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	• Thailand	T +662.207.3456	F +66.2207.3488
Worldwide Hotline		T +1.607.786.8131 T +1.800.295.2392	F +1.607.786.8309
Visit us at Momentive.com			

MOMENTIVE

Momentive Performance Materials
22 Corporate Woods Boulevard
Albany, NY 12211

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Technical subject matter in this publication is described and protected by one or more of the following U.S. Patents and their foreign counterpart patents and/or patent applications: U.S. Patent No. 6,221,922. Other U.S. and foreign patents and/or patent applications not listed covering the subject matter may be relevant.

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CoatOSil* and Silwet* additives for high performance coatings and inks

Momentive's CoatOSil* and Silwet* coatings additives are used in a wide variety of industries and applications, including water and solvent-borne coatings, high solids, powder and UV/EB cure coatings, as well as inks. These products may offer multiple advantages:

- Enhanced flow & leveling (eliminate defects)
- Improved slip (reduce coefficient of friction)
- Increased mar resistance
- Control of foam and enhanced air release
- Improved substrate wetting
- Increased gloss
- Anti-blocking (release)

There are three main types of additives:

silicone-polyether block copolymers, trisiloxanes and reactive silicone additives.

Silicone-polyether block copolymers

Most of the CoatOSil and Silwet additives fall into this category. They have a pendant (grafted) architecture (Figure A) or a linear (ABA) structure (Figure B).

By varying m, x, y and z, a tremendous variety of properties can be achieved.

These CoatOSil silicone-polyethers have a strong effect, at low concentration, on all types of coatings. The silicone part of the molecule provides low surface tension, high surface activity. The effect of a silicone-polyether depends on the type and amount of polyether it contains:

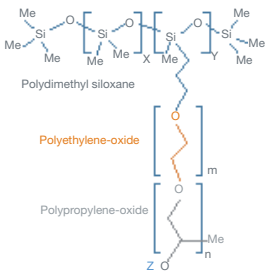
- A molecule with significant silicone content will increase slip and mar resistance; if the silicone content is very high then the additive will act as a defoamer, and provide anti-blocking and release.
- A silicone with high polyethylene oxide content will be compatible with waterborne coatings and it can be even water-soluble (see table on the following page). Such additives help wetting, flow, and leveling of waterborne coatings, allowing the coating to be "overcoatable" while providing gloss retention.
- If the polyether consists of polypropylene oxide, then the copolymer will be compatible with solventborne and high solids coatings and inks and can be used as a flow and leveling (anti-cratering) agent for such formulations.

Trisiloxanes

CoatOSil and Silwet trisiloxanes have special properties. These molecules are often called 'superspreaders,' because they are excellent wetting and spreading agents, especially in waterborne coatings and inks.

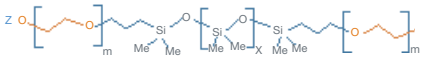
Reactive silicone additives

While most CoatOSil silicone additives act in a non-chemical manner, reactive silicone additives are exceptions due to their high surface activity. These CoatOSil additives react chemically with the resin and thus permanently modify the coating. In these products, the terminal group is an epoxy or an acrylic group. Our EPI-REZ™ Waterborne Epoxy Resins and HELOXY™ Epoxy Modifiers are ideal as components in adhesive formulations for the adhesion of PET cord fabric to rubber for tires, belts and hoses. They are available in a wide variety of chemistries, functionality and resin compositions. EPI-REZ Waterborne Epoxy Resins are nonionic in nature and compatible with most other types of waterborne resins. EPI-REZ Waterborne Epoxy Resins are stable after dilution to very low solids levels. All "epoxy" performance benefits are available with EPI-REZ Waterborne Resins, and all of the products are chemically, shear and storage stable.



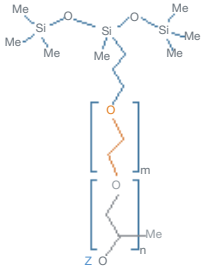
Silicone-polyether block copolymer-pendant structure

Figure A



Silicone-polyether block copolymer-linear structure

Figure B



Trisiloxane structure

Product	Molecular Architecture	End-group (Z)	MW	Surface tension + mN/m or dmy/cm2	Polyether type	Solubility++ in Water	In Hexane	Typical applications in various types of coatings and inks +++			
								Waterborne	Solventborne and high solids	UV/EB cure	Powder
CoatOSil* products:											
CoatOSil 1211[1]	N/A	N/A	N/A	20.5	N/A	DII	SSD	Wetting, F/L substrate wetting, air release	Wetting, F/L substrate wetting, air release	Wetting, F/L, substrate wetting, air release	
CoatOSil 2400	Pendant	H	5000	35.6	All-EO	SSS	III	F/L, wetting	F/L	F/L	F/L, gloss
CoatOSil 2812	Linear	H	2000	26.6	All-EO	SDD	SII	Slip, mar resist, COF reduction; defoaming	Defoaming, COF reduction, slip, mar resistance		
CoatOSil 3500	Linear	H	2100	25.4	All-EO	SSS	III	F/L, slip	Substrate wetting, defoaming, F/L, gloss	F/L, COF reduction, slip, mar resistance	
CoatOSil 3501	Pendant	H	8000	Insoluble	All-EO	III	SSD	Defoaming, antiblocking, COF reduction	Defoaming, antiblocking, COF reduction	Defoaming, COF reduction, slip, mar resistance	
CoatOSil 3505	Linear	H	2800	Insoluble	All-EO	III	SSS	Defoaming, slip	F/L, slip, mar resist, gloss retention, defoaming	COF reduction, mar resistance, slip	
CoatOSil 3573	Pendant	Me	10,000	Insoluble	All-EO	III	SSI	Defoaming, antiblocking, slip	Defoaming, antiblocking, slip, COF reduction	Defoaming, COF reduction, slip, mar resistance	
CoatOSil 7001[2]	Pendant	Me	20,000	28.2	EO/PO	SDD	III	F/L	Wetting, F/L	F/L	
CoatOSil 7500	Pendant	Bu	3000	Insoluble	All-EO	III	SSS	Defoaming	F/L, wetting, gloss	F/L, gloss	
CoatOSil 7510	Pendant	H	13,000	Insoluble	All-EO	III	SSS	Defoaming	F/L, defoaming	Defoaming	
CoatOSil 7600	Pendant	Me	4000	25.1	All-EO	SSS	III	F/L	F/L		
CoatOSil 7602	Pendant	Me	3000	26.6	All-EO	DDD	SII	Slip, mar resist, F/L, antiblocking	Slip, COF reduction, mar resistance		
CoatOSil 7604	Pendant	H	4000	25.4	All-EO	SSS	III	F/L, wetting	F/L	F/L	
CoatOSil 7605	Pendant	Me	6000	30.2	All-EO	SSS	III	F/L, wetting, gloss	F/L, gloss	F/L	F/L, gloss
CoatOSil 7650	Pendant	H	3000	23.2	All-EO	SDD	III	Slip, mar resist	F/L		
CoatOSil 77	Trisiloxane	Me	600	20.5	All-EO	DDD	SSS	Air release, wetting, substrate wetting F/L	Wetting, substrate wetting, F/L, air release	F/L, substrate wetting, air release	
CoatOSil* 7608	Trisiloxane	H	600	21.4	All-EO	SDD	III	F/L, gloss, air release	Air release, wetting, F/L, gloss	F/L, gloss, wetting, air release	
Silwet* products:											
Silwet L-7200	Pendant	H	19,000	34.2	EO/PO	SSS	III	F/L, wetting	F/L		
Silwet L-7210	Pendant	H	13,000	30.3	EO/PO	SDD	III	Defoaming, slip	F/L		
Silwet L-7220	Pendant	H	17,000	26.8	EO/PO	DDD	SSS	Defoaming	F/L, gloss		
Silwet L-7230	Pendant	H	29,000	32.4	EO/PO	SSS	III	Defoaming	F/L		
Silwet L-7280	Trisiloxane	H	600	21.5	EO/PO	DDD	SSD	Air release, wetting, substrate wetting	Substrate wetting, air release	F/L, substrate wetting, air release	
Silwet L-7550	Trisiloxane	H	400	Insoluble	All-EO	III	SSS	Defoaming	Air release, wetting		
Silwet L-7607	Pendant	Me	1000	23.4	All-EO	SSS	SII	Substrate wetting, F/L, wetting	Wetting, substrate wetting	F/L, wetting	
Silwet L-8610	Linear	H	1700	25.7	All-EO	SDI	SII	Defoaming, antiblocking	Defoaming, F/L, antiblocking		
Epoxy reactives:											
CoatOSil MP200	N/A	Epoxy/Silanol	N/A	Insoluble	No polyether			Crosslinking			

S: soluble; D: dispersible; I: insoluble; EO: Polyethylene-oxide;
PO: polypropylene-oxide; COF: coefficient of friction; F/L: flow and leveling
(1) Blend of various silicone-polyethers.
(2) 75% actives

+ 0.1% aqueous solution, ambient temperature, using Du Nouy Ring or Wilhelmy plate method
++ At 77°F (25°C), solubility at 0.1%, 1% and 5%.
+++ Applications in bold are most typical

Choosing a CoatOSil* or Silwet* additive for the job

The effect of silicone additives on a coating strongly depends on their mutual compatibility. Compatibility is controlled by the amount of polyethylene oxide (EO), polypropylene oxide (PO) and polydimethylsiloxane (PDMS) in a molecule. This is illustrated for Momentive CoatOSil and Silwet additives products in the triangle diagram below.

Most properties (except wetting) of a silicone-polyether additive can be predicted from their position on the triangle diagram. (For wetting, CoatOSil 1211 non-foaming wetting agent and trisiloxanes should always be considered.)

Each vertex of the triangle respectively represents

1) 100% (pure) PDMS (silicone)

2) polyethylene oxide ("EO")

3) polypropylene oxide ("PO").

The base of the triangle represents polyalkylene oxide (no silicone).

Depending on its locus relative to the corners of the triangle, each CoatOSil or Silwet additive offers varying properties. For example:

- Additives at the top of the triangle have more silicone properties, such as defoaming, anti blocking, release and slip.
- Additives near the EO vertex are water soluble and are good flow, leveling and wetting agents, especially for waterborne systems (see table).
- Additives near the PO vertex are oil soluble (see table) and are good leveling agents for solventborne and high solids coating and inks.

There are often multiple requirements for any particular application. For example, a coating might require good leveling, as well as improved mar resistance, with nonfoaming properties. In cases like this, the best additives are often found in the midsection of the triangle (CoatOSil additives 3500, 7602, 7001, etc.)

Optimal CoatOSil or Silwet additive concentration depends on the type and composition of the coating as well as the required functionalities of the silicone additive. A ladder study may be considered strongly, in order to find the optimum additive concentration.

Typical starting concentrations for a ladder study:

- For antifoaming: 0.1-0.2%;
- For slip and mar resistance: 0.5%
- For solvent borne flow and leveling: 0.5%
- For waterborne flow and leveling: 0.1-0.2%,
- For powder coatings: 0.2-0.3% and
- For radiation cured systems: 1% (based on the weight of the coating).

CoatOSil additives are essentially silicone oil (polydimethyl siloxane). Most Silwet and CoatOSil products are solventless (100% actives); most CoatOSil silicone-polyethers are soluble in methanol, acetone, xylenes, dimethyl-chloride and IPA; and most of them are liquids at ambient temperature. The exceptions are CoatOSil 7605 additive and CoatOSil 2400 additive, which are waxy solids, making them especially useful in powder coatings.

Patent Status

Technical subject matter in this publication is described and protected by one or more of the following U.S. Patents and their foreign counterpart patents and/or patent applications: U.S. Patent No. 7,595,372. Other U.S. and foreign patents and/or patent applications not listed covering the subject matter may be relevant.

You can find additional information on Momentive Performance Materials - Silicones additives in the individual marketing bulletins and in our Product Selection guides. Or visit us at www.momentive.com.

Around the world call us at:

Americas 800.295.2392

China +1.800.820.0202

Europe +00.800.4321.1000