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P.IVA e CF 02478641208

Evaluation of bactericidal effect on GHA treatment

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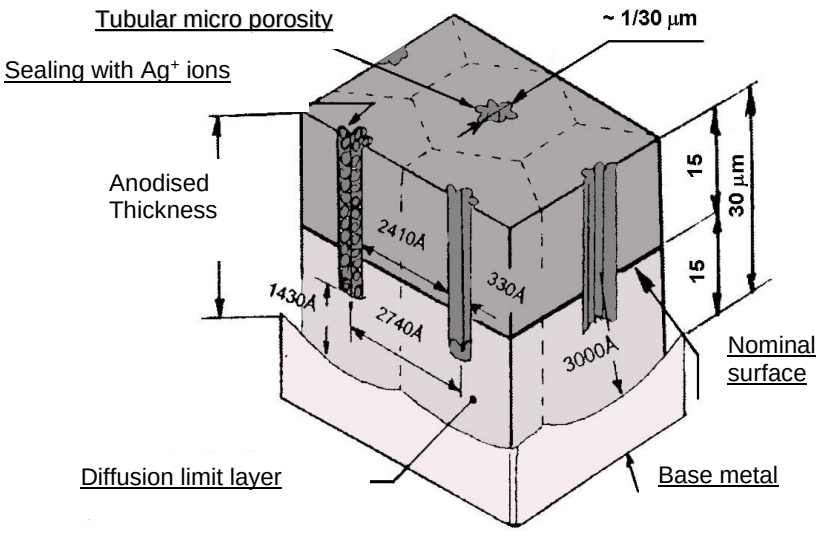
1. What is GHA

GHA® is the most recent and innovative technology applicable to the surface of all aluminum alloys. It consists of a special anodic oxidation treatment, with thickness ranging from 1 to 200 μm, followed by a sealing of the microporosities through silver ions (Ag +).

Aluminum alloys have a surface area which is extremely vulnerable to scratching and abrasive wear because of their low hardness. They also tend to oxidize spontaneously, causing dangerous types of corrosion, widespread or localized (Pitting). That is why there is always a protection such as painting, chromium plating, nickel plating, anodizing, etc. on aluminium bodies.



The Anodic Oxidation of aluminum alloys is the safest among all the protective treatments because it's unremovable, in fact, during the galvanic process, aluminum is transformed into aluminum oxide (Al_2O_3), generating a very hard protective layer, similar to ceramic, which is refractory and unremovable. Aluminum oxide crystals are disposed in a honeycomb structure, very hard and compact, with a capillary hole at the center of the octahedro which passes through them almost completely. Unfortunately, the porosity of the crystals of the anodic oxide constitutes a real defect that limits their applications, especially in cases where surfaces work in highly corrosive environments. The base aluminum, in fact, is in contact through the pores with the corrosive environment. These pores are also a receptacle for dirt and bacteria so that the anodised surfaces get dirty easily. For this reason they are often treated with colouring substances to seal the pores (with black or other colours).

The researchers of the company SOUKEN of Kyoto studied the possibility of sealing the crystal pores of the anodic oxides by a special galvanic process using Silver ions (Ag^{+}), thereby transforming what was considered a weakness (the porosity) into a winner. In fact, these pores provide a proper reservoir for Ag^{+} ions, thus being uniformly distributed on the surface and permanently present during the wear of the oxide layer. The process GHA (Golden Hard Anodizing) was then patented in Japan, Korea, United States and European Community (Patent No. EP1207220). The high hardness of anodic oxide, HV 500-600, combined with the extraordinary properties of silver ions, see Table 1, gives to the treated surface biotechnological characteristics of great practical interest, see Table 2, ranging from the pharmaceutical and food industry to the technical and scientific fields, see Table 3. Not to mention the high hardness and refractory heat factor that are typical of the anodic oxides.

Table 1 - Property of GHA® treatment with silver ions Ag^{+}
- Low coefficient of friction, self-lubrication and wear resistance
- Corrosion resistance
- High thermal conductivity and high thermodynamic efficiency
- High antistatic capacity
- Ability to absorb heat and diffuse it as ultra-infrared waves
- High antibacterial capacity and anti-mold (Bactericidal)

Table 2 - Biotechnology Features						
Material	**Hardness HV**	**Melting**	**Coefficient of friction**	**Bacteriostatic capacity**	**Corrosion resistance SST**	**Resistance to consumption**
Aluminum Alloy	70÷100	680°C	0,44	None	100 hours	10^2 hours
Hard anodising with GHA®	500÷550	2100°C	0,025	High	10.000 hours	10^5 hours
hard anodising	500÷550	2100°C	0,15	None	200 ÷ 500 hours	10^3 hours

Table 3 - Applications of GHA® treatment
- Components of industrial machines - Automotive components - Components of office machines - Kitchen Items and appliances - Components for housing and related accessories - Components for electronics - Thermal radiators, heat exchangers, solar panels - Clothing, electric blankets, carpets - air conditioning filters

Table 4 - Results of tribological tests of three selected coatings			
Sample of Anticorodal 100 with a coating of:	**Coating hardness $HV_{0,05/15"}$**	**Δ Weight (g)**	**Coating thickness**
GHA®	520	0,0006	4 μm
NICHEL-TEFLON	730	0,0013	19,5 μm
ELECTROLESS NICKEL	780	0,0025	30 μm

Therefore the coating GHA, if combined with the appropriate aluminum alloy, can be considered by the designers as a real new material and can be a good alternative to expensive metals such as titanium alloys, stainless steel or steel coated with expensive noble treatments like TIN - PVD - CVD - Hard chromium - Chemical nickel - nickel-Teflon etc.

2. Foodborne Illness

Foodborne Illness diseases are still a major public health problem, caused mainly by demographic and cultural factors as well as the increased mobility of people and goods around the world. In the past, episodes of foodborne illness were more limited, they took place in family or community environments, mainly due to family behaviors and techniques of food preservation. These diseases show in most cases a higher incidence and morbidity in certain groups of people such as the elderly, children, pregnant women and immunosuppressed. The majority of these diseases has a short period of durability and a self-limited course, even if certain pathogens can cause chronic diseases.

3. Classification of Foodborne Illness

Among the main foodborne illness, we distinguish:

Food infections - caused principally by the ingestion of living microorganisms that multiply and invade the host. Often these microorganisms are natural guests of the enteric tract of Animals and Men (E. coli, Salmonella, Campylobacter, etc.). They are most often transmitted by faecal-oral route due to poor personal hygiene practices or contamination of surfaces of common use such as door handles, handlebars of shopping trolleys, computer keyboards, bus seats and handles, money... The pathogenicity is generally related to the factors of bacterial adhesion with which the pathogens cause cellular damage in the intestine once ingested, as in the case of dysentery.

Infections by Food Toxins - caused by the ingestion of food containing microorganisms that multiply in the body producing toxins. Usually, bacteria enter the body and release toxin (like Clostridium perfringens). These diseases represent rarely a threat for healthy adults but can characterize epidemics forms for elderly people and children.

Food poisoning - due to the ingestion of a preformed toxin in the food, the only responsible for the disease. A very well known example is mushroom poisoning or Botulinum poisoning caused by the toxin present in badly prepared or preserved handicrafts. Among the most common causative agents of food poisoning we can find Staphylococcus aureus, Clostridium botulinum, Cl. Perfringens and Bacillus cereus.

4. The European Food Safety Authority (EFSA)

EFSA is the European agency that operates independently and in close cooperation with national authorities, it provides scientific advice on the safety of food and feed. EFSA was established in January 2002 and periodically publishes a report on the cases of foodborne illness occurring within the European area. Recently they have reported more than 50,000 cases of which more than 5,000 have led to hospitalization and 41 to death (data relating to the year 2012).

5. Contamination of Food

It is important to know that is not necessary to be sick to release pathogens into the environment, in fact, many of these can live in our oral cavity, such as Staphylococcus, or in our gut, such as Escherichia coli, and we can relase it unwittingly into the environment. Bacteria, viruses, toxins and Chemical contaminants of various nature are the main causative agents of the Foodborne Illness which can contaminate food during production, processing, preparation, storage, transport and distribution. It is therefore easy to understand that there are different modes of contamination, distinguished as follows:

Primary contamination - when the food raw materials contain the contaminant, such as chemical residues in milk, fruit and eggs or meat contaminated from feed of poor quality;

Secondary contamination - when the human processing practices cause contamination of the food raw materials directly or indirectly, often through inadequately sterilised equipment or poor hygiene of the staff. In these cases, contamination can take place via microorganisms from respiratory infections and oral cavity, such as bronchitis and tonsillitis, or by bacteria present in the excrement as in the fecal-oral trasnmitted diseases, such as salmonella, or bacteria due to skin injuries.

6. Microbial Strains considered by ISO 22196:2011

The norm ISO 22196 : 2011 under consideration requires, as a basic criterion for this type of investigation, the analysis of two bacterial species, a Gram-positive and Gram-negative, considered the most representative and here listed in Table 5.

Name	Strain
Escherichia Coli (*Gram-*)	ATCC 8739 CIP 53.126 DSM 1576 NBRC 3972 NCIB 8545
Staphylococcus aureus (*Gram+*)	ATCC 6538P CIP 53.156 DSM 346 NBRC 12732 NCIB 8625

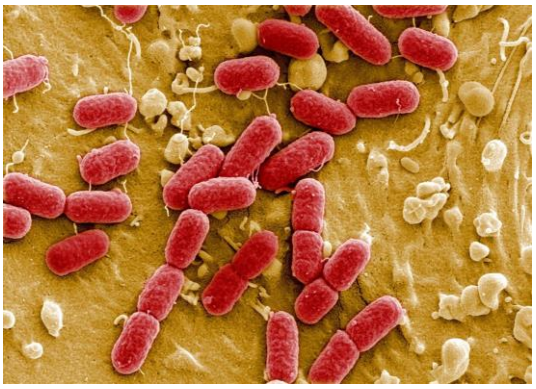
Tabella 5 – ceppi batterici presi in considerazione dalla norma ISO 22196

Among the Bacterial strains most involved in the Foodborne illness, the faecal coliforms are the most represented group. Belonging to the family of Enterobacteriaceae, they mainly live in the intestine of humans and other warm-blooded animals. These Bacteria are generally rod-shaped, aerobic-anaerobic facultative, non-spore-forming, able to live at the temperature of 44.5 ° C.

They are considered a good detector of faecal contamination for food when detected, having mainly an intestinal habitat. Among these we analyzed two of the most representative ones: Escherichia Coli and Salmonella Typhimurium.

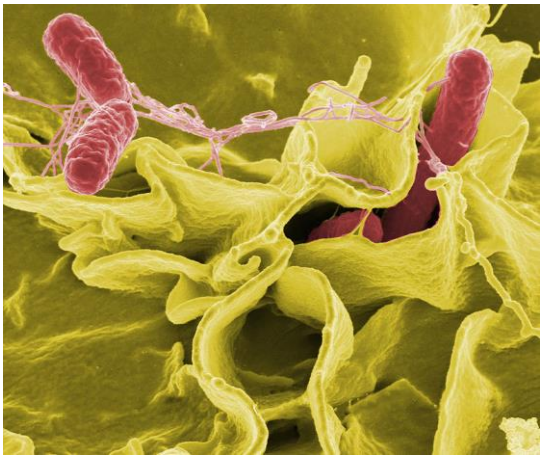
In this study we have also taken into consideration also bacteria responsible for diseases of the respiratory tract, such as Legionella Pneumophila and Staphylococcus aureus, and others considered opportunistic pathogens for man, or responsible for diseases that occur only in presence of predisposed categories such as the elderly, the immunocompromised and people with serious chronic illness or subjected to prolonged antibiotic treatments. Among these, we considered the bacterium Pseudomonas Auruginosa and the fungus Candida albicans.

7. Escherichia Coli



Considered the most representative among the fecal coliform, named after its discoverer, the Austrian Theodor Escherich. It is a Gram-negative Bacterium, with optional aerobic-anaerobic capacity. In the world there are many variations, at least 171, distinct in serotypes with a different combination of antigens (divided into O, H, K, F). It is one of the most versatile pathogens in the human body and, having different pathogenic factors, can cause various morbid diseases. We can distinguish strains called **uropathogenic**, because responsible for most of the endogenous infections of the urinary tract, and **enterithogenic**, responsible for enteritis, often due to exogenous infection contracted by the ingestion of contaminated food. Among these, 4 distinct groups assume an important role for their pathogenicity: the Enteropathogenic (EPEC), Enterotoxigenic (ETEC), Enteroinvasive (EIEC) and Enterohemorrhagic (EHEC). The first two (EPEC, ETEC) don't produce toxins and their pathogenic action is linked to the damage of the intestinal mucosa, while the remaining two groups (EIEC, EHEC) play an essential role in the production of toxins.

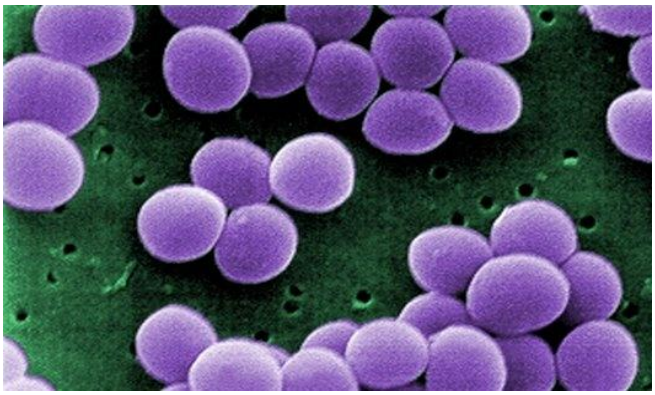
8. Salmonella



It is a Gram-negative bacillus, asporogenous, facultative anaerobic, provided with scourges sides to move within the body once ingested. Generally we can find them in the intestine of infected people, they are divided into pathogenic serotypes, exclusive to humans as S.typhi and S. Paratyphi, exclusive to animals.

They can cause Salmonellosis minor as well as rare and severe Typhoid. The period of incubation, in any case, is very short and the first symptoms affect the gastro-intestinal tract with abdominal pain, nausea, vomiting, fever and diarrhea.

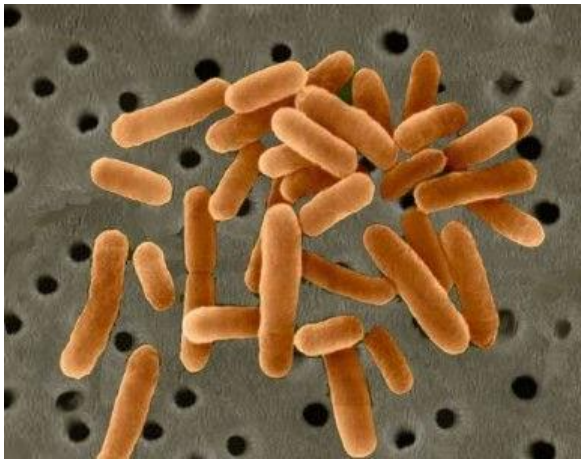
9. Staphylococcus Aureus



It is a bacterium of spherical-shape, often arranged in irregular clusters in the form of bunch of grapes. It is motionless, Gram-positive, aerobic-anaerobic facultative, non-spore-forming, its development takes place between 10°C and 45°C with an optimum of temperature between 30°C and 37°C. It is normally present in the skin and mucosa of the anterior portion of the nose and pharynx in most adults, it is easy to imagine how the man is constantly exposed to the risk of infection. The resulting pathologies differ among each other greatly according to the location of the infection. There are up to 30 species of Staphylococcus Aureus, some of which can cause intoxication and various pathological manifestations due to some characteristics *exotoxins* and enzymes capable of damaging other cells and spread to the surrounding tissues. Among these can be found the *citolisine*, toxins that can attack the host cells and the *enterotoxins*, that exert their toxic action on the gastrointestinal mucosa. *Epidermolytic toxins* can also be produced, they are known as exfoliative and are responsible for the epidermal necrosis and *Toxic-shock syndrome* toxin. Unfortunately, these bacteria

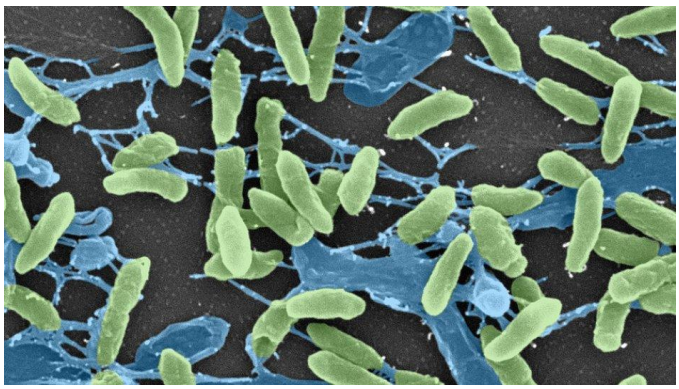
are antibiotic resistant, especially in the so-called nosocomial infections (contracted during a hospital stay), constituting a very serius health problem.

10. Legionella



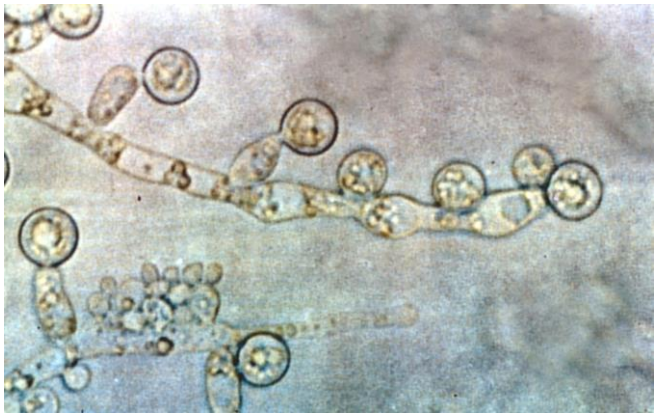
It's a Bacterium belonging to the Family of Legionellaceae, denomination specifically created in 1979 to include a new bacterium that just before had caused a form of pneumonia, manifested in the form of outbreak in a group of veterans of the American Legion (an epidemic named Legionnaires' disease). It is a Bacterium Gram-negative, occasionally mobile, known at least in 30 different species divided into 50 different serotypes. It is mostly found in natural aquatic environments or in artificial water systems like tanks, air conditioning systems (enviroment and car), plumbings, fountains and swimming pools. It can survive with a water temperature between 5°C and 55°C with an optimal temperature between 25°C and 42°C. The infection occurs via aerosols (tiny droplets of water in suspension), and may cause two different clinical conditions: Legionellosis, a serious disease that can give headaches, cough, gastrointestinal and neurological symptoms, and Pontiac fever, a disease of short duration (2-5 days) but with fever, indisposition and headache.

11. Pseudomonas aeruginosa



It is a Gram-negative bacillus, capable of moving thanks to a polar flagellum, aerobic-anaerobes facultative. As a result of its poor nutritional needs and its ability to adapt to different environments, it is defined ubiquitous, also defined as occasional commensal of the upper airways and of the fecal material in humans. It is also called an opportunistic bacterium because it can generally cause infections in humans only if there are favouring circumstances such as injuries, burns, immunosuppression, AIDS... It causes diseases especially in the lower respiratory tract in patients with predisposing conditions, but also bones and joints infections. The pathogenic action is determined by the production of numerous substances including toxins such as *exotoxin-A*, *cytolytic toxins*, capable to attack and kill the host cells and numerous substances that favor the adhesion and dissolution of cell membranes.

12. Candida albicans



It is a commensal fungus belonging to the group of the yeast-like fungi (class: Saccharomycetes, family Debaryomycetaceae). It is a normal commensal of the skin and membranes of mucose of the mouth, gastrointestinal tract and genitals. Like all these opportunistic pathogens, these endogenous yeast are capable of exerting their virulence only if the indispensable predisposing conditions exist, as in the case of debilitated people, immunocompromised or subjected to lengthy antibiotic treatments as well as people subjected to prolonged and intense stress (study-related and work-related). It can become pathogenic in humans causing *Candidiasis*, revealing himself as a mucosae disease (thrush, vulvovaginitis), skin and nails (onychomycosis). It multiplies abnormally, and through the intestines it can reach the circulatory system by releasing some toxins causing Candidaemia with bloating, slow digestion, constipation, diarrhea, irritability, insomnia, headaches and depression.

13. Regulatory Aspects

The International Organization for Standardization (ISO), creates and publicizes international norms, requirements, guidelines and parameters in order to provide a unique and rational criterion to ensure clarity and safety at work. The creation of International Standards encourages therefore the exchange of ideas and stimulates the trade quality, minimizing errors and uncertainty. The standard to which we refer is the ISO 22196: 2011 regarding the measurement of antibacterial activity on plastic surfaces, which is based itself on the method JIS Z 2801:2010. These rules place the guidelines on the methods of analysis, the materials and the evaluation criteria for interpreting the results to provide unequivocal standards of analysis.

14. Method of Analysis of Norm ISO 22196 : 2011

The method involves the analysis of at least three replicates for each treated sample and six replicates of the same sample, untreated (Blank).

Half of the six untreated replicates are used for the determination of viable bacterial cells, soon after inoculation (time zero), while the other three are used for counting the number of viable cells after incubation for 24h. The use of at least three replicates per test sample helps to reduce the variability of the test eliminating by the final evaluation any false-negative and/or false-positive.

The materials to be analyzed, the treated and untreated, must comply with common standards, including the size of the sample which, in this case must be of (50±2)mm per side and no more than 10mm of thickness (see Figure 1).

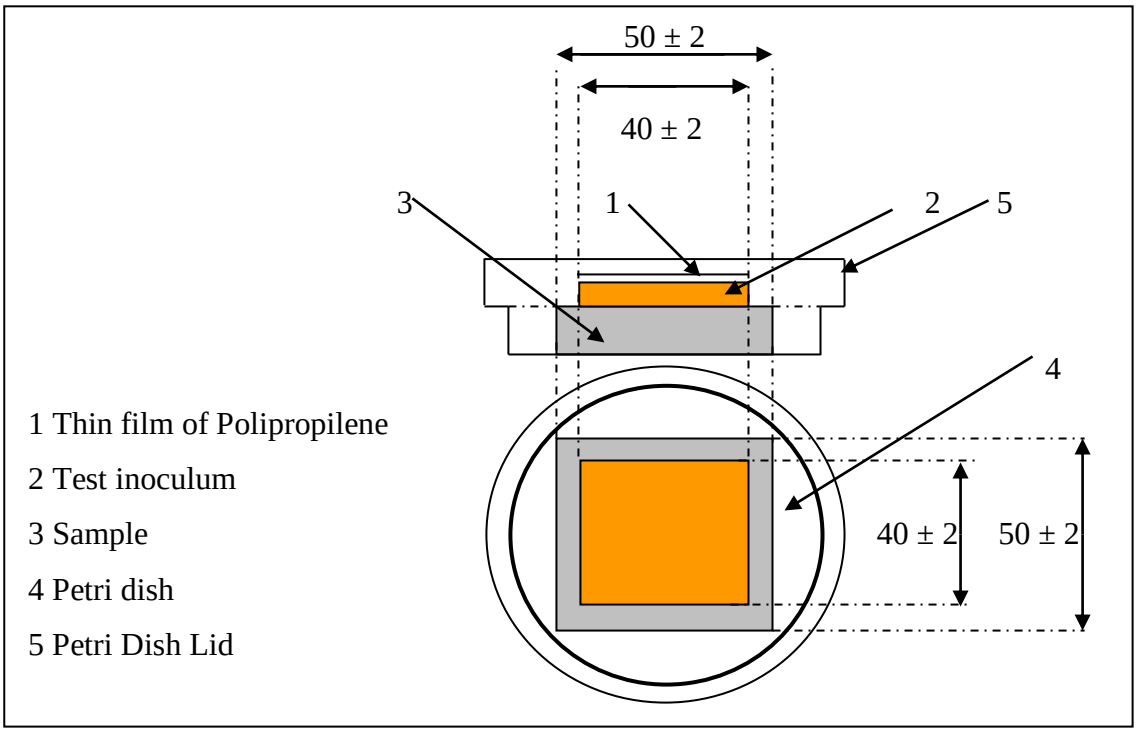
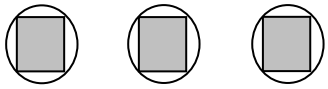
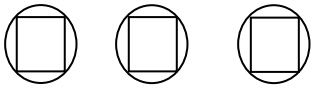
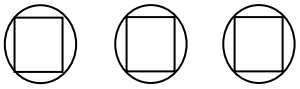


Figure 1

15. Procedure of the method performed

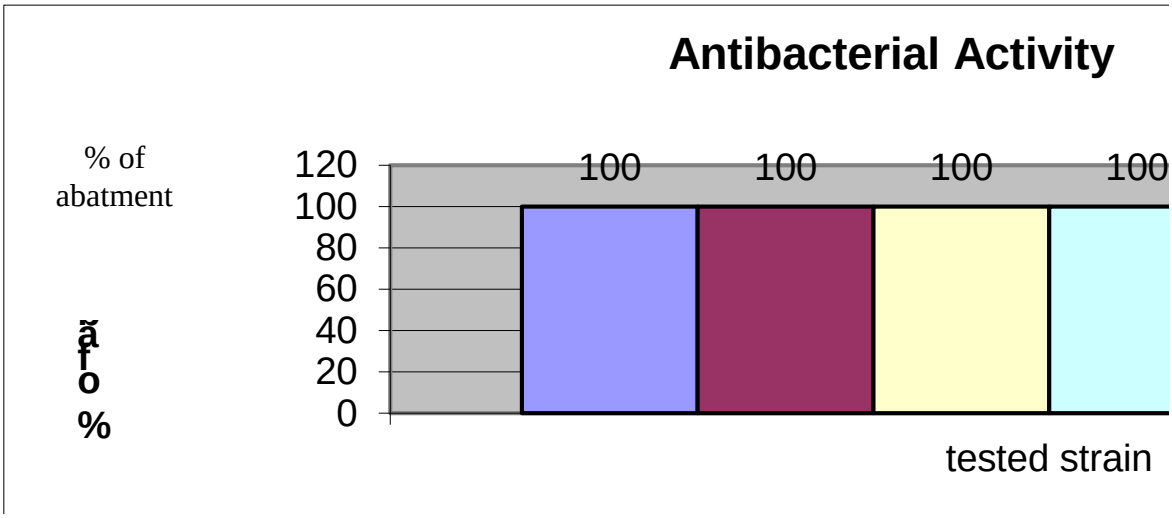
Once Bacterial crops are prepared, the sowing of specimens treated with a dilution of a known concentration of the bacterial suspension takes place. The sample is covered with a thin film, which can be of polyethylene, polypropylene or polyester. After pressing gently the film, ensuring the inoculation test spreads until the edge of the cover film, three Petri dishes of the six Blanks are immediately "washed" through a slight mechanical agitation, adding 10 ml of a standard culture (called SCDLP) which has the double function to avoid cross-reactions between inoculated bacterial strains and possible contaminants. This phase, called "washing", allows to pick up the bacteria at the beginning of the test (Time 0). The 6 Petri dishes containing the samples and the three inoculated culture broths, are then closed and incubated at a temperature of (35±1)°C, at a relative humidity of not less than 90% for (24 ± 1)h. After 24 hours, the 3 Petri dishes containing the culture broths are analyzed for the bacterial colony counting, related to the contamination of the Blanks at Time Zero while the remaining samples are then "washed" with SCDLP broth and spread on new Petri plates and incubated for a further 24h. After this incubation, the count of the bacterial colonies on the remaining plates takes place, finally comparing GHA treated samples with Blanks to evaluate the difference in growth (see summary diagram of the analysis being performed).

Simplified diagram of the main analysis steps			
	Treated Samples	***Untreated Samples (Blanks)***	
			
Step 1	Sowing a known concentration of bacterial preparation and coverage of all the specimens with a polypropylene film,		
Step 2			Wash 3 Blanks with 10 ml of SCDLP and sowing on Petri plates for the determination of bacterial concentration at Time Zero (T0)
Step 3	Incubation at (35±1)°C for (24±1)h at a relative humidity of not less than 90% of all trucks.		
Step 4			Evaluation of the three Blanks for counting bacterial colonies at Time Zero (T0)
Step 5	Washing of 3 treated samples and 3 Blanks remained with 10 ml of SCDLP and sowing on Petri dishes		
Step 6	Incubation of the samples at (35±1)°C for (24±1)h at a relative humidity of not less than 90%		
Step 7	Evaluation of Petri dishes (relative to the treated samples and the Blanks) for the detection and counting of the bacterial colonies at Time 24h		

16. Results

The antibacterial activity (R), as outlined in the norms ISO 22196: 2011 and JIS 2801: 2010, defines as BACTERICIDAL a substance that has an (R) value ≥ 2.0. Following the parameters of analysis and canons of determination of these standards, the GHA treated samples we tested showed BACTERICIDAL efficacy in all cases (See table 6).

Table 6 – Detrmination of antibacterial activities on samples treated at 25 µm		
Bacteria tested	**R**	**antibacterial activities %**
- Escherichia Coli	3,6	100
- Salmonella Typhimurium	3,3	100
- Staphylococcus Aureus	4,2	100
- Pseudomonas Aeruginosa	2,6	100
- Legionella Pneumophila	2,9	100
- Candida Albicans	3,1	100

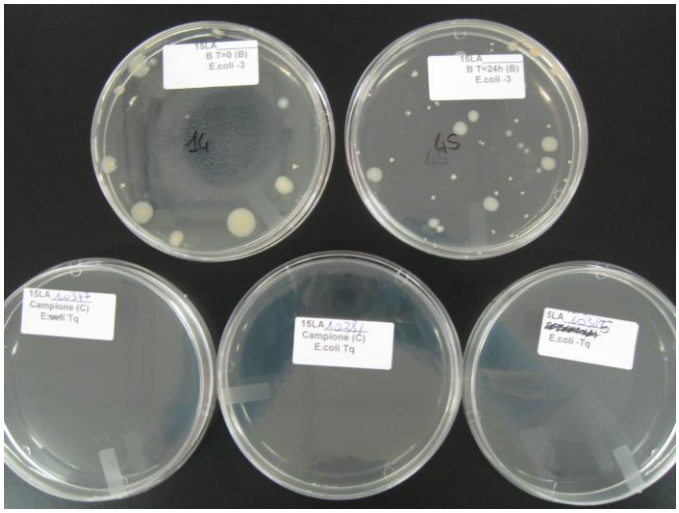


We also tested the bactericidal activity considering different thicknesses of treatment (10µm, 25µm, 40µm) to value their effectiveness and, as can be seen in Table 7, the antibacterial activity (R) has remained constant for each strain, confirming that the bactericidal activity of GHA is closely linked to the treatment itself.

Tabella 7 - Determination of antibacterial activities (R) = (U_t - U_0) - (A_t - U_0)	
Samples trated at 10µm	**R**
- Escherichia Coli	3,3
- Staphylococcus Aureus	4,2
- Candida Albicans	3,2
Samples trated at 25µm	
- Escherichia Coli	3,6
- Staphylococcus Aureus	4,2
- Candida Albicans	3,1
Samples trated at 40µm	
- Escherichia Coli	3,3
- Staphylococcus Aureus	4,2
- Candida Albicans	3,2

ESCHERICHIA COLI

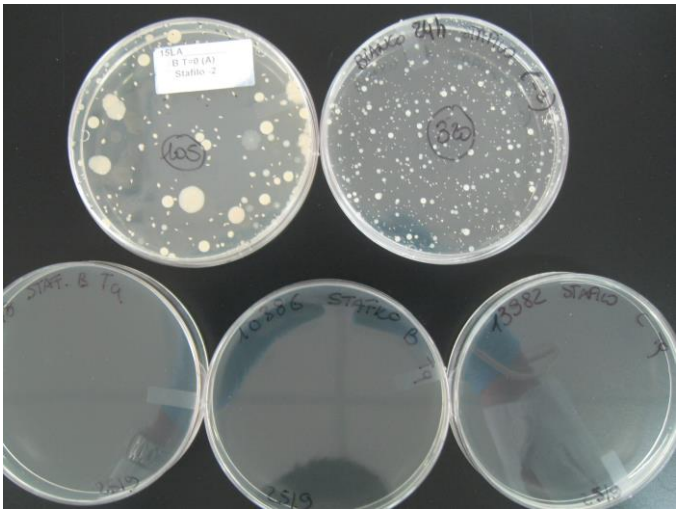
Blank at Time 0 Blank after 24h



Treated Samples after 24h

STAPHYLOCOCCUS AUREUS

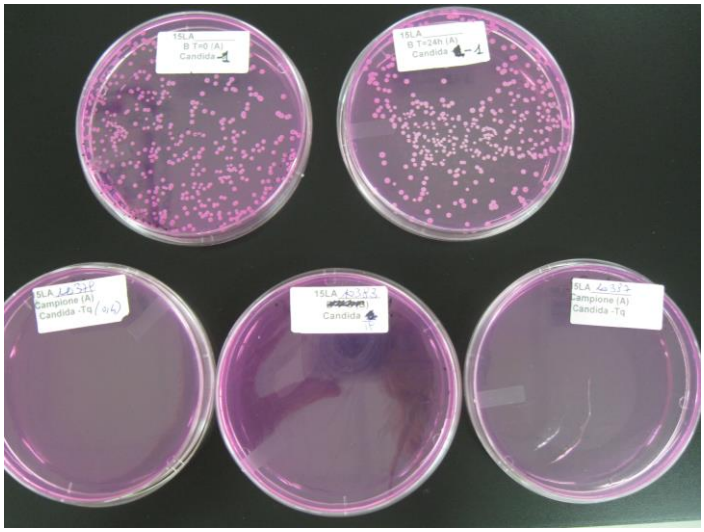
Blank at Time 0 Blank after 24h



Treated Samples after 24h

CANDIDA ALBICANS

Blank at Time 0 Blank after 24h



Treated Samples after 24h

3A Laboratori

LAB N° 1165

Test report n°: **15LA10381** of **09/11/2015**

Spett.
GHA Europe srl
Via Piemonte 7/1A
40069 Zola Predosa (BO)

Sample Information

Test subject: **Generic Material**

Description: **Treated sample - 25µm - Closed pore**

Registration date: **31/07/2015**

Date of arrival: **31/07/2015**

Date analysis commenced: **21/09/2015** Date analysis completed: **28/09/2015**

Sampling data

Date: **31/07/2015**

Sample supplied by: **Client**

Transport: **Client**

Parameter *Method*	U.M.	Result	LoQ
Determination of antibacterial activity (R) - R=(Ut-Uo)-(At-Uo) *ISO22196:2011*		**3,6**	0.6
Size of test specimens (H x L)	mm	**50x50**	
Thickness of test specimens	mm	**2,0**	
Type of polymer used for the cover film		**polypropylene**	
Size of the cover film (H x L)	mm	**40x40**	
Thickness of the cover film	mm	**0,10**	
Type of Gram-negative strain		**Escherichia coli - ATCC 25922**	
Volume of test inoculum	ml	**0,3**	
Number of viable bacteria in the test inoculum	n°	**130000**	
Uo - N° of viable bacteria recovered from the untreated test specimens after	log	3,9	1
Ut - N° of viable bacteria recovered from the untreated test specimens after 24	log	**3,6**	1
At - Count bacteria recovered from the treated samples 24 hours post	log	< 1.0	1

LEGEND: **U.M.** = Unit of measurement; **(Sup)** = upper limit; **(Inf)** = Lower Limit ;; **x ÷ y** = acceptable range; **LoQ** = limit of quantification, the threshold value below which you choose not to bring any numerical result for the parameter in question; this limit is provided directly by the method, or is chosen on the basis of the experimental detection limits (LoQ or LoD) so as not to be changed over time or according to the chemical-physical or microbiological single sample; **LOD** = limit of detection; **NQ** = unquantifiable, indicates a value less than LoQ
"<x" or **">x"** respectively indicate a value lower or higher than the measuring range of the test

UNLESS OTHERWISE SPECIFIED: quantitative microbiological tests (excluding MPN) are performed on single replica and two consecutive dilutions in accordance with ISO 7218: 2013; the results of this test report are not correct for recovery factors (R) as the values of recovery are in the tolerance specified in the test method; summations are calculated using the criterion of the lower bound (LB)

The results marked in red indicate a exceeding the defined limits.

If the sampling isn't the responsibility of 3ALaboratori Ltd., the test results were obtained on the basis of the data declared.

Note:
The product tested is considered effective when the antibacterial activity value is R >= 2.0 (as suggested by the standard JIS 2801:2010)

Technical Director

Dr. Giovanni Mitaritonna
Chemist
Ordine Interprov. Chimici del Veneto - Padova n° 910 SEZ. A

The analytical results are exclusively referred to the sample.
Representation of a Test Report signed electronically in accordance with current legislation.
The test report can not be reproduced in part without the written permission of the laboratory.

Laboratory management system certified UNI EN ISO 9001: 2008 by CSQA with the No. 14270. Inclusion in the list of regional laboratories carrying out analysis in the context of self-control procedures for Food Industries No. 52. Recommended by AIC for the analysis of quantification of gluten in food matrices. Registrated laboratory for the analysis of food contact materials intended for export to Japan.

Mod.PT01.01 Rev.4

3A Laboratori

LAB N° 1165

Test report n°: **15LA13582** of **09/11/2015**

Spett.
GHA Europe srl
Via Piemonte 7/1A
40069 Zola Predosa (BO)

Sample Information

Test subject: **Generic Material**

Description: **Treated sample - 25µm - Closed pore**

Registration date: **14/10/2015**

Date of arrival: **14/10/2015** Hour of arrival: **11.30.00**

Date analysis commenced: **14/10/2015** Date analysis completed: **22/10/2015**

Sampling data

Date: **12/10/2015**

Sample supplied by: **Client**

Transport: **Client**

Parameter *Method*	U.M.	Result	LoQ
Determination of antibacterial activity (R) - R=(Ut-Uo)-(At-Uo) *ISO22196:2011*		**3,3**	0.6
Size of test specimens (H x L)	mm	**50x50**	
Thickness of test specimens	mm	**2,0**	
Type of polymer used for the cover film		**polypropylene**	
Size of the cover film (H x L)	mm	**40x40**	
Thickness of the cover film	mm	**0,10**	
Type of Gram-negative strain		**Salmonella typhimurium ATCC**	
Volume of test inoculum	ml	**0,3**	
Number of viable bacteria in the test inoculum	n°	**400000**	
Uo - N° of viable bacteria recovered from the untreated test specimens after	log	**4,4**	1
Ut - N° of viable bacteria recovered from the untreated test specimens after 24	log	**3,3**	1
At - Count bacteria recovered from the treated samples 24 hours post	log	< 1.0	1

LEGEND: **U.M.** = Unit of measurement; **(Sup)** = upper limit; **(Inf)** = Lower Limit ;; **x + y** = acceptable range; **LoQ** = limit of quantification, the threshold value below which you choose not to bring any numerical result for the parameter in question; this limit is provided directly by the method, or is chosen on the basis of the experimental detection limits (LoQ or LoD) so as not to be changed over time or according to the chemical-physical or microbiological single sample; **LOD** = limit of detection; **NQ** = unquantifiable, indicates a value less than LoQ
"**<x**" or "**>x**" respectively indicate a value lower or higher than the measuring range of the test

UNLESS OTHERWISE SPECIFIED: quantitative microbiological tests (excluding MPN) are performed on single replica and two consecutive dilutions in accordance with ISO 7218: 2013; the results of this test report are not correct for recovery factors (R) as the values of recovery are in the tolerance specified in the test method; summations are calculated using the criterion of the lower bound (LB)

The results marked in red indicate a exceeding the defined limits.

If the sampling isn't the responsibility of 3ALaboratori Ltd., the test results were obtained on the basis of the data declared.

Note:
The product tested is considered effective when the antibacterial activity value is R >= 2.0 (as suggested by the standard JIS 2801:2010)

Technical Director

Dr. Giovanni Mitaritonna
Chemist
Ordine Interprov. Chimici del Veneto - Padova n° 910 SEZ. A

The analytical results are exclusively referred to the sample.
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Laboratory management system certified UNI EN ISO 9001: 2008 by CSQA with the No. 14270. Inclusion in the list of regional laboratories carrying out analysis in the context of self-control procedures for Food Industries No. 52, Recommended by AIC for the analysis of quantification of gluten in food matrices. Registrated laboratory for the analysis of food contact materials intended for export to Japan.

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3A Laboratori

LAB N° 1165

Test report n°: **15LA10382** of **09/11/2015**

Spett.
GHA Europe srl
Via Piemonte 7/1A
40069 Zola Predosa (BO)

Sample Information

Test subject: **Generic Material**

Description: **Treated sample - 25µm - Closed pore**

Registration date: **31/07/2015**

Date of arrival: **31/07/2015**

Date analysis commenced: **21/09/2015** Date analysis completed: **28/09/2015**

Sampling data

Date: **31/07/2015**

Sample supplied by: **Client**

Transport: **Client**

Parameter *Method*	U.M.	Result	LoQ
Determination of antibacterial activity (R) - R=(Ut-Uo)-(At-Uo) *ISO22196:2011*		**4,2**	0.6
Size of test specimens (H x L)	mm	**50x50**	
Thickness of test specimens	mm	**2,0**	
Type of polymer used for the cover film		**polypropylene**	
Size of the cover film (H x L)	mm	**40x40**	
Thickness of the cover film	mm	**0,10**	
Type of Gram-positive strain		**staphylococcus aureus - ATCC 259**	
Volume of test inoculum	ml	**0,3**	
Number of viable bacteria in the test inoculum	n°	**140000**	
Uo - N° of viable bacteria recovered from the untreated test specimens after	log	**3,9**	1
Ut - N° of viable bacteria recovered from the untreated test specimens after 24	log	**4,3**	1
At - Count bacteria recovered from the treated samples 24 hours post	log	< 1.0	1

LEGEND: **U.M.** = Unit of measurement; **(Sup)** = upper limit; **(Inf)** = Lower Limit ;; **x ÷ y** = acceptable range; **LoQ** = limit of quantification, the threshold value below which you choose not to bring any numerical result for the parameter in question; this limit is provided directly by the method, or is chosen on the basis of the experimental detection limits (LoQ or LoD) so as not to be changed over time or according to the chemical-physical or microbiological single sample; **LOD** = limit of detection; **NQ** = unquantifiable, indicates a value less than LoQ
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The results marked in red indicate a exceeding the defined limits.
If the sampling isn't the responsibility of 3ALaboratori Ltd., the test results were obtained on the basis of the data declared.

Note:
The product tested is considered effective when the antibacterial activity value is R >= 2.0 (as suggested by the standard JIS 2801:2010)

Technical Director

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3A Laboratori

LAB N° 1165

Test report n°: **15LA13581** of **09/11/2015**

Spett.
GHA Europe srl
Via Piemonte 7/1A
40069 Zola Predosa (BO)

Sample Information

Test subject: **Generic Material**

Description: **Treated sample - 25µm - Closed pore**

Registration date: **14/10/2015**

Date of arrival: **14/10/2015** Hour of arrival: **11.30.00**

Date analysis commenced: **21/10/2015** Date analysis completed: **29/10/2015**

Sampling data

Date: **12/10/2015**

Sample supplied by: **Client**

Transport: **Client**

Parameter *Method*	U.M.	Result	LoQ
Determination of antibacterial activity (R) - R=(Ut-Uo)-(At-Uo) *ISO22196:2011*		**2,6**	0.6
Size of test specimens (H x L)	mm	**50x50**	
Thickness of test specimens	mm	**2,0**	
Type of polymer used for the cover film		**polypropylene**	
Size of the cover film (H x L)	mm	**40x40**	
Thickness of the cover film	mm	**0,10**	
Type of Gram-negative strain		**Pseudomonas aeruginosa ATCC**	
Volume of test inoculum	ml	**0,3**	
Number of viable bacteria in the test inoculum	n°	**200000**	
Uo - N° of viable bacteria recovered from the untreated test specimens after	log	**4,1**	1
Ut - N° of viable bacteria recovered from the untreated test specimens after 24	log	**4,3**	1
At - Count bacteria recovered from the treated samples 24 hours post	log	1,7	1

LEGEND: **U.M.** = Unit of measurement; **(Sup)** = upper limit; **(Inf)** = Lower Limit ;; **x ÷ y** = acceptable range; **LoQ** = limit of quantification, the threshold value below which you choose not to bring any numerical result for the parameter in question; this limit is provided directly by the method, or is chosen on the basis of the experimental detection limits (LoQ or LoD) so as not to be changed over time or according to the chemical-physical or microbiological single sample; **LOD** = limit of detection; **NQ** = unquantifiable, indicates a value less than LoQ
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The results marked in red indicate a exceeding the defined limits.

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Note:
The product tested is considered effective when the antibacterial activity value is R >= 2.0 (as suggested by the standard JIS 2801:2010)

Technical Director

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3A Laboratori

Test report n°: **15LA13580** of **09/11/2015**

Spett.
GHA Europe srl
Via Piemonte 7/1A
40069 Zola Predosa (BO)

Sample Information

Test subject: **Generic Material**

Description: **Treated sample - 25µm - Closed pore**

Registration date: **14/10/2015**

Date of arrival: **14/10/2015** Hour of arrival: **11.30.00**

Date analysis commenced: **21/10/2015** Date analysis completed: **02/11/2015**

Sampling data

Date: **12/10/2015**

Sample supplied by: **Client**

Transport: **Client**

Parameter *Method*	U.M.	Result	LoQ
Determination of antibacterial activity (R) - R=(Ut-Uo)-(At-Uo) *M.I. 3053A Rev0 2015: In similitudine alla ISO22196:2011*		**2,9**	0.6
Size of test specimens (H x L)	mm	**50x50**	
Thickness of test specimens	mm	**2,0**	
Type of polymer used for the cover film		**polypropylene**	
Size of the cover film (H x L)	mm	**40x40**	
Thickness of the cover film	mm	**0,10**	
Type of Gram-negative strain		**LegionellaPneumophila ATCC**	
Volume of test inoculum	ml	**0,3**	
Number of viable bacteria in the test inoculum	n°	**61000**	
Uo - N° of viable bacteria recovered from the untreated test specimens after	log	**3,6**	1
Ut - N° of viable bacteria recovered from the untreated test specimens after 24	log	**2,9**	1
At - Count bacteria recovered from the treated samples 24 hours post	log	**< 1.0**	1

LEGEND: **U.M.** = Unit of measurement; **(Sup)** = upper limit; **(Inf)** = Lower Limit ;; **x ÷ y** = acceptable range; **LoQ** = limit of quantification, the threshold value below which you choose not to bring any numerical result for the parameter in question; this limit is provided directly by the method, or is chosen on the basis of the experimental detection limits (LoQ or LoD) so as not to be changed over time or according to the chemical-physical or microbiological single sample; **LOD** = limit of detection; **NQ** = unquantifiable, indicates a value less than LoQ
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Note:
The product tested is considered effective when the antibacterial activity value is R >= 2.0 (as suggested by the standard JIS 2801:2010)

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3A Laboratori

Test report n°: **15LA10383** of **09/11/2015**

Spett.
GHA Europe srl
Via Piemonte 7/1A
40069 Zola Predosa (BO)

Sample Information

Test subject: **Generic Material**

Description: **Treated sample - 25µm - Closed pore**

Registration date: **31/07/2015**

Date of arrival: **31/07/2015**

Date analysis commenced: **21/09/2015** Date analysis completed: **28/09/2015**

Sampling data

Date: **31/07/2015**

Sample supplied by: **Client**

Transport: **Client**

Parameter *Method*	U.M.	Result	LoQ
Determination of antibacterial activity (R) - R=(Ut-Uo)-(At-Uo) *M.I. 3053A Rev0 2015: in similitudine alla ISO22196:2011*		**3,1**	0.6
Size of test specimens (H x L)	mm	**50x50**	
Thickness of test specimens	mm	**2,0**	
Type of polymer used for the cover film		**polypropylene**	
Size of the cover film (H x L)	mm	**40x40**	
Thickness of the cover film	mm	**0,10**	
Type of Gram-negative strain		**Candida albicans ATCC 10231**	
Volume of test inoculum	ml	**0,3**	
Number of viable bacteria in the test inoculum	n°	**20000**	
Uo - N° of viable bacteria recovered from the untreated test specimens after	log	**3,1**	1
Ut - N° of viable bacteria recovered from the untreated test specimens after 24	log	**3,1**	1
At - Count bacteria recovered from the treated samples 24 hours post	log	**< 1.0**	1

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Note:
The product tested is considered effective when the antibacterial activity value is R >= 2.0 (as suggested by the standard JIS 2801:2010)

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