

REOLOSIL[®]

Fumed Silica



REOLOSIL is a very fine amorphous silica manufactured using techniques developed by TOKUYAMA. REOLOSIL offers many practical applications.

Basics

REOLOSIL is a very fine amorphous silicon dioxide made from highly purified chlorosilanes via combustion with oxygen and hydrogen.

REOLOSIL has numerous applications due to its remarkable properties, including high purity, excellent dispersion, enormous surface area, and extremely fine particle size. These characteristics offer advantages for use in a wide range of products such as silicone rubber, sealants, organic elastomers, coatings, printing inks, adhesives and materials used to improve flow characteristics.

■ HIGH PURITY

Highly purified chlorosilanes are used as the raw materials of REOLOSIL. Rigorous production process controls safeguard against product contamination.

■ EXCELLENT DISPERSION

In the flame of the reactor, the first produced non-microporous primary particles fuse into aggregates that form larger agglomerates upon cooling.

In liquid systems, REOLOSIL is finely dispersed and exhibits thickening and thixotropic effects, as three-dimensional networks of REOLOSIL particles form under optimum dispersion conditions.

Adding REOLOSIL improves the mechanical properties of elastomers. Especially using the large specific surface area of the REOLOSIL into the elastomers, the transparency property of the products is also excellent because the dispersion proceed to the aggregates smaller than light wave length (400~760nm).

■ ENORMOUS SURFACE AREA

Fumed silica consists of extremely fine particles with large specific surface areas on the order of 50-500 m²/g and particles averaging 5-50 nm in diameter (Fig.1, 2). Primary particles do not exist in isolation; they form aggregates and agglomerates.

■ SURFACE CHEMISTRY

Silanol groups (about 1.5 silanol groups per nm²) are found on the surface of hydrophilic REOLOSIL grades. In storage, untreated REOLOSIL is hygroscopic. Hydrophobic REOLOSIL is manufactured by allowing the surface silanol groups of hydrophilic REOLOSIL to react with various surface-treated agents. This treatment reduces the number of silanol groups to less than 10% of hydrophilic REOLOSIL. Hydrophobic REOLOSIL is characterized by low water adsorption for more effective rheology control in complex solvents and easier dispersion in nonpolar media.

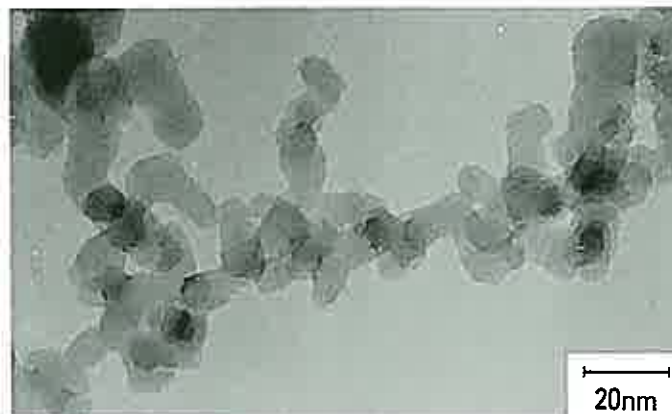
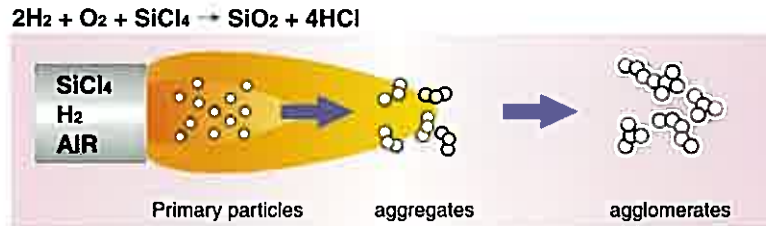


Fig. 1 TEM photograph of QS-20

Producing REOSIL

REOSIL is manufactured by controlled combustion of highly purified chlorosilanes with oxygen and hydrogen. A schematic diagram is given below. The silica generated in the flame is transported to HCl removal process, cooling process, adjusting the bulk density process and packaging process in the closed-system.



General Properties

Fumed silica generally exists as an agglomerate having particle sizes on the order of μm - mm . The primary particle sizes depend on specific surface area of REOSIL as shown in Fig.2.

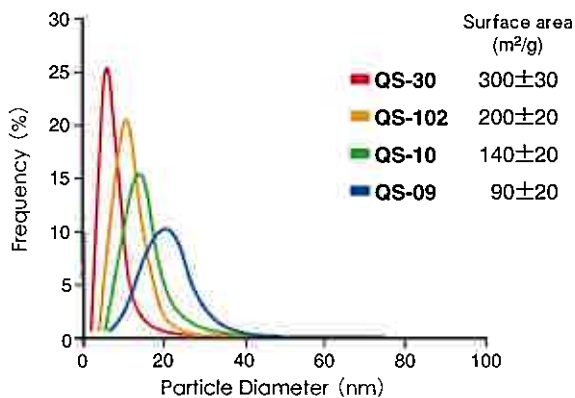


Fig. 2 Primary particle size distribution of REOSIL

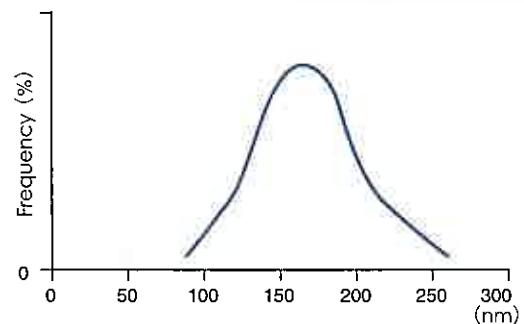


Fig. 3 QS-102 Particle size distribution in the water

As shown in Fig.3, REOSIL is highly dispersed in dispersing media until achieving a colloidal state. Due to its tendency to form aggregates (fused primary particles) and the interaction between particles, REOSIL cannot be dispersed until broken down into primary particles.

REOSIL is generally free of impurities, due to use of highly purified chlorosilanes.

Typical analysis data for REOSIL QS-102

Alkaline metal & Alkaline-earth metal element					Metal & semimetal element				
		Typical Value (ppm)	Detection Limit (ppm)	Analysis Method			Typical Value (ppm)	Detection Limit (ppm)	Analysis Method
Na	Sodium	N.D.	0.2	AAS	Zn	Zinc	N.D.	0.1	ICP-AES
K	Potassium	N.D.	0.7	AAS	Cd	Cadmium	N.D.	0.1	ICP-AES
Mg	Magnesium	N.D.	0.2	ICP-AES	Hg	Mercury	N.D.	0.01	ICP-AES
Ca	Calcium	N.D.	0.2	ICP-AES	Al	Aluminum	N.D.	0.1	ICP-AES
Sr	Strontium	N.D.	0.05	ICP-AES	Pb	Lead	N.D.	0.04	ICP-AES
Transition element					As	Arsenic	N.D.	0.1	ICP-AES
Ti	Titanium	N.D.	0.05	ICP-AES	Sb	Antimony	N.D.	0.1	ICP-AES
V	Vanadium	N.D.	0.2	ICP-AES	Halogen element				
Cr	Chromium	N.D.	0.1	ICP-AES	F	Fluorine	N.D.	5	Spectrometry
Mn	Manganese	N.D.	0.05	ICP-AES	Cl	Chlorine	29	5	Spectrometry
Fe	Iron	N.D.	0.1	ICP-AES	Chemical compound				
Ni	Nickel	N.D.	0.1	ICP-AES	CN	Cyanide	N.D.	0.1	Spectrometry
Cu	Copper	N.D.	0.2	ICP-AES	CeHeO	Phenol compounds	N.D.	0.1	Spectrometry

Characteristics

Thickening and thixotropy

REOLOSIL provides thickening and thixotropic effects in liquid systems such as polyesters, epoxies, and urethane resins due to interactions between aggregates and the development of three-dimensional networks between REOLOSIL particles.

Reinforcement

Adding REOLOSIL as a filler material improves various mechanical properties of elastomers, including modulus, elongation at break, tensile strength and tear resistance.

REOLOSIL's large specific surface area also makes it possible to achieve excellent transparency in elastomers.

Anti-settling effects

REOLOSIL improves the suspension behavior in liquid systems, such as pigmented coatings or resins containing fillers.

Anti-caking, effects for improved flow characteristics

Due to a property that makes it behave like ball bearings, REOLOSIL resists lumping and clogging. It can be used to improve the storage stability of powders that are especially prone to caking. REOLOSIL can also be used to improve flow characteristics and prevent flow problems.

Anti-blocking effects

REOLOSIL is added to film resins to reduce "sticking." It reduces close contact between film layers.

Adsorbent

Gaseous, liquid or solid materials can be precipitated or adsorbed on the surface of REOLOSIL. This serves as an ideal carrier or substrate for active ingredients due to its high specific surface area and inertness in the presence of all chemicals except strong alkalis and hydrofluoric acid.

Insulation

With its very low solid state conductivity and vast spacing between particles, REOLOSIL provides excellent electrical and thermal insulation properties.

Electrical charge

Hydrophobic REOLOSIL is used as a toner additive to stabilize electrical charge characteristics. TOKUYAMA can provide hydrophobic REOLOSIL grades manufactured to custom specifications.

Polishing

In the semiconductor manufacturing process, the planarization of silicon wafers is achieved via CMP (chemical mechanical polishing) processes such as ILD, STI and metal CMP.

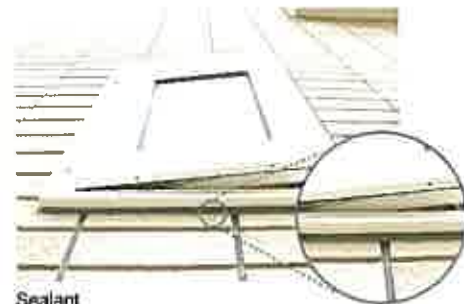
REOLOSIL is used in certain CMP slurries as a polishing agent, due to high purity, sub-micron particle size and its distribution characteristics.



Clear rubber (Sole)



Silicone rubber



Sealant

Applications

	Effect	REOLOSIL grades
Synthetic rubbers	Reinforcing effect Electrical insulation	QS-102, CP-102, QS-20, QS-30, QS-30C DM-10, DM-10C
Silicone rubbers	Reinforcing effect Electrical insulation	QS-10, QS-102, CP-102, QS-30, QS-30C DM-10, DM-10C, HM-30S
Sealants	Thickening and thixotropy Reinforcement, improved adhesion	QS-10, QS-102, CP-102, QS-20 MT-10, MT-10C, DM-10
Unsaturated polyester resins	Thickening and thixotropy	QS-102, QS-20, QS-20L, QS-20LS, QS-30 HM-20L, PM-20L
Paints / Coatings	Thickening and thixotropy Storage stability (resistance to settlement)	QS-10, QS-102, QS-20, QS-30, QS-40 MT-10, DM-10, HM-20L, PM-20L
Printing inks	Thickening and thixotropy Storage stability, corrosion protection	QS-102, QS-20, QS-30, QS-40, MT-10
Adhesives	Thickening and thixotropy, improved adhesion Storage stability (resistance to settlement)	QS-102, QS-20, QS-20L, QS-20LS, QS-30 MT-10, DM-10, HM-20L, PM-20L
Paper	Adsorbent Transparency	QS-09, QS-10, QS-102, QS-30
Bulk materials	Anti-caking, free flow aids, Adsorbent Anti-blocking effect, moisture resistance	QS-102, QS-20 MT-10, DM-30, KS-20SC
CMP	Polishing agent	QS-09, QS-10, QS-102
Toners	Improved flow properties, electric charge control Improved toner transfer to paper	HM-30S, PM-20



Fiber-reinforced plastic
(Unsaturated polyester resins)



Coating materials



Ink jet papers

Grades

► Hydrophilic REOSIL

Grade	QS-09	QS-10	QS-102	CP-102	QS-20 QS-20L QS-20LS	QS-20A	QS-30 QS-30C	QS-40
Appearance	White powder							
BET surface area (m ² /g)	90±20	140±20	200±20	200±20	220±20	220±20	300±30	380±30
Primary particle (nm)	22	15	12	12	12	12	7	7
Bulk density (g/L)	50	50	50	100	50 45 40	50	50 100	50
Moisture content (Dry up, %) ¹⁾	<1.0	<1.5	<1.5	<1.5	<1.5	<2.0	<2.0	<2.0
pH (4% suspension)	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2
SiO ₂ purity (%)	>99.9	>99.9	>99.9	>99.9	>99.9	>99.9	>99.9	>99.9
Cl (ppm)	<50	<50	<50	<50	<50	<50	<50	<50
Fe (ppm)	<20	<20	<20	<20	<20	<20	<20	<20
Al (ppm)	<20	<20	<20	<20	<20	<20	<20	<20
325 mesh Residue (%)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Packaging (kg)	10	10	10	15	10	10	10 C type:15	10

► Hydrophobic REOSIL

Grade	MT-10 MT-10C	DM-10 DM-10C	DM-30	KS-20SC	HM-20L	HM-30S	PM-20 PM-20L
Appearance	White powder						
BET surface area (m ² /g)	120±20	120±20	230±20	160±20	150±20	200±20	100±20
Primary particle (nm)	15	15	7	12	12	7	12
Carbon content (%)	0.9	0.9	1.7	2.0	2.5	3.5	5.5
M value (vol.%) ²⁾	47	48	47	55	64	64	65
Bulk density (g/L)	50 100	50 100	50	100	40	50	50 40
Moisture content (Dry up, %)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
pH (4% suspension) ³⁾	4.8	4.8	4.5	5.1	6.0	6.6	5.2
Cl (ppm)	<100	<100	<100	–	–	–	–
Fe (ppm)	<20	<20	<20	<20	<20	<20	<20
Al (ppm)	<20	<20	<20	<20	<20	<20	<20
Packaging (kg)	MT-10:10 MT-10C:15	DM-10:10 DM-10C:15	10	15	10	10	10

1) When leaving plant

2) M value indicates the titrimetric amount of methanol when silica was completely dipped into methanolic aq.
Larger value shows higher hydrophobicity.

3) In a mixture of water and methanol

Packaging

REOLOSIL is generally supplied in multi-layer paper bags. Standard grade (bulk density: approximately 50g/L) and compact grade (approximately 100g/L) REOLOSIL bags are 10 kg and 15 kg, respectively.



Registration and Safety Data

	ENCS (JAPAN)	TSCA (USA)	EINECS (EU)	IARC classifications
Hydrophilic grade (QS, CP)	(1)-548	7631-86-9	231-545-4	3
Hydrophobic grade (MT)	(1)-548	121375-93-7	—	3
Hydrophobic grade (DM)	(1)-548, (7)-476	68611-44-9	271-893-4	3
Hydrophobic grade (KS)	(1)-548	68583-49-3	271-514-2	3
Hydrophobic grade (HM)	(7)-476	68909-20-6	272-697-1	3
Hydrophobic grade (PM)	(7)-476	67762-90-7	—	3

● IARC classifications : 3 ; not classifiable as to its carcinogenicity in humans



- ※ Before use, refer to the Material Safety Data Sheet (MSDS) for these products for important safety information.
- ※ Avoid continuous or excessive inhalation of the powder products. Wear dust masks designed to block fine particles.
- ※ The powder products may generate static electrical charges during mixing, sliding, pouring, or transport. All equipment must be adequately grounded during work involving inflammable or explosive substances. Take all appropriate safety precautions to prevent accidents.
- ※ Store the powder products in a dry environment to maintain its purity and characteristics.

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TOKUYAMA Corporation

**Silica & Derivatives Sales Department
Specialty Products Business Division**

HEAD OFFICE : Kasumigaseki Common Gate West Tower 2-1,
Kasumigaseki 3-chome, Chiyoda-ku,
Tokyo 100-8983, Japan
TEL: +81-3-3597-5026 FAX: +81-3-6205-4891

OSAKA BRANCH : Nakanoshima Central Tower, 19F, 2-2-7 Nakanoshima
Kita-ku Osaka-shi Osaka 530-0005, Japan
TEL: +81-6-6201-7203 FAX: +81-6-6201-7223

<http://www.tokuyama.co.jp>

