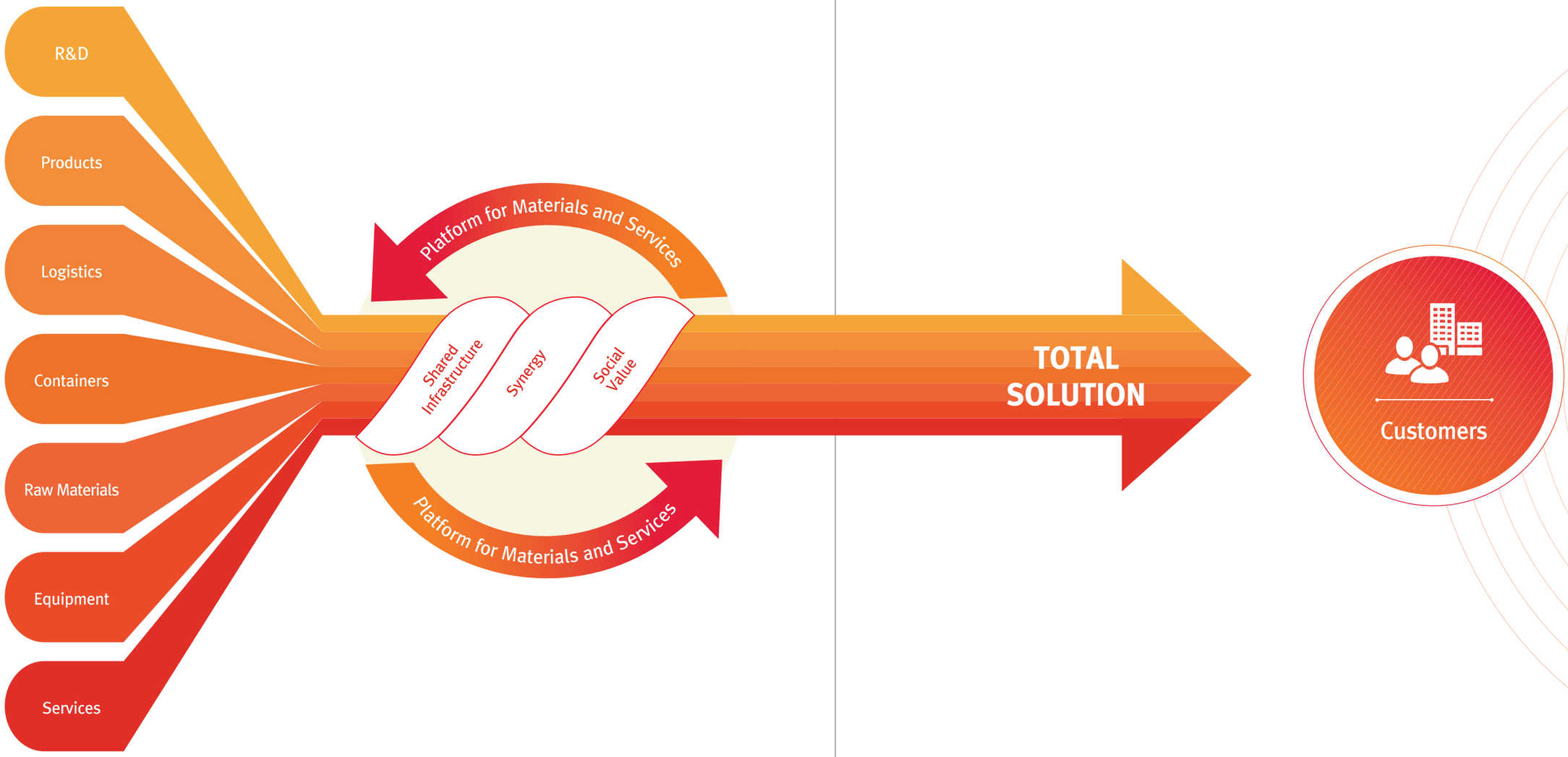
Customer Value

Platform for Materials & Services

Sharing & Cooperation

Global No.1
Total Solution Provider

In order to offer greater value to its customers, SK materials is sharing tangible / intangible assets and pursuing collaborative work with its core players in various fields such as raw materials, logistics, chemical containers, and services. This is a part of SK materials' committed effort to build a platform for materials and services so that customer value will increase.



The formation of such an materials platform will deliver goods and services demanded by SK materials' customers so that SK materials can succeed in not only becoming the leading Total Solution Provider on a global scale but also in creating a business model capable of sustainable growth.

Business Information

A variety of materials produced by SK materials are used in the most cutting-edge manufacturing processes of semiconductor displays, which shall shape the new tomorrow.

SK materials will continue to secure its position as the best partner creating customer value, with its continuous development of new products and provision of unmatched services.

*BSGS (Bulk Specialty Gas Supply System)

1. Cleaning Gas

As the first manufacturer of nitrogen trifluoride(NF_3) in Korea,
SK materials has been stably providing its customers with high-quality nitrogen trifluoride through novel technology development and proactive investments in facilities since 2001.

Nitrogen trifluoride(NF_3)

NF_3 is used during the manufacturing process of semiconductor, display, and PV, as it removes residues from inner wall of the chamber after CVD manufacturing process.

Carbon dioxide(CO_2)

CO_2 is a supercritical fluid with zero surface tension, and is used as a gas to remove the impurities from semiconductor wafers following the completion of the etching process. It is also used for ArF immersion or EUV equipments.
It offers both the advantages of a liquid that easily dissolves impurities, and gas that removes residues settled deep inside the equipment by accurately reaching the corners of even the finest patterns.

2. Deposition Gas

SK materials manufactures and sells various deposition gases for deposition of film in semiconductors, display panels, and solar cells.
SK materials continuously develops new deposition gases to keep pace with the rapid changes in the IT industry.

Tungsten hexafluoride(WF_6)

WF_6 is used in patterning semiconductor to form metal contacts and gates.

Monosilane(SiH_4)

SiH_4 is used during the manufacturing process of semiconductor, display and PV, where it is employed for Si insulator film and Si anti-reflection layer deposition.

Monochlorosilane(SiH_3Cl)

SiH_3Cl is a precursor material used in the manufacturing of semiconductors and display panels.

Disilane(Si_2H_6)

Si_2H_6 is used during the manufacturing process of semiconductor, display and PV, where it is employed for Si insulator film and Si anti-reflection layer deposition.

Dichlorosilane(SiH_2Cl_2)

SiH_2Cl_2 is a gas used for nitride(SixNy) deposition.

3. Industrial Gas

Industrial gases are being used in various industries, such as petrochemicals, semiconductors, steel, healthcare, and food. SK materials highly purifies its industrial gases by using air-separation units and stably delivers them by means of on-site supply, pipelines, and tank lorries.

Oxygen(O_2)

Oxygen is used in various industries including iron and steel, automobiles, machinery, and chemicals. Its oxidizing nature is particularly useful in common processes, such as dissolution and amputation in the iron and steel industry.

Nitrogen(N_2)

Nitrogen is widely used in food quick-freezing and artificial insemination and serves as an important gas in semiconductor and electronics industries. it is used as a purge and carrier gas in chemical and metal heat treatment processes. Also, it interacts with metals at high temperature and pressures to form nitrides and binds with hydrogen through catalytic reactions.

Argon(Ar)

Argon is an essential gas in refinement and processing of metal that must not be exposed to oxygen, nitrogen, and impurities. It is used not only in the welding of non-metallic materials such as stainless steel and aluminum, but also in the refinement and processing of high-purity materials, including titanium, silicon, and aluminum.

4. Etching Gas

Etching gases etch the shape of a space for a circuit prior to the circuit formation inside the semiconductor. They are used to add precision when etching semiconductors with a 3D structure.
SK materials provide an array of etching solutions, such as via production and sales of Monofluoromethane (CH_3F), Hexafluorobutadiene (C_4F_6), and Difluoromethane (CH_2F_2), etc.

Monofluoromethane(CH_3F)

CH_3F, an etching gas for nitride films in 3D NAND flash memory devices, is becoming more widespread with the increase of 3D NAND use. SK materials is the first and only manufacturer of CH_3F in Korea.

Difluoromethane(CH_2F_2)

CH_2F_2, along with CH_3F, is a gas used in etching nitride films in NAND flash memory devices. It has been widely utilized since 3D NAND has been increasingly used in the recent.

Trifluoromethane(CHF_3)

Used in the process of 3D NAND Flash memory nitride layers and microscopic DRAM nitride layers etching.

Hexafluoroethane(C_2F_6)

C_2F_6 is a high purity etching gas for semiconductors, used for cleaning and removal of residues inside the chamber, following metal deposition in the semiconductor manufacturing processes.

Hexafluorobutadiene(C_4F_6)

C_4F_6 is used in the etching of oxide films for miniaturized DRAMs and 3D NAND flash memory devices. C_4F_6 has seen a significant increase in demand.

Octafluorocyclobutane(C_4F_8)

C_4F_8 is a high purity gas used in semiconductor DRAM and 3D NAND manufacturing processes, mainly used for oxide film etching.

Hydrogen Fluoride Gas (HF Gas)

Hydrogen fluoride gas is used to remove residues in the chamber and to etch unnecessary parts of a circuit in the semiconductor manufacturing process.

5. Precursor

Precursors are used in the semiconductor process where various kinds of reactive gases are brought into a reactor and chemically reacted to deposit a thin film of desired material onto the wafer.
SK materials produces and supplies the best quality precursors, a next-generation material, manufactured atop the essence of Japan Tri Chemical Laboratories' expertise and customer's trust gained through prompt responsiveness in the semiconductor materials market.

Zr-Precursor

Used in the manufacturing of capacitors for semiconductor DRAMs and in the depositing of ZrO_2 thin films in the ALD process.

Si-Precursor

Used in the manufacturing of semiconductor DRAMs and 3D-NAND and in the depositing SiO_2 thin films in the CVD/ALD process.

Ti-Precursor

Used in the manufacturing of capacitors for semiconductor DRAMs and in the depositing TiO_2 thin films in the ALD process.

Hf-Precursor

Used in the fabrication process of DRAM capacitors for semiconductor devices. Also used in HfO_2 thin-film deposition as part of the ALD process.

6. Wet Chemical Solutions

As device structures are being advanced, wet cleaning and etch steps become more critical in the chip-making process. And It is required to develop an optimized product to customer's process and to supply huge volume with consistent quality. SK materials will be able to provide various wet chemical solutions in the near future by expanding its portfolio.

High Selectivity Phosphoric Acid(HSP)

As an etchant used to manufacture 3D NAND, HSP is used to selectively etch only nitride films out of layers of nitride and oxide films.

Tungsten Etchant

An etching solution used in 3D NAND memory production that enables the selective etching of tungsten thin films and diffusion barrier films.

7. Other High-Purity Gas

We strive to provide a number of solutions to our customers through not only manufacturing but also sourcing and refining high value-added items that are in high demand thanks to the wide use of semiconductor circuit scaling and 3D NAND.

Krypton(Kr)

Kr is used as a momentum gas in the etching of deep holes in 3D NAND of semiconductors.

Silicon Tetrachloride($SiCl_4$)

SiCl4 is a gas used together with Si powder when manufacturing polysilicon wafers, and is also used for deposition and etching in semiconductor manufacturing processes.

A Global Partner Leading the World's Industry Market

The competitive edge of SK materials is well received not just in Korea but also globally. With its corporations and production plants in China, Japan, Taiwan and other cities, SK materials is now advancing into an industry-leading global partner that provides world-class products and services to customers in the high-tech semiconductor and display industries, clustered in Northeast Asia.

SK materials Co., Ltd.

Specialty gases and materials for semiconductors and displays

Head Office and Factory: 59-33 Gaheung Gongdan-ro, Yeongju-si, Gyeongsangbuk-do
Tel. 054-630-8114 Fax. 054-630-8145

Seoul Office: Tower 1, Gran Seoul Building, 33, Jong-ro, Jongno-gu, Seoul, Korea
Tel. 02-728-0910 Fax. 02-728-0998

SK airgas Incorporated

Manufacture and sale of industrial gases for IT and other industries

255, Yongjam-ro, Nam-gu, Ulsan, Korea
Tel. 070-7437-1500 Fax. 052-227-5861

SK trichem Co., Ltd.

Manufacture and sale of semiconductor precursors

110-5, Myeonghaksandan-ro, Yeondong-myeon, Sejong-si, Korea
Tel. 044-417-1570 Fax. 044-417-1571

SK showa denko Co., Ltd.

Manufacture and sale of etch gases for semiconductors

71 Gaheunggongdan-ro, Yeongju-si, Korea
Tel. 054-918-9710 Fax. 054-630-8456

Hanyu Chemical Co., Ltd.

Manufacture and sale of carbon dioxide for semiconductor processes

72 Cheoyong-ro, Nam-gu, Ulsan, Korea
Tel. 052-256-1641~6 Fax. 052-261-1682

SK materials Jiangsu Co., Ltd.

Annual production capacity(NF_3) : 1,500 tons

No.59 Longxi Road, New Area Zhenjiang, Jiangsu, China
Tel. +86-511-8086-9800 Fax. +86-511-8086-9728

SK materials Xian Co., Ltd.

Sales Office / Warehouse

1211 Baoba Road, Xian Gaoxin Comprehensive Bonded Zone, Xian, Shaanxi, China
Tel. +86-29-6803-9592 Fax. +86-29-6803-9591

SK materials Shanghai Co., Ltd.

Sales Office / Warehouse

Room 602, THE SUMMIT, 118, Suzhou Avenue West, Industrial Park Suzhou, China
Tel. +86-0512-6730-2842 Fax. +86-0512-6730-2849

SK materials Taiwan Co., Ltd.

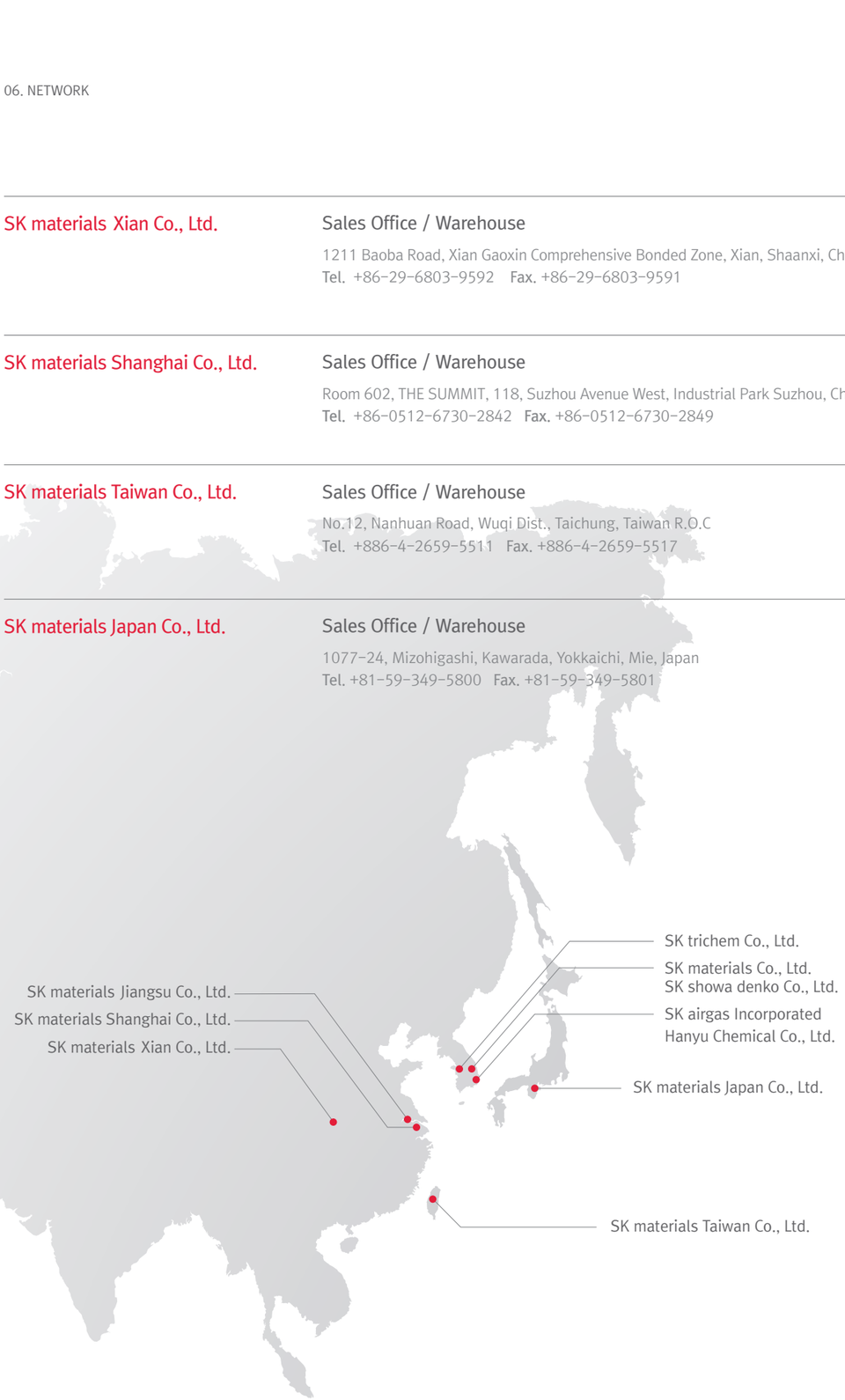
Sales Office / Warehouse

No.12, Nanhuan Road, Wuqi Dist., Taichung, Taiwan R.O.C
Tel. +886-4-2659-5511 Fax. +886-4-2659-5517

SK materials Japan Co., Ltd.

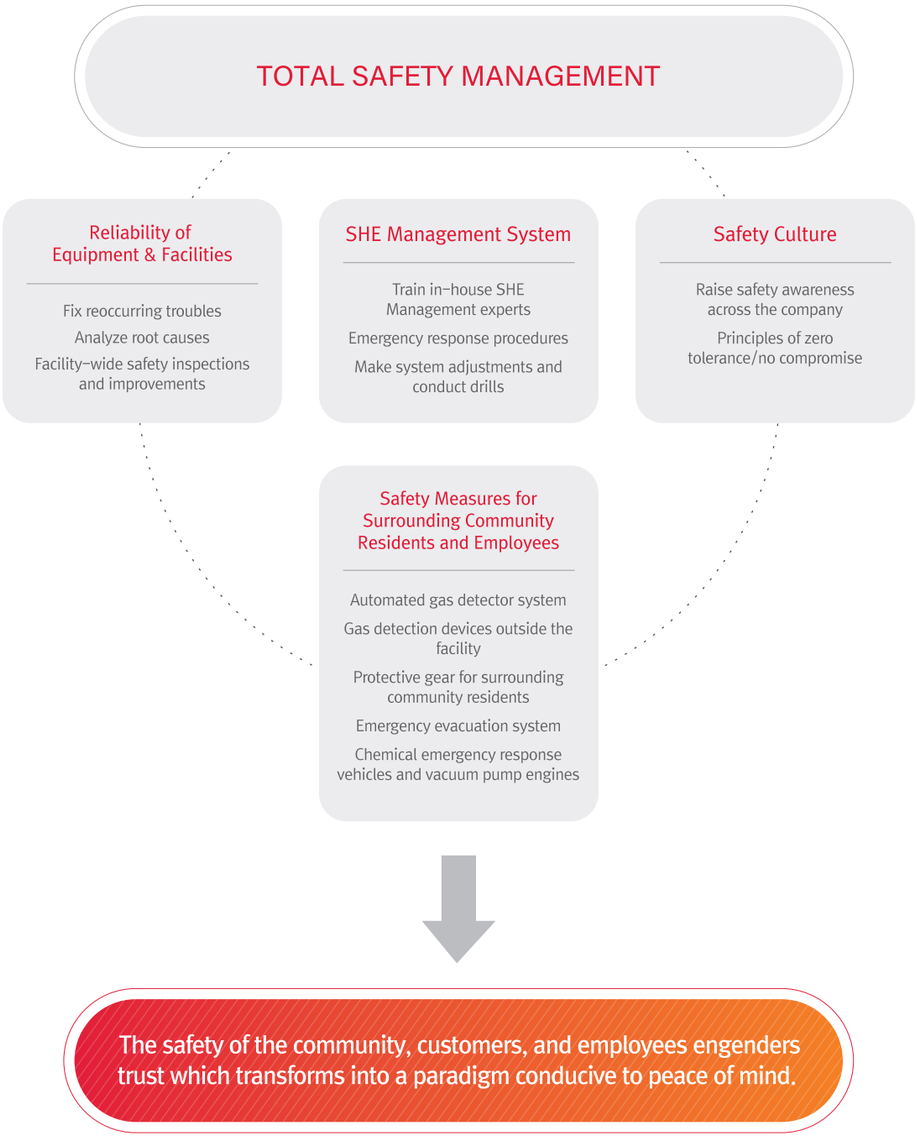
Sales Office / Warehouse

1077-24, Mizohigashi, Kawarada, Yokkaichi, Mie, Japan
Tel. +81-59-349-5800 Fax. +81-59-349-5801



SHE Management System

SK materials is committed to building an SHE Management System for zero incidents in the workplace and the environment. Our utmost value is to operate production facility safe for our employees and peace of mind is enjoyed by all stakeholders, including our customers and local communities. We are fully dedicated to realizing these objectives.

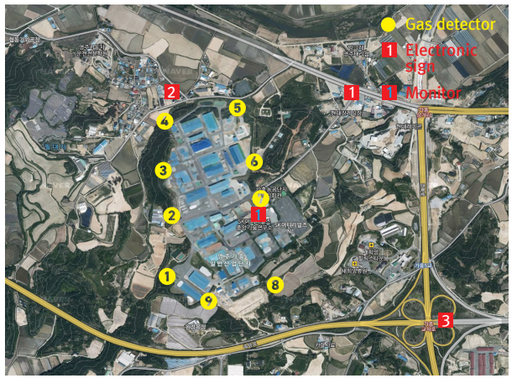


Core Safety Activities

❶ Enterprise-wide emergency drills conducted jointly by private and public authorities	• In cooperation with public authorities, SK materials performs semiannual emergency response drills to prepare for large-scale incidents. • Local residents participate in a joint emergency evacuation drill with SK materials once a year.
❷ Running an Emergency Operations Center (EOC)	• The EOC makes possible 24-hour emergency monitoring to improve initial response to incidents.
❸ Safety golden rules in effect	• To prevent incidents, establish safety principles which employees of both SK and partner companies must adhere to when on site, and perform checks to monitor compliance.
❹ Foster a culture of self-directed safety compliance	• Endeavor to raise safety awareness through safety consulting and related taskforce activities so that a culture of self-directed safety compliance takes root.
❺ Organize safety & Health awareness months	• Designate July and August as Safety & Health Awareness Months to strengthen employee awareness of the importance of safety through activities such as fire emergency skills competition, quizzes on safety regulations and guidelines, along with slogan and poster contests.
❻ Safety awareness campaign with partner companies	• Through win-win cooperation programs with partner companies and by improving our partner companies' safety awareness, we build a culture that values safety for all parties are empowered to thrive.

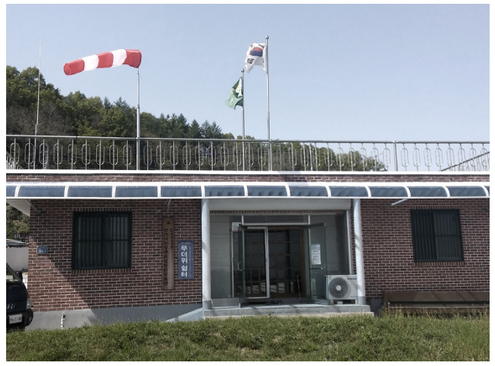
※ **SAFETY CERTIFICATION STATUS** OHSAS 18001 | ISO 14001

Community Emergency Response Enhancement Activity



❶ Gas detection devices installed in the area surrounding the facility

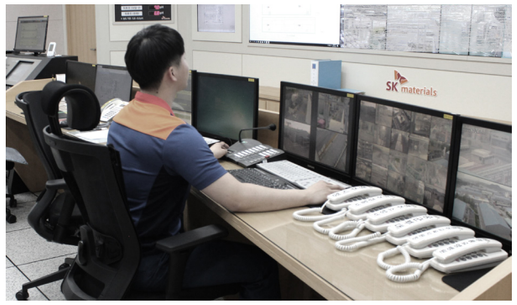
- Nine locations around the facility have gas detection devices installed.
- Detection results are displayed at the entrance to the town and the facilities, while monitoring is in effect via EOC and the city government's control center.



❷ Anemoscopes for the community are erected in the area surrounding the facility(Twenty anemoscope posts)

❸ Monitoring of gas leaks at facility

- Connected to the city government's disaster situation room.



❹ Hot line in place linking local authorities

- 24-hour emergency monitoring in effect at EOC.

❺ Protective gear supplied according to emergency scenarios for residents within the potential radius of exposure

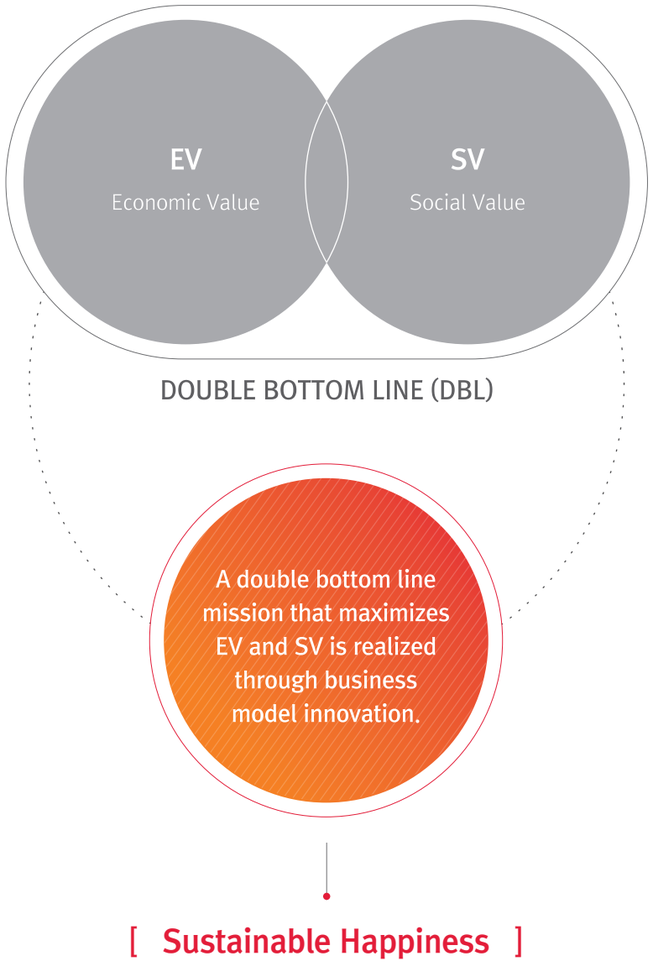
❻ The booklet on 〈Guidance on Responding to Chemical Accidents〉 shall be provided.

❼ Emergency alarm system in place for all business operations on site

Social Value (SV)

SK materials works in harmony with the society by not only contributing to economic growth but by also generating social value so that it can build a society in which all members can achieve happiness.

Not only for corporate stability and economic growth, SK materials creates social value also for the sustainable happiness of all its stakeholders, today and in the future. This will drive the continuous growth and development of the company, thereby creating a virtuous circle. With confidence in this paradigm, SK materials dedicates resources and time towards this aim.



SK materials generates a wide range of social value so that our communities can experience **sustainable happiness**.

Efforts to Resolve Environmental Issues	• Improvement of production processes to raise energy efficiency and to minimize carbon emission. • Investment in pollution control devices to reduce emission of pollutants and expansion of measures to reuse and recycle resources. • Development of environmentally friendly industrial materials for the future to promote sustainable growth.
Stakeholder's reassurance through Safe and conscious Plant Management	• Expansion in investment in safety equipment and facilities, and implementation of innovative safety measures at the manufacturing sites will reassure all citizens, customers, partner companies, SK employees, and the regional communities. • Cooperation with partner companies and share its knowledge and know-how on safety enhancement so that SK materials is able to contribute to national safety and to prevent chemical incidents and emergencies.
Win-win Cooperation and Mutual Growth with Diverse Stakeholders	• Building a platform for industrial materials via open partnerships with customers and suppliers • Providing the system and infrastructure for better communication with, and performance of, suppliers • Increasing employment of socially vulnerable groups via creating positions for the physically challenged
Labor and Management Relations	• Exerting effort to tackle social issues, such as corporate culture and working conditions, by active engagement among the management and the employees • Creating and helping a joyful corporate culture take root
Boosting CSR Activities	• Actively carrying out socially responsible activities to create harmony with the local community and revitalize its economy • Carrying out social contribution activities with employee so as to support the underprivileged and nurture youth talent

SK materials

COMPANY BROCHURE

www.sk-materials.com

Head Office and Factory: 59-33 Gaheunggongdan-ro, Yeongju-si, Gyeongsangbuk-do, 36059 **Tel.** 054-630-8114 **Fax.** 054-630-8145
Seoul Office: Tower 1, Gran Seoul Building, 33, Jong-ro, Jongno-gu, Seoul, 03159 **Tel.** 02-728-0910 **Fax.** 02-728-0998

www.sk-materials.com