

# NANORESTORE PLUS®

## Technical Sheet

### OVERVIEW

Nanorestore Plus® formulations are composed of calcium hydroxide nanoparticles dispersed in short-chain alcohols such as ethanol and 2-propanol; these systems, also known as nanolimes, are highly compatible with carbonate-based materials, such as wall paintings and carbonatic stone. Due to their compatibility, they represent an alternative to traditional consolidation materials used in restoration practice, for instance synthetic polymer coatings that exhibit poor compatibility with inorganic porous works of art and can produce detrimental effects in the long-term.

### AVAILABLE FORMULATIONS

**Nanorestore Plus® Ethanol 5:** Calcium hydroxide nanoparticles dispersed in ethanol at a concentration of 5 g/L. These particles are specifically designed for consolidation purposes.

**Nanorestore Plus® Ethanol 10:** Calcium hydroxide nanoparticles dispersed in ethanol at a concentration of 10 g/L. These particles are specifically designed for consolidation purposes.

**Nanorestore Plus® Propanol 5:** Calcium hydroxide nanoparticles dispersed in 2-propanol at a concentration of 5 g/L. These particles are specifically designed for consolidation purposes.

**Nanorestore Plus® Propanol 10:** Calcium hydroxide nanoparticles dispersed in 2-propanol at a concentration of 10 g/L. These particles are specifically designed for consolidation purposes.

**Nanorestore Plus® Test Kit:** This kit includes 100 ml of Nanorestore Plus® Ethanol 5 and Nanorestore Plus® Propanol 5. It could be used for preliminary tests, in order to choose the best formulation for your specific need.

### WHEN ARE THEY USED?

Due to several reasons (pollution, weathering, mechanical stress) wall paintings and stones lose their original cohesion during time. When this happens a consolidation intervention has to be performed in order to recover the mechanical properties of the material and avoid the loss of the pictorial layer. Nanorestore Plus® formulations are specifically designed for consolidation purposes.

#### OK to be used for

- ✓ Consolidation of frescos paintings
- ✓ Consolidation of carbonate-based *secco* paintings (check the compatibility of paint binders with the dispersions' solvents)
- ✓ Consolidation of carbonatic stones or limestones

✘ *For different applications, it is advised to contact us for assistance. We will be glad to help you in finding the best solution for your conservative need.*

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## HOW DO THEY WORK?

Calcium hydroxide nanoparticles of Nanorestore Plus® formulations penetrate into the pores and cracks of the artifacts, where they act as a binder for the de-cohered layers and powdering surface of the works of art by turning into calcium carbonate through the reaction with atmospheric CO<sub>2</sub>. The carbonation process is highly favored by the nanosize of the particles.

## HOW ARE THEY USED?

### General features

Nanorestore Plus® formulations, composed of calcium hydroxide nanoparticles dispersed in short-chain alcohols, i.e., ethanol and 2-propanol, are systems specifically designed for the consolidation intervention on carbonate-based mural paintings and stone artifacts.

### Storage

Nanorestore Plus® dispersions are shipped in HPDE bottles, which should be kept firmly closed to prevent the contact between calcium hydroxide nanoparticles and air, to avoid the clustering of particles and their carbonation. The contact between nanoparticles dispersions and humidity has to be avoided too. Water doesn't affect the effectiveness of Nanorestore Plus®, but it may cause changes in nanoparticles size. Bigger particles than the ones originally present may result in white haze on the treated surfaces, which has to be promptly removed. Nanorestore Plus® formulations contains no additives and are formulated to prevent sedimentation. Even though, after long storage, it is recommended to shake energetically the dispersion before use.

### Safety

Nanorestore Plus® dispersions should be handled with care, following the same standard operating procedure recommended for ethanol and 2-propanol. Therefore, the formulations must be used in the presence of good air ventilation, and should be handled wearing goggles and gloves. Nanorestore Plus® dispersions cannot be used in presence of open flames, sparks, and hot surfaces.

### Preliminary tests

Before the application of Nanorestore Plus® dispersions, preliminary test should be carried out to evaluate the conservation status of the artifact that needs to be consolidated. In particular, the presence of sulfates must be evaluated. Their presence could hamper the consolidation action Nanorestore Plus® formulations. Therefore, in case of sulfate pollution, their removal should be carried out before the consolidation intervention.

### Dilution (optional)

Nanorestore Plus® dispersions are available at a concentration of 5 g/L or 10 g/L. It is worth noting that for standard applications, a concentration of 2.5 g/L is advisable. In the case of low porous substrate, white hazes can be seen on treated surface. To avoid the formation of these hazes, each Nanorestore Plus® dispersion can be diluted to the appropriate concentration by using the corresponding pure and anhydrous solvent (it is important that the chosen solvent does not contain water).

### Product consumption

Considering that several factors affect product consumption, it is hard to predict the amount of dispersion needed for a standard intervention. Based on available data, it can be said that, for the consolidation of wall paintings, 1L of Nanorestore Plus® Ethanol 5 or Propanol 5 can be used for 5-10 m<sup>2</sup> of pictorial surface.

### Pre-treatment of the surface

A consolidation intervention should be performed on surfaces free from detrimental coatings, such as polymers, glues and fixatives, which could hinder nanoparticles penetration. For the removal of undesired coatings, please refer to the Technical Sheet of Nanorestore Cleaning® formulations. Pre-treatment of the surface to be treated is required when the substrate contains large amount of moisture or is wet. In this case, the application of alcohol could help in drying the substrate, favoring the penetration of nanoparticles (Fig. 1.1).

### Application

Nanorestore Plus® formulations are usually applied on the surface to be consolidated by brushing (Fig. 1.2) or by spraying (Fig. 2.1). In the case of brushing, the usage of a Japanese paper sheet, having a grammage of 9 g/m<sup>2</sup> is recommended. The spraying of Nanorestore Plus® dispersion should be carried out on fragile, flaking, degraded surfaces, which cannot tolerate mechanical stresses. The dispersion should be applied until the matrix seems completely full with the product (Fig. 1.3); after the evaporation of the alcohol, a second application can be carried out. As a general rule, it is advisable to perform several application (up to 10-12) with less concentrated dispersion than one or two application with more concentrated systems.

### After the application

Right after the application of Nanorestore Plus® dispersions, a cellulose poultice soaked with distilled water should be applied over Japanese paper on the treated surface and removed only when dry (Fig. 1.4 - 1.7). The cellulose pulp compress prevents the formation of white haze and favors the carbonation of nanoparticles.

### Assess consolidation effectiveness

For the assessment of consolidation effectiveness it is recommended to wait for one month after the application of Nanorestore Plus® dispersions. As a matter of fact, full carbonation may require, depending on the environmental conditions, from 2 to 4 weeks.

## APPLICATION GUIDELINES AT A GLANCE

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Goggles Yes

Gloves Yes

Ventilated hood or environment Recommended

Application methods If possible, dispersions should be applied by brushing over Japanese paper. On very fragile surfaces, spraying of dispersion is preferable

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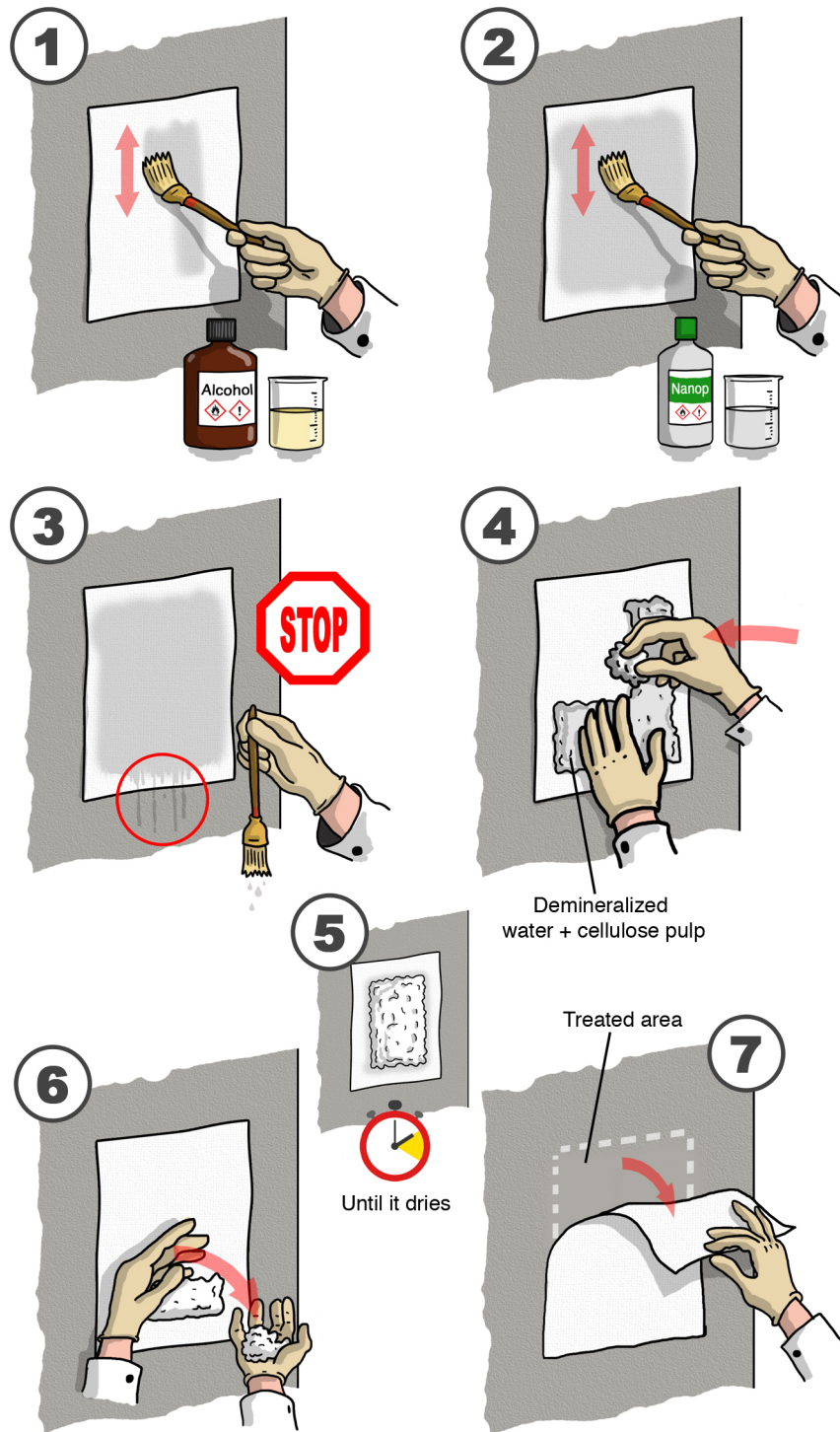
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**After treatment**

After the consolidation, a cellulose pulp poultice soaked with distilled water should be applied with the aim of favoring carbonation of particles and hindering the formation of white hazes

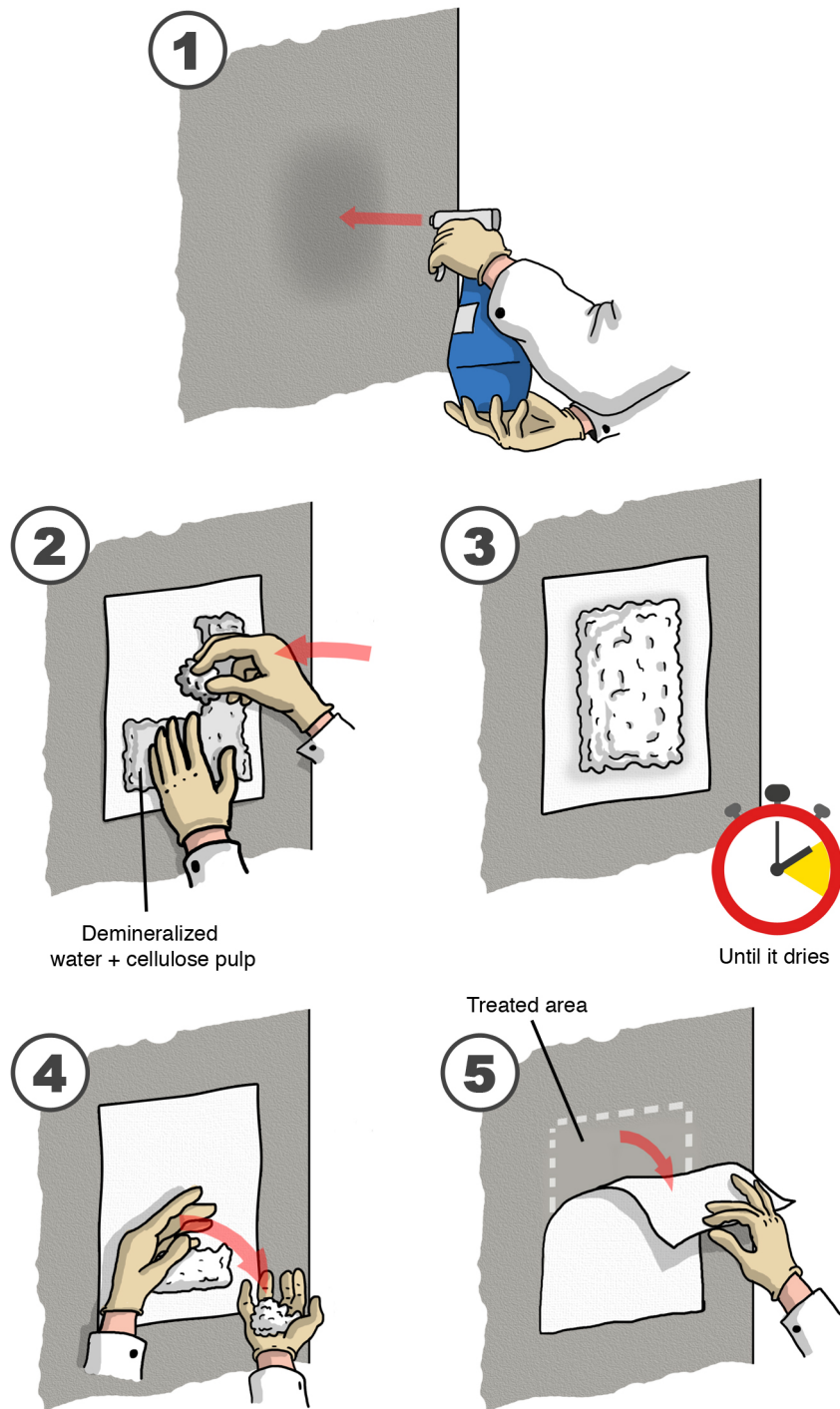
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## FIGURES



**Figure 1.** Application of Nanorestore Plus® by brushing.

- (1) Pre-treatment with alcohol, if the substrate is wet or contains moisture. (A sheet of Japanese paper is interposed between the brush and the substrate).
- (2) Application of the dispersion using a brush over a Japanese paper sheet.
- (3) Stop when the substrate is completely wet. (Several applications can be carried out).
- (4) Application of a humid (not dripping) cellulose pulp poultice.
- (5) Let the poultice dry.
- (6) Remove the dried poultice.
- (7) Gently remove the Japanese paper sheet.



**Figure 2.** Application of Nanorestore Plus® by spraying.

- (1) Application of the dispersion by spraying.
- (2) Application of a humid (not dripping) cellulose pulp poultice.
- (3) Let the poultice dry.
- (4) Remove the dried poultice.
- (5) Gently remove the Japanese paper sheet.

## FREQUENTLY ASKED QUESTIONS

**Q** After the consolidation intervention with Nanorestore Plus® dispersions, I applied a humid cellulose pulp compress, as suggested. Even though, on the treated surface a white haze is present. How can I remove it?

**A** Gentle mechanical action by means of a brush soaked with the same alcohol of the applied dispersion can help in removing white hazes. In case white haze persists, the application of another cellulose pulp compressed soaked with distilled water left for few hours is recommended.

## REFERENCES

Further information can be found in the following textbooks:

1. Piero Baglioni and David Chelazzi. *Nanoscience for the Conservation of Works of Art*. Royal Society of Chemistry, 2013.
2. Piero Baglioni, David Chelazzi and Rodorico Giorgi. *Nanotechnologies in the Conservation of Cultural Heritage: A Compendium of Materials and Techniques*. Springer, 2014.

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