For the People of Tomorrow

TOKUYAMA

REOLOSIL™

PM-20L

Hydrophobic Fumed Silica

REOLOSIL PM-20L is a grade of a hydrophobic silica prepared by treating a high purity fumed silica with polydimethylsiloxane.
Its unique properties offer advantages in many applications; organic elastomers, paints, inks, coatings, adhesives. It is used as thickening and thixotropic agents in the polar liquid systems such as epoxy resins, vinyl ester resins and polyurethane.

Typical Properties

Specific Surface Area (BET)	**80-120 m^2/g**
Carbon Content	**5.5%**
Bulk Density	**40 g/L (approximately)**
pH (4% suspension)	**5.2**
Al	**< 20 ppm**
Fe	**< 20 ppm**
Moisture Content (Dry up, %) *1	**< 0.5 %**

*1 When leaving plant

Characteristic Properties
One of the highest hydrophobic grade.
(mean primary particle size: c.a.12nm) .

Typical Packaging Forms
Packaged in 5 kg / paper bag.

April, 2023

TOKUYAMA Corporation
Silica & Derivatives Sales Department
Silica & Derivatives Manufacturing Department
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https://www.tokuyama.co.jp/eng/

TOKUYAMA

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. Therefore, REOLOSIL is used as the raw material for the semiconductor material such as CMP slurry.

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 m^2 /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 nm^2) 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.

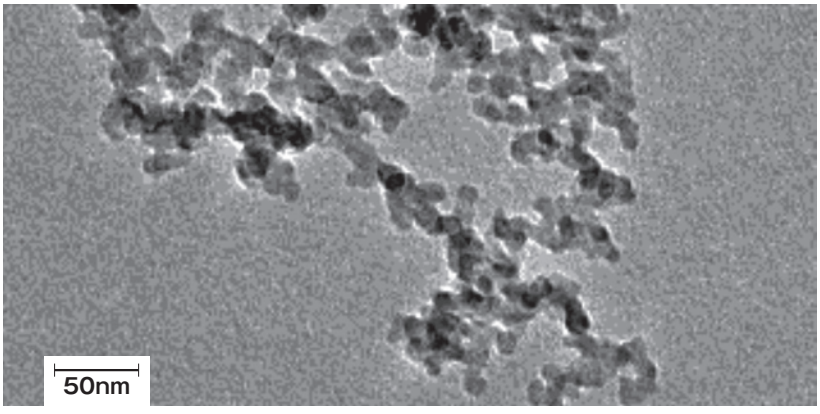
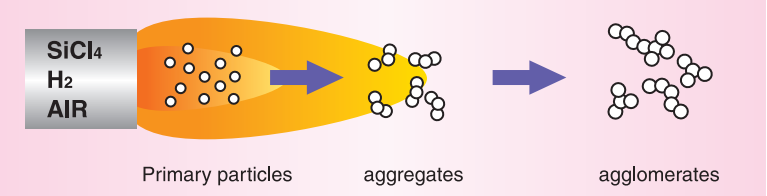


Fig. 1 TEM photograph of QS-102

Producing REOLOSIL

REOLOSIL 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.

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



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 REOLOSIL as shown in Fig.2.

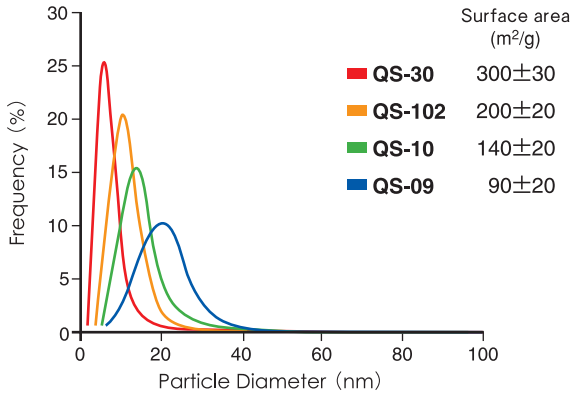


Fig. 2 Primary particle size distribution of REOLOSIL

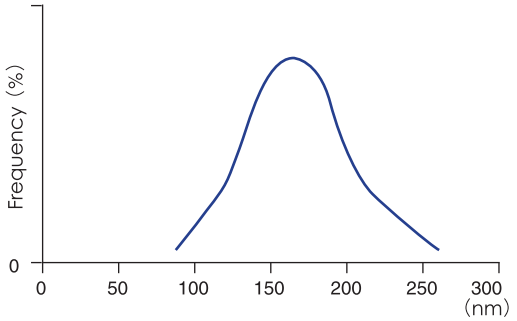


Fig. 3 QS-102 Particle size distribution in the water

As shown in Fig.3, REOLOSIL 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, REOLOSIL cannot be dispersed until broken down into primary particles.

REOLOSIL is generally free of impurities shown below, due to use of highly purified chlorosilanes in the closed-system.

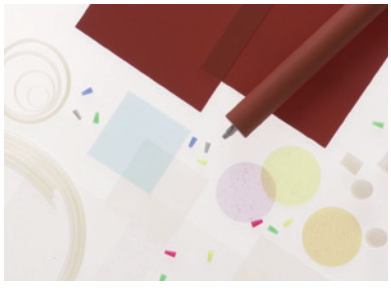
■ Typical analysis data on metal impurities for REOLOSIL QS-102

		Typical Value (ppm)	Analysis Method			Typical Value (ppm)	Analysis Method			Typical Value (ppm)	Analysis Method
Alkaline metal & Alkaline-earth metal element				**Transition element**				**Metal & semimetal element**			
Na	Sodium	<0.1	ICP-AES	**Ti**	Titanium	<0.1	ICP-AES	**Zn**	Zinc	<0.1	ICP-AES
K	Potassium	<0.1	ICP-AES	**V**	Vanadium	<0.1	ICP-AES	**Cd**	Cadmium	<0.1	ICP-AES
Mg	Magnesium	<0.1	ICP-AES	**Cr**	Chromium	<0.1	ICP-AES	**Hg**	Mercury	<0.1	ICP-AES
Ca	Calcium	<0.1	ICP-AES	**Mn**	Manganese	<0.1	ICP-AES	**Al**	Aluminum	<0.1	ICP-AES
Sr	Strontium	<0.1	ICP-AES	**Fe**	Iron	<0.1	ICP-AES	**Pb**	Lead	<0.1	ICP-AES
				Ni	Nickel	<0.1	ICP-AES	**As**	Arsenic	<0.1	ICP-AES
				Cu	Copper	<0.1	ICP-AES	**Sb**	Antimony	<0.1	ICP-AES

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, DM-10, DM-10C
Silicone rubbers	Reinforcing effect Electrical insulation	QS-10, QS-102, CP-102, QS-30, 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-30, HM-20L, PM-20L
Paints / Coatings	Thickening and thixotropy Storage stability (resistance to settlement) corrosion protection	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	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-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	DM-20S,HM-30S,HG-09,PM-09, PM-20,X-20,X-30,ZD-30ST

Fiber-reinforced plastic
(Unsaturated polyester resins)

Coating materials

Ink jet papers

Grades

Hydrophilic REOLOSIL

Grade	QS-09	QS-10	QS-102 CP-102	QS-20 QS-20L	QS-30	QS-40
Appearance	White powder					
BET suface area (m^2/g)	90±20	140±20	200±20	220±20	300±30	380±30
Primary particle (nm)	22	15	12	12	7	7
Bulk density (g/L)	50	50	50 100	50 45	50	50
Moisture content (Dry up,%)	<1.0	<1.5	<1.5	<1.5	<2.0	<2.0
pH (4% suspension)	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
Cl (ppm)	<50	<50	<50	<50	<50	<50
Fe (ppm)	<20	<20	<20	<20	<20	<20
Al (ppm)	<20	<20	<20	<20	<20	<20
325 mesh Residue (%)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Packaging (kg)	10	10	5,10 10,15	5,10 5,10	5,10	10

Hydrophobic REOLOSIL

Grade	MT-10 MT-10C	DM-10 DM-10C	DM-20S	DM-30	DM-30S	KS-20SC	HG-09
Appearance	White powder						
BET suface area (m^2/g)	120±20	120±20	180±20	235±20	230±20	160±20	65±20
Primary particle (nm)	15	15	12	7	7	12	22
Carbon content (%)	0.9	0.9	1.6	1.7	2.2	2.0	1.5
Bulk density (g/L)	50 100	50 100	50	50	50	100	50
Moisture content (Dry up,%)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
pH (4% suspension) [1]	4.8	4.8	4.8	4.5	4.5	5.1	9.2
Cl (ppm)	<100	<100	<100	<100	<100	-	-
Fe (ppm)	<20	<20	<20	<20	<20	<20	<20
Al (ppm)	<20	<20	<20	<20	<20	<20	<20
Packaging (kg)	10 10,15	10 15	10	10	10	10	10

Grade	HM-20L	HM-30S	ZD-30ST	PM-09	PM-20 PM-20L	X-20	X-30
Appearance	White powder						
BET suface area (m^2/g)	150±20	205±20	200±20	40±20	100±20	90±20	115±20
Primary particle (nm)	12	7	7	22	12	12	7
Carbon content (%)	2.5	3.5	2.9	5.5	5.5	7.4	7.5
Bulk density (g/L)	40	50	50	50	50 40	50	50
Moisture content (Dry up,%)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
pH (4% suspension) [1]	6.0	6.6	6.4	5.2	5.2	5.3	5.3
Cl (ppm)	-	-	-	-	-	-	-
Fe (ppm)	<20	<20	<20	<20	<20	<20	<20
Al (ppm)	<20	<20	<20	<20	<20	<20	<20
Packaging (kg)	5	10	10	10	10 5	10	10

1) In a mixture of water and methanol

Packaging

REOLOSIL is generally supplied in multi-layer paper bags. Regarding available package size for each product, please refer to the [Packaging (kg)] line in the tables of [Grades].

Registration and Safety Data

	CAS NUMBER	ENCS (JAPAN)	TSCA (USA)	EINECS (EU)
Hydrophilic grade (QS, CP)	7631-86-9 112945-52-5	(1)-548	7631-86-9	231-545-4
Hydrophobic grade (MT)	121375-93-7	(1)-548	121375-93-7	–
Hydrophobic grade (DM)	68611-44-9	(1)-548	68611-44-9	271-893-4
Hydrophobic grade (KS)	68583-49-3	(1)-548	68583-49-3	271-514-2
Hydrophobic grade (HG)	199876-44-3	(1)-548	–	–
Hydrophobic grade (HM)	68909-20-6	(1)-548	68909-20-6	272-697-1
Hydrophobic grade (ZD)	172640-49-2	(1)-548	–	–
Hydrophobic grade (PM, X)	67762-90-7	(1)-548	67762-90-7	–

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

※ Before use, refer to the Safety Data Sheet (SDS) 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.

Tokuyama Corporation

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