

Functions of Fumed Silica (Metal Oxides) in Coatings Applications and Selection Criteria in Various Application

Functions of Fumed Metal Oxides in Coatings Application

Fumed metal oxides are versatile, efficient additives used in coatings to achieve one or more important functions.

In Liquids:

- ▶ Rheology control
- ▶ Anti-settling

In powders:

- ▶ Free-flow
- ▶ Anti-caking
- ▶ Fluidization

The Rheology control function includes thickening (bodying), Thixotropy, Anti-sag, Hold out, Edge coverage and Pattern control in metallic finishes. Fumed metal oxides prevent the settling and hard caking of pigments in storage. The coating uniformity is improved by preventing the pigment stratification during the curing, even at high temperatures.

In powder coatings, fumed silica enhances the free flow, anti-caking and fluidization properties. By providing a range of physical properties and surface chemistries, the various grades of fumed metal oxides allow the selection of a balance between sag control, flow and leveling and thixotropy. The formulator is offered rheology and performance alternatives, which are well suited to many high solids, low VOC coatings. When used properly, fumed metal oxides will enhance the desired properties of a coating without causing undesirable side effects. This brochure is intended to help the formulator in selecting the proper grade fumed metal oxides to achieve the desired effects in a coating. It will also explain the mechanism by which fumed silica functions and how to properly disperse it into a coating system.

Untreated Fumed Silica's

The properties of CAB-O-SIL untreated fumed silica grades recommended for coatings are shown in table as the surface area of fumed silica increases, it's potential as a rheology control agent increases; therefore

grades with surface areas below 200 m²/g are not recommended. More energy is generally required to disperse the fumed silica as the surface area increases. Grade M-5 (200 m²/g) can be properly dispersed by high speed dispersion equipment such as a Cowles dissolver. Higher surface area grades such as H-5 (300 m²/g), HS-5 (325 m²/g) and EH-5 (380 m²/g) may require higher shear equipment such as a sand mill.

Inadequately dispersed silica will be less effective. For example, the rheological performance of a poorly dispersed high surface area fumed silica can be less than that of a properly dispersed lower surface area fumed silica.

Several untreated grades are available in densed form. The mechanical compression increases bulk density from ~50 g/l tamped density to ~120 g/l tamped density. Because densing reduces the dispersability of the silica, densed grades of CAB-O-SIL fumed silica are not recommended for use in coatings.

The index of refraction for all grades of CAB-O-SIL fumed silica is 1.46. For many systems fumed silica affects neither the color of pigmented systems nor the transparency of clear finishes. Properly dispersed CAB-O-SIL fumed silica has a minimal effect on gloss.

TYPICAL PROPERTIES OF UNTREATED FUMED SILICAS

CAB-O-SIL (UNTREATED FUMED SILICAS)	SURFACE AREA (M ² /G)	PH (4 % SLURRY)	LOSS ON HEATING (WT % AT 105° C)
M-5	200	4.0	< 1.5
H-5	300	4.0	< 1.5
HS-5	325	4.0	< 1.5
EH-5	380	4.0	< 1.5

Treated Fumed Silicas

The properties of the treated grades of CAB-O-SIL fumed silica recommended for coatings are shown in below Table. The degree of hydrophobicity of the surface treated silica's varies with TS-720 and TS-530 being very hydrophobic and TS-610 less so.

Typical Properties of Treated Fumed Silica's

CAB-O-SIL (treated fumed silicas)	Treating Agent	Surface Area (m ² /g)	pH (4 % slurry)	Carbon Content (Wt %)
TS-720	Dimethylsilicone Fluid	115	NA	5.4
TS-610	Dimethyldichlorosilane	125	> 4.0	0.85
TS-530	Hexa methyl disilazane	225	5.5	4.25

Fumed Silica (Metal oxides) Selection Criteria in Various Application

	APPLICATION	CARRIER/ SYSTEM	PRIMARY PERFORMANCE CRITERIA	BEST GRADE SUGGESTIONS	
Coatings	Powder coating	Corona charging	Fluidization (free flow), surface smoothness.	CAB-O-SIL [®] TS-610, M-5, H-5, HS-5, EH-5	
	Clear coat	Polyurethane, acrylic, epoxy ester, amino	High gloss, rheology control, sag resistance, leveling	CAB-O-SIL CT 1206, TS-530, TS-610, M-5, EH-5	
	Liquid coating	Solvent-based or high solid coating		Anti-settling, sag resistance, flatting	CAB-O-SIL M-5, H-5, HS-5, EH-5, M-7D, TS-720,
		Acrylic, polyester, nitrocellulose			TS-610.
		Epoxy, vinylester, polyurethane		Sag resistance, rheology control, anti-settling	CAB-O-SIL M-5, EH-5, CAB-O-SPERSE 2020K
		Polychromatic finishes (metal flakes)		Sag resistance, rheology control, anti-settling	CAB-O-SIL TS-720, TS-610
		Industrial and marine		Metallic flake orientation	CAB-O-SIL M-5, H-5, HS-5, EH-5, TS-720, TS-610.
				Corrosion protection, moisture resistance	CAB-O-SIL TS-610, TS-720, TS-530
	UV-curing coating	All systems		Sag resistance, rheology control	CAB-O-SIL M-5, CAB-O-SIL TS-610

	APPLICATION	CARRIER/ SYSTEM	PRIMARY PERFORMANCE CRITERIA	BEST GRADE SUGGESTIONS
Adhesives	Electronic	Epoxy, acrylic	Thixotropy, sag resistance, constant viscosity over storage time	CAB-O-SIL TS-720, EH-5
	Structural	Polyurethane, epoxy, MS-polymer	Thixotropy, sag resistance	CAB-O-SIL TS-720, M-5
	Other applications	Rubber (neoprene, butyl, polychloroprene), solvent	Sag resistance, anti-settling	CAB-O-SIL M-5, H-5, EH-5, TS-720, TS-610, TS-530
		Epoxy, polyurethane, UP, PVC, PVAc	Sag resistance, rheology control, anti-settling	CAB-O-SIL M-5, H-5, EH-5, TS-610
		Cyanoacrylate	Sag resistance	CAB-O-SIL TS-720
Sealants	Automotive (DGX)	Polyurethane	Thixotropy, sag resistance, extrusion rate, low moisture control	CAB-O-SIL TS-720, TS-610, M-5
	Construction (non silicone)	Polyurethane, MS-polymer	Thixotropy, sag resistance	CAB-O-SIL TS-720, TS-610
	Other applications	Silicone, polyurethane, acrylic resins	Sag resistance, rheology control, anti-settling	CAB-O-SIL TS-720, LM-150, M-5, TS-530
		Butyl rubber and others	Reinforcement	CAB-O-SIL TS-610, TS-720, M-5

	APPLICATION	CARRIER/ SYSTEM	PRIMARY PERFORMANCE CRITERIA	BEST GRADE SUGGESTIONS
	Lipsticks and mascara	All systems	Rheology, viscosity, temperature stability	CAB-O-SIL M-5, H-5, HS-5, EH-5
	Nail polish	All systems	Anti-settling	CAB-O-SIL M-5, H-5, HS-5, EH-5
	Antiperspirant (gels, sticks, roll-on)	Cyclomethicone, dimethicone, aluminum chlorohydrate	Anti-settling, hydrophobicity, adsorbent, stability	CAB-O-SIL M-5, TS-530, TS-610
	Fragrance	Natural and essential oils	Adsorbent, encapsulation, carrier, anti-caking, free-flow	CAB-O-SIL TS-530, TS-610, M-5, H-5, HS-5, EH-5
	Hair and body care	Gels, shampoo, lotion: water/oil, oil/water emulsions	Rheology, viscosity, suspension, anti-settling, stability	CAB-O-SIL TS-610, TS-530, M-5
		Sunscreen: water, glycerin, benzene groups	Suspension, anti-settling, water resistance	CAB-O-SIL M-5, H-5, HS-5, EH-5, TS-610, TS-720
Printing Inks	Liquid inks	Solvent/aqueous/oil based	Rheology control, anti-settling, anti-misting	CAB-O-SIL M-5
	Lithographic printing inks	Oil based	Rheology control, hydrophobicity, anti-misting	CAB-O-SIL M-5
	Screen printing inks	All resin systems	Rheology control	CAB-O-SIL M-5, EH-5