Technical Information

September 2010
Supersedes issue dated April 2010

Lupasol® types

® = Registered trademark of BASF group

Lupasol FG
Lupasol G 20 waterfree
Lupasol PR 8515
Lupasol WF
Lupasol G 20
Lupasol G 35
Lupasol G 100
Lupasol HF
Lupasol P
Lupasol PS
Lupasol PO 100
Lupasol PN 50
Lupasol PN 60
Lupasol SK

Fields of application

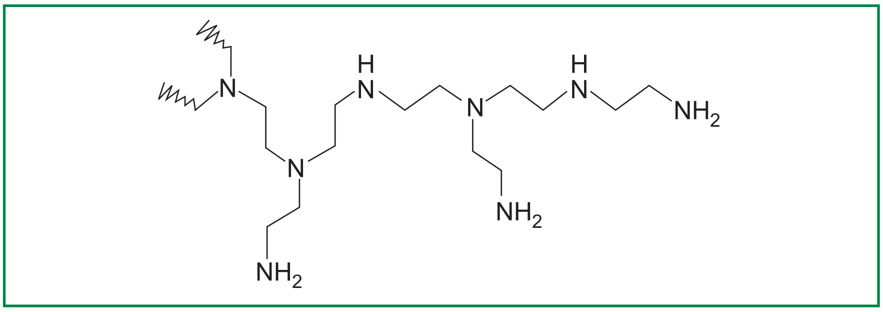
Printing inks Adhesion promoters in car tires Adhesives Complexing Plastics modification Coatings and paints Pigment manufacture Protein immobilization Textile auxiliaries Packaging Water treatment

BASF
The Chemical Company

Care Chemicals
& Formulators

Nature

Lupasol products are multifunctional cationic polyethyleneimines (PEI) with a branched polymer structure.



Their composition is expressed by the following general molecular formula:

$-(CH_2 - CH_2 - NH)_n -$
$10 < n < 10^5$

The nitrogen to carbon ratio in polyethyleneimines is 1:2, so that they have the largest possible amino group density of all known commercial polyamines. Polyethyleneimines have a definite ratio of primary, secondary and tertiary amino groups.

PRD-Nos.*

30048277	Lupasol FG
30048280	Lupasol G 20 waterfree
30048286	Lupasol PR 8515
30048289	Lupasol WF
30048279	Lupasol G 20
30048281	Lupasol G 35
30048278	Lupasol G 100
30048282	Lupasol HF
30048284	Lupasol P
30048287	Lupasol PS
30077313	Lupasol PO 100
30242144	Lupasol PN 50
30262706	Lupasol PN 60
30048291	Lupasol SK

*BASF's commercial product numbers.

Properties

Lupasol products are clear to slightly turbid*, colorless to yellowish liquids. Their viscosity depends on the molecular weight, concentration and degree of branching.

Polyethyleneimines	Modified polyethyleneimines
Anhydrous:	*Aqueous solution:*
Lupasol FG	Lupasol PN 50
Lupasol G 20 waterfree	Lupasol PN 60
Lupasol PR 8515	Lupasol SK
Lupasol WF	
Aqueous solution:	*In methoxypropanol:*
Lupasol G 20	Lupasol PO 100
Lupasol G 35	
Lupasol G 100	
Lupasol HF	
Lupasol P	
Lupasol PS	

All Lupasol products are miscible with water in all proportions.

The following tables contain the most significant data for the Lupasol products.

** Lupasol SK is slightly turbid to turbid.*

Lupasol		FG	G 20 wfr	PR 8515	WF	G 20	G 35
Average molar mass (GPC, BASF method)	[g/mol]	800	1300	2000	25000	1300	2000
Viscosity (ISO 2555, Brookfield)	[mPa·s]	5000	8000	14000	>200000	400	600
Concentration (ISO 3251)	[%]	99	99	99	99	50	50
Water content (DIN 53715, K. Fischer)	[%]	1	1	1	1	50	50
Refractive index (DIN 51423, 20 °C)		1.523	1.526	1.527	1.530	1.451	1.450
pH (DIN 19268, 1% dry substance in dist. H_2O)		11	11	11	11	11	11
pH (as supplied)		13	13	13	13	13	13
Density (DIN 51757, 20 °C)	[g/cm^3]	1.03	1.03	1.05	1.10	1.08	1.08
Charge density (cationic)[1]	[meq/g TS]	16	16	16	17	16	16
monomeres Ethylenimin (BASF-Methode)	[ppm]	<1	<1	<1	<1	<1	<1
Pour point (ISO 3016)	[°C]	-18	-16	-9	-3	-24	-18
Ratio of prim./sec./tert. amine (BASF method, ^{13}C NMR)		1/0.9/0.5	1/0.9/0.6	1/0.9/0.6	1/1.1/0.7	1/0.9/0.6	1/1/0.6

Lupasol		G 100	HF	P	PS	PN 50	PN 60	SK	PO 100
Average molar mass (GPC, BASF method)	[g/mol]	5000	25000	750000	750000	1000000	–	2000000	5000
Viscosity (ISO 2555, Brookfield)	[mPa·s]	1100	11000	25000	1700	6000	500	700	300[2]
Concentration (ISO 3251)	[%]	50	56	50	33	49	40	24	50[3]
Water content (DIN 53715, K. Fischer)	[%]	50	44	50	67	51	60	76	–
Refractive index (DIN 51423, 20 °C)		1.450	1.464	1.452	1.409	1.435	1.420	1.382	1.455
pH (DIN 19268, 1% dry substance in dist. H_2O)		11	11	11	11	8	4	7	10
pH (as supplied)		13	13	13	13	8	–	8	–
Density (DIN 51757, 20 °C)	[g/cm^3]	1.08	1.08	1.09	1.08	1.10	1.14	1.06	1.00
Charge density (cationic)[1]	[meq/g TS]	16	17	17	17	13	–	8	8[4]
Monomeres Ethylenimin (BASF-Methode)	[ppm]	<1	<1	<1	<1	<1	–	<1	<1
Pour point (ISO 3016)	[°C]	-18	-20	-3	-5	-5	–	0	–
Ratio of prim./sec./tert. amine (BASF method, ^{13}C NMR)		1/1/0.7	1/1,1/0.7	1/1/0.7	1/1/0.7	1/1/0.7	–	–	

1) BASF method, 100% dry substance at pH 4.5
2) At 50 °C
3) in methoxypropanol
4) Calculated

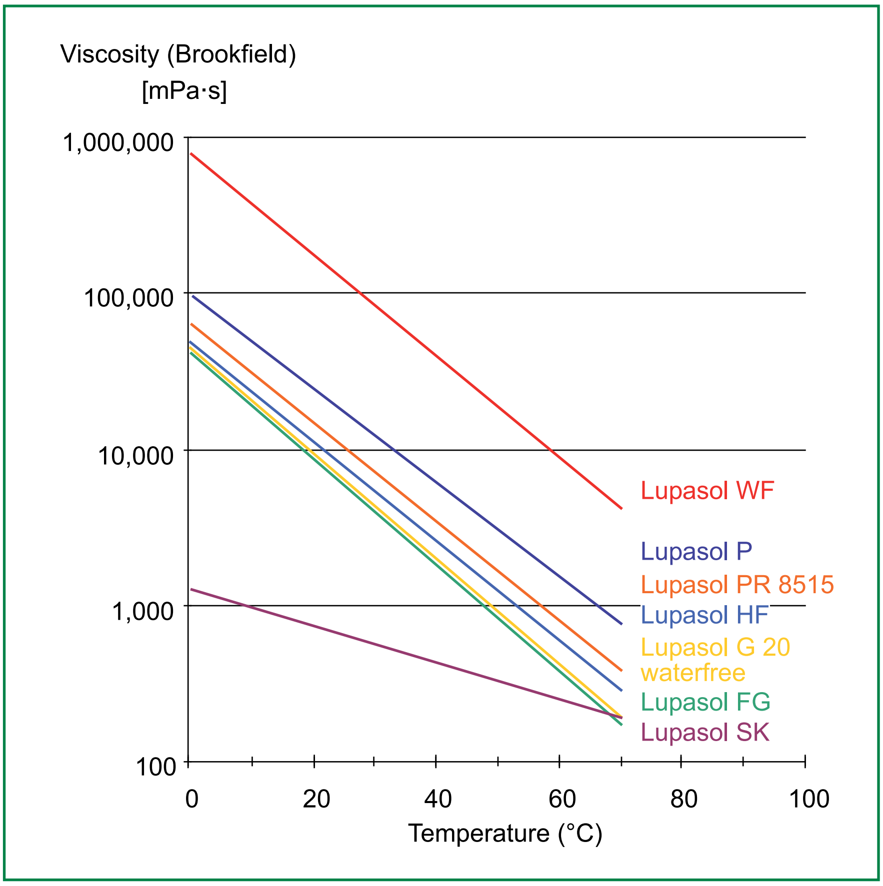
The above data are current as at the date of publication and are not all included in the product specification.

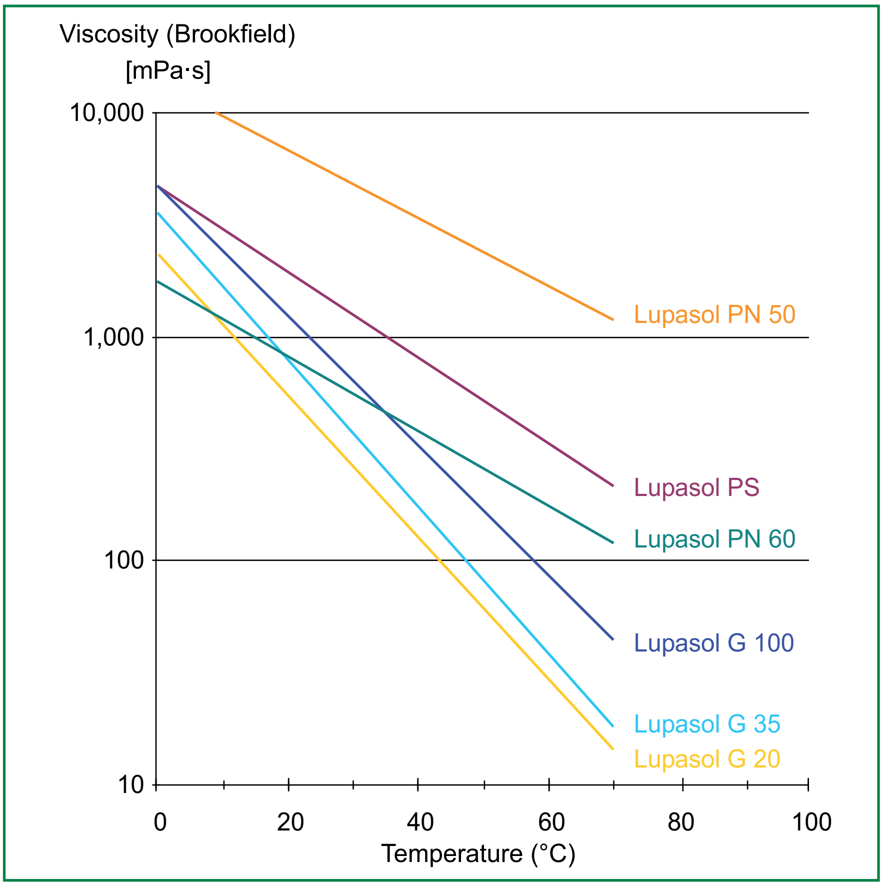
The specified test characteristics are given in the product specification, which may be requested from your local BASF representative.

All numerical data are approximate.

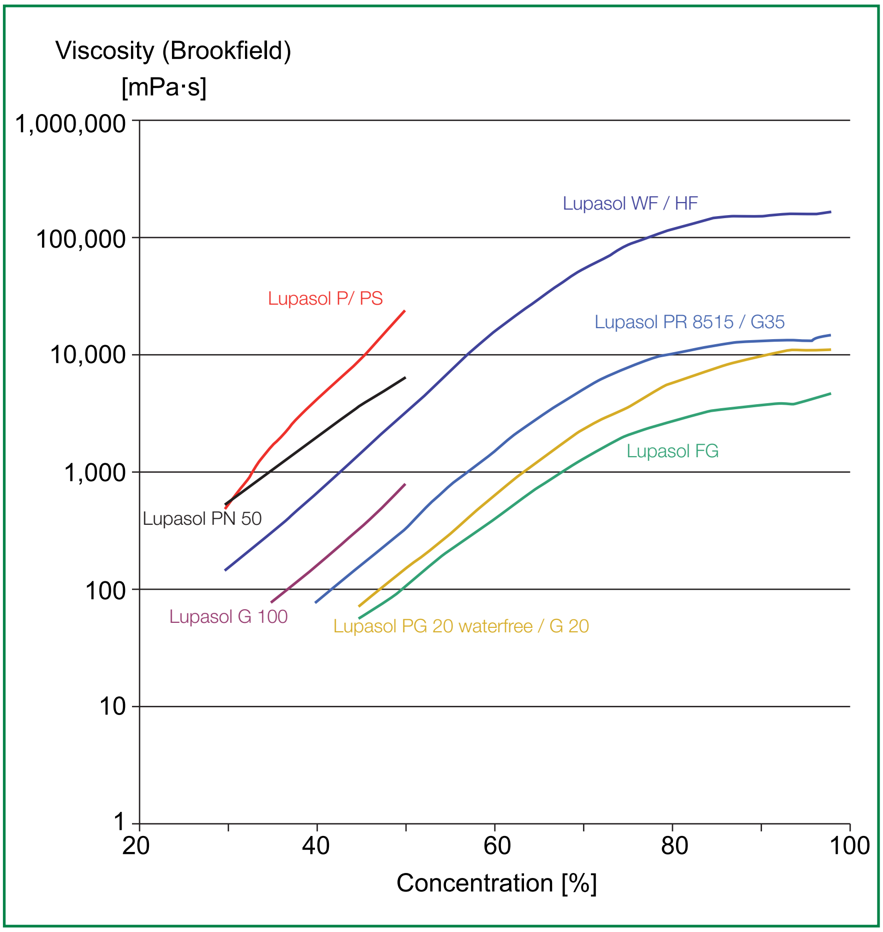
Viscosity

It is important for the transport, storage and processing of Lupasol products to know how their viscosity changes with temperature and concentration. The two graphs below show the viscosity of some of the Lupasol products as a function of temperature.



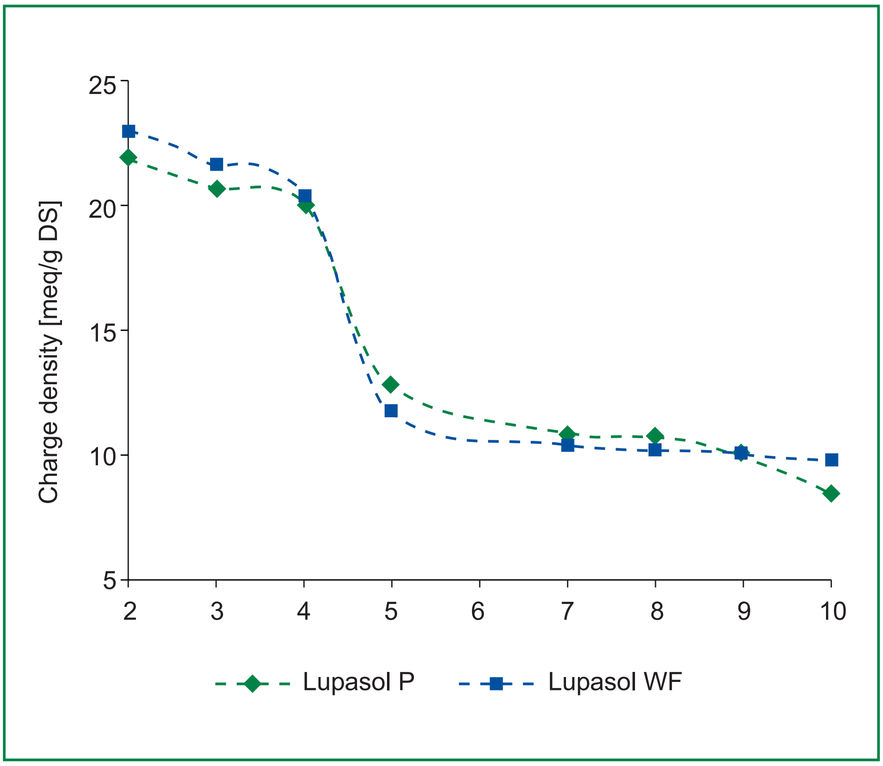


The following graph shows how the viscosity of some of the Lupasol products depends on the water content.



Charge density

As examples for the Lupasol products, the charge densities of Lupasol P and Lupasol WF are shown here as function of pH.



Solubility

Lupasol products are soluble in water and polar solvents.

The following solubility data are of a general nature only and can vary according to the amount of Lupasol to be dissolved. Aldehydes, ketones and chlorinated hydrocarbons are unsuitable as solvents, since they are likely to react with Lupasol. With acids, typical neutralization reactions occur.

	Dist. water	**Methanol ethanol, n-propanol isopropanol**	**n-Hexane**	**Ethyl acetate**	**Toluol Xylol**
Lupasol FG	+	+	–	○	○
Lupasol G 20 waterfree	+	+	–	○	○
Lupasol PR 8515	+	+	–	○	○
Lupasol WF	+	+	–	○	○
Lupasol G 20	+	+	–	○	–
Lupasol G 35	+	+	–	○	–
Lupasol G 100	+	+	–	○	–
Lupasol HF	+	+	–	–	–
Lupasol P	+	+	–	–	–
Lupasol PS	+	+	–	–	–
Lupasol PN 50	+	+	–	–	–
Lupasol SK	+	+	–	–	–

\+ = *soluble*
– = *insoluble*
○ = *partially soluble*

Compatibility

Lupasol products are compatible with cationic and nonionic systems. In anionic systems, the addition of a Lupasol product can result in incompatibilities (gelatinization, precipitation). The compatibility can generally be improved by selecting the appropriate molecular weight or by adding ammonia.

Lupasol products may change the coloristic properties of dyes and pigments.

Storage

Lupasol products should be stored in the tightly sealed original containers in cool, dry rooms. High temperatures and direct sunlight can lead to discoloration and the formation of surface films. At temperatures below 0 °C, the products may solidify, but brief heating to a maximum of 80 °C and stirring reverses the process. Prolonged exposure to atmospheric oxygen can cause discoloration. We therefore recommend storage under an inert atmosphere of nitrogen.

Storage materials

Suitable materials for containers are stainless steel and numerous plastics (e. g. PE, PP and PVC). Containers of low alloy steel, copper or copper alloys cause discoloration and are therefore unsuitable.

Shelf life

For Lupasol PS and Lupasol SK the standard shelf life is 6 months. For all other Lupasol brands referred to in this technical information, the standard shelf life is 12 months, always calculated from the date of dispatch. Proper storage in the original sealed container is a precondition.

Application

Because of their high charge density, Lupasol products adsorb strongly on negatively charged surfaces such as cellulose, polyester, polyolefins, polyamides and metals. They are therefore used as adhesion promoters for bonding different materials. The usual application rate for these applications is very low, in the 50 – 150 mg/m^2 range.

In addition, owing to the large number of peripheral amino groups, Lupasols can act as physical or chemical crosslinking agents in coatings, paints and adhesives.

Printing inks

Lupasol WF is an effective adhesion promoter for printing inks for laminated films, in which two or more layers of material are combined to form a solid composite. Lupasol WF is particularly suitable for sandwich-printed laminated films. The application rate is approx. 0.5 to 1% Lupasol WF to the printing ink. Lupasol WF is strongly basic and must only be used with binders and pigments that are stable to alkalis. Polyvinylbutyral is the preferred binder.

Flocculant

Lupasol P is used to flocculate highly charged anionic particles. Good results have been obtained in precipitating proteins, zeolites and silicates.

Adhesion promoter in car tires

Lupasol WF improves the adhesive properties of styrene-butadiene rubber towards the fibers incorporated in car tires. Particularly in systems based on resorcin/formaldehyde, vinylpyridine and polyethylene terephthalate, the use of Lupasol results in improved adhesion and reduces the hardness of the rubber mixture.

Adhesives

In combination with polyvinyl alcohol, polyvinylbutyral, polyvinyl acetate and styrene copolymers, Lupasol products can be used as adhesion promoters in adhesives. The application concentration is usually in the 0.1 – 5% range (percent active substance). Lupasol P, PS and HF are particularly suitable.

Because of their crosslinking action, the use of low-molecular Lupasol products in dispersion-based label adhesives results in significantly increased cohesion for the same level of adhesion.

Low-molecular anhydrous Lupasol products can also act as crosslinkers and hardeners in epoxy resin and polyurethane adhesives. The amounts used depend on the epoxide or isocyanate component and the desired product properties.

Complex formation

Lupasol products can form reversible complexes with heavy-metal ions. They have a high cation-binding capacity similar to that of EDTA. Complexing is preferably carried out in an alkaline medium. Lupasol products exhibit outstanding binding capacities towards divalent metal ions (Zn^{2+}, Hg^{2+}, Cu^{2+}, Pb^{2+}, Ni^{2+}, Cd^{2+}). Lupasol P is suitable for separating heavy metals from aqueous solutions by ultrafiltration. The heavy metals can be subsequently recovered by electrodeposition.

Coatings and paints

Lupasol products are used as primers in coating applications, where they improve adhesion to the substrate. Especially in UV-curing systems, which often exhibit poor adhesion because of volume shrinkage, considerable improvements can be obtained by using Lupasol P as a primer.

The addition of even a small concentration (0.1%) of Lupasol G 20 to standard emulsion paints significantly improves the wet adhesion, which is of particular significance in bath and kitchen applications. Lupasol G 20 or Lupasol G 35 can be added directly to the paint formulation. This makes the use of special monomers in emulsion paint manufacture unnecessary.

Low-molecular, anhydrous Lupasol products can also be used as a crosslinking polyamine component in epoxy resin and polyurethane coatings. Lupasol products improve the early rain resistance of stucco finishes.

Lupasol G 35 is used to prepare stucco formulations with long-term stability. Lupasol G 100 is an additive that can be incorporated immediately before the stucco is applied.

Pigment manufacture

Pigments dispersed with Lupasol-based compounds are easier to process and exhibit higher color strength..

Protein immobilization

Lupasol products can be used to immobilize proteins on inorganic materials. The proteins are usually bound to the Lupasol using dialdehydes (e. g. glutaraldehyde). Lupasol PN 50 is particularly suitable for this application.

Textile auxiliaries

Lupasol P improves fixation of reactive dyes on cotton. It can be applied during pretreatment or aftertreatment. Lupasol P can also be used to fix flame retardants.

Packaging films

Lupasol P is very effective as an adhesion promoter in multilayer packaging films manufactured by coating, lamination, extrusion coating or coextrusion. Applying Lupasol P in composite films (laminates) allows the use of material combinations that result in improved physical, chemical and mechanical properties and substantially increase the barrier effect.

The following materials are suitable as substrates: cellulose, paper, cellophane, viscose, polyolefins (PP, OPP, BOPP, PE, LDPE, HDPE), polyester (PET), polyamide, alogenated polymers (PVC, PVDC), and metals (e. g. aluminum).

The following coating agents can be used: polyolefin waxes (PE, LDPE, HDPE), PVAc, PVA, acrylates, and PVDC.

Application

Film pretreatment
Oxidative pretreatment of the film considerably improves adhesion. Inline pretreatment (corona, flame or ozone) of films before coating is therefore recommended.

The solids content of an aqueous Lupasol P primer solution is between 0.5 and 1%. The water used to prepare it should be low in Ca^{2+} ions. Up to 30 wt% alcohol (methanol, ethanol or isopropanol) can be added to improve drying and wettability. Where films with low surface tension are used, we recommend the addition of 0.5% nonionic surfactant (Lutensol ON 60). The primer solution is applied at the rate of 1 – 5 g (of a 1% solution) per square meter (corresponding to 10 – 50 mg/m^2 of pure Lupasol P).

Coating
The primer solution can be applied, for example, by means of a dip bath with a plastic or metal transfer roll.

Drying
After application of the primer solution, the coating is usually dried conventionally in a stream of warm air (≥50 °C). Adding alcohol allows the drying time and temperature to be reduced. Insufficiently dried primer coatings lead to poorer adhesion or blocking in offline applications.

Combination
Combination of the Lupasol-coated polymer film with a topcoat is carried out under heat (50 °C – 100 °C, depending on the type and thickness of material) and pressure.

Typical application
A widely used application is the extrusion of polyethylene (LDPE) under oxidizing conditions on a film coated with Lupasol P at 300 °C – 320 °C. Under optimum conditions extremely good adhesion is achieved (adhesive strengths of up to180 g/cm^2).

Safety

We know of no adverse effects resulting from the use of Lupasol products for their intended purpose and from processing them in accordance with sound manufacturing practice. According to the experience we have gained over many years and other information at our disposal, Lupasol products do not exert any harmful effects on health, provided that they are used properly, due attention is given to the precautions necessary for handling chemicals, and the information and advice given in our Safety Data Sheets are observed.

Labeling

Information on classification and labeling, as well as other information on the safe use of our products, are provided in the current Safety Data Sheets..

Note

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