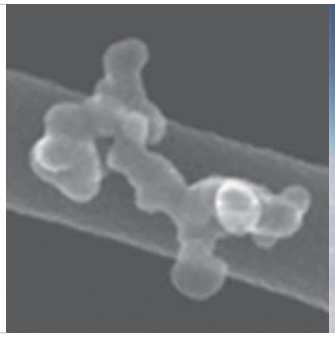
www.oci.co.kr

KONASIL®
Fumed Silica

KONASIL® Fumed Silica



OCI Company Ltd.

KONASIL®
fumed silica

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Greetings

Welcome to OCI

Founded in 1959, OCI has been a leader in the Korean chemical industry by ceaselessly developing the chemical sectors that are essential for the industrial development of a nation, such as inorganic chemistry, petro & coal chemistry, fine chemistry, etc. for more than 50 years now.

Today, we, as the leading global green energy company, are delivering a wide range of achievements from the creation of energy to the conservation of energy resources by launching the new & renewable, green energy businesses of poly-silicon, photovoltaic (PV) power generation, fumed silica, fumed silica vacuum insulation and more based on our accumulated technology and know-how that we have developed and acquired during the 50 years of our chemical business.

All the employees at OCI, with an aim to fulfill the social responsibility and duty of the global corporate citizens, are putting in their best efforts into building a Global Leading Green Energy & Chemical Company based on its core principles of transparent and ethical management.

We look forward to your continuous interest, encouragement and support in the future.

Thank you.

Woo Hyun Lee
President

OCI Business Area

KONASIL® fumed silica

RENEWABLE ENERGY

As the primary raw material used in the solar PV industry, polysilicon is at the top of the supply value chain, followed by ingot, wafer, cell, modules, and solar power system. It is also requires advanced technology and a purity level of 99.9999999%(referred to as "9-nine").
OCI successfully launched commercial production of 9-nine grade polysilicon in 2008 through continued investment in R&D, and is currently providing 10-nine grade and 11-nine grade polysilicon to major customers.

INORGANIC CHEMICALS

OCI Company Ltd. supplies many of the inorganic chemical products needed by industries to produce a wide range of essential goods. With advanced technology and quality inorganic chemicals, we will maximize our strong performance by securing and expanding overseas production bases, ensuring effective suppliers of raw materials and upgrading our product quality while manufacturing higher value products. We will also continue to build client relationships and deliver outstanding products to global markets.

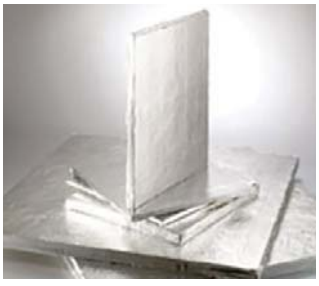
PETRO & COAL CHEMICALS

OCI Company Ltd. blazed the way in the petro and coal chemicals industries by constructing a pioneering coal tar plant in 1976. We solidified that leadership with a new pitch plant in 1978, a naphthalene and tar acid plant in 1979, and a carbon black plant in 1981. These facilities led us to construct our coal chemical complex, which produces an array of chemical products by distilling byproducts from the process of iron making, such as coal tar and light oil. It also allowed vertical integration in our production processes of petrochemical products, such as BTX, carbon black, phthalic anhydride, plasticizer and TDI. We now provide many of the conveniences of everyday life as well as core materials for such diverse industries as automotive, construction, electric, electronic and textile.

FINE CHEMICALS

OCI Company Ltd. produces an array of chemical reagents, agrochemicals. We also produce specialty reagents used in the semiconductor, organic synthesis and biochemistry fields, as well as reagents for general analytic purposes. Recently, we developed a range of top-quality medical ingredients to serve the rapidly growing pharmaceutical industry.



What is *KONASIL*®

KONASIL® fumed silica

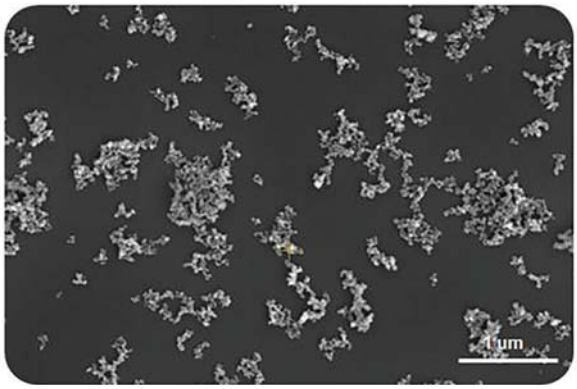
KONASIL®, our brand name of fumed silica, is a fluffy, white and amorphous powder. It is also characterized by its sub-micron particle size, spherical morphology, high specific surface area, high purity and unique surface chemistry. These properties allow *KONASIL*® to be used in various industrial applications.

Each particle varies in size from 7 to 40 nm in diameter, and ranges from 50 to 400 m2/g in specific surface area with BET.

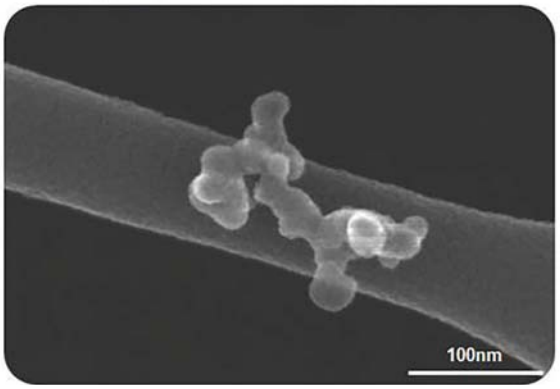
The particle size of fumed silica can be altered by manipulating the reaction conditions during manufacturing in the flame.

There are two distinctive categories of *KONASIL*® : hydrophilic and hydrophobic. Hydrophilic grade silica is untreated fumed silica, while hydrophobic fumed silica is surface-treated with organosilanes.

SEM Image of KONASIL



TEM Image of KONASIL



MANUFACTURING

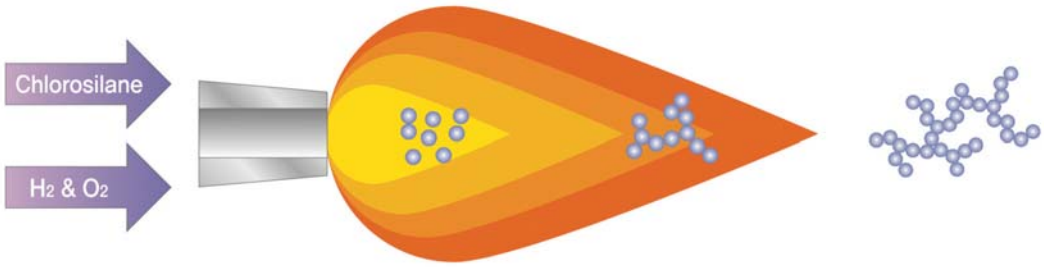
KONASIL® fumed silica

Hydrophilic *KONASIL*® is synthesized from the hydrolysis of silicon tetrachloride in a flame of oxygen and hydrogen at temperatures of 1000°C or higher. Different grades of silica with varying particle sizes/BET surface area can be produced by altering the reaction conditions, such as the flame temperature and ratio of the reactants.

Primary particles of silica that form in the flame collide into each other irreversibly and create small, three-dimensional cluster called aggregates. When surrounded in close proximity to each other, fumed silica aggregates will interact weakly with each other, forming tertiary structures called agglomerates. These agglomerates are not difficult to disperse, and contribute greatly to fumed silica's nature as a thixotropic agent.

$$\text{Metal Silicon(Si)} + 4HCl \rightarrow SiCl_4 + 2H_2$$

$$2H_2 + O_2 + SiCl_4 \rightarrow SiO_2 + 4HCl$$



Primary Particles → Aggregate → Agglomerate

A byproduct of the synthesis is hydrochloric acid, which is easily removed by treating the silica with water steam. After drying, the resulting *KONASIL*® product has a very low bulk density, which is increased by mechanical compression to above 50 g/L.

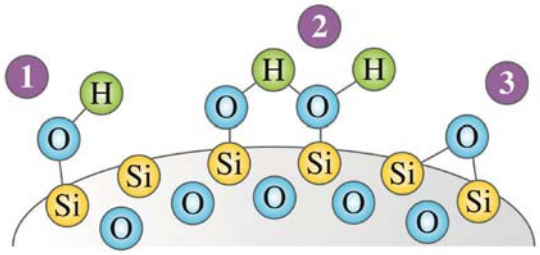
Hydrophobic *KONASIL*® is produced by reacting hydrophilic silica with organosilanes (such as dimethyldichlorosilane, etc.). This results in the binding of an organosilane of interest onto the surface of hydrophilic silica. Hydrophilic fumed silica is for use in non-polar to semi-polar media, while hydrophobic fumed silica is for use in semi-polar to polar media.

CHARACTERISTICS

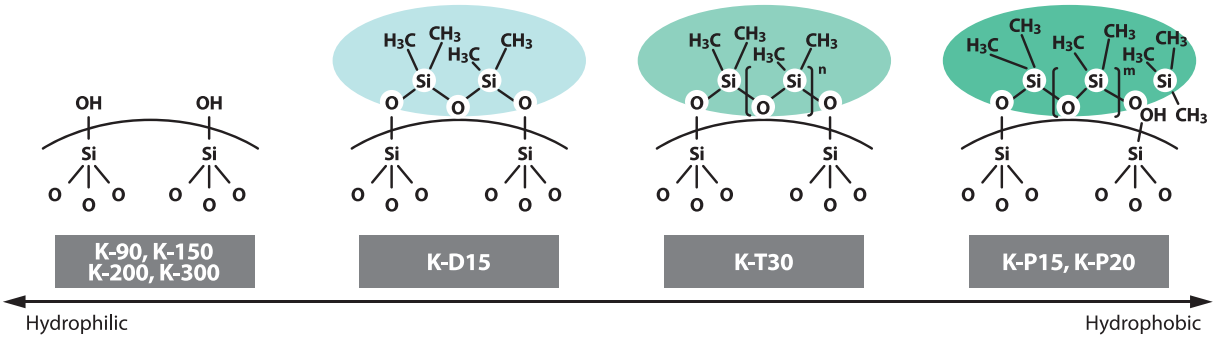
KONASIL® fumed silica

Surface Chemistry

During synthesis of *KONASIL*®, hydroxyl groups attach to some of the surface silicon atoms. These terminal hydroxyl groups are what make untreated fumed silica hydrophilic. With increased surface area, there is increased capacity for moisture absorption.
In hydrophobic fumed silica, different organosilanes are used to treat fumed silica surface. Based on the hydrophobicity of the treatment and the size of the fumed silica particle, the different grades of hydrophobic *KONASIL*® are for different applications.



1) Isolated silanol
2) Vicinal silanol
3) Siloxane bond



HIGH PURITY

Chemically pure reactants, as well as careful handling, produce a high-purity product in *KONASIL*®.

Chemical Analysis of KONASIL

(wt%)

SiO_2	Al_2O_3	Fe_2O_3	TiO_2	HCl
>99.8	**<0.05**	**<0.003**	**0.03**	**<0.025**

Based on material ignited for 2 hours at 950°C

APPLICATIONS

KONASIL® fumed silica

SEALANTS, ADHESIVES AND CAULKS

In sealants, adhesives, and caulks, fumed silica is often utilized to increase viscosity, provide reinforcement, and improve bond strength. *KONASIL*® can be used in RTV1 and RTV2 silicone sealants at a concentration of 5-10% (w/w) to provide rheology and reinforcement control.
In adhesives, fumed silica improves rheology and bond strength of the elastomers to improve overall performance. Fumed silica is also used in hot-melt adhesives at about 5% (w/w) in polystyrene-polyolefin copolymer rubber to add significant improvement in the strength of the adhesive.

SILICONE RUBBER

Fumed silica is used as a reinforcing filler in silicone rubber to increase mechanical strength and tensile strength more efficiently than carbon black.
The similar refractive index of fumed silica and silicone rubber also helps the silicone rubber maintain its transparency, even after fumed silica is added.

CMP SLURRY (ABRASIVE)

for Semi conductor Wafer Electronics

Fumed silica is often used in the metal-oxide slurries used to polish semiconductor substrates in semiconductor manufacturing.

KONASIL®'s high chemical purity, uniform particle size, can help stabilize dispersion and help leave the metal substrates with less scratches and defects, with a more efficient waste removal rate.

Hydrophilic fumed silica with narrow particle size distribution and relatively low surface area is recommended for this application.

RHEOLOGY CONTROL

Fumed silica is used in many systems to provide viscosity and thixotropic control, and is often used in paints and coatings. Thickening, suspension and thixotropy rely on the weak inter-particle interactions of fumed silica aggregates in solution. The interactions are weak enough to be disrupted with light mechanical force, but will form again when undisturbed.

In order for fumed silica particles to be inert in the system of interest, it should be of the opposite polarity. Hydrophilic silica will not perform in hydrogen-bonding systems, but is effective in non-polar to semi-polar media.

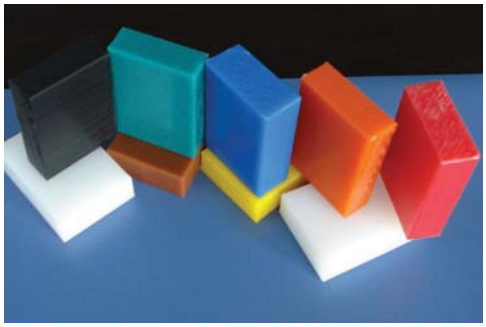
These properties of fumed silica make it a good addition to pigmented polyester varnishes and epoxy paints.

APPLICATIONS

KONASIL® fumed silica

UNSATURATED POLYESTER GEL COATS

Gel coats are usually applied with generosity, sometimes up to 200 mm in thickness. To impart viscosity to the coat, fumed silica is used. Adding fumed silica also prevents sag and drain of the coating on a vertical mold surface, prior to gelation.



UNSATURATED POLYESTER RESINS

In order to prevent sag and drain, fumed silica is often applied to unsaturated polyester resins because of the thixotropic effect fumed silica imparts to the resin. This thixotropic behavior can be amplified by applying ethylene glycol, or another suitable hydroxyl-containing polar chemical. These hydroxyl-containing additives act as bridges to link the silanol groups of fumed silica to the hydroxyl groups of the hydroxyl-containing additive, thereby increasing the viscosity of the system.

FREE FLOW

Adding fumed silica to hygroscopic powders, chemicals, solid resins, and solid adhesives can reduce clumping and caking. It is effective when used in concentrations of less than 2% (w/w). Nanometer sized fumed silica will interrupt interactions (mechanical or electrostatic) in the powder, reducing frictional force and enforcing free flow. Additionally, substances with liquid or paste consistencies can be converted into free-flowing powders by combining with appropriate levels of fumed silica. *KONASIL*® is safe for human consumption and is Halal and Kosher certified for suitable use in foods, dietary supplements, and pharmaceuticals.

HEAT AND ELECTRIC INSULATION

Fumed silica has low thermal conductivity, and is stable at high temperatures, and is of very high purity, unlike precipitated silicas. For these reasons, fumed silica can be used as a material for heat or electrical insulation. It can also be added to elastomers as double-purposed reinforcing filler with insulating properties.

HANDLING & STORAGE

KONASIL® fumed silica

KONASIL® is a white fluffy powder of very light density. Inhalation of the powder may cause respiratory irritation. *KONASIL*® should be used in an environment with adequate ventilation. *KONASIL*® should be handled with proper skin and eye protection; contact with the eyes or skin may cause significant dryness and irritation. Please do not handle *KONASIL*® around explosive or flammable materials as the dry fumed silica powder can build electrostatic charge when friction is applied.
Please refer to our MSDS for more detailed handling and disposure procedures.

KONASIL® is slightly hygroscopic and thus has a tendency to absorb moisture. *KONASIL*® should be stored in a dry environment to protect it from any atmospheric and direct contact with moisture. If *KONASIL*® is exposed to excess moisture, it will affect the efficiency and dispersibility of fumed silica in certain applications.

KONASIL® is a stable chemical product not subject to extreme degradation if proper precautions are taken to protect it from exposure to moisture or other chemicals. *KONASIL*® can safely be used up to 1 year after manufacture.

GRADES & PACKING

KONASIL® fumed silica

KONASIL® GRADES

Typical Properties	Unit	Hydrophilic					Hydrophobic				
		K-90 K-90D	K-150 K-150D	K-200 K-200D	K-300 K-300D	K-400	K-D15	K-P15	K-P20	K-T20	K-T30
Specific Surface Area (B.E.T.)	m^2/g	**90 ± 15**	**150 ± 20**	**200 ± 25**	**300 ± 30**	**400 ± 40**	**130 ± 20**	**100 ± 20**	**120 ± 20**	**170 ± 30**	**230 ± 30**
pH value *1		**3.7-4.7**	**3.7-4.7**	**3.7-4.7**	**3.7-4.7**	**3.7-4.7**	**3.6-6.0**	**4.0-7.0**	**4.0-7.0**	**3.7-6.0**	**3.7-6.0**
Drying Loss *2	wt.%	**≤ 1.0**	**≤ 1.0**	**≤ 1.5**	**≤ 1.5**	**≤ 1.5**	**≤ 0.5**	**≤ 0.5**	**≤ 0.5**	**≤ 0.5**	**≤ 0.5**
Tap Density Standard Densified	g/L	50 100	50 100	50 100	50 100	50 100	50	50	50	50	50
Sieve Residue *3	wt.%	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Surface Treatment *4							DDS	PDMS	PDMS	D4	D4
Carbon Content							0.8-1.5	4.0-7.0	4.0-7.0	1.0-2.0	1.5-3.0

*1 4 wt.% slurry in water or 4 wt.% slurry in Methanol mixture (CH3OH:H2O=1:1) for Hydrophobic Fumed Silica
*2 Measurement when packing at plant (Condition: 2 hours at 105°C)
*3 325 Mesh residue Max % (44 micron)
*4 Dichloro-Dimethyl Silane (DDS), Poly DiMethyl Silane (PDMS), Octamethyl-Cyclotetrasiloxane (D4)

KONASIL® PACKING

*1 **Paper bag:** 10kg of undensified type or 15kg of densified type
*2 **Big bag:** 150kg, 180kg or 200kg with different bulk density range of 50 to 100 g/L
*3 **No. of bags on pallet:** 18 bags or 20 bags (3.6mt or 4.0mt per 40ft container)

R&D for *KONASIL*®

KONASIL® fumed silica

With the goals of pushing the boundaries of technology and generating new enterprises, the OCI Company Ltd. R&D center was established in 1982.

Today, the Center employs more than 100 highly trained researchers who strengthen OCI Company Ltd.'s global competitiveness by improving existing products and by exploring new technologies and products that will grow the company.

R&D Center has acquired innovative technologies and patents that represent a broad range of improvements in product quality, process technologies and new product development. These strategic R&D acquisitions contribute to OCI Company Ltd.'s outstanding success. In the future, we intend to maximize profits by the efficient use of resources and the continuous development of state-of-the-art technology in the key fields of carbon materials, polymers, information and electronic materials, powder and nano materials, organic and inorganic chemicals and environment/ analytical supports

Analysis Instruments

KONASIL® fumed silica

1. Organic Analyzer

FT-NMR (Nuclear Magnetic Resonance),
GC (Gas Chromatography), GC-AED, Head Space & GC, GC-MASS
HPLC (High Performance Liquid Chromatography), Prep-LC (Preparative LC)
FT-IR (Fourier Transform Infrared Spectroscopy)
UV (UV Visible Spectroscopy), Gas-Mass
EA(Elemental Analyzer),
TOC-TN Analyzer

2. Inorganic Analyzer

ICP-Mass (Inductively Coupled Plasma Mass Spectrometer), ICP
AA (Atomic Absorption Spectrometer)
I.C(Ion Chromatography)
Mercury Analyzer

3. Polymer Analyzer

GPC (Gel Permission Chromatography)
Light Scattering
UTM (Universal Testing Machine)
Rheo-meter

4. Surface Analyzer

SEM-EDX(Scanning Electron Microscope)
AFM (Atomic Force Microscope)
XRD(X-ray Diffractometer), Polarization micros

5. Thermal Analyzer

DSC (Differential Scanning Calorimeter)
TGA (Thermogravimetric Analyzer)

6. Analysis instruments

BET, Large particle counter, Micro-fluidizer, SEM, UTM(Universal Test Machine),
Oil Absorptometer, Viscometer, ICP(Inductively Coupled Plasma), H-NMR

OCI members with YOU

KONASIL® fumed silica

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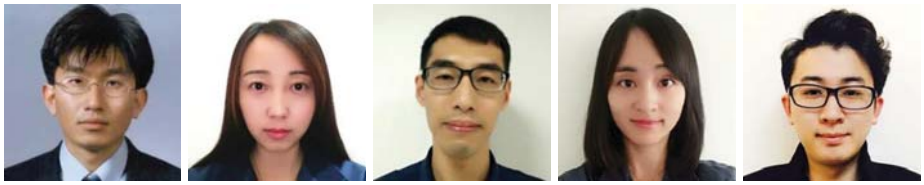

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KONASIL® *6th Edition, 2018*