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Academic Patent

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HYBRID

DEFINITIVE PROTECTION AGAINST INFILTRATIONS ON NATURAL AND ARTIFICIAL STONES, CONCRETES, PLASTER

WATER-REPELLENT 100% IDROREPELLENTE

BREATHABLE TRASPIRANTE

TRANSPARENT TRASPARENTE

SOLVENT FREE SENZA SOLVENTI

ACADEMIC PATENT

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HYBRID

Innovative nanostructured product for the protection of fair-faced wall in natural stone, artificial stone and concrete.

UNIVERSITÀ DEL SALENTO

Product Developed On European Patent University Of Salento

THE PRODUCT

HYBRID is an innovative water-repellent photopolymerisable nano-structured Organic-Inorganic hybrid, patented by University of Salento in Europe.
The product is made of organic domains, based on silanes and siloxanes, which are interconnected with an inorganic nanoscale structure, ensuring a highly water-repellent, breathable and transparent effect in only a few hours, in the absence of solvents.

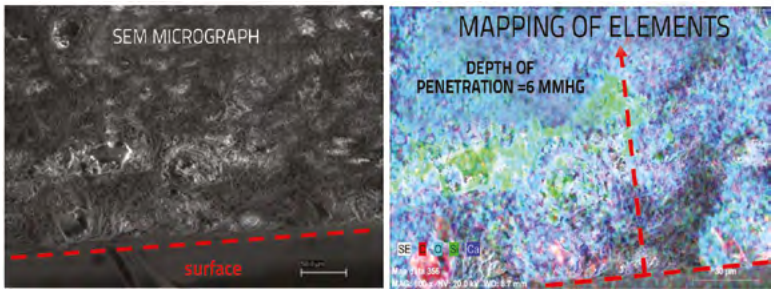
USES

Protection of walls and wall coverings in natural stones, artificial stones and concrete. Also suitable for porous surfaces.

PROPERTIES:

- Does not dissolve in the solvent;
- Non-toxic and non-polluting;
- It is activated in situ at room temperature by solar radiation;
- Low viscosity and adequate depth of penetration;
- High water repellency;
- High breathability;
- Does not alter the natural colour of the stone;
- High resistance to scratching;
- High level of protective efficacy.

ANALYSIS OF THE PENETRATION OF THE PRODUCT INTO THE STONE



The Problem

The main cause of degradation of masonry is water in its various forms and even more so in environmental conditions that induce the change of state.

The moisture present inside the wall structure, under harsh conditions of temperature, induces the formation of ice crystals which, occupying a greater volume, cause continuous mechanical stresses and, as a consequence, phenomena of decohesion and fractures.
The mechanical action of driving rain has an abrasive effect on the stone surface, which gradually disintegrates. Moreover, water is the most common vehicle for soluble salts which, migrating into the structure, under certain conditions of temperature and humidity, crystallize causing fractures or salt efflorescences.
"Acid rain", produced as a result of the combination of water and gas pollutants dispersed into the atmosphere, leads to the breakdown of some compounds in the stone favoring chemical reactions which also determine the formation of " black crusts ".

Degradation effects of moisture includes:

- **Chemical Phenomena**: corrosion , hydrolysis , oxidation and hydration;
- **Physical phenomena**: mechanisms stress induced dilation, exfoliation heat, frost, salt crystallization;
- **Biodeterioration**: mold, fungi , algae, microorganisms , etc. decay of thermo hygrometric state.

Some examples of degradation of exposed walls.

The Solution

In order to reduce degradation phenomena it is necessary to apply a protective film able to inhibit the entry of water but at the same time maintaining the breathability of the structure.

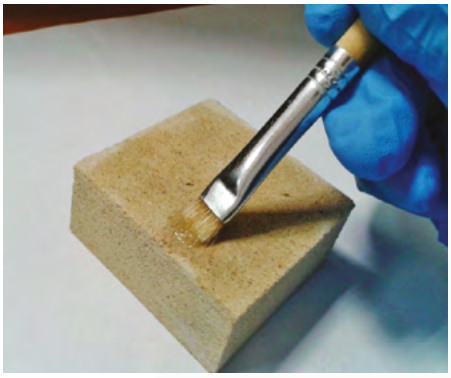
HYBRID, protects the support by external degrading agents ensuring high standards of performance in terms of water repellency, water vapour permeability, transparency, chemical inertness towards the substrate, water insolubility and low volatility.

Composition

HYBRID is an innovative photopolymerizable nanostructured organic-inorganic (O-I) hybrid product, based on a methacrylic resin, an organic silane and siloxanes-based compatibilizing agent and an inorganic precursor. Compared to the common polymeric hydrophobic products, HYBRID is not solvent-based.

Application method

It is recommended to apply HYBRID by brush or by roller on a sunny day (temperature 20-40°C). In a few hours a protective, homogeneous, hydrophobic and highly resistant film is obtained by means of sunlight exposure (photopolymerization). The curing process of the film does not require the use of any solvents, which are toxic for the health and the environment.

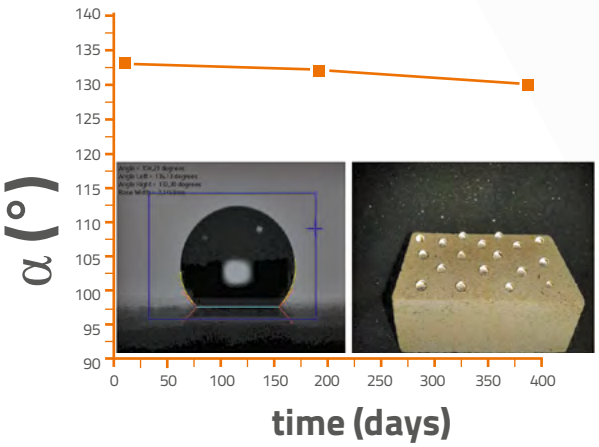


TECHNICAL CHARACTERISTICS

HIGH WATER REPELLENCY

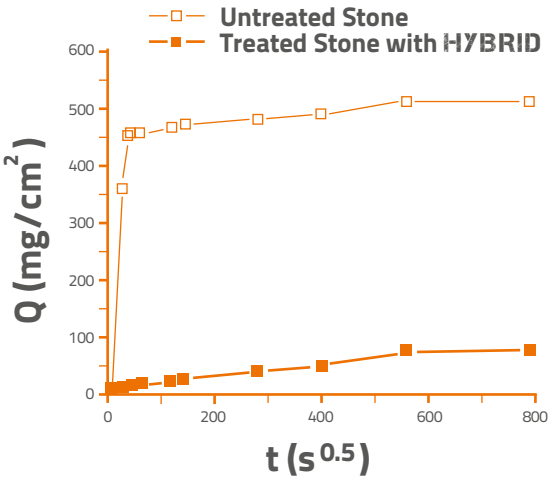
Static contact angle

The static contact angle α(°) is a thermodynamic extent described by the angle between the tangent to liquid-solid interface and the solid surface.
The measure of static contact angle, according to NORMAL 33/89 allows the assessment of the hydrophobic effect of the products used as protective coatings for stone materials. Conventionally, a surface with > 90° is defined as hydrophobic. HYBRID shows contact angle values higher than 130°, and they remain stable over time.



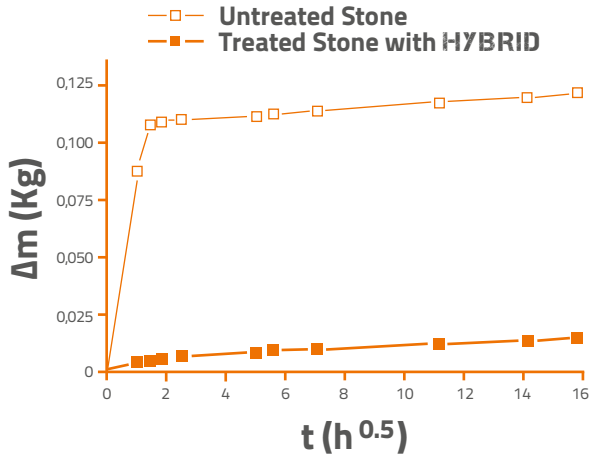
Water absorption by capillarity

The water absorption coefficient by capillarity Q [mg/cm^2] measures the amount of water absorbed by capillary action per unit area as function of the time, according to UNI 10859:2000. The protective effectiveness of HYBRID is higher than 88% after 8 days of water contact.



Liquid water transmission degree

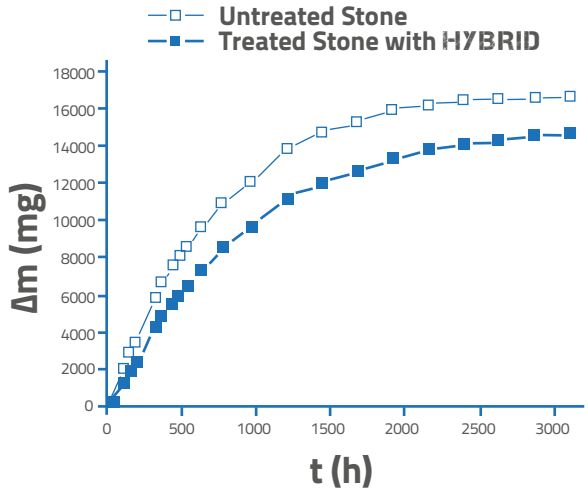
The liquid water transmission coefficient W [Kg/m^2 t$^{0.5}$], according to the code UNI EN 1062-3:2001, indicates the capability of the treatment to resist liquid water penetration. According to the normative UNI EN 1062-1:1996, HYBRID is classified as Class II with W values equal to 0.45 Kg/m^2 t$^{0.5}$, after 10 days of water contact.



HIGH BREATHABILITY

Water vapour transmission degree

The water vapour transmission coefficient V [g/m^2 day], according to the code UNI EN ISO 7783-2:2001, assesses the capability of the treatment to allow the free water vapour transport across the stone. According to the normative UNI EN 1062-1:1996, the water vapour transmission degree of HYBRID is equal to 70 g/m^2 day (Class II).



HIGH TRANSPARENCY

The ΔE value, determined according to NORMAL 43/93, expresses the colorimetric variation of the stone surface after the treatment. **HYBRID** does not change the natural aesthetical aspect of the stone, showing ΔE values equal to 5.

	TIME FROM THE APPLICATION	CONTACT ANGLE, α(°)	COLORIMETRIC VARIATION, ΔE*
HYBRID	1 Day	133.8±3.4	8
	12 Months	133.0±1.4	5
OTHER PRODUCTS	7 Days	135.4 ±5.1	11
	12 Months	122.6±2.1	7

HIGH AGING RESISTANCE

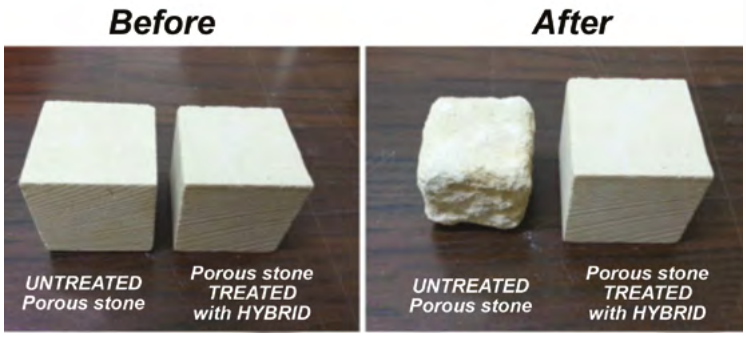
Abrasion resistance

The ΔL value, measured according to the code EN 14157:2005, describes the capacity of the stone to wear due to an abrasive action. **HYBRID** increases the abrasion resistance of the natural stone by 65%, thus it reduces the alveolization phenomenon due to erosion by wind and particles.

Resistance to salt crystallization

The saline efflorescence and the inner stresses due to the formation of salt crystals inside the pores are a clear effect of the action of salts dissolved in water, with which the stone is in contact. According to the standard 12370:2001, the resistance to salt crystallization is determined as mass variation, Δm, which can be simulated by means of repeated cycles of immersion in saline solution and drying. After 15 cycles the untreated stone appears consumed with a reduction in weight 42%, whereas the stone treated with **HYBRID** shows high resistance totally preserving its aspect.

SALTS CRYSTALLIZATION EFFECT



Resistance to aging by SO2 action in the presence of humidity

The effect of the polluted atmosphere is one of the most frequent causes of degradation for stone materials. According to the code UNI EN 13919:2004, HYBRID resists aging due to the synergistic action of acids and high humidity, showing a high capability to inhibit the formation of sulfation products >50%.

Freeze-thaw resistance

The constant mechanical stresses due to repeated freeze-thaw cycles in severe climatic conditions (T<0°C) compromise the stone structure. According to UNI EN 12371:2003, HYBRID is able to resist freeze-thaw cycles, reinforcing the stone with an extraordinary enhancement of 56% of the mechanical properties (compressive strength UNI EN 1926:2000), very unexpected behaviour for a traditional protective product.

FREEZE THAW CYCLES EFFECT

HYBRID - ITEM SPECIFICATIONS

Protective hydrophobic treatment for brickwork, natural and artificial stone facing, porous substrates and concrete, through the supply and pose in work of an hydrophobic photopolymerizable nanostructured organic-inorganic hybrid coating, composed of organic domains of silanes and siloxanes interconnected with a nanometric inorganic structure (type HYBRID – Linea COPERNICO), without any solvents. Highly hydrophobic, breathable and transparent effect.
The application must be performed by brush, by roller or by low pressure spraying, in a single coat wet on wet, upon clean and visibly dried surfaces.

Technical characteristics of the product:

- **Aspect** = liquid;
- **Inorganic content (nanometric silica)** = 30%;
- **Organic content (mainly consisting of silanes and siloxanes)** = 70 %;
- **Density** = 1.10 g/cm^3;
- **Viscosity at 23°C** = 9mPa*s;
- **Yield** = 0,10 – 0,80 kg/m^2 (according to the absorption capability of the substrate).

Properties of HYBRID applied on Porous stone

PROPERTY	STANDARD	Value on UNTREATED Porous stone	Value on Porous stone TREATED with HYBRID
Water repellency	NORMAL 33/89	undeterminable	>130°
Protective effectiveness for capillary rising after 8 days of water contact	UNI 10859:2000	undeterminable	≥89%
Liquid water transmission resistance after 10 days of total immersion	UNI EN 1062-3:2001	W=5.66 Kg/m^2 h^{0,5}	W=0.45 Kg/m^2 h^{0,5}
Water vapour permeability	UNI EN ISO 7783-1:2001	S_D<0.14m	S_D=0.32 m
Accelerated aging by cycles of UV340nm/water condensation	ISO 11507 Method A-Cycle H	undeterminable	>1700h (under investigation)
Abrasion resistance	EN 14157:2005	Thickness loss equal to (0.85 ± 0.17) mm	Thickness loss equal to a (0.30 ± 0.25) mm Increase in surface wear resistance ~65%
Salt crystallization resistance	UNI EN 12370:2001	Mass loss equal to (42.5 ± 1.3) %	Mass loss equal to (0.2 ± 0.01) %
Resistance to aging for high SO_2 concentration in the presence of humidity	UNI EN 13919:2004	Mass variation equal to (1.3 ± 0.3) %	Mass variation equal to (0.6 ± 0.1) %
Resistance to aging for low SO_2 concentration in the presence of humidity	UNI EN 13919:2004	Mass variation equal to (0.2 ± 0.1) %	Mass variation equal to (0.09 ± 0.02) %
Freeze-thaw resistance (25 cycles)	UNI EN 12371:2003	Decrease in the compressive strength equal to 10.6 %	Decrease in the compressive strength equal to 7.4 %
Compressive strength	UNI EN 1926:2000	R= (8.4 E^{-03} ± 0.4E^{-03}) MPa	R= (1.3 E^{-02} ± 0.2E^{-02}) MPa Increase in compressive strength ~56%

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Via Angelo Costa, 1 - 73043 Copertino (Le) ITALY
Tel: (+39) 0832 457457 - Email: info@lineacopernico.com