

STARLIKE DEFENDER

ANTIBACTERIAL, ANTI-MOULD
EPOXY MORTAR
FOR GROUTING CERAMIC TILES



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PRODUCT HISTORY

Over the years, Litochrom Starlike has become the European and international market standard in epoxy mortars for grouting ceramic surfaces and mosaics.

Its innovative, special features have been recognised with the awarding of an international patent in December 2007 and by customers, making it today's flagship Litokol S.p.A. product. Its design, started in early 2004, led to an initial industrialisation of the product exactly one year later, with the marketing of an initial range of seven colours.

On the wave of significant production growth and thanks to increasingly enthusiastic applicator feedback, the finishing colour range and number slowly increased, now boasting a range of 95 available finishes to meet the varying needs of designers and architects in search of new creative ideas.

Parallel to this new colour development, Litokol gradually revamped its Litochrom Starlike production facilities, increasing its production capacity and

adding on-line checking devices in order to constantly monitor the quality of finished products. Always attentive to the specific



and implied demands of its customers, Litokol has never ceased its product research and development activities, reaching milestones such as Litochrom Starlike certification for direct contact with food, the development of Starlike Decor, a new decorative system for interior walls, and Starlike Crystal, the translucent mortar epoxy for grouting glass mosaics applied on transparent supports and artistic mosaics. For Litokol, industrial innovation also means giving its products, and Litochrom Starlike specifically, high level aesthetic characteristics associated with considerable technical performance.

The **STARLIKE DEFENDER** – antibacterial epoxy mortar research product, carried out by Litokol in collaboration with the Departments of Chemistry and Biomedical Sciences, Microbiology Section of the University of Modena and Reggio Emilia and with an external certified (ACCREDIA) microbiology laboratory fits fully in this context.

With this document, we intend to illustrate the stages that led to the conferment of this important antibacterial feature to Litochrom Starlike mortar, without a doubt putting it at the top of its class. We will therefore analyse the research, experimentation and result verification, the product features and new fields of application, also supplying useful information regarding the requirements that must be fulfilled by environments in need of high performance in terms of cleanliness and hygiene.

**STARLIKE
Defender
Antibacterial**



Insertion of sample in the contaminant solution

The higher porosity of cementitious products results in easier dirt absorption...

Portland cement grout carbonation front

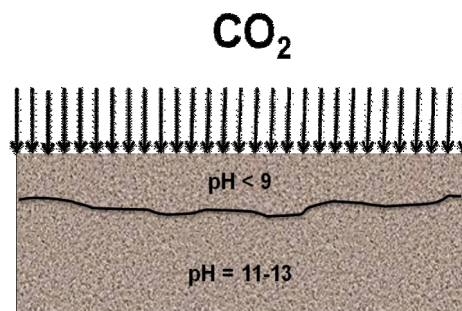
Advanced research behind the development of Starlike Defender

The development of a highly technological product Like **STARLIKE DEFENDER** could not disregard the identification of skills required to deal with problems which were little known or only partially addressed until now. LITOKOL therefore formalised a partnership with three leading area companies; namely, the Departments of Chemistry and Biomedical Sciences, Microbiology Section University of Modena and Reggio Emilia and with a private accredited microbiology laboratory. The search for effective active antibacterial ingredients compatible with the epoxy system and the definition of reliable test and analysis methods are only the main issues that have been faced and that have been overcome, thanks to the experience, expertise and tenacity of those involved. The main reason why Litokol chose to direct research on an epoxy

product, rather than on traditional cement grouts, is due to the fact that a cementitious matrix product has some degree of absorption, being porous. With an epoxy mortar, on the other hand, the absorption level is significantly lower, as also confirmed by the requirements defined by European standard UNI EN 13888 regarding mortars for grouting, whereas improved class CG2 cement grouts require a maximum absorption of 5 g after 4 hours of partial immersion in test water, while the requirement is 0.1 g for reactive epoxy resin products.

The higher porosity of cementitious products results over time in an easier absorption of dirt, creating a surface film difficult to remove by washing, which decreases the antibacterial capacity of the grout. Consider also that, over time, Portland cement based cementitious

grouts undergo a process of "carbonation," due to a reaction between calcium hydroxide Ca(OH)_2 with carbon dioxide CO_2 in the atmosphere, leading to the formation calcium carbonate (CaCO_3) which significantly lowers the pH of the grout. This process extends from the exposed surface and evolves over time towards the lower layers. On the other hand, with epoxy grouting, characterised by almost zero porosity, dirt deposits can be easily eliminated from the surface by washing with common household detergents, all the while maintaining the antibacterial capacity of the grouting.



Verification procedures

Antimicrobial activity and efficacy testing have been carried out according to the methods described by standards JIS Z 2801:2000 and ISO 22196:2007.

Tests were extended to the two main bacterial strains: *Staphylococcus aureus*, and *Escherichia coli*.

In addition, the staff in charge of testing developed and performed further tests using different methodologies in order to make a more complete assessment of our materials.



Bacterial count of the sample without the active principle



Bacterial count of the sample with the active principle

...an active bacterial principle capable of reducing up to 99.9% of bacteria was identified.

The reason why these two bacterial strains were chosen is that these bacteria are mainly responsible for infections that can develop in hospitals and are also extremely aggressive and, in some cases, resistant to antibiotics.

All methods used for the characterisation of materials are based on the fundamental principle of artificially contaminating sample with selected strains at high concentrations.

The next step is to monitor how and when the bacteria in contact with the product vary over time.

The standards suggest that, to be considered "antibacterial", a product must be able to kill at least 99% of the bacteria inoculated during functionality verification testing. Upon completion of this first phase of research, an active antibacterial principle capable of reducing up to 99.9% of bacteria was identified.

It should also be emphasised that these results are not influenced by environmental factors such as the

presence or absence of light.

An important difference with respect to products defined as "photocatalytic," which are effective only in the presence of light and based on the active ingredient titanium dioxide.

In the case of **STARLIKE DEFENDER**, the active antibacterial principle remains embedded within the hardened epoxy mortar and works by direct surface contact.

Since epoxy mortar is extremely resistant to abrasion and characterised by high mechanical strength, it follows that the antibacterial effect persists over time as the grout is not subject to degradation.

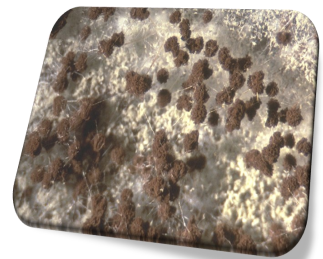
Our customers frequently ask our technical support department if Litochrom Starlike is resistant to mould growth when used as a grout for grouting ceramic tiles or mosaics in wet areas such as showers, bathrooms or kitchens.

To provide a proper and comprehensive response to our customers and, given the positive results

concerning the antibacterial effectiveness of **STARLIKE DEFENDER**, we decided to perform additional tests regarding resistance to fungal growth in accordance with standard BS 5980:1980 - Appendix B (Specification for "Adhesives for use with ceramic tiles and mosaics").

In particular, a sample of **STARLIKE DEFENDER** was inoculated with a microbial suspension of *Aspergillus Niger* CM 17454 and, after 14 days of incubation at a temperature of +29 °C, fungal growth was evaluated on the specimen in question.

At the end of incubation, no visible fungal growth appeared on the specimen, so we can scientifically affirm that **STARLIKE DEFENDER** prevents mould formation.



Aspergillus Niger

What are moulds and how do they develop

Moulds are a type of multicellular fungi whose development depends on the temperature and humidity of an environment. The optimum temperature for growth is between +10/+35°C and relative humidity must be at least 60%. They can grow both inside and outside homes. Locations which are particularly conducive to mould growth can be found in bathrooms, kitchens or places characterised by high humidity levels. From a standpoint of health effects, fungi can act as infectants and allergens in that they can free mycotoxins, substances that cause respiratory allergies and some type of allergic dermatitis.



Mould formation on agar

Further testing conducted by Litokol covered continued suitability in direct contact with food.

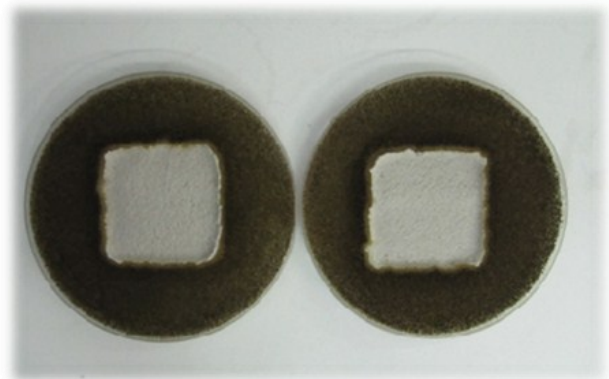
It should be stressed that, although **STARLIKE DEFENDER** drastically reduces mould growth, it is, however, necessary to perform appropriate cleaning and maintenance, as moulds can proliferate in contact with organic substances such as soaps, dead skin cells and dirt deposited on a surface. In addition to adequate routine cleaning, it is advisable to ventilate damp areas to prevent moisture condensation on surfaces.



Further testing conducted by Litokol covered continued suitability in direct contact with food.

Essentially, we wanted to ensure that the introduction of a new antimicrobial additive would not undermine this important product feature. In collaboration with the

Department of Chemistry at the University of Modena and Reggio Emilia, global migration tests were repeated in accordance with the experimental requirements and methods outlined in Ministerial Decree 21.03.1973 and in Decrees of the Ministry of Health 26/04/1993, nr.220, and 22/07/1998, nr.338 and 28/03/2003, nr.123. Examinations conducted established that the **STARLIKE DEFENDER** epoxy mortar is suitable for contact with food 01-02-03-04-05-06-07-08 (reference numbers for food name as per Health Ministry Decree 26/04/1993, nr.220, Annex II) under conditions of prolonged contact (temperature from +5 to +40°C).



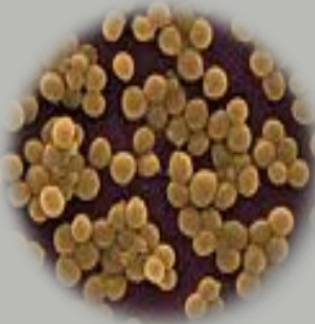
Test of STARLIKE DEFENDER resistance to fungal growth in accordance with standard BS 5980:1980

Synergies

At this point, Litokol thought it was necessary to find a partner company that produces ceramics with antibacterial properties, in order to verify not only its epoxy sealant, but an "antibacterial coating system." The choice fell on Casalgrande Padana S.p.A., manufacturer of **BIOS** who had already conducted the same experience with the University of Modena and Reggio Emilia. The synergies put in place, coordinated by Prof. Paolo Zannini of the Department of Chemistry of the University of Modena and Reggio Emilia, developed a method of analysis and verification of results on the "grout-tile" system which enabled them to show how floors and finishes made of antibacterial porcelain **BIOS** by Casalgrande Padana, grouted with Litokol**STARLIKE DEFENDER** epoxy mortar represent the ideal combination for obtaining floors completely active against bacteria and, consequently, without any other obvious weaknesses. It follows then that the "antibacterial ceramic - antibacterial mortar" combination is the most suitable for covering all those areas where a high level of hygiene, cleanliness and safety is required.

STARLIKE Defender Antibacterial

The main bacterial strains



Staphylococcus Aureus



Escherichia Coli

**...with the creation
of STARLIKE
DEFENDER
antibacterial epoxy
mortar, application
areas are further
expanded...**

Staphylococcus Aureus

Staphylococcus Aureus is part of a large family of bacteria called Staphylococcus characterised by a spherical shape (cocco), Gram-positives, gathered in clusters of irregular-shaped clusters, comprising some thirty species.

Staphylococcus Aureus is an invasive saprophyte pathogen of the mucous membranes and skin of humans and animals.

Besides being the most virulent of the Staphylococcus species, causing septicaemia, food poisoning and pneumonia, but it also has a high capacity of generating new strains able to resist antibiotics. Its pathogenicity is caused by its ability to produce an enormous variety of extracellular pathogens such as enterotoxins, coagulase, hyaluronidase and staphylokinase.

Staphylococcus Aureus grows at temperatures between +7 and +48°C, while it is inactive with a pH below 4.2.

Contamination due to environmental causes are mainly due to: manipulation by persons that do not adhere to hygienic requirements, since Staphylococcus Aureus is normally present in the skin, nasopharyngeal mucosa, intestine and also in different types of lesions such as boils, sores, general wounds, etc.

Improper storage conditions of already

cooked food kept in unsuitable temperatures that favour toxin production, if the microorganism is already present, facilitated also by the absence of the antagonistic microflora.

Escherichia Coli

Escherichia Coli is a genus of Gram negative straight rod-shaped bacteria that increases at a temperature of +44.5°C. It is one of the main species of bacteria living in the lower intestines of warm-blooded animals and is necessary for proper digestion of food.

Although it is a common inhabitant of the intestine and plays a key role in the digestive process, there are situations in which Escherichia coli can cause disease in humans and animals. Some strains of Escherichia coli are the aetiological agents of intestinal and extra-intestinal diseases such as urinary tract infections, meningitis, peritonitis, septicaemia and pneumonia.

In water intended for human consumption, pool water or bathing water, but also in other types of matrices (e.g. food, cosmetics) compulsory absence of Escherichia coli is required in relation to its role as the primary indicator of faecal contamination. Any failure to meet the parametric value set constitutes non-conformity of the product (water, food Escherichia Coli, etc).

New opportunities with Starlike Defender

The arrival of Litochrom Starlike on the market led to a transition to the use of epoxy grouting for ceramic tiles in the civil construction industry, as it is a prominent product from an aesthetic and functional point of view.

In fact, whereas before with traditional epoxy grouting, which were used only on industrial flooring such as for dairies, wineries, slaughterhouses, etc. according to their chemical resistance required for washing with aggressive products, and because of the difficulty involved in their use, the application areas with Litochrom Starlike have expanded also to flooring finishes and coatings in private homes, shops, swimming pools, saunas, terraces, etc. Its particularly easy application and cleaning, coupled with its significant range of colours, make it the ideal grout for a variety of design solutions in conjunction with all types of ceramic tiles and mosaics.

Today, with the creation of **STARLIKE DEFENDER** antibacterial epoxy mortar, application areas have been further expanded to include health facilities, analysis and research laboratories, kindergartens, schools, sports facilities, changing rooms, shower areas in gyms, public swimming pools, private and collective kitchens, canteens, factories, food warehouses, spas, etc.

Even in private housing, where Litochrom Starlike has long been used successfully, it is now possible to give antibacterial properties to room surfaces such as bathrooms, showers and kitchens, increasing the comfort of living by integrating increased hygiene performance and durability.



Certification



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CAMPIONE

Descrizione/nome commerciale: **LITOKROM STARLIKE® DEFENDER**
 Tipologia: **Fugante per la posa e la stuccatura di pavimenti e rivestimenti ceramici.**
 Matrice: **Epossidica**
 Data di produzione: 18/01/2011
 Data di ricevimento: 20/01/2011
 Committente: LITOKOL S.p.a.
 Test richiesti: Caratterizzazione analitica e verifica attività antibatterica
 Specie batteriche saggiate: **Staphylococcus aureus ATCC 6538 - Escherichia Coli ATCC 25922**
 Sede dei test: Dipartimento di Chimica, Università degli Studi di Modena e Reggio Emilia
 Laboratorio 3A sas di Cerchiarì Manuele & C.

ESECUZIONE PROVA

Il materiale fugante in oggetto, dopo una accurata caratterizzazione analitica, per evidenziarne le proprietà di adesione secondo le norme EN 13888 (Classe: RG – per gli stucchi reattivi) ed EN 12004 (Classe: R2T – per gli adesivi reattivi), resistenza ad attacco chimico secondo la norma EN 12808-1, adesione e resistenza all' invecchiamento secondo la norma DIN-EN-ISO 11341/A, è stato sottoposto alla caratterizzazione della attività antibatterica con differenti metodi analitici, tramite un Laboratorio esterno certificato (ACCREDIA), con valutazioni incrociate tramite una specifica metodica sviluppata in collaborazione tra il **Dipartimento di Scienze Biomediche, Sezione di Microbiologia** ed il laboratorio esterno.

ESITO

Il campione ha mostrato evidenti doti antibatteriche, raggiungendo valori di abbattimento delle cariche batteriche fino al 99,9%; questo caratterizza il prodotto analizzato come perfettamente compatibile con i bisogni funzionali di ambienti ad elevati requisiti igienici.

IL RESPONSABILE SCIENTIFICO
 Prof. Paolo Zannini

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