

TO: EM Sullivan Associates, INC



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# REOLOSIL<sup>®</sup>

**Hydrophobic type**

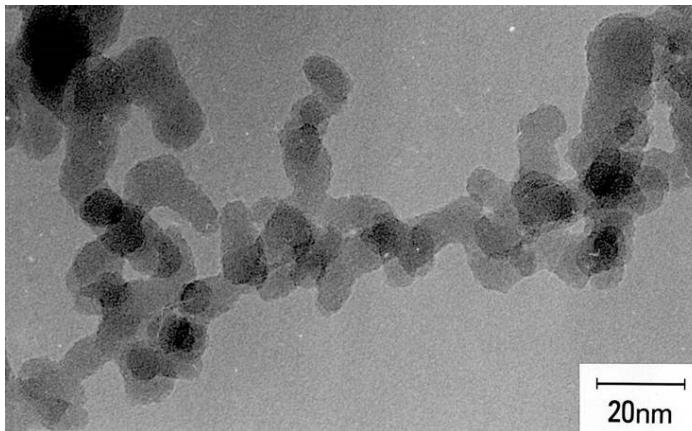
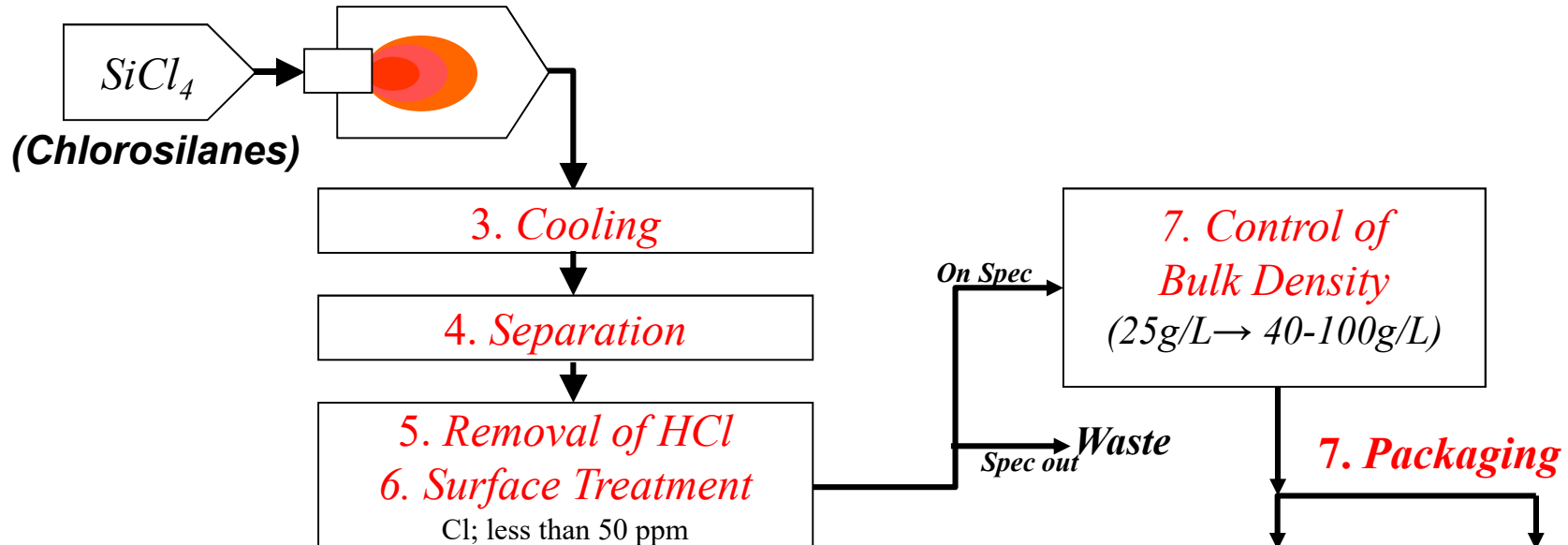
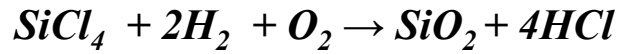
**Technical brochure**

Tokuyama Corporation  
Tokuyama Chemicals (Zhejiang) Co., Ltd.  
Rev. Mar., 2018

## Block Diagram of *Hydrophobic REOLOSIL* Production Process

**1. Supply of raw materials**

**2. Combustion**



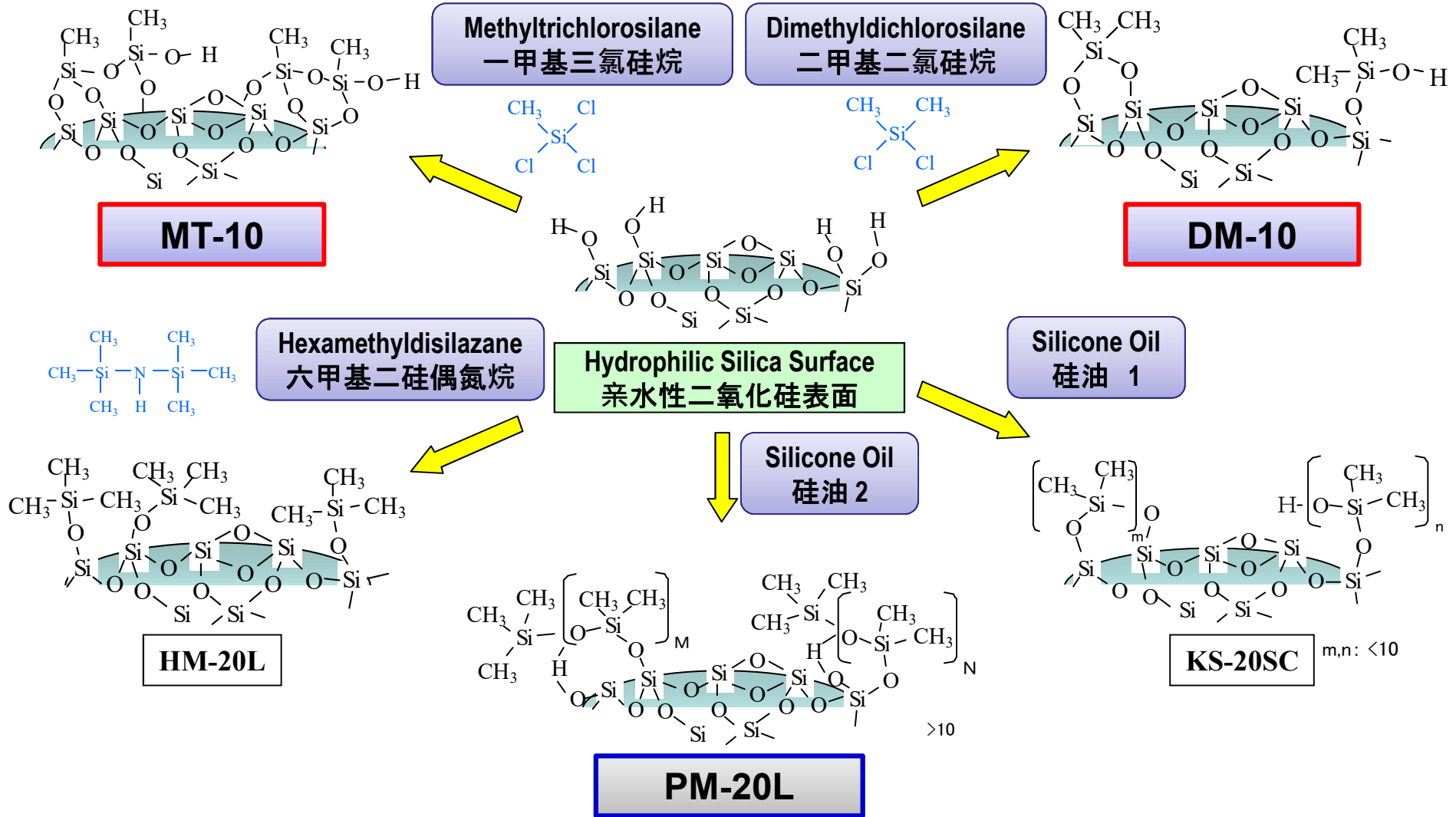
TEM Photograph of REOLOSIL QS-20



paper bag

One-way flexible container

# Surface Structures of Hydrophobic REOSIL



NOTE:

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## Hydrophobic REOSIL

### 疏水性等级

Hydrophobic REOSIL (KS Grade and HM Grade import from Japan)

等级名 Grade	MT-10 MT-10C	DM-10 DM-10C	DM-20S	DM-30	DM-30S	KS-20SC	HM-30S	PM-20L
外观 Appearance						白色微细粉末 White powder		
BET 比表面积 (m <sup>2</sup> /g) BET surface area (m <sup>2</sup> /g)	120±20	120±20	180±20	230±20	230±20	160±20	200±20	100±20
平均一次粒子直径 (nm) Primary particle(nm)	15	15	12	7	7	12	7	12
含炭量 (%) Carbon content (%)	0.9	0.9	1.6	1.7	2.2	2.0	3.5	5.5
堆积密度 (g/L) Bulk density(g/L)	50 100	50 100	50	50	50	40	50	40
水分 (干燥减量法、%) Moisture content(Dry up,%)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
pH (4% 悬浮液) <sup>3)</sup> pH(4% suspension) <sup>3)</sup>	4.8	4.8	4.8	4.5	4.5	5.1	6.6	5.2
Cl (ppm)	<100	<100	<100	<100	<100	-	-	-
Fe (ppm)	<20	<20	<20	<20	<20	<20	<20	<20
Al (ppm)	<20	<20	<20	<20	<20	<20	<20	<20
纸袋包装重量 (kg) Packaging(kg)	MT-10:10 MT-10C:15	DM-10:10 DM-10C:15	10	10	10	15	10	10

1) 出货时

When leaving plant

2) 在水中滴入甲醇、二氧化硅完全湿润时的甲醇浓度。值越大，疏水性越好。

M value indicates the titrimetric amount of methanol when silica was completely dipped into methanolic aq.

3) 在水/甲醇的混合液中测定。

In a mixture of water and methanol

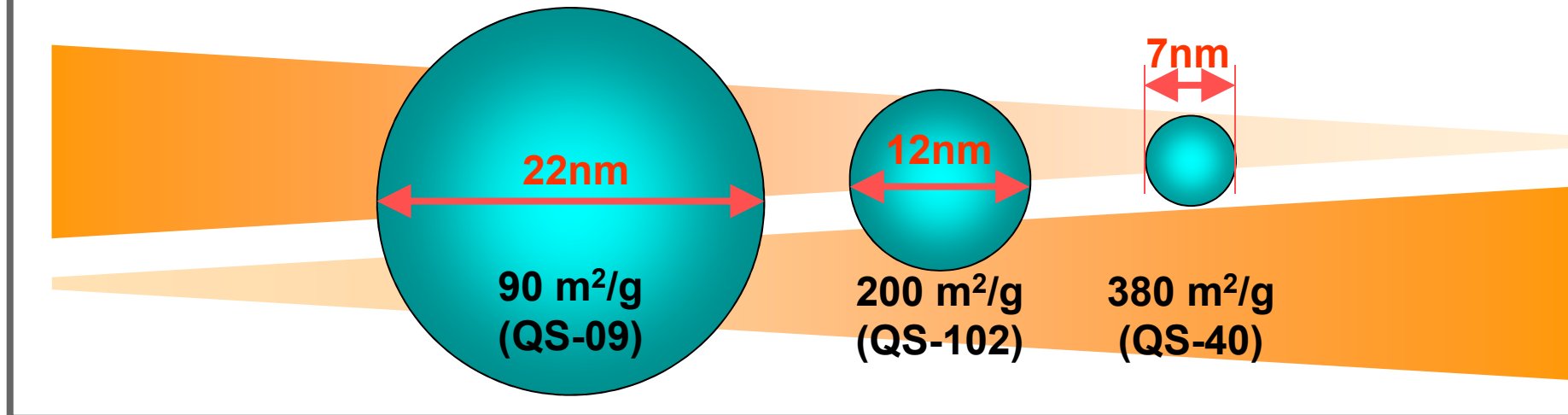
Made in Japan

## Primary particle size images of Hydrophobic REOLOSIL

- ✓ Particle size depend on hydrophilic silica before surface treated.
- ✓ Specific surface area decrease by hydrophobication.

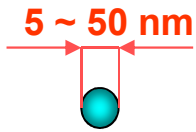
等级名	MT-10 MT-10C	DM-10 DM-10C	DM-30	DM-30S	KS-20SC	HM-20L	HM-30S	PM-20 PM-20L
BET比表面积(m <sup>2</sup> /g)	120±20	120±20	230±20	230±20	160±20	150±20	200±20	100±20

等级名	QS-09	QS-10 QS-10LS	QS-102	CP-102	QS-20 QS-20LS	QS-30	QS-30C	QS-40
BET比表面积(m <sup>2</sup> /g)	90±20	140±20	200±20	200±20	220±20	300±30	300±30	380±30
平均一次粒子直径(nm)	22	15	12	12	12	7	7	7



## Particle image of Reolosil

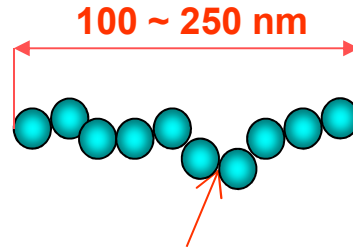
Beginning stage in reaction



Primary particle

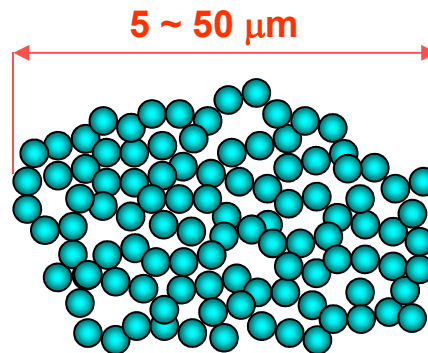
The size relates with S.S.A

Immediately after reaction



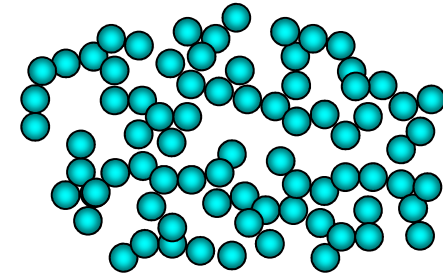
Bonding between primary particles by melting

Product



(Bulk density 40~100g/L)

Before final product



Very fluffy  
(ca. 25g/L)

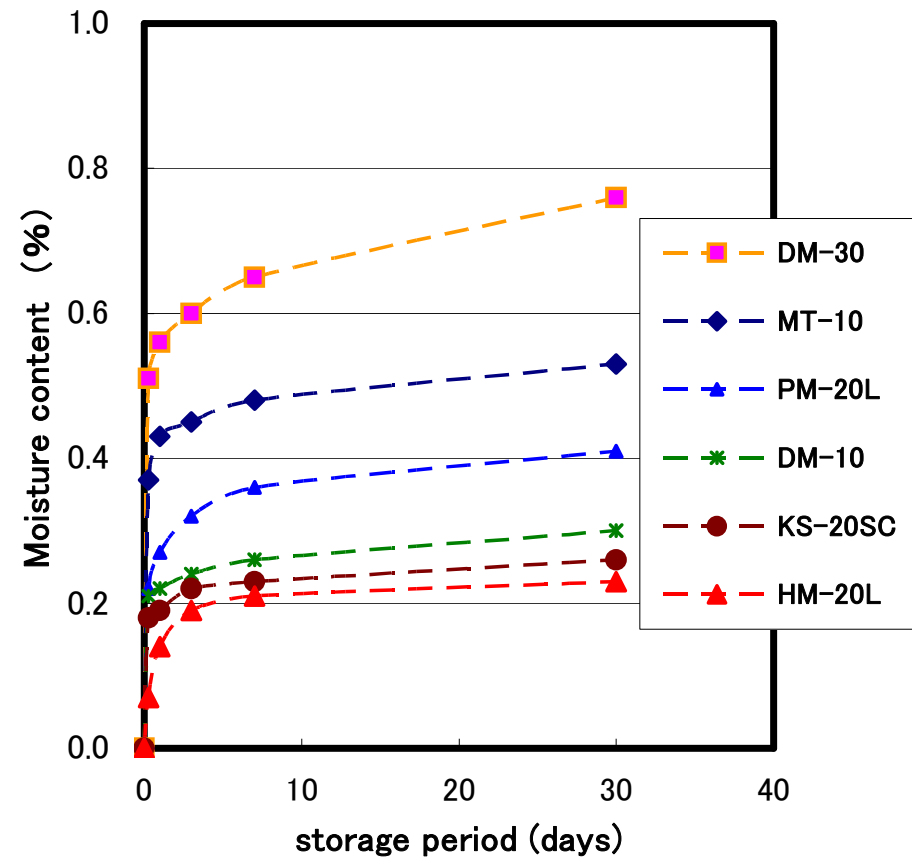
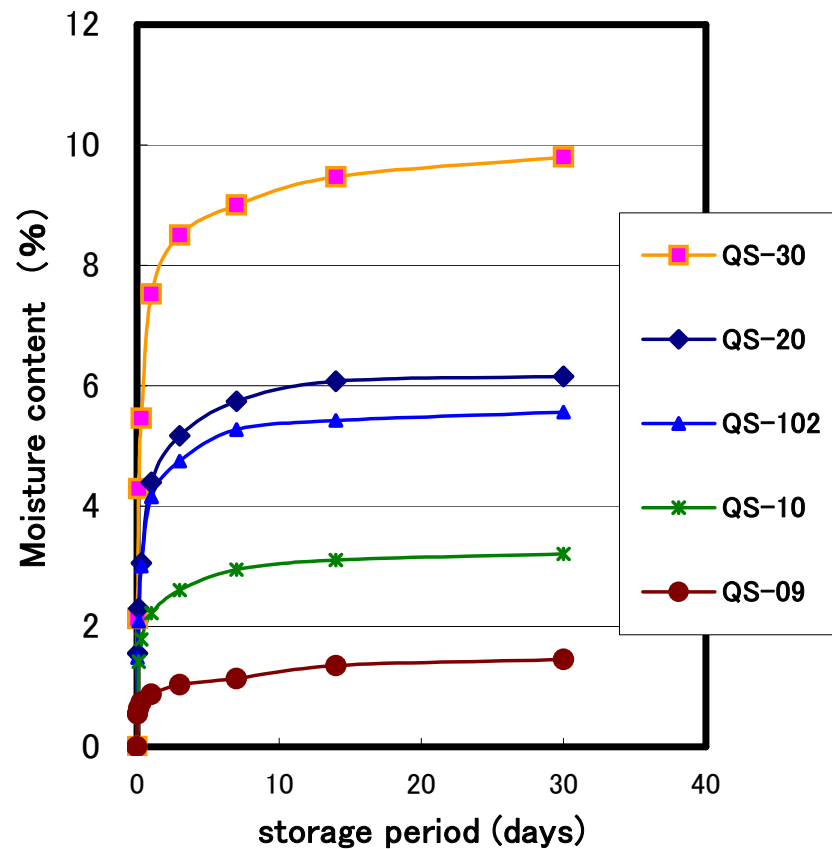
Compacting

Influence to handling or dispersibility

**NOTE:**

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# Change in moisture content of Reolosil



Change in moisture content of Reolosil® under exposure to the following conditions

**Air condition temp.: 35°C, R.H.: 80%**

(under high temperature and high humidity)

~ Drying up method : weight loss 110°C for 12hr ~

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## REOLOSIL DM&MT-series Products (made in China)

Grade	MT-10	DM-10	DM-20S	DM-30	DM-30S
Primary particle size [nm]	15	15	12	7	7
Specific surface area [m <sup>2</sup> /g]	120 ± 20	120 ± 20	180 ± 20	230 ± 20	230 ± 20
Carbon content [%]	0.9	0.9	1.6	1.7	2.2
Bulk density[g/L]	50	50	50	50	50

➤ The data in this table represent typical values, NOT guaranteed.

**NOTE:**

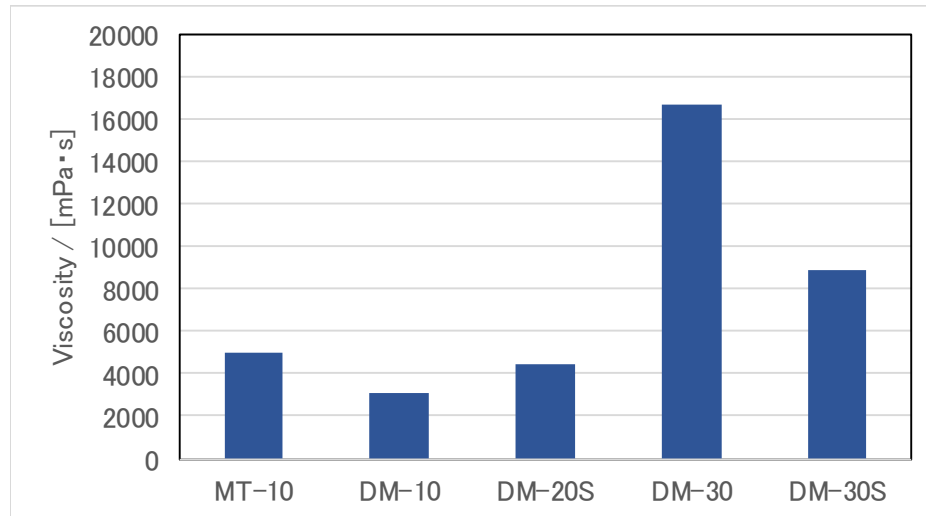
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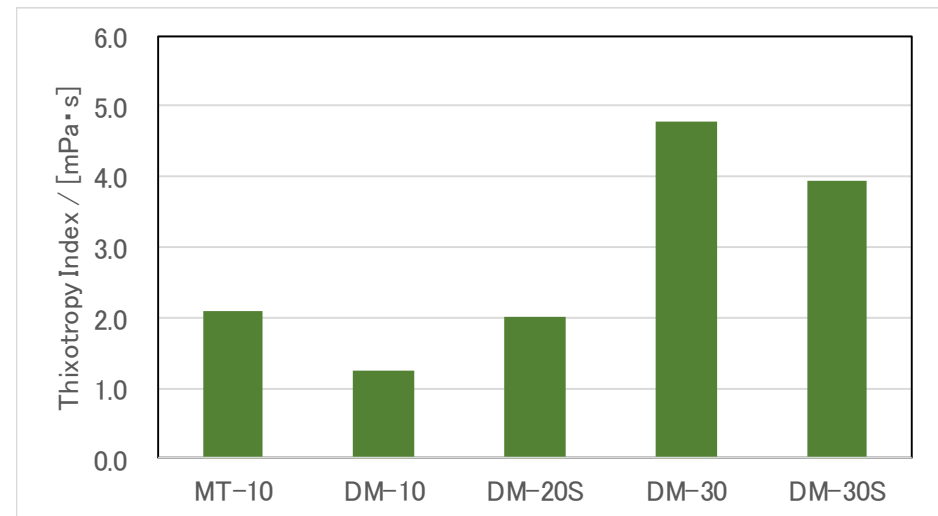


## Viscosity properties of MT&DM-series in silicone oil.

Viscosity



Thixotropy Index



**The silicone oil viscosity of MT-10 is higher than that of DM-10.**

**DM-30 are little hydrophilic compared with DM-30S, therefore its viscosity is higher than that of DM-30S.**

**Silicone oil: SH200 (TORAY 1,000mPa·s), Silica Content: 5.5PHR**

**Dispersing Time:2min Dispersing Speed: 3000rpm (tip speed 6.3m/s)**

**(PHR: parts per hundreds of resin)**

**BL-type viscosimeter, rotor: No.4 / DM-30, DM-30S were used No.5 / DM-30-10,000rpm was used No.6**

**Viscosity = measurement value at 60rpm / DM-30, DM-30S-10,000rpm at 20rpm (rpm: rotor speed)**

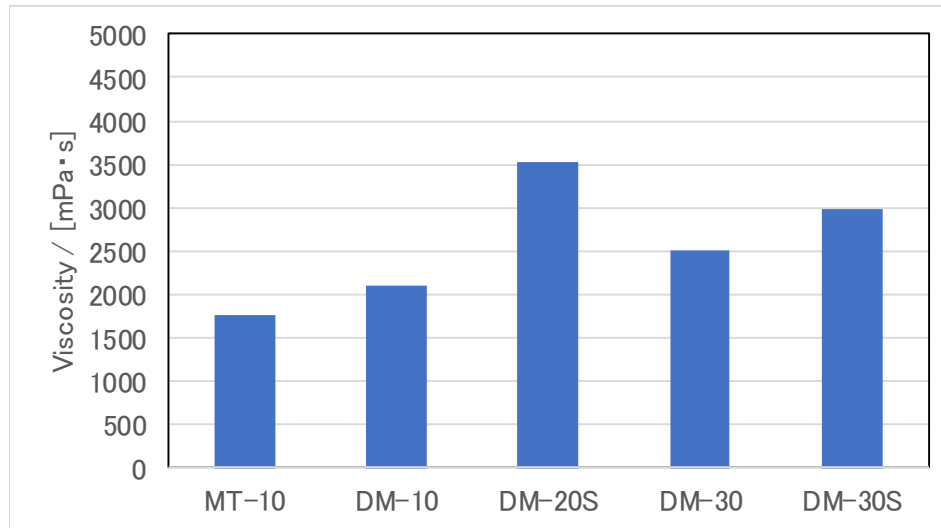
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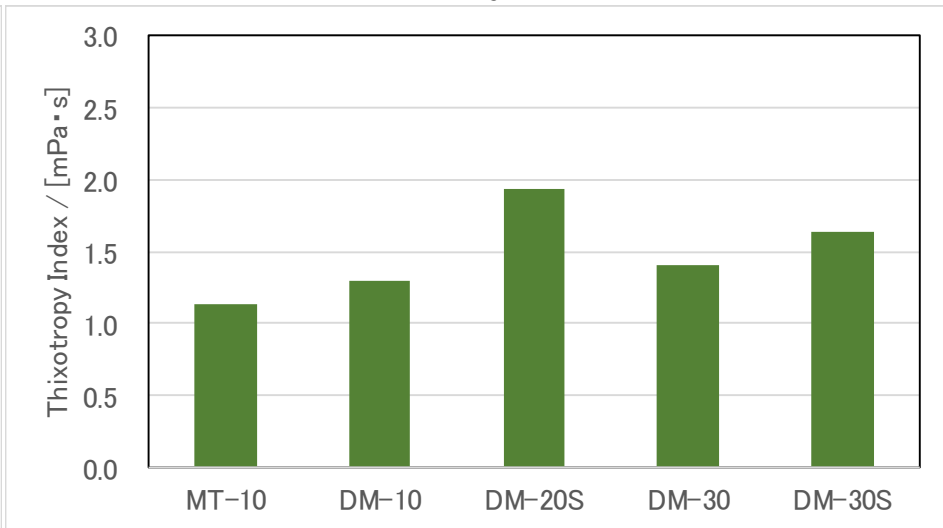
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## Viscosity properties of MT&DM-series in epoxy resin.

Viscosity



Thixotropy Index



**The silicone oil viscosity of DM-10 is higher than that of MT-10.**

**DM-20S and DM-30S are hydrophobic compared with DM-30, therefore its viscosity is higher than that of DM-20 and DM-30.**

**Epoxy resin: EPIKOTE815(HEXION, 700-900mPa·s) , Silica Content: 3PHR  
 Dispersing Time:2min Dispersing Speed: 3000rpm (tip speed 6.3m/s)  
 (PHR: parts per hundreds of resin)**

**BL-type viscosimeter, rotor: No.4**

**Viscosity = measurement value at 60rpm (rpm: rotor speed)**

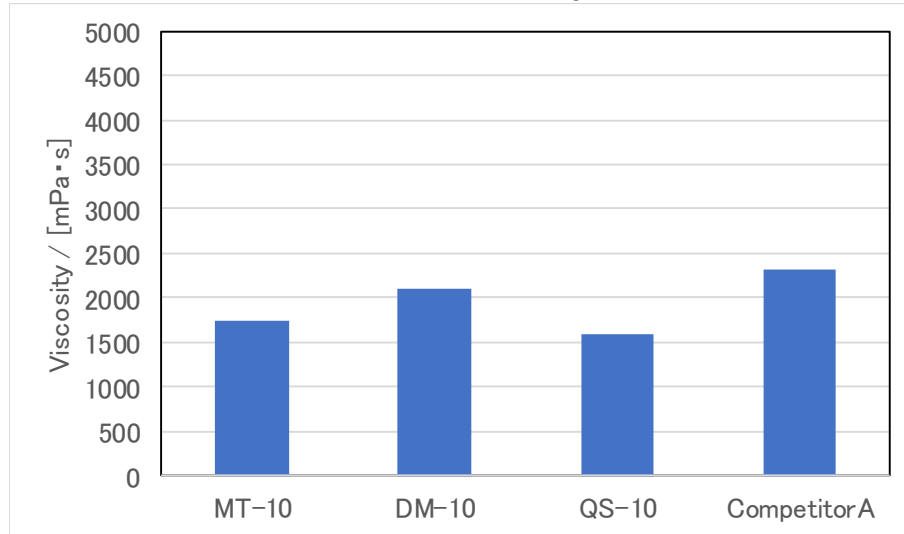
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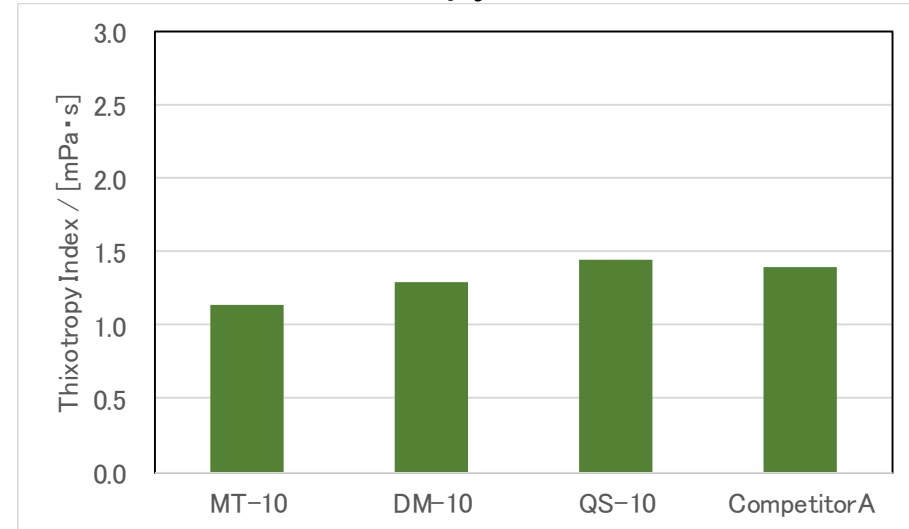
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## Viscosity properties of MT&DM-series in epoxy resin.

Viscosity



Thixotropy Index



**The epoxy viscosity of Hydrophobic silica is bigger than that of Hydrophilic silica.**

**Epoxy resin: EPIKOTE815(HEXION 700-900mPa·s) , Silica Content: 3PHR  
Dispersing Time:2min Dispersing Speed: 3000rpm  
(PHR: parts per hundreds of resin)**

**BL-type viscosimeter, rotor: No.4**

**Viscosity = measurement value at 60rpm (rpm: rotor speed)**

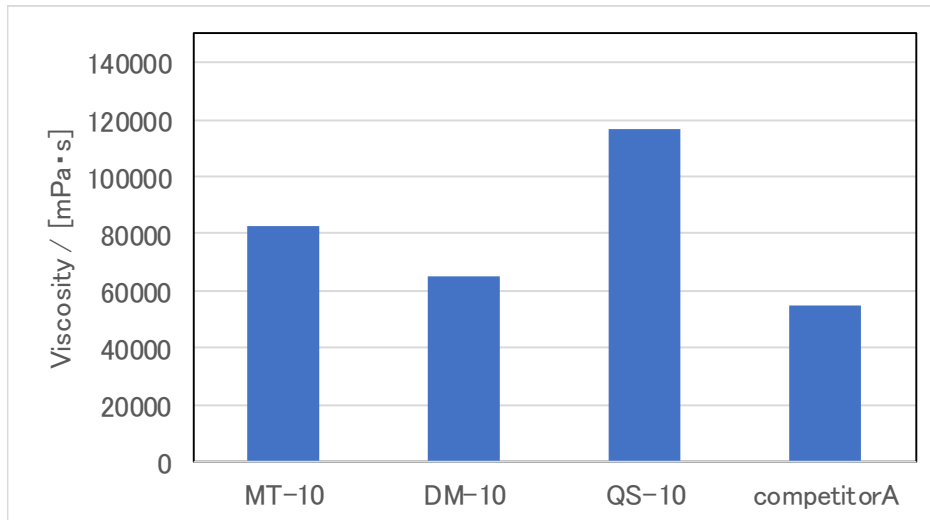
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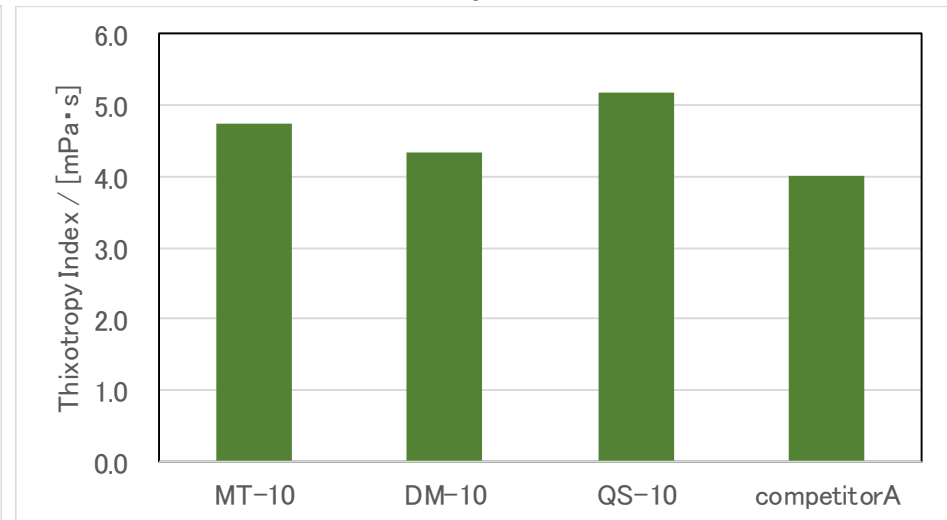
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## Viscosity properties of MT&DM-series for RTV.

Viscosity



Thixotropy Index



**The viscosity and T.I. of MT-10 is bigger than that of DM-10.**

**MT-10 and DM-10 are easily dispersed than QS-10 in silicone(RTV).**

**They can be used for High-end silicone sealant.**

**Silicone: 107silicone rubber(SHINETSU) , Silica Content: 7PHR**

**Additive: White oil(5#) : 35phr, Coupling agent : Methyl triacetoxysilane : 5phr**

**Dispersing Time:40min(vacume), Dispersing Speed: Rotation (100rpm), Revolution (50rpm)**

**(PHR: parts per hundreds of resin)**

**BL-type viscosimeter, rotor: No.7**

**Viscosity = measurement value at 20rpm (rpm: rotor speed)**

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# The dispersion factor of fumed silica in media for rheology control

## 1. Dispersion Conditions

**Silica:** Specific surface area, Bulk density, Dosage of Silica

**Method:** Dispersing Machine, Mixing Time etc.

## 2. Affinity between the silica surface and resin molecules

**Good affinity :** silica is easily dispersed into resin.

ex. hydrophilic silica and polar solvent

**Poor affinity:** large dispersion force is required to disperse.

ex. hydrophilic silica and non-polar solvent

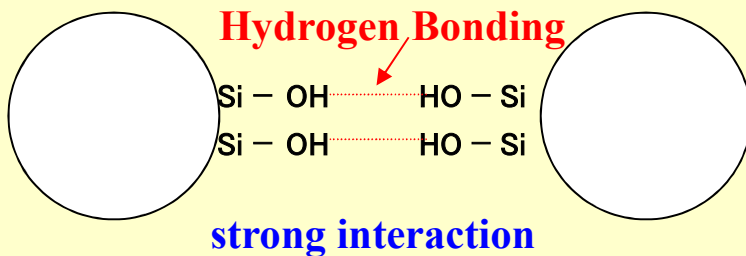
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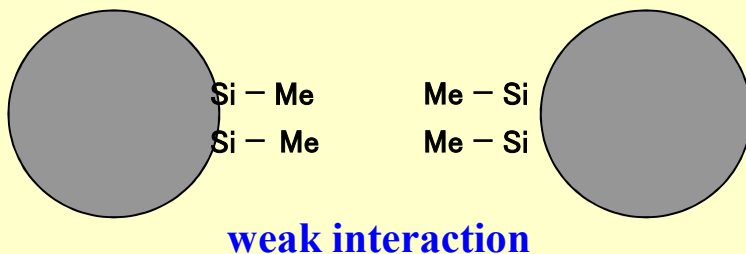
## Affinity between the silica surface and resin molecules

1. in Non-polar Solvent  
 e.g., Silicone, UPR (Orth-, Iso- and Bis type)

*Hydrophilic REOLOSIL ; poor affinity*  
 → *High Viscosity, T.I.*

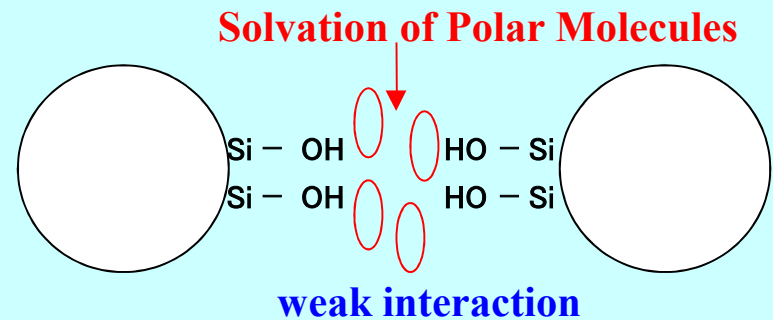


*Hydrophobic REOLOSIL ; good affinity*  
 → *Low Viscosity, T.I.*

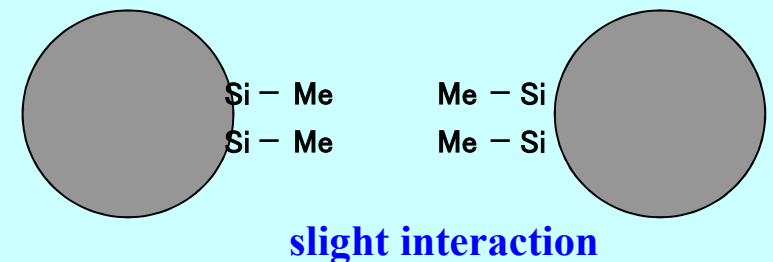


2. in Polar Solvent.  
 e.g., Epoxy Resin, UPR (Vinyl ester type)

*Hydrophilic REOLOSIL ; good affinity*  
 → *Low Viscosity, T.I.*

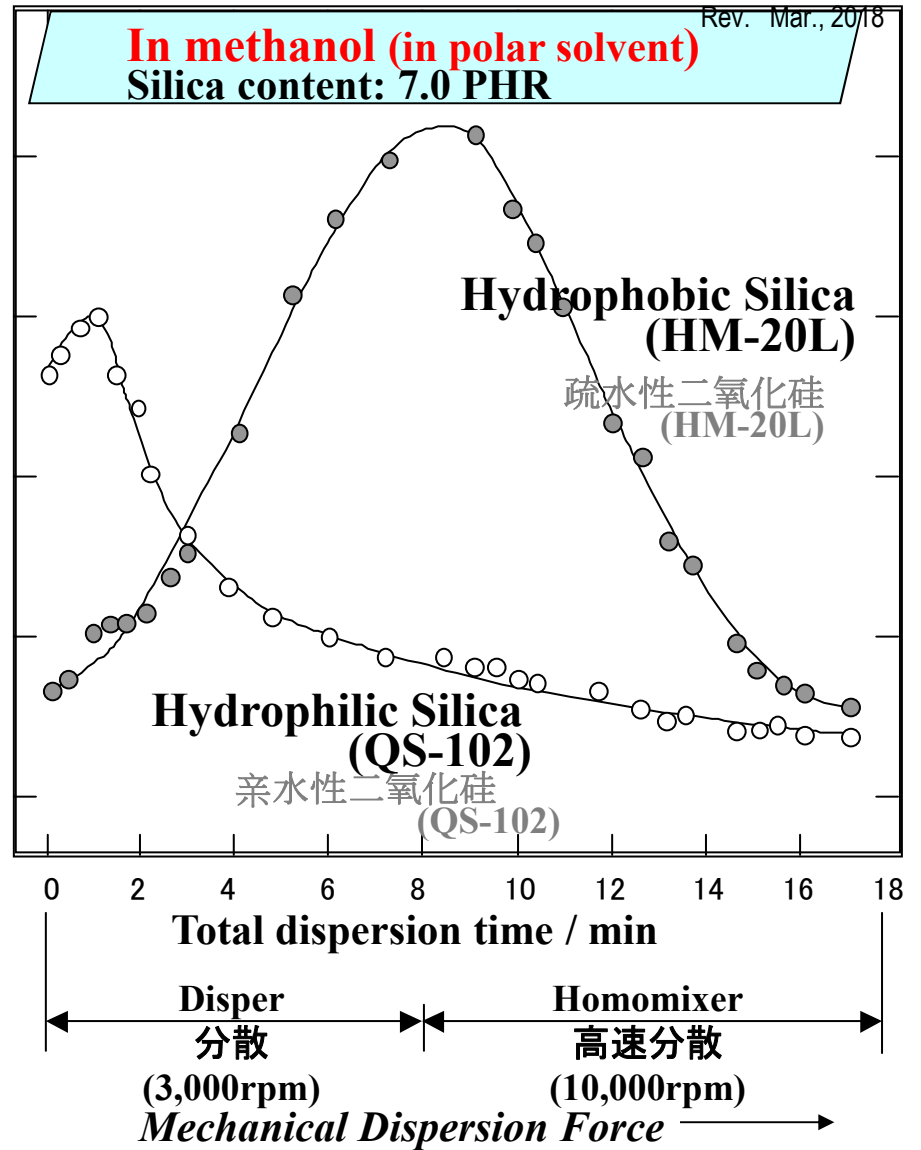
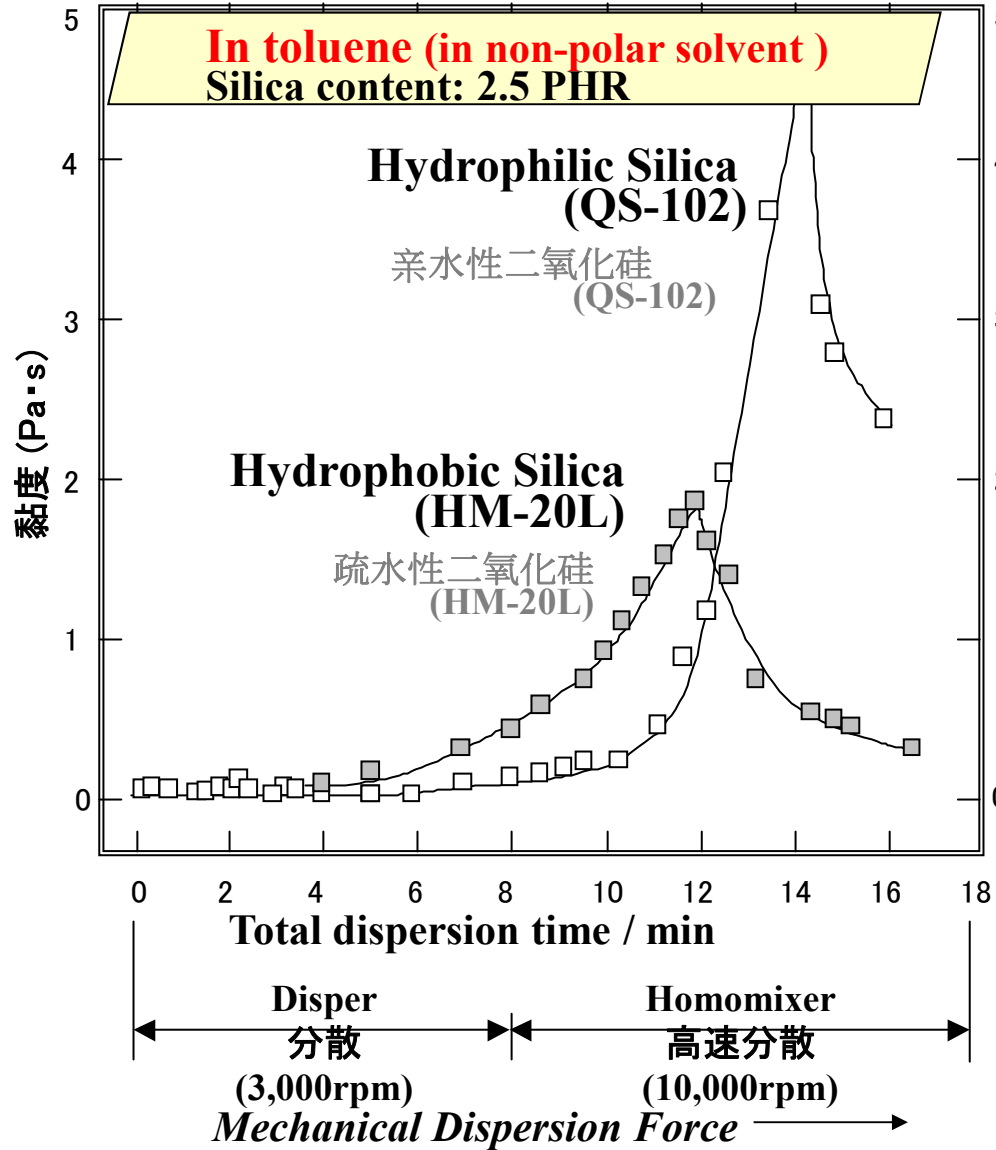


*Hydrophobic REOLOSIL ; slightly poor affinity*  
 → *Slightly High Viscosity, T.I.*



**NOTE:**

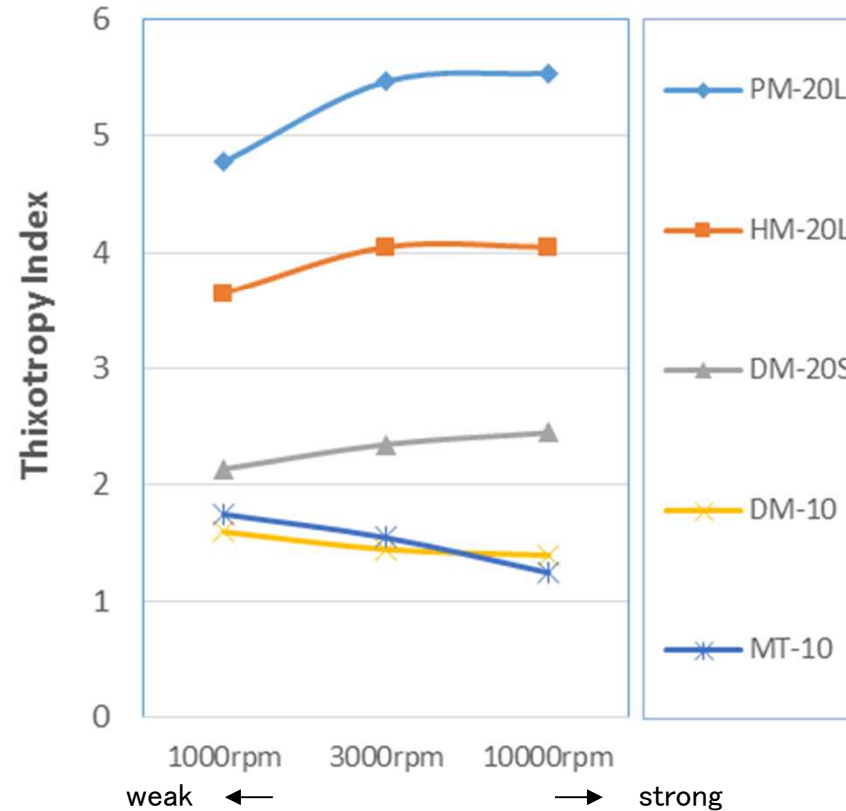
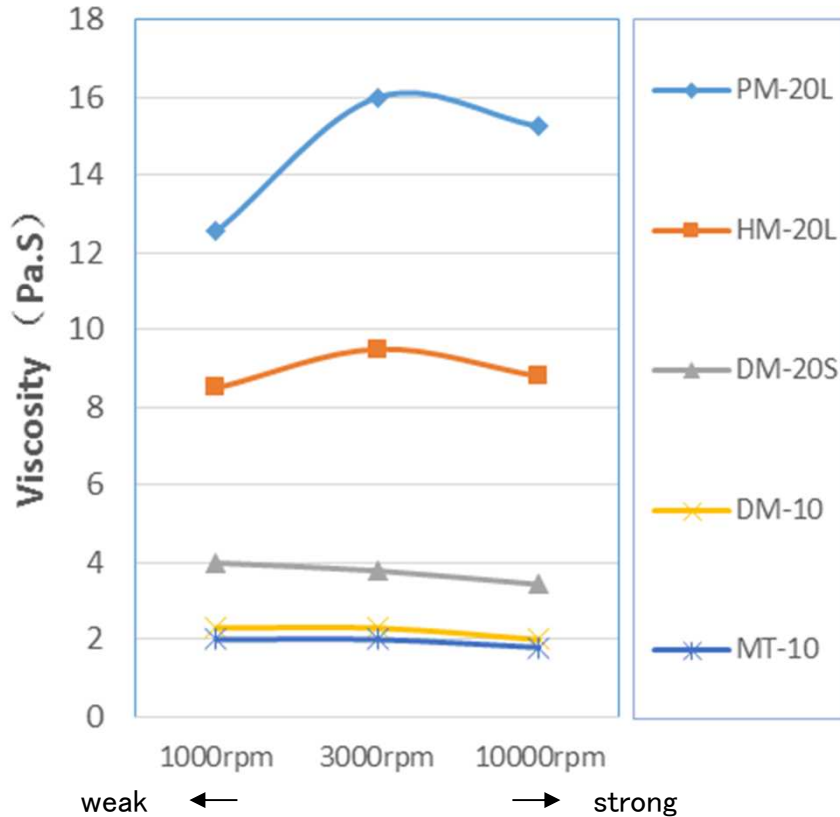
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**Change in Viscosity of non-polar/polar solvent during dispersion of Reolosil**

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## Viscosity properties of Hydrophobic silica.



### Change in Viscosity of Epoxy Resin during dispersion of hydrophobic Reolosil ·

Epoxy Resin: Epicoat 815 (YUKA Shell Corp., Epicoat 815, Resin Viscosity : 0.8Pa·s),  
 Silica Dosage: 3.0 PHR

Dispersion time : 2 minute

Thixotropy index = 2rpm Viscosity / 20rpm Viscosity

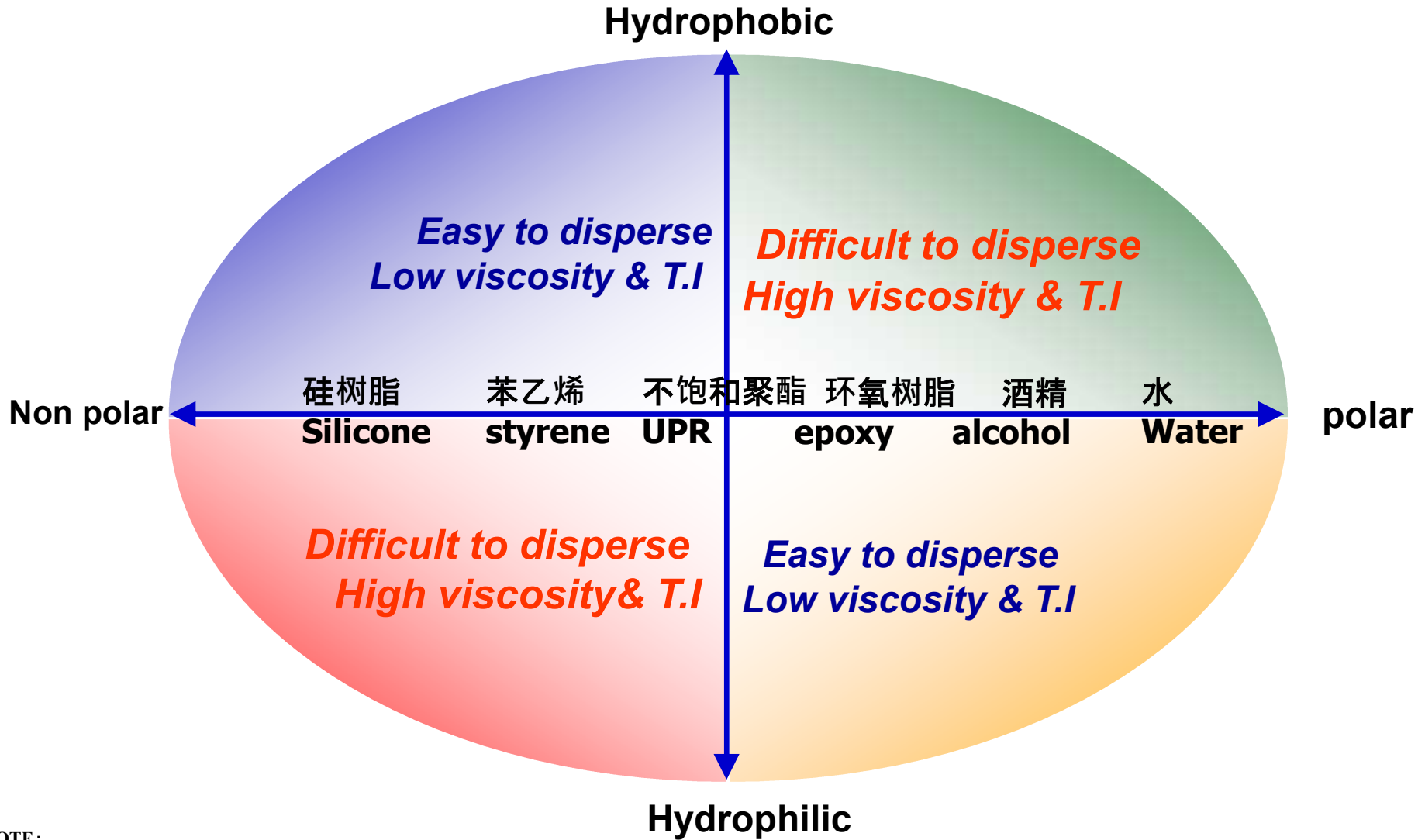
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**Image of dispersion**



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## Application list of Reolosil

Application	Reolosil Grade (mainly used)
Silicone Rubber (HTV,RTV)	CP-102, <u>QS-102</u> , <u>QS-30</u> , <u>QS-40</u> , <b>DM-10</b> , <b>MT-10</b> , <b>HM-30S</b>
Silicone Sealant	<b>DM-10</b> , <b>MT-10</b> , CP-102, <u>QS-10</u> , QS-10LS
Unsaturated Polyester Resin <i>Laminating</i>	QS-102, QS-20, <u>QS-20LS</u>
<i>Gel coats</i>	QS-102, QS-20, <u>QS-20LS</u> <b>HM-20L</b>
Paint <i>Polyester, Epoxy, Acrylic paints</i>	<u>QS-102</u> , <u>QS-30</u> , <u>QS-40</u> , <b>DM-10</b> , <b>HM-20L</b> , <b>PM-20L</b>
<i>Powder coating</i>	<u>QS-102</u> , <b>MT-10</b> , <b>DM-10</b>
Printing Inks <i>Gravure, Screen printing</i>	<u>QS-102</u> , QS-20, QS-30, QS-40
<i>Offset printing</i>	<b>MT-10</b>
Adhesive <i>Epoxy resin, modified Silicone, Urethane</i>	QS-102, QS-20, QS-30, <b>DM-10</b> , <u>MT-10</u> , <u>PM-20L</u>
<i>Vinyl ester</i>	<u>PM-20L</u> , <b>HM-20L</b>
Urethane (Sealant)	QS-10, QS-10LS, <u>QS-102</u> , QS-20, <b>DM-20S</b> , <b>HM-20L</b> , <b>PM-20L</b>
Bulk goods <i>Polymer powder for Disposal diapers</i>	<u>CP-102</u> , QS-20
<i>Fire-extinguishing power</i>	<b>MT-10</b> , QS-102, <b>KS-20SC</b>
Ink jet slurry	QS-20, <u>QS-30</u>
Toner	<b>HM-30S</b> , <b>PM-05</b> , <b>PM-09L</b> , <b>PM-10LV</b> , <b>PM-20L</b> , <b>DM-10</b>