FUMED METAL OXIDES

CABOT
creating what matters

General guide: CAB-O-SIL® fumed silica and SpectrAl® fumed alumina




Introduction

Exceptional performance benefits with CAB-O-SIL® fumed silica and SpectrAl® fumed alumina

Cabot's cornerstone products: CAB-O-SIL® fumed silica and SpectrAl® fumed alumina provide exceptional performance benefits for a wide variety of applications and industries.
Since the early 1950s, our fumed metal oxides (FMO) business has been developing, producing and marketing fumed metal oxides to meet the challenging requirements of our customers around the world.

Cabot's Fumed Metal Oxides (FMO) business is made up of two product families:

Fumed Silica includes CAB-O-SIL fumed silicas, which are free-flowing powdered products, available in untreated and treated grades. They are very versatile and used in a variety of applications, ranging from spark plugs and printing inks to pharmaceuticals and cake mixes. CAB-O-SIL's versatility is related to its high degree of purity and amorphous structure, both of which lead to excellent performance.

Fumed Alumina includes SpectrAl fumed aluminas, available in untreated and treated grades. These products are unique because of their unusual particle characteristics, crystallinity and high purity. In powder form, fumed alumina is fine, white, and extremely fluffy. However, when finely dispersed in liquids and polymers, it appears colorless and clear. SpectrAl fumed alumina enhances several different properties in a formulation, such as hardness and positive charge.

CABOT

CAB-O-SIL® fumed silica

CABOT

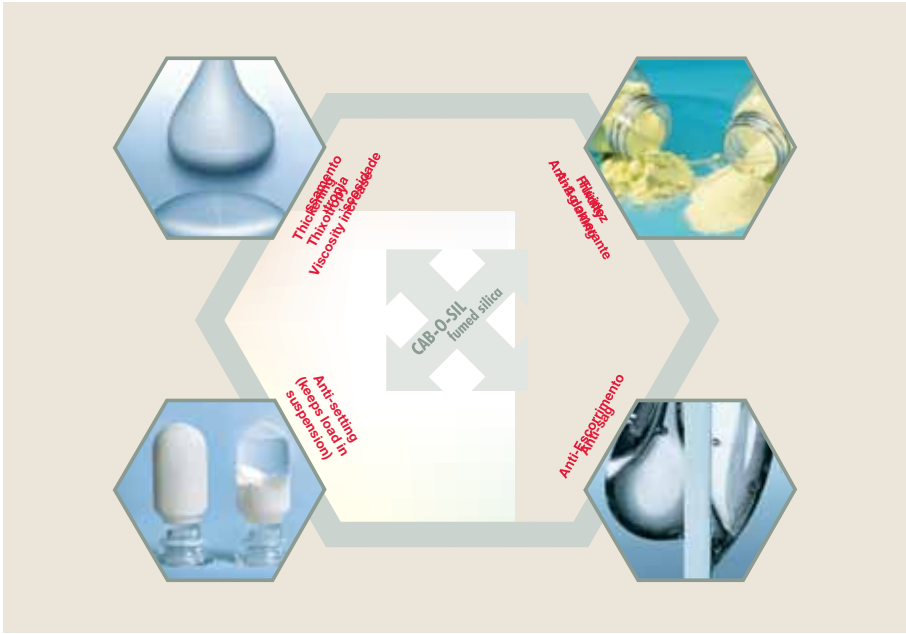
Functions
Manufacturing
Applications:

- Adhesives & sealants
- Silicone elastomers
- Coatings & inks
- Composites
- Pharmaceuticals
- Personal care - Cosmetics
- Fire extinguisher
- Food

CAB-O-SIL® fumed silica

Functions

It is produced with state-of-the-art technology and obtained through a continuous process, resulting in a product with the highest degree of purity. It delivers a unique performance in both liquid and powder form.



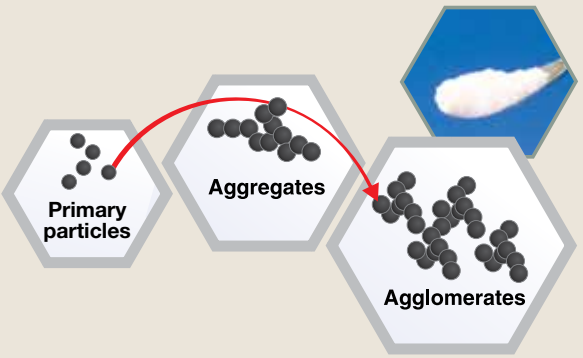
Liquids

- Thickening, increased viscosity and thixotropy
- Anti-sag, anti-settling of loads, pigments, heavy active ingredients, etc.

Powders (solids)

- Improves fluidity, anti-caking and anti-moisture
- Increases powder mechanical resistance, providing greater compacting resistance

Manufacturing



CHARACTERISTICS

- Amorphous
- Non-porous
- Chemically inert
- Odorless
- White
- Insipid

PROPERTIES

- Degree of purity: > 99.8% SiO2
- Surface area: 90 to 380m²/g
- Loss on drying: 0.5 - 1.5% by weight
- Specific weight: 2.2 g/cm³
- X-Ray structure: amorphous
- Index of refraction: 1.46
- Color: white
- PH (4% of water): 3.7 - 4.3

Pyrogenic process

$$Si\,Cl_4 + 2\,H_2 + O_2 \xrightarrow{1800°C} SiO_2 + 4\,HCl$$

Right choice		
Ideal grades of CAB-O-SIL fumed silica		
CAB-O-SIL M 5	CAB-O-SIL EH 5	CAB-O-SIL TS 720
CAB-O-SIL M 5P	CAB-O-SIL HP 60	CAB-O-SIL CT 1221
CAB-O-SIL M 5DP	CAB-O-SIL TS 610	CAB-O-SIL CT 1111G
CAB-O-SIL M 7D		

Applications

Adhesives and sealants

CAB-O-SIL fumed silica increases the viscosity of adhesives and sealants, provides thixotropy, improves extrusion properties during application, prevents sagging during curing (drying) and improves adhesive and reinforcing properties. It extends the product's shelf life and maintains its characteristics during storage.

Right choice	
Ideal grades of CAB-O-SIL fumed silica	
Most adhesives and sealants	CAB-O-SIL TS 610 & TS 720
Hot-melt reactive adhesives / UV cured	CAB-O-SIL TS 610
Epoxy and PUR (polyurethane) systems with high polarity or moisture-sensitive (moisture cured)	CAB-O-SIL TS 720

▶ **Reasons for using CAB-O-SIL TS 610 and TS 720 in PURs & epoxy**

TS 610

- Due to its excellent hydrophobicity, it offers great storage stability and an extended product shelf life. TS-610 is an excellent choice for use in reactive/moisture curing systems such as isocyanate or silane. In addition to being moisture resistant, it provides excellent corrosion resistance while remaining process-friendly.

TS 720

- Lower moisture content (prevents adhesive/sealant pre-curing during storage)
- Provides good viscosity in epoxy and PUR (polyurethane) systems, and keeps the system from losing stability and sagging over time.

RHEOLOGY CONTROL
THIXOTROPY THICKENING
EXTRUSION CONTROL (During application)
ANTI-SAG (During curing)
COHESIVE AND ADHESIVE PROPERTIES / REINFORCEMENT (Improved tearing tension)

CHARACTERISTICS
REINFORCEMENT - Increased Modulus - Increased Tear Strength - Increased Tensile Strength - Greater Elongation
HARDNESS
TRANSPARANCY

Silicone elastomers:

CAB-O-SIL fumed silicas are used for reinforcement of silicone compounds and organic polymers. Cabot fumed silica strengthens rubber, allowing it to be stretched and deformed without breaking. Cabot offers a range of untreated and treated fumed silicas for optimum performance in silicone applications including:

- Room Temperature Vulcanizing (RTV) silicones
- High Temperature Vulcanizing (HTV) silicones
- Liquid Silicone Rubbers (LSR)
- Silicone Defoamers

Fumed silica provides thixotropy and reinforcement for RTV sealants, while its shear-thinning property provides thickening and sag resistance at rest or low shear and thinning at high shear for easy application.
In HTVs and LSRs, fumed silica strengthens the cured rubber, increasing hardness, modulus, tensile strength and tear strength. Unlike other reinforcing fillers, fumed silicas can be used in transparent or clear applications.

In general, as the surface area of fumed silica increases, so does thickening and reinforcement. However, high surface area fumed silicas require high shear dispersion equipment to achieve optimal performance.

In moisture curing RTVs, treated fumed silicas have less adsorbed moisture -- offering better shelf-life and compound stability. Their hydrophobic surface treatments are more compatible with silicones, making it easier to wet-in and incorporate and greatly reducing compounding time. Some Cabot treated silicas do not require additional in-situ treatment or processing aids -- which are required for all untreated fumed silicas in HTVs and LSRs to prevent crepe hardening or structuring.

Right choice	
Ideal grades of CAB-O-SIL fumed silica:	
CAB-O-SIL H 5	CAB-O-SIL M 7D
CAB-O-SIL H 300	CAB-O-SIL S 17D
CAB-O-SIL LM 150	CAB-O-SIL TS 530
CAB-O-SIL TS 622	CAB-O-SIL TS 720
CAB-O-SIL M 5	CAB-O-SIL TS 610

Coatings and inks

CAB-O-SIL fumed silica increases ink viscosity, provides thixotropy, prevents its absorption in very porous surfaces, prevents sagging and curing during application and also prevents the settling in heavy loads, such as for pigments.

Right choice	
Ideal grades of CAB-O-SIL fumed silica	
Most Inks	CAB-O-SIL M 5 & EH5
Anti-corrosive inks	CAB-O-SIL TS 610 & TS 720
High solid ink	CAB-O-SIL TS 610
Inks that require low viscosity	CAB-O-SIL TS 610
PURs and Epoxy systems or systems with high polarity	CAB-O-SIL TS 720
Powdered Inks	CAB-O-SIL CT 1111G & CT 1221

▶ **Reasons for using CAB-O-SIL TS 610**
The TS 610 grade provides lower viscosity to any system. Since solid inks already have high viscosity, TS 610 is the ideal choice as it prevents pigments and loads from settling, as well as having a good anti-sag effect and decreasing the system's viscosity.

RHEOLOGY CONTROL

THIXOTROPY THICKENING

HOLD OUT

PATTERN CONTROL (Metallic Finishings)

HIGH COVERING

RHEOLOGY CONTROL

THIXOTROPY THICKENING

ANTI-SAG (During curing)

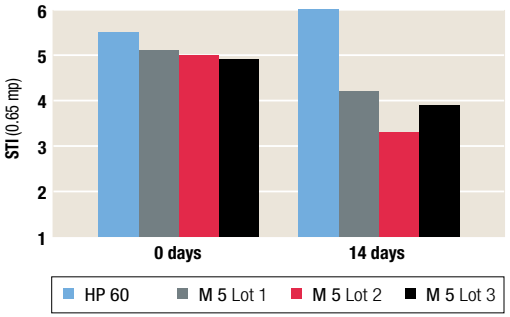
Composites

CAB-O-SIL fumed silica increases polyester/gelcoat resin viscosity, provides thixotropy and prevents sagging primarily during application on vertical surfaces. It also prevents load sedimentation in formulations with heavy elements or in large concentrations.

Right choice	
Ideal grades of CAB-O-SIL fumed silica	
Most composites	CAB-O-SIL M 5
Polyester resins	CAB-O-SIL HP 60
Requires higher thixotropy	CAB-O-SIL HP 60
Vinyl ester systems	CAB-O-SIL TS 720

▶ **Reasons for using CAB-O-SIL TS 720 instead of M 5 in vinyl ester**
Vinyl ester system possesses high polarity. M 5 does offer good viscosity at the beginning, however, over time, the gelcoat loses stability, especially at high temperatures. Viscosity therefore falls, which may lead to sagging.

Reasons for using CAB-O-SIL HP 60



- 10-15% increased thixotropy as compared to CAB-O-SIL M 5.
- Conservation of viscosity / thixotropy or even higher value after a certain period of time (see graph at the side).

Pharmaceuticals

CAB-O-SIL fumed silica promotes the free-flow of the formulation's powdered components and increases tablets' mechanical resistance through direct compression. This increases the productivity of the pharmaceutical industry, thus creating more accurate dosages and reducing loss rates from tablet breakage during pressing.
In liquid systems (syrups, etc.), CAB-O-SIL fumed silica improves the uniform distribution of the active ingredients, enhances system viscosity and prevents the sedimentation of formulation components.

Right choice	
Ideal grades of CAB-O-SIL fumed silica	
Most products	CAB-O-SIL M 5P
Companies that follow the international Pharmacopeias, the USP EU or JP	CAB-O-SIL M 5P
Fewer dust particles	CAB-O-SIL M 5P & M 5DP

▶ **Why and when to use CAB-O-SIL M 5P**
M 5P is produced under a process oriented to the use of medicines; it comes out of the factory with a complete analysis certificate that meets international pharmacopeias required parameters, such as USP (American) and EU (European).

▶ **What is CAB-O-SIL M 5DP grade**
M 5DP is a compacted version of the M 5P grade. The advantage of using this grade is that it generates less dust in the environment, because M 5DP is heavier than M 5P. This grade also complies with international pharmacopeias.

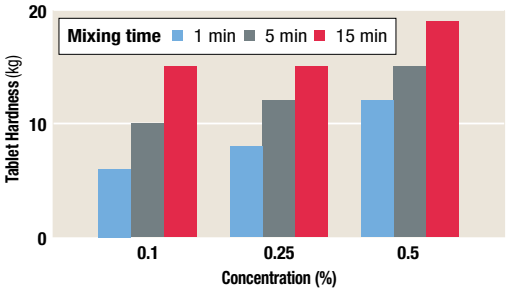
TABLETS
INCREASED MECHANICAL RESISTANCE / HARDNESS
BETTER UNIFORMITY OFACTIVE INGREDIENTS
ANTI-CAKING FLUIDITY

LIQUIDS
THICKENING
ANTI-SETTLING
BETTER UNIFORMITY OF ACTIVE INGREDIENTS

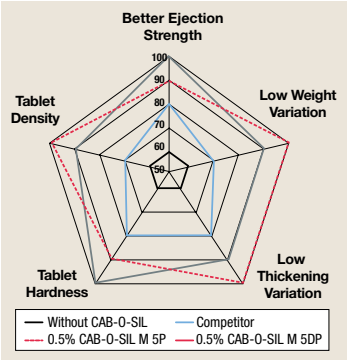
ACETAMINOPHEN TABLETS
REDUCED BREAKAGE (Loss)
INCREASED HARDNESS
HIGHER PRODUCTIVITY

Performance in acetaminophen tablets

The influence of CAB-SIL M 5P's mixing time and concentration on an acetaminophen (n=10) tablet hardness.



Comparison CAB-O-SIL M 5P & M 5DP



Process conditions: 40rpm, 1.5mt for tablet compression.

POWDERS
ANTI-CAKING FLUIDITY
PREVENTS SPRAY VALVE BLOCKAGE
INCREASED MECHANICAL RESISTANCE / HARDNESS

LIQUIDS
INCREASED VISCOSITY
TIXOTROPIC AGENT ENHANCES THICKENING
ANTI-SETTLING OF LOADS AND PIGMENTS
MAINTAINS STABILITY AT HIGH TEMPERATURES

Personal care - cosmetics

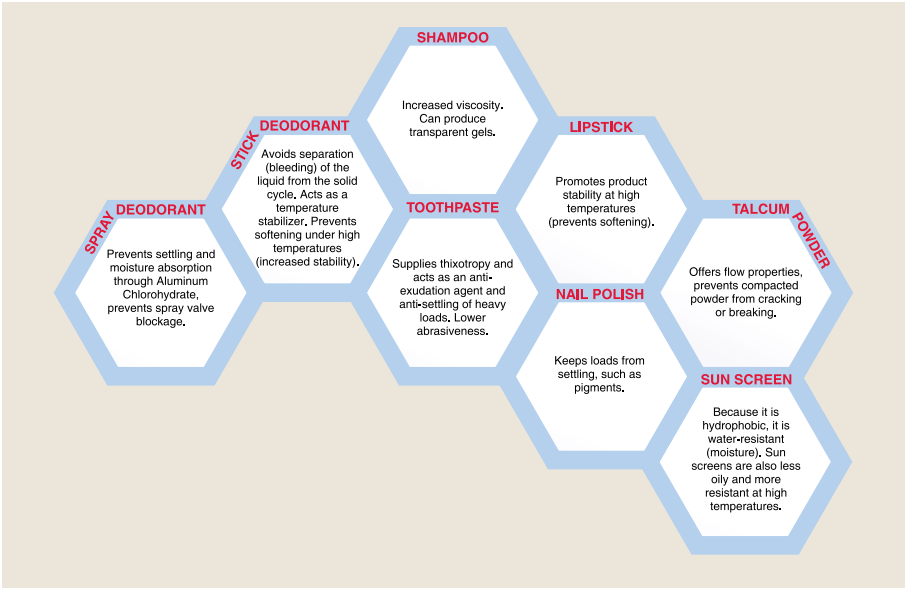
CAB-O-SIL is the most versatile fumed silica for the cosmetics and personal care sector, including hair products, antiperspirants, nail polishes, make-up, creams, lotions, lipsticks, etc. This versatility is due to its high purity and amorphous structure which provides excellent performance in liquid and powder systems in several applications.

Among the CAB-O-SIL fumed silica product line, there are two different families: hydrophilic silicas (with a surface area ranging from 90 to 380 m^2/g) and hydrophobic silicas, such as the TS 610, TS 720 and TS 530.

New formulations appear every day, which shows the versatility that only the one-of-a-kind CAB-O-SIL fumed silica features provide.

Right choice	
Ideal grades of CAB-O-SIL fumed silica	
Most cosmetics	CAB-O-SIL M 5
Need for increased thixotropy and viscosity	CAB-O-SIL EH 5
Need for greater transparency	CAB-O-SIL EH 5
Need for better moisture resistance	CAB-O-SIL TS 610

Performance in applications



▶ **Tip**
CAB-O-SIL fumed silica is an excellent agent for keeping oil/water emulsions stable. Due to its high water polarity, optimal performance is ideally achieved if you first add CAB-O-SIL fumed silica in the oily phase.

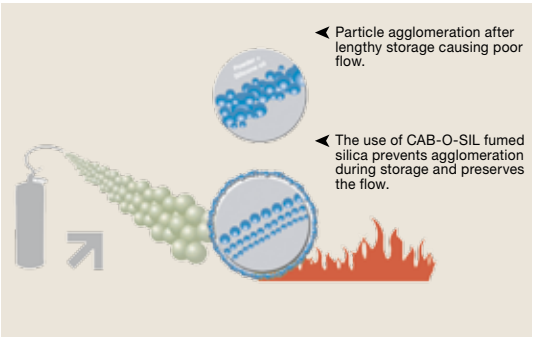
	APPLICATIONS						
CHARACTERISTIC	**Deodorant**	**Talcum Powder**	**Hair Care**	**Toothpaste**	**Nail Polish**	**Lipstick**	**Sun Screen**
Free-flow agent		●					
Suspension agent	●		●	●	●		
Anti-blockage (nozzles)	●						
Temperature stabilizer	●					●	●
Anti-bleeding	●						
Liquid thickening			●				
Thixotropic				●			
Moisture-resistant							●
Anti-exudation agent	●					●	●

CHARACTERISTICS
IMPROVES FLOW
ANTI-CAKING
IMPROVED STABILITY (DURING STORAGE)
FACILITATES PULVERIZATION

Fire Extinguisher (Powder)

When developing an efficient formulation for powdered fire extinguishers, the greatest challenge comes from the ingredients because they possess high hygroscopicity. Otherwise, the poor flow may cause lumps to form.

CAB-O-SIL fumed silica provides excellent flow for fire-fighting equipment by preventing any agglomeration, even after long storage time.



Right choice	
Ideal grades of CAB-O-SIL fumed silica	
ABC and BC powders	CAB-O-SIL M 5
Need for Better Flow	CAB-O-SIL TS 610

Tip

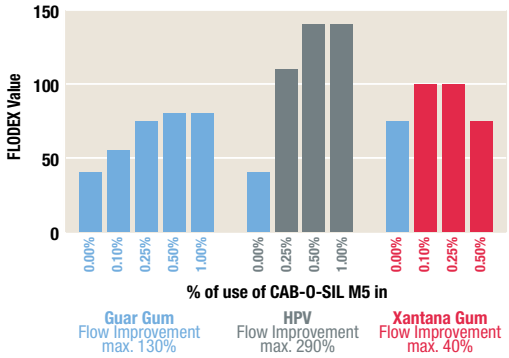
The use of CAB-O-SIL M 5 (hydrophilic silica) at 1% concentration or CAB-O-SIL TS 610 (hydrophobic silica) at 0.5% concentration will result in better flow, preventing the agglomeration of particles. Silica is mixed right after the addition of silicone oil to the powder, forming a protective film that prevents moisture absorption and improves flow and overall performance.

Food

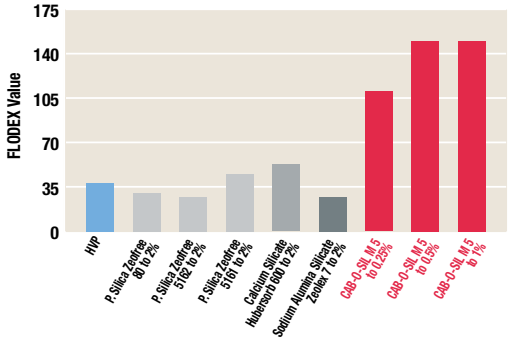
CAB-O-SIL fumed silica provides excellent flow and stability in powdered food, even in products with poor flow, such as HVP (Hydrolyzed Vegetable Protein), Xantana Gum and Guar Gum.

CHARACTERISTICS
IMPROVES FLOW
PREVENT THE FORMATION OF CHUMPS
CORRECT DOSAGE
IMPROVED STABILITY (during storage)

Performance of flow in additives



Performance of flow in HVP



Applications

Right choice	
Ideal grade of CAB-O-SIL fumed silica	
Most food	CAB-O-SIL M 5

CABOT

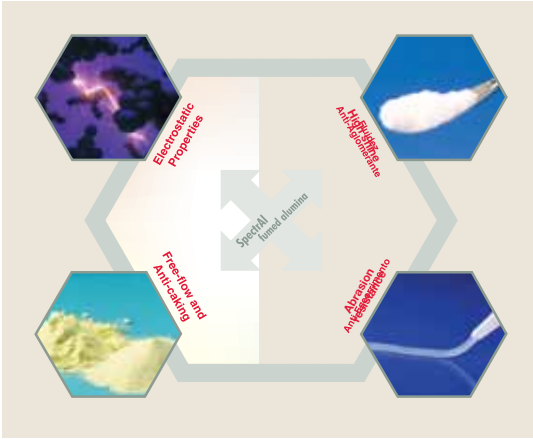
SpectrAl® fumed alumina

Functions
Manufacturing
Applications:
- Powder coatings
- Cosmetics
- Lighting

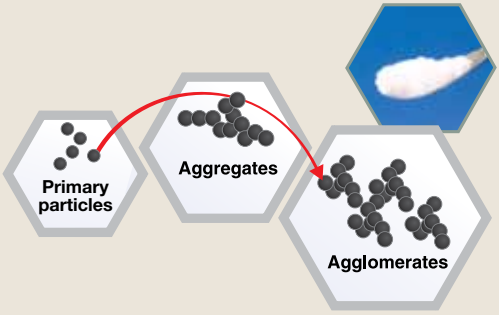
SpectrAl® fumed alumina

Functions

SpectrAl is the commercial name of Cabot's fumed alumina family. It is produced with cutting edge technology which results in a product for several applications with the highest purity content.



Manufacturing



Pyrogenic process

$$2\ AlCl_3 + 3\ H_2 + 1{,}5\ O_2 \xrightarrow{2400°C} Al_2O_3 + 6\ HCl$$

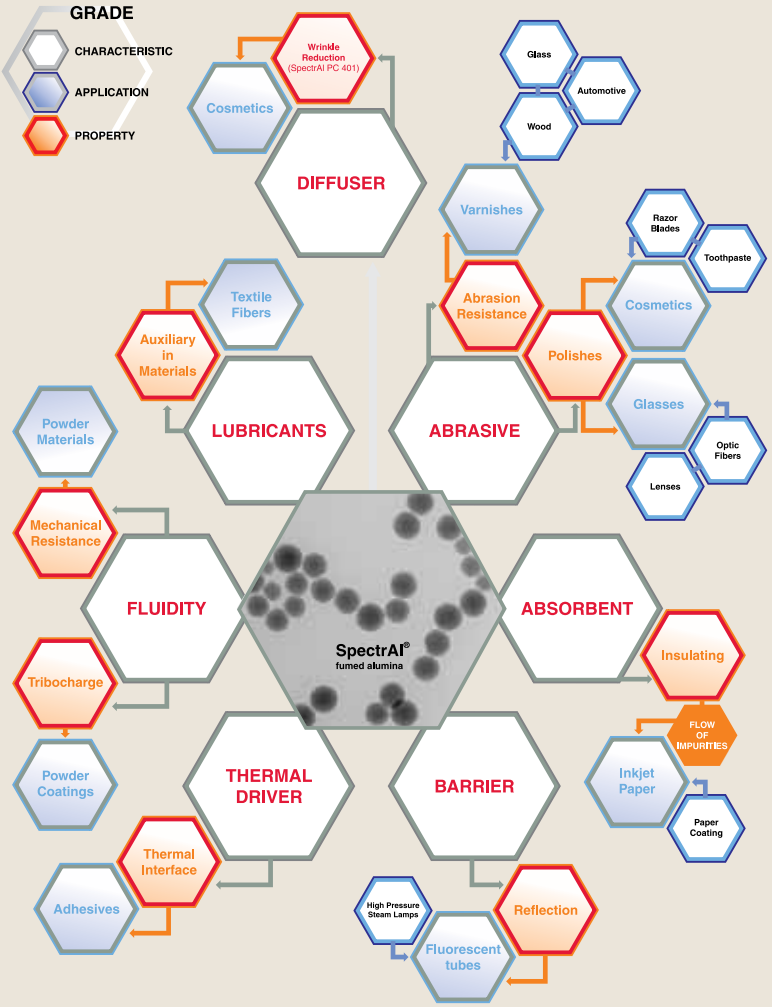
CHARACTERISTICS
- Semi-crystalline
- High Index of refraction
- High thermal conductivity
- Cationic

PROPERTIES
- B.E.T. surface area: 55 m²/g - 95 m²/g
- PH (4% aqueous slurry): > 4.7
- Density*: 110 - 60 g/l
- [Densed]: 120 g/l
- Loss on drying*: < 1.5% max.
- Loss on ignition: (1.000oC), < 3 wt. %
- Specific weight: 3.6 g/cm³
- Weight per gallon: 30.0 lb
- Index of refraction: 1.77
- X-Ray structure (≈)
  THETA 56%
  DELTA..... 20%
  AMORPHOUS .. 24%
- Purity (% Al203): > 99.8 %

* At manufacturing time

Right choice
Ideal grades of SpectrAl fumed alumina:
SpectrAl 51
SpectrAl 81
SpectrAl 100
SpectrAl PC 401

Characteristics



Applications

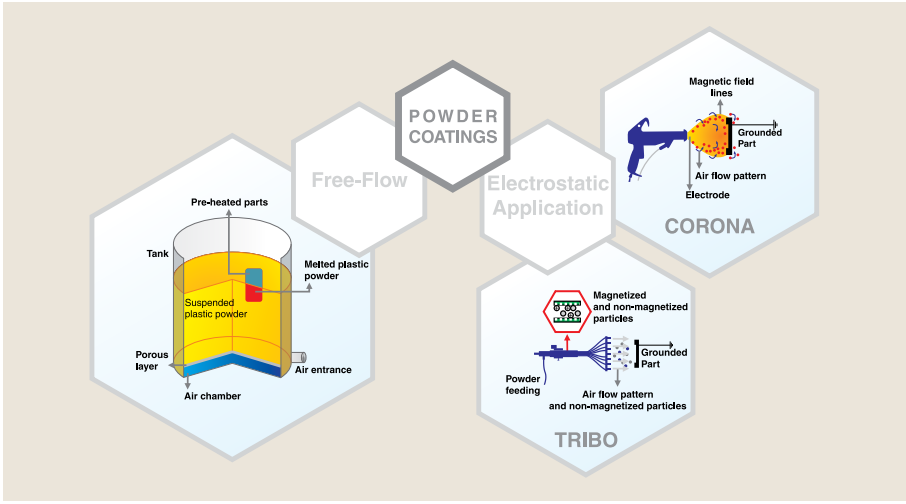
Powder coatings

The manufacturing process for powder coatings requires a consistent flow in its formulation. For this application, Cabot offers the SpectrAl fumed aluminas that provide this performance.

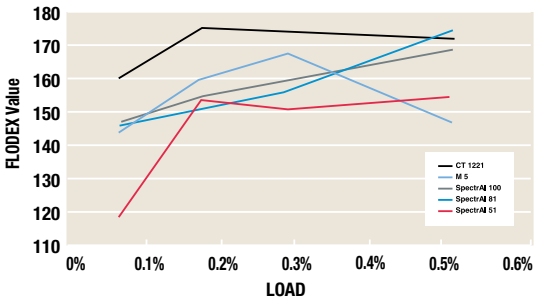
As SpectrAl fumed alumina has a cationic load, it becomes an effective additive in manufacturing powder coatings for use in tribocharge systems and works remarkably in various types of resins, such as hybrid (epoxy-polyester), polyester-TGIC, and others.

CHARACTERISTICS
FREE-FLOW AGENT
TRIBOCHARGE SYSTEM
CATIONIC LOAD
BETTER STORAGE STABILITY

▪ Applied methods



▪ Flow



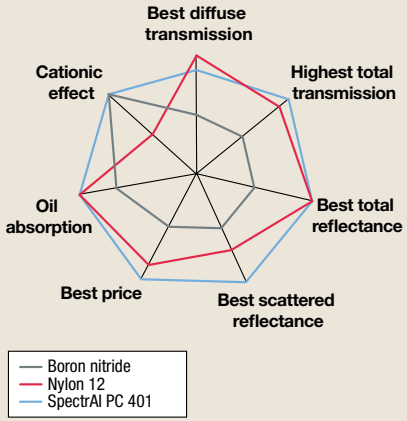
Right choice
Ideal grades of SpectrAl fumed alumina:
SpectrAl 51
SpectrAl 81
SpectrAl 100

Cosmetics

SpectrAl fumed alumina is an excellent wrinkle reducer and performs particularly well in liquids, anhydrous bases and eye shadows. It is also a perfect matting agent in shadows and eye masks. Its perfect tone diffusion of natural skin color greatly reduces wrinkle visibility, resulting in a smoothing effect and high performance for this application.

AVERAGE DATA	CHARACTERISTICS			
THICKENING	Total transmission	Diffuse	Total reflectance	Scattered reflectance
Boron nitride	74	59	15.4	79
Nylon 12	84	61	11.7	85
SpectrAl PC 401	85	57	11.7	89
Coated particles	86	32	13.1	71

CHARACTERISTICS
HIGH TONE TRANSMISSION
PERFECT & UNIFORM DIFFUSION
MATTING AGENT
CATIONIC LOAD (Allows better adhesion to skin)



Right choice
Ideal grade of SpectrAl fumed alumina:
SpectrAl PC 401

Lighting

SpectrAl fumed alumina has a key role in fluorescent lamp manufacturing since it works as a phosphate inorganic (binder) carrier enhancing their performance and improving the service life of lamps.

It can be used not only as an inorganic carrier, but also as a glass coating, helping UV light absorption and refraction.

Key requirements in lamp manufacturing

	SpectrAl fumed alumina impact
Lumen output	Strong or preferred
Service life (lumen)	
Mercury consumption	
Phosphorous concentration	
Coating strength	Moderate or in stabilization process
Appearance	
Color output	Weak

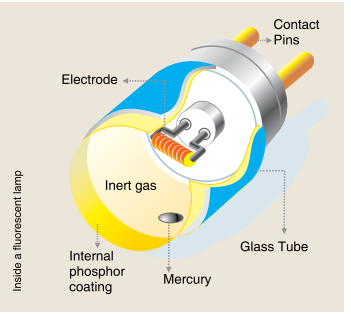
CHARACTERISTICS
FREE-FLOW AGENT
PROTECTIVE COATING
REFLECTIVE PROPERTIES
INCREASES ELECTROPOSITIVE CHARGE

Key functions

In the barrier layer
- Prevents migration of sodium into the phosphor during production of lamps and mercury into the glass tube
- Forms a chemical barrier for alkali metals (aluminates) and a physical barrier for Mercury (Hg)

In the reflector layer
- Maximizes the necessary phosphor effectiveness in capturing UV light

As an inorganic carrier
- Aids phosphor components manipulation because of its highest surface area.



Right choice
Ideal grades of SpectrAl fumed alumina:
SpectrAl 81
SpectrAl 100

Cabot in the world

With business extending in 19 countries, Cabot has 5 fumed metal oxides manufacturing facilities in the world, besides research and development facilities focused in developing new products and technology and bringing new solutions to our customers.

Technical centers:

- Billerica, MA - USA
- Rheinfelden - Germany
- Shanghai - China

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creating what matters