

# DEVELOPMENT OF ANTIBACTERIAL TREATMENT AND VIRUCIDAL TREATMENT FOR METAL SURFACES

TECHNICAL REPORT 28.01.2021



in collaboration with:







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### INTRODUCTION

The following report summarizes the R&D proces, with the purpose of developingof an antibacterial coating applicable to metal surfaces, with high mechanical and adhesion strength and high resistance in indoor and outdoor environments

### DEVELOPED AND TESTED FORMULATIONS

The coating is based on patented sol-gel technology and involves the synthesis of specific SOLs to create a micrometric layer of functionalized silica on the metal surface, with the addition of active antimicrobial particles.

The sol-gel formulations synthesized during the experimentation were the following.

Formulated	Summary date	Description
SOL INDIA 1	18/09/2020	Silica functionalized with aliphatic groups in isopropyl alcohol (concentration 1).
SOL INDIA 2	18/09/2020	Silica functionalized with aliphatic groups in isopropyl alcohol with the addition of silver nanoparticles (1000 ppm solution)
SOL INDIA 3	29/09/2020	Silica functionalized with aliphatic groups in isopropyl alcohol (concentration 2)
SOL INDIA 4	29/09/2020	Silica functionalized with methyl groups in isopropyl alcohol (concentration 2)
SOL INDIA 5	16/10/2020	Silica functionalized with methyl groups in isopropyl alcohol (concentration 2) with the addition of silver nanoparticles (1000 ppm solution)
SOL INDIA 6	28/10/2020	Silica functionalized with methyl groups in isopropyl alcohol and ethyl acetate (concentration 2) with the addition of silver nanoparticles (1000 ppm solution)
SOL INDIA 7	02/11/2020	Silica functionalized with methyl groups in isopropyl alcohol and ethyl acetate (concentration 2)
SOL INDIA 8	27/11/2020	Silica functionalized with methyl groups in isopropyl alcohol and ethyl acetate (concentration 2) with the addition of silver nanoparticles (500 ppm solution).

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### SAMPLES

The metal samples tested are the following 6 types

Disk AISI 304



Disk AISI 316



Plate AISI 304

Plate AISI 316



Satin plate AISI 304









### METHODS OF APPLICATION

In the preliminary phase of evaluation of the different formulations, the coatings were applied by immersion (manual), evaluating the film-forming power and the aesthetic differences (morphological and chromatic) between the treated and untreated part.



Immersion phase in the SOL

SOL extraction phase

Difference between treated and untreated part

The application of the coating causes a slight reviving effect in the steel, also known as the "wet effect", due to the presence of the thin layer of silica which affects the refractive index and therefore the reflection of light. There are no product accumulations or defects, and in the treated part the coating is homogeneous

To replicate the application in an industrial context, the samples subjected to further tests were made with the conventional spray method (airbrush powered by compressed air). The application of the coating was performed through a fine nebulization of the sol-gel formulations, trying not to create excesses or dripping of the product, with the following parameters:

- Pressure: 0,5 bar
- Nozzle: 0.5 mm
- Distance: 4-5 cm



Application of the sol-gel coating with the spray method.



Application of the sol-gel coating with the spray method.



Application of the sol-gel coating with the spray method.



### **TEST METHODS**

### Characterization of the samples and analysis of the coating

The samples without coating and the coated samples were analyzed through:

- Observations in digital optical fiber microscopy
- Chemical-morphological analysis ESEM-EDS (Environmental scanning electron microscope energy dispersive spectrometry)

The observations in digital microscopy were performed using digital fiber optic microscopes Dino-Lite mod. AM211 with variable magnification (50-200X), mod. AM313T5 with fixed magnification (500X). The ESEM-EDS analysis was performed with an "environmental" scanning electron microscope (ESEM) model FEI Quanta 200 connected to an X-ray fluorescence system (CEASC, Center for Analysis and Services for Certification, University of Padua).



Fiber optic digital microscopy on steel samples.



Fiber optic digital microscopy on steel samples.



ESEM-EDS analysis on steel samples.



ESEM-EDS analysis on steel samples.



### Evaluations on chemical resistance, physical resistance, adhesion

The formulations have been subjected to tests to evaluate the resistance to the main disinfectant procedures defined by the OMS:

- 70% alcoholic solution (water + isopropyl alcohol)
- Sodium hypochlorite 4% in aqueous solution (bleach)
- Soap and water (detergent with anionic surfactant)

The substances were put into contact with the coating by carrying out a first contact test at 5 minutes, and a second at 30 minutes (Internal method).

To evaluate the duration of the coating during the cleaning cycles, using the appropriate methods (soft sponge and aqueous solution with neutral detergent), 5 specimens were subjected to the following test:

- application of the coating with a polyester sponge brush on half of the specimen to make the treated part recognizable;
- wait 72 hours to achieve the stability of the coating;
- application of an aqueous solution and neutral soap on half of the specimen and cleaning with a roto-orbital sander with a polyester sponge (14,000 rpm);
- observation of the specimens after 24 hours.

The adhesion of the coating to steel was tested on AISI 304 and AISI 316 polished discs according to ISO 2409: 2013 (*Paints and varnishes - Cross-cut test*).

The final evaluations for the three test types were performed through ESEM-EDS analyzes.



discs subjected to chemical resistance tests



disc subjected to adhesion test (Cross-cut test)



Discs subjected to adhesion test (Cross-cut test)

### **Outdoor durability assessments**

To evaluate the resistance in the external environment, tests were carried out in an accelerated aging climate chamber. The test parameters were as follows:

- Exposed samples: 3 untreated stainless steel plates (named (NT-1, NT-2 and NT-3) and 3 plates of the same steel treated with SOL INDIA 8 (named 8-1, 8-2 and 8-3).
- Test conditions according to UNI EN ISO 9227: exposure to neutral salt spray
- 5% NaCl nebulized solution;
- Temperature 35 ° ± 2 ° C;

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- pH of the condensate 6.5-7.2;
- Duration 720 hours (for HIGH RESISTANCE CLASS C3);
- 25 ° exposure angle.

The assessment of the degradation of the coating at the end of exposure to the neutral salt spray was carried out according to the following standards:

- UNI EN ISO 4628-2: Evaluation of the degradation of coatings Indication of the quantity and size of defects, and the intensity of uniform changes in appearance Part 2: Evaluation of the degree of blistering;
- UNI EN ISO 4628-3: Paints and varnishes Evaluation of the degradation of coatings Designation of the quantity and size of defects and intensity in uniform changes in appearance Part 3: Evaluation of the degree of rusting.

Tests were performed at "A. Daccò", the Corrosion and Metallurgy Study Center, of Engineering Department - University of Ferrara.

### **Evaluations on antimicrobial efficacy**

Preliminary evaluations with internal method were carried out on bright discs and artificially contaminated satin plates (solution of water and soil, and aqueous solution containing yeast). The verification of the antimicrobial power was measured with a Lumitester smart bioluminometer (Kikkoman) and LuciPacA3 swabs.

The measurements were carried out over a period of 4 hours, collecting the measurement every 15 minutes for the first hour, and every 30 minutes for the following hours..



Internal evaluation test with bioluminometer.



Internal evaluation test with bioluminometer.

The effectiveness of the treatment was tested according to ISO 22196: 2011 - *Measurement of antibacterial activity on plastics and other non-porous surfaces.* The test involves the inoculation of 2 bacterial strains (E. Coli and S. Aureus) and the evaluation of bactericidal efficacy at 24 hours.



### RESULTS

### Preliminary characterization of the material

The analyzes in digital microscopy, and even better the ESEM analyzes, allowed to highlight the structure of the finishing surface of the two types of steel. On a morphological level, the samples have a very similar surface micro-roughness, consisting of almost parallel grooves with variable depths, more consistent in the edges of the holes.

The EDS microanalyses performed both on the polished discs and on the plates indicate almost similar compositions of the two materials, with varying levels of iron, chromium, nickel and carbon. Higher sulfur contents (residue from processing in the ovens) are noted in the shiny samples. In the satin samples (plates) the sulfur values are reduced (for the removal of the first surface) and traces of silicon are present, due to the silicon carbide satin finishing process.

Below are the digital microscopy analyzes of untreated steel.



Sample: untreated AISI 316 plate (central body)							
Ing 50X	Ing 200X	Ing. 500X					



Below are the images of the ESEM morphological analysis of untreated steel.



Sample: untreated AISI 316 plate (central body)								
Ing 1000X	Ing 2500X	Ing. 5000X						



The EDS spectra of the analyzes performed on untreated steel are shown below.

Sample: untreated AISI 304 plate	e (central body)		
	-	Element	Weight %
		СК	1,45
		Si K	0,78
		Cr K	19,26
the instants	11	Fe K	71,14
and the last the last the same of the last		Ni K	7,37

Sample: untreated AISI 316 plate (central body)		
	Flomont	Woight %
	СК	1,21
	Si K	0,62
	SK	0,98
the little	Cr K	18,6
	Fe K	70,01
	Ni K	8,59



### Chemical-morphological analysis of the coating

The ESEM-EDS analyzes made it possible to define SOL INDIA 8 as a product characterized by an optimal formulation and concentration for the purpose of the research carried out. The coating obtained with SOL INDIA 8 is homogeneously diffused on the surface, with slight accumulations in the deepest roughnesses. Small cracks in the coating occur only in the vicinity of edges and are due to product accumulation and analytical conditions (high vacuum conditions generated in the analysis chamber of the instrument). The ESEM analyzes highlight the ability of the coating to saturate the grooves of the satin finish and contribute to a leveling effect without altering the aesthetic characteristics of the steel.







ESEM (BSD) image of the surface of the steel treated with SOL INDIA 8.



EDS spectrum of steel treated with SOL INDIA 8.





Silver appears as a fine dispersion, which gives the coating observed in BSD a hazy appearance. There are accumulations of silver less than 500 nm in size. In ESEM-EDS analysis, the silver signal is always associated with the presence of silicon and therefore with the presence of the coating.

An elementary mapping was performed on the material treated with SOL INDIA 8 to verify the distribution of silver and silicon. The mappings confirm a greater presence of silver where there are higher concentrations of silica, or in the grooves created by the satin finish. The ESEM analyzes of the samples made with the combined system show accumulations of silver and not a uniform dispersion.



Chrome

Nickel



### **Chemical resistance**

The coating has excellent resistance to cleaning with alcoholic solutions (70% ethanol or isopropyl) and to aqueous solutions with neutral surfactants.

The coating has poor resistance to sodium hypochlorite solutions due to the basic attack that is triggered on the silica.



Photo of the sample subjected to chemical resistance tests. The area without coating is the one in contact with sodium hypochlorite solution.



ESEM image confirming the removal of the coating by the sodium hypochlorite solution.

### Physical resistance to cleaning cycles

For the test 5 specimens were subjected to the following cleaning cycles with water and surfactants (neutral solution).

- 3500 cycles test passed
- 7000 cycles test passed
- 10.500 cycles test passed
- 14.000 cycles test passed
- 28.000 cycles test passed



Image of the 5 specimens subjected to cleaning cycles. On the right the specimen of the 28,000 cycles.

The toning of the steel due to the presence of the coating is maintained even after 24 hours from the 28,000 cycle tests. It is concluded that the coating has a resistance higher than 28,000 clining cycles.



### Adhesion

The adhesion tested according to ISO 2409: 2013 (Paints and varnishes - Cross-cut test) shows ISO values close to 0, no gaps of coating are detected to the naked eye after the test. This is shown by the ESEM analyzes which detect only slight and rare detachments located near the orthogonal cuts and affect restricted areas 20-30 microns away from the edge of the cut.



Cross-cut test samples.



AISI316 sample coated with sol-gel coating subjected to *Cross-cut* test.



EXEM images of sample subjected to cross-cut test.



EXEM images of sample subjected to cross-cut test.



### Resistance in the external environment

Following the accelerated aging tests (UNI EN ISO 9227, 720 hours in salt spray) the coating demonstrates a high resistance in the external environment. According to UNI EN ISO 4628-2 and UNI EN ISO 4628-3, was obtained a 0 blistering density ( complete absence of blistering) and a degree of rusting equal to Ri 0 (. complete absence of rust spots).



Labored 6.4 timbers align 128 and photosecurity in terms within



Levines 4.2 holids man 758 yrs or experiment in reason value.



Images taken from the analysis report, samples treated with SOL INDIA 8 after the accelerated aging test.



### Antimicrobial activity

The results of the measurements performed with a bioluminometer are shown below. These results demonstrate an exponential reduction of contamination by microorganisms. Specifically, the coating is able to reduce the microorganisms present on the surface by 96.35% in 3 hours.

Solution contaminated with soil



Trend of RLU values over time, measurements performed on AISI 304 satin plate treated with SOL INDIA 8.



RLU value versus Time

Trend of RLU values over time, measurements performed on AISI 316 polished disc treated with SOL INDIA 8.



### Aqueous solution with yeasts



**RLU** value versus

Andamento dei valori RLU nel tempo, misure eseguite su placca satinata AISI 304 non trattata.



### RLU value versus

Trend of RLU values over time, measurements performed on AISI 304 satin plate treated with SOL INDIA 8.



The tests performed according to ISO 22196: 2011 - Measurement of antibacterial activity on plastics and other non-porous surfaces were successful and report the following values:

STRAIN: Escherichia Coli ATCC 8739	SOL INDIA 8 test 1	SOL INDIA 8 test 2 (according to ISO)
Determination of antibacterial activity	> 5,5	> 5,5
Antibacterial activity (%)	> 99,999	> 99,999
No bacteria available in the inoculum	160.000	400.000
Uo (bacteria on untreated after inoculation) log	4,0	4,4
Ut (bacteria on untreated 24 hours after inoculation) log	5,5	5,5
At (bacteria on specimens treated after 24 hours from inoculation) log	NQ	NQ

STRAIN: Staphylococcus Aureus ATCC 6538	SOL INDIA 8 test 1	SOL INDIA 8 test 2 (according to ISO)
Determination of antibacterial activity	> 3,3	> 2,5
Antibacterial activity (%)	> 99,948	> 99,714
No bacteria available in the inoculum	350.000	260.000
Uo (bacteria on untreated after inoculation) log	4,3	4,2
Ut (bacteria on untreated 24 hours after inoculation) log	3,3	2,5
At (bacteria on specimens treated after 24 hours from inoculation) log	NQ	NQ



Once the antibacterial property had been verified, following the results obtained on bacterial strains, it was virucidal activity was also evaluated ISO 21702:2019 'Measurement of antiviral activity on plastics and other non-porous surfaces'. The analysis was performed by inoculating SARS-CoV-2\_COV2019 ITALY/INMI1 (Log TCID50 inoculum: 6.88) on treated and untreated samples, measuring antiviral activity using the following formula:

R = Ut - At

dove:

R is the value of antiviral activity

Ut is the average of the log TCID50/cm2 of the 3 untreated samples at time Tx At is the average of the log TCID50/cm2 of the 3 samples processed at time Tx

The tests were positive and reported the following values::

Cysercainay and								
Modin Log TCID <sub>10</sub> S (TCID <sub>10</sub> Test solid of Remote TCID <sub>10</sub> () ad anity								
Negativa control-	433	10,011	Se - 101.00	0.0	000			
Vintration annuals	4,08	10 th	So = 10 <sup>4000</sup>	150-Sult (0.5.)	0.25	Valid-		
Trented sample	3.92	-101.4	$St = 10^{4.91}$	Se-Stor 0.5	6.41	Valid		

	Tim	Log	YCID	(TCID-Jun')	TR.	R	Tail talid (Crowl) in between
Alimnoise?	19	5.25	$10^{1+\epsilon}$	1.11×10*	64	1/ an la	25 x 10' - 1.2 x 10' (TCID-scinic)
secopte /	134	8.75 -	102-00	- 8.93 x 10 <sup>+</sup>	8.55		

_	Tem	Average Log TCID <sub>10</sub>	TCD-11	(Trillsalam)	M	ell'as	(74 confectacio version 7.9)
Tirested Sample	Di	Ait	10/10	ALL	X901	0.10	99.17

(Tables extracted from report 21RP00734 dated 29/03/2021)

The antiviral efficacy found in the sample treated with SOL INDIA 8 after 24 h, compared to the untreated sample after 24 h, is as follows

R = 3.96-4.55 = **0.59** which corresponds to **74.88%** abatement.

Considering only the sample treated with SOL INDIA 8, and evaluating the efficacy at 24 h after inoculation compared to time 0, a knock-down rate of 99.17 % is obtained.



### Test report n°: 21RP00734 dated 29/03/2021

Dear IND.I.A. S.p.a. Via Vicenza, 8/12 36034 Malo (VI)

### Acceptance Data

Subject of the test: Generic Material Transport: Customer Date of arrival: 23/02/2021 Time of arrival: 17.12 Acceptance date: 23/02/2021



### Sample data (C)

Description: IAM Design + Antibact

### Sampling data

Sampling by: Customer Place: Sede del Cliente



### follows Test report nº: 21RP00734 dated 29/03/2021

Parameter - Specification Method - Notes	M.U.	Results Notes	LoQ	LoD	Test start Test end
Virucidal activity (e) ISO 21702:2019	ຮ	See Test report n 2100033/01 of 29/03/2021	o		23/02/21 29/03/21

If the sampling is not the responsibility of Chimicambiente S.r.I., the latter declines all responsibility for the information relating to sampling as provided by the Customer; the results of the tests refer exclusively to the sample as received. When these data include measurements that impact on the unit of measurement, the results expressed are obtained by processing them. The acceptance data are the responsibility of the Laboratory while the data relating to the sample are marked with a "C" if it is the responsibility of the Customer.

If the sample is unsuitable but the Customer chooses to continue anyway, the laboratory declines all responsibility for the results that could be influenced by the deviation.

LEGEND: **U.M.** = unit of measurement; (**sup**) = upper limit; (**inf**) = Lower Limit; **LoQ** = limit of quantification, is the lower concentration limit above which it is possible to obtain a quantitative measurement instrumentally; in microbiology the LoQ is theoretical in nature; LoD = limit of detection, it is the lower concentration limit below which the sample cannot be detected; in qualitative analyzes it represents the minimum concentration at which it is possible to determine or not the presence of an analyte; **NQ** = not quantifiable, indicates a value lower than LoQ; "**< x**" or "**> x**" respectively indicate a value lower or higher than the measurement range of the test, where x is the result; **N.A.** = not applicable to the test; **M.I.** = internal method. (**m**): Indicates a change from the previous version of the test report.

(m): indicates a change from the previous version of the test report. (e): Indicates that the test/activity was performed under subcontract.

The analytical results refer exclusively to the sample under test.

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The samples are kept in the laboratory for 2 weeks from the end of the test, unless otherwise indicated.

The records of the tests carried out are kept by the laboratory for 5 years from the issue of the test report.

IF NOT DIFFERENTLY SPECIFIED: the results of this test report are not correct for the recovery factors (R) as the recovery values fall within the tolerance indicated in the test method; the summations are calculated using the lower bound criterion (L.B.); the values for present on the test report) reported in the "uncertainty" column refer to the expanded uncertainty with coverage factor K approximated to 2, probability level = 95%; the sampling report is identified and filed with the same sample acceptance code or with the relative order number.

The uncertainty is expressed in units of measurement of the parameter to which they relate. The coverage factor is equal to k=2 with a probability range of 95%.

**Technical Director** 

Gioachin Dr. Carlo Chemist Ordine Interprov. Chimici del Veneto - Padova nº 860 SEZ. A

----- End of Test Report



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## Test report n° 2100033/01

### CHIMICAMBIENTE S.R.L. VIA LEONARDO DA VINCI, 2 35042 - ESTE (PD) - IT

Test information							
MATERIAL	Not specified						
ITEM	Samples: 21RP00734 Treated, 21RP00734 Untreated Treatment: not specified						
METHOD	ISO 21702:2019 "Measurement of antiviral activity on plastics and other non porous surfaces"						
Date of receipt	25 February 2021						
Samples	<ul> <li>Treated sample: 50 x 50 mm<sup>2</sup>, 1 mm thick;</li> <li>Untreated sample: 50 x 50 mm<sup>2</sup>, 1 mm thick;</li> <li>Cover film: polypropylene film 40 x 40 mm<sup>2</sup>, thickness 0.10 mm</li> <li>All the samples were sterilized by exposure to UV rays;</li> <li>Volume of test inocululm: 400 uL.</li> </ul>						
Conservation	Room temperature						
Test temperature	25°C ± 1°C						
Incubation temperature	37°C ± 1°C						
Viral strain	SARS-CoV-2_COV2019 ITALY/INMI1						
Permissive host cell line	VERO E6						
Contact time	24h						

### Test report n° 2100033/01

### Calculation of antiviral activity

Antiviral activity is calculated with the following formula:

R = Ut - At

where

R is the evaluation of antiviral activity

Ut is the mean of log TCID50/cm<sup>2</sup> of the 3 untreated samples at time Tx

At is the mean of log TCID50/cm<sup>2</sup> of the 3 treated samples at time Tx

Log TCID<sub>50</sub> inoculum: 6.88

- )									
	Media Log	TCID <sub>50</sub>	S (TCID <sub>50</sub> /	Test valid if	Resu	ılts			
	TCID <sub>50</sub>	/1 ml	ml)						
Negative control	4.33	104.33	$Sn = 10^{4.33}$	n/a	n/a	n/a			
Untreated sample	4.08	10 <sup>4.08</sup>	$Su = 10^{4.08}$	$ \text{Sn-Su}  \le 0.5$	0.25	Valid			
Treated sample	3.92	10 <sup>3.92</sup>	$St = 10^{3.92}$	$ \text{Sn-St}  \le 0.5$	0.41	Valid			

Cytotoxicity test

### Test results

	Time	Average Log TCID <sub>50</sub>	TCID <sub>50</sub> /1 ml	N (TCID <sub>50</sub> /cm <sup>2</sup> )	Ut	R  Ut-At	Test valid if result is between
Untreated sample	Т0	5.25	10 <sup>5.25</sup>	1.11 x 10 <sup>6</sup>	n/a	n/a	$\begin{array}{c} 2.5 \text{ x } 10^5 - 1.2 \text{ x } 10^6 \\ (\text{TCID}_{50}/\text{cm}^2) \end{array}$
	T24	3.75	$10^{3.75}$	$3.51 \times 10^4$	4.55	n/a	n/a

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### Test report n° 2100033/01

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	Time	Average Log TCID <sub>50</sub>	TCID <sub>50</sub> /1 ml	N (TCID <sub>50</sub> /cm <sup>2</sup> )	At	R  Ut-At	[% reduction versus T0]
Treated Sample	T24	3.17	10 <sup>3.17</sup>	9.17 x 10 <sup>3</sup>	3.96	0.59	99.17

This Test Report refers only to the sample tested; the name and description of the sample are declared by the Customer. This test report may only be reproduced in full; partial reproduction must be authorized with written approval by the Laboratory. ° Test in service (same Group).

Prato, 29 March 2021

End of test Report

The Responsible,



### Test report n°: 21RP00734 dated 19/04/2021

Dear IND.I.A. S.p.a. Via Vicenza, 8/12 36034 Malo (VI)

### Acceptance Data

Subject of the test: Generic Material Transport: Customer Date of arrival: 23/02/2021 Time of arrival: 17.12 Acceptance date: 23/02/2021



### Sample data (C)

Description: IAM Design + Antibact

### Sampling data

Sampling by: Customer Place: Sede del Cliente



### follows Test report nº: 21RP00734 dated 19/04/2021

Parameter - Specification Method - Notes	M.U.	Results Notes	LoQ	LoD	Test start Test end
Virucidal activity (e) ISO 21702:2019	S	See Test report n 2100033/01 of 29/03/2021	l°		23/02/21 29/03/21

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The uncertainty is expressed in units of measurement of the parameter to which they relate. The coverage factor is equal to k=2 with a probability range of 95%.

### Notes:

(m) The result in according to ISO 21702:2019 is expressed as R=Ut-At=0.59, which in percentage corresponds to 74.296%.

**Technical Director** 

Gioachin Dr. Carlo Chemist Ordine Interprov. Chimici del Veneto - Padova nº 860 SEZ. A

----- End of Test Report



### CONCLUSIONS

The experimentation allowed to develop a suitable solution for the application required by the research purpose. The **SOL INDIA 8** formulation proves to have the characteristics to be applied on steel to give antibacterial properties to the IAM + range

The main properties of the formulation are the following:

• Solution based on functionalized silica with the addition of silver nanoparticles, conveyed by isopropyl alcohol;

- Applicable with low pressure spray system;
- Excellent adhesion to the substrate (steel) according to ISO 2409: 2013;
- Resistance to> 280,000 cleaning cycles;

• Cleanable surface with hydroalcoholic solutions or neutral aqueous solutions with surfactants;

- Not resistant to sodium hypochlorite solutions (even at low concentrations);
- Antibacterial activity> 99% according to ISO 22196: 2011;
- Outdoor resistance (UV and salt spray conditions): HIGH DURABILITY according to UNI EN ISO 9227, UNI EN ISO 4628-2 and UNI EN ISO 4628-3.

Malo 28.01.2021

Padova 28.01.2021

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