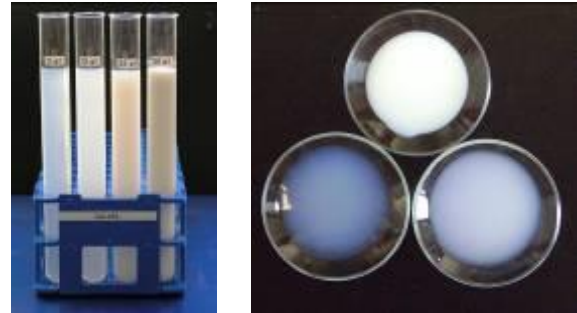


# Technical Data Sheet

## CaLoSiL®

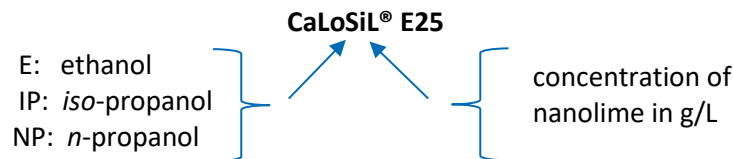
Colloidal nano-particles  
of lime for stone and plaster  
consolidation  
- nanolime -



CaLoSiL® in different concentration

### Properties

CaLoSiL® contains nano-particles of lime hydrate ( $\text{Ca}(\text{OH})_2$ ) suspended in different alcohols. Typical concentrations are between 5 g/L and 50 g/L. The average particle size is 150 nm, which is approximately 100 times smaller than conventional air lime. Ethanol, iso-propanol or n-propanol serve as solvents. Due to the low particle size, stable sols are formed. This means, the solids do not sediment for a long time.



CaLoSiL® is used for structural consolidation of stone, mortar and plaster as well as for the strengthening of wall paintings. It is a ready-to-use product.

Treatment with CaLoSiL® results in the formation of solid calcium hydroxide particles after evaporation of the alcohol. That converts into calcium carbonate in a way similar to traditional lime mortars by reaction with atmospheric carbon dioxide. All alcohols evaporate completely. Chemicals or residues deteriorating stone or mortar are not formed. The evaporation rate depends on the environmental conditions and decreases in the following order: ethanol > iso-propanol > n-propanol. It is recommended to work under conditions leading to slow evaporation of the alcohols. Otherwise, the evaporation leads also to a back-migration of the nano-particle to the surface, resulting in white haze formation.

All products are nearly waterfree (alcohol content > 92 %). They can be intermixed in all ratios. Also, dilution with ethanol, iso-propanol or n-propanol is possible without any problems. In contrast, mixing with water is only with extremely small volumes possible, otherwise gel-like systems are formed or flocculation takes place.

All CaLoSiL-products are characterised by an excellent wetting behaviour.



## Available products

The following standard products are available:

- CaLoSiL® E5, E25 and E50
- CaLoSiL® IP5, IP15 and IP25
- CaLoSiL® NP5, NP15 and NP25

Other concentrations and solvents are available on demand. All products are available in 0.5 L, 1 L, 5 L and 10 Liter containers. CaLoSiL®-IP and CaLoSiL®-NP contain for technical reasons also small volumes of ethanol.

Special products are CaLoSiL® grey, CaLoSiL® paste like and CaLoSiL® micro. These are described in detail in separate Technical Data Sheets.

## Application advices

CaLoSiL® can be applied by dipping, capillary suction, spraying or injection. It is important that the complete weathered zone of the substrate is treated.

The penetration into mortar, stone or plaster depends on many factors. Of special importance are:

- Characteristics of the CaLoSiL® type applied,
- Structure and surface characteristics of the materials to be treated,
- Porosity and capillary rise,
- Moisture content of the material,
- Air temperature and air humidity during the application.

The calcium hydroxide particles formed after evaporation of the alcohol cover the surface of treated cracks, pores or joints. They bridge cracks and small pores and bind loose particles. The carbonation, that means the reaction of  $\text{Ca}(\text{OH})_2$  with  $\text{CO}_2$  to calcium carbonate is a very complex reaction, in which several steps overlap. Important is that the reaction requires the presence of water. Thus, sufficient humidity is essential. Covering with wet clothes or careful moistening of treated substrates are recommended. Depending on the required strengthening, repeated applications of the nanolime dispersion maybe required. These can be realised immediately after the alcohol has evaporated.

Weathered materials are often characterised by pores or cracks which have hydrophobic properties, resulting from dust and biological growth. In order to increase the penetration behaviour it is recommended to pretreat such substrates 24 hours before the application of CaLoSiL® with water or water/ethanol mixtures. Essential is that the solvent evaporates complete before the CaLoSiL® treatment starts.

It has to be regarded that the transport of solutions in the most stones and mortars bases on capillarity, gravity is only in large openings important. Saturation of a stone by capillarity is a relatively slow process, which needs some time. CaLoSiL® has a lower capillarity than water. Water is able to push the nanolime dispersion deep into the substrate and to prevent fast evaporation of the solvent.

The following recommendations are given to avoid the whitening of treated substrates (white haze formation) after the application of nanolime dispersions:

- Start the treatment with low concentrated products, increase the calcium hydroxide concentration step by step.
- Avoid the treatment of wet materials, reduce the moisture content by pre-treatment with ethanol or ethanol-water mixtures (1:1).
- In the case of sensitive surfaces, try to use CaLoSiL®-grey, which has a special consistency allowing deep penetration without white haze formation.



- Avoid an “oversaturation” of the treated stone, plaster or mortar. Remove all CaLoSiL<sup>®</sup> which could not penetrate into the treated material, for example by sponging.
- Test the addition of small amounts of acetone or heptane.
- Test the combination with CaLoSiL<sup>®</sup> micro, which has a bigger particle size allowing the fixation of small particles.
- Careful after-spraying of treated surfaces with water. Due to the higher capillarity of water, the nanolime dispersion is “pushed” into deeper zones. Additionally, fast evaporation of the alcohol is avoided.
- Aftertreatment with 0.5 wt.-% solution of hydroxy-propyl cellulose in a water/ethanol mixture (1:1 by volume).

The timely course of carbonation can be followed by using ethanolic phenolphthalein solutions. As long as a purple colour is formed after spraying on treated surfaces, unreacted Ca(OH)<sub>2</sub> is still present (pH >10). When the colour does not change, all Ca(OH)<sub>2</sub> has converted into CaCO<sub>3</sub>.

When dense materials are treated with highly concentrated CaLoSiL<sup>®</sup> products (CaLoSiL<sup>®</sup> E50, CaLoSiL<sup>®</sup> paste-like etc.) the penetration behaviour may be low, only. Especially the presence of dense surface layers (for examples gypsum crusts on mortars, plasters) prevent a penetration of CaLoSiL<sup>®</sup> into deeper zones.

The penetration into materials with high moisture contents is generally more difficult than into dry substances. Pre-wetting with ethanol may help to reduce the moisture content of the material. After evaporation of the ethanol, it should be possible to apply CaLoSiL<sup>®</sup> without any problems.

## CaLoSiL<sup>®</sup> and silicic acid esters

The strengthening of calcareous materials by silicic acid esters (SAEs) is often difficult because the formed silica gels do not bind on the surface. The specifics of SAE's do also not allow a bridging of cracks or pore rooms greater than 10 µm. Many problems can be overcome through the successive treatment with nanolime and silicic acid esters. For that, the substrate to be strengthened is treated in a first step with CaLoSiL<sup>®</sup> (for example E-25 or IP-25) followed by the application of SAE's. The calcium hydroxide formed from CaLoSiL<sup>®</sup> acts as adhesion promoter as well as catalyst accelerating the hydrolysis of the silicic acid ester. Important is, that the SAE treatment is realized approximately 24 hours after the application of CaLoSiL<sup>®</sup>. When the treatment is realized earlier, alcohol may be still present covering the surface of the pores and diluting the SAE. After 24 hours, significant carbonisation will start leading to the formation of CaCO<sub>3</sub> and the catalytic effect of nanolime will be lost. Repeated pre-treatment with CaLoSiL<sup>®</sup> enhances the final strength significantly. The accelerated hydrolysis of the SAE's results in substrates which have earlier hydrophobic properties than in the case of treatment with SAE only.

The combination of CaLoSiL with silicic acid esters allows the successful consolidation and strengthening of materials at which pure silicic acid esters do not work satisfactorily. The final strength is in many cases much higher than it can be achieved by single treatment with silicic acid esters. All commercially available silicic acid esters can be used.

## Further information

A detailed overview about fundamentals, laboratory testing and the application of nanolime is given in: *Ziegenbalg, G., Drdacky, M., Dietze, D., Schuch, D. (editors): Nanomaterials in Architecture and Art Conservation, Pan Stanford Publishing, 2018, ISBN 978-981-4800-26-6*

The book summarizes the current knowledge about nanolime and gives an overview about mechanism of the deterioration of stone, mortar and plaster as well as enhanced laboratory tests for the



characterization of stone strengthener. The practical use of nanolime dispersions for the conservation of historical monuments is discussed on 16 different objects.

## Storage

All materials have to be stored between +5 °C and +25 °C. When CaLoSiL® remains in unopened, original containers, storage for at least 6 months is possible. After that time, agglomeration and connected with that, sedimentation may occur. The settled particles, however, can be re-dispersed by shaking the closed bottle or by ultrasonic treatment. The properties of the nano-sols remain unaffected.

## Safety

CaLoSiL® is flammable/combustible. Keep away from oxidisers, heat, sparks and flames. Avoid spilling, skin and eye contact. Ventilate well, avoid breathing vapours. CaLoSiL® is strongly alkaline. Do not smoke. Keep containers closed. Use safety gasses and gloves. Wash thoroughly after handling. Keep away from sources of ignition. Please store in a cool, dry place and in a tightly closed container. Further information concerning safety during transport, storage and handling as well as for disposal can be found in our latest Material Safety Data Sheets. Before using in large scale, we recommend to treat a small test field with CaLoSiL® in order to find out the most favourable application method and the required volumes of CaLoSiL®.

The information mentioned above is state of the art and has been developed by intensive research and development. The application of our products and their use is beyond the range of our influence. Therefore, IBZ-Salzchemie GmbH & Co. KG cannot take any liability from events that result from the information contained in this Technical Data Sheet. Careful and considered use of CaLoSiL® is highly recommended.

