

WHITE PAPER I

A NOVEL LIQUID TRI-PHASIC SIMULTANEOUS MOLD AND STAIN REMEDIATION WITH EXTENDED SURFACE PROTECTION

PURPOSE

To demonstrate and confirm that a safe, novel, Liquid Tri- Phasic Mold Remediation Process based on oxidative chemistry, provides effective, simultaneous mold (PHASE I), and stain (PHASE II) remediation. PHASE III leaves a protective, dry, anti-microbial transparent film on treated surfaces.

BACKGROUND

The prevalent remediation methods currently in common use for mold contaminated structural components are time and labor intensive. Current standard practices most often employ some form of manual surface mold layer removal, using Emory/Sand paper, wire-brushing or some form of media blasting. These methods result in removing approximately 150 - 250 microns of wood surface. From a practical standpoint, it is extremely difficult to sand and clean around obstructions and into nooks and crannies; in addition, media blasting has safety, aerosolization, and other concerns.

The approach outlined in this paper offers a liquid-based solution that reduces labor time/expense and more easily penetrates into difficult-to-reach mold and stain locations. The oxidizing properties of the liquid eliminate the digestive surface staining and reduce the adhesion of the mold to the surfaces. This approach facilitates the physical removal of fungal debris from surfaces which is accomplished by HEPA vacuuming.

The following indicates how oxidative methods generally work:

- A liquid, usually an oxidizer such as Hydrogen Peroxide is applied to surfaces where mold growth is present.
- The liquid reacts with mold structures and breaks them down.
- No scrubbing or agitation is required.
- When dry, the mold is no longer strongly attached to the surface.
- The process loosens mold growth from the surface to facilitate HEPA vacuuming.
- The mold debris is subsequently easily vacuumed away with normal or HEPA vacuuming using brush attachments.
- This process accomplishes the same outcome as sanding, wire brushing or blasting.

- The goal, as indicated in guide documents including the S520 Standard, is physical removal of mold contamination.
- This process has been utilized in many mold remediation jobs, and assessed by post-remediation clearance tests.
- The outcome success rates are similar to traditional methods and possibly better.

The question as to why such a liquid based process hasn't been more widely adopted and why is it not being taught in official training courses should be asked.

The Downsides for using a liquid- based process are:

- Although many successful clearance tests and anecdotal evidence support this liquid methodology, published controlled scientific studies are lacking.
- Concentrated liquid products that are sufficiently strong to accomplish mold removal effectively and consistently are usually hazardous to use.
- Hydrogen Peroxide products at low concentration do not have the strength to accomplish the oxidation process.
- The appearance of mold-staining, a consequence of organic breakdown processes, is not consistently eliminated by previous products.

The advantage of a novel liquid tri-phasic process is that it is a one-step process that is:

- Consistently effective in oxidizing mold (PHASE I), so that it can be HEPA vacuumed away.
- Safe and non-toxic to ship, store, and use.
- Effective for simultaneous and complete removal of mold stains (PHASE II).
- Has the option of applying an anti-mold protective coating on treated surfaces (PHASE III).
- Results in a significant reduction in costs vs. manual methods (i.e. sanding or media blasting).

In January 2012, Siamons International released a proprietary product using new technology named: **CONCROBIUM MOLD STAIN REMOVER (CMSR)**. **CMSR** is added to water to form a buffered 3% Peracetic Acid solution.

The CMSR Mold Remediation process:

- Is in compliance with the principles of the S520 Mold Remediation Standard,
- Significantly reduces the cost of mold remediation projects,
- Is more effective at facilitating the physical removal of mold spores and fragments from surfaces including crevases.
- Is safe to use and leaves no toxic residual chemistry.

The single most key advantage is that the Siamons **CMSR** process does not require the use of physical abrasion, yet achieves superior results in simultaneous mold stain and mold removal. A HEPA vacuum post-process physically removes inactivated, dead/non-viable mold debris.

Remediation procedures broadly used in the field need to:

- Comply with the IICRC/ANSI S520 Standard which defines the procedure as “physical removal of mold contamination as the primary means of remediation. Mold stain and mold contamination should be physically removed from the structure, systems and contents to be returned to a normal fungal ecology condition.”
- Ensure that both the mold and stains are completely removed.
- Use tape lift or other tests for microscopic particle analysis on target surfaces, to confirm effective removal of mold/particles.

PHASE I: A NOVEL LIQUID TRI-PHASIC SIMULTANEOUS MOLD AND STAIN REMEDIATION

Laboratory Investigation

Objectives

To test and compare the effectiveness of the **CMSR** process - liquid phase mold remediation for **CMSR** removal of mold growth (PHASE I) and mold stain removal (PHASE II) on wood samples versus physical sanding using standardized Tape Lift Testing particle counts.

To confirm the ease of use of **CMSR** and to provide a more thorough understanding of application and efficacy by close emulation of standard mold and stain remediation cleaning procedures as commonly employed in the field as follows:

- Ensure that mold and stain were completely removed from the sanded/vacuumed sample by visual confirmation prior to performing the next test (PHASE III), the step where the samples are returned to the incubator.
- For **CMSR**, any physical agitation such as scrubbing or brushing is not used. In the field, one of the key advantages of **CMSR** is that no physical abrasion is needed. Only HEPA vacuuming is used to remove the dead mold /spores/ debris.
- Perform a tape lift test/microscopic analysis on the treated target surfaces, i.e. sanded + vacuumed, **CMSR** + vacuumed and control for particles that have been left behind.

Study procedure

- Cut 8 pieces of pine wood, into 1"x4"x4" samples. Labeled them 1-8 respectively and drew a line through the middle of each sample.
- Prepared *Aspergillus niger* ATCC6275 conidia with hyphae in a YM broth.
- On each piece of the samples, applied 200 µl x 12 above 10⁶/ml conidia, inoculation spots as shown in Figure 1, making sure the four corners were inoculated to facilitate later sample retrieval for microscopic study.



Figure 1: Inoculated samples before drying

- The Conidia suspensions were dried at room temperature.
- Incubated all samples at 30⁰C, at >85% humidity for a week resulting in all samples having mold growth. For the tape lifting test, dried all samples at room temperature for 2 hours; a 3x3 cm² area on each piece was then defined. A piece of un-treated control wood was included for comparison.
- Tape lift test: referred to methods ASTM E1216 and F312 to perform the test.
- Divided 8 pieces of moldy samples into 4 groups of 2 pieces each. From the defined areas on each piece, tape lifted mold spores/hyphae and mounted them on slides (Figure 2).

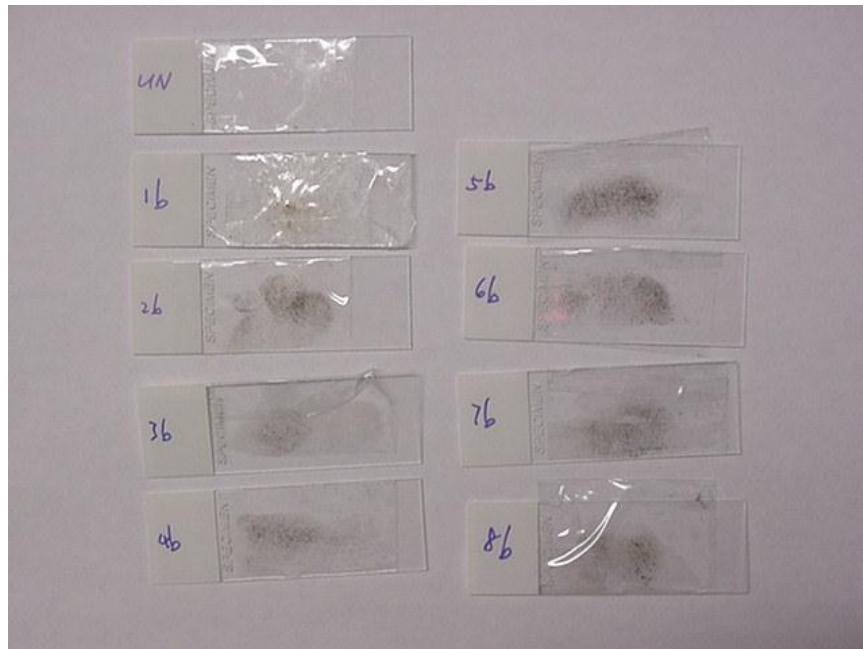


Figure 2: Tape-lifted samples before cleaning

- Counted mold spores/hyphae using a microscope at 40x magnification within an area of 1 cm². The spore/hyphae counts were recorded in Table 1.
- Cleaned the samples using the modalities shown respectively as:

Group 1: Sanding followed by vacuuming, Nos 1 and 2

Using P400 coarse sand paper, sanded both pieces thoroughly, and then cleaned the samples by vacuuming.

Group 2: Water-Vacuum cleaning control, Nos 3 and 4

Using a spray bottle, sprayed tap water onto the two pieces, dried overnight and cleaned by vacuuming.

Group 3: **CMSR** cleaning, Nos 5 and 6

Dissolved the **CMSR** (1 bottle) in 4.7 liters of warm tap water. Sprayed the **CMSR** solution on the two sample pieces, dried them overnight and cleaned them by vacuuming.

Group 4: **CMSR** cleaning, Nos 7 and 8

Sprayed dissolved **CMSR** onto the two pieces, dried them overnight and cleaned them by vacuuming.



Figure 3: Pine wood samples after cleaning

- From a defined area on each cleaned piece, Tape Lift samples were taken and mounted on slides (Figure 4).

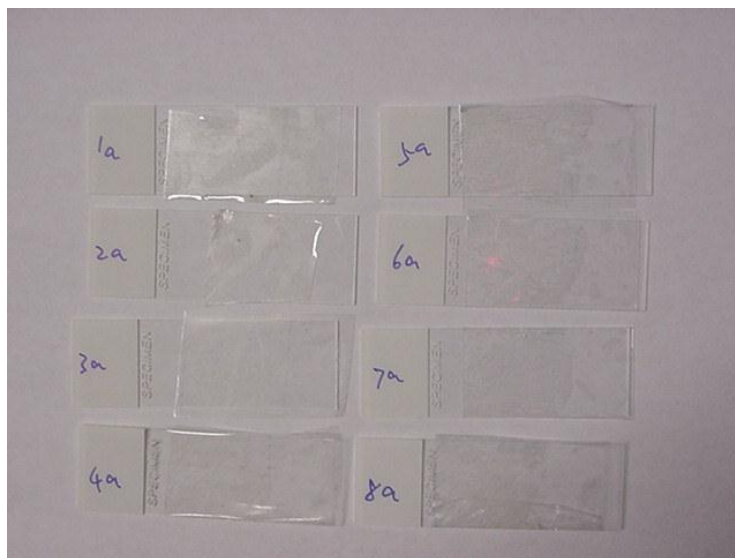


Figure 4: Tape-lifted samples post cleaning

- Counted mold spores/hyphae using a microscope at 40x magnification within a surface area of 1 cm². The counts were recorded in Table 1.

Results and discussion

Table 1: Mold spore/hyphae counts on the tape lifted (1 cm² surface area)

Treatment	Piece #	Before-cleaning counts	After-cleaning counts
Un-treated	0	0	NA
Sanding	1	134	7
	2	121	4
Water	3	91	39
	4	98	26
CMSR	5	148	4
	6	90	5
CMSR	7	96	3
	8	112	4

Chart 1: Tape lifted Fungal Fragments remaining on surface post procedure.

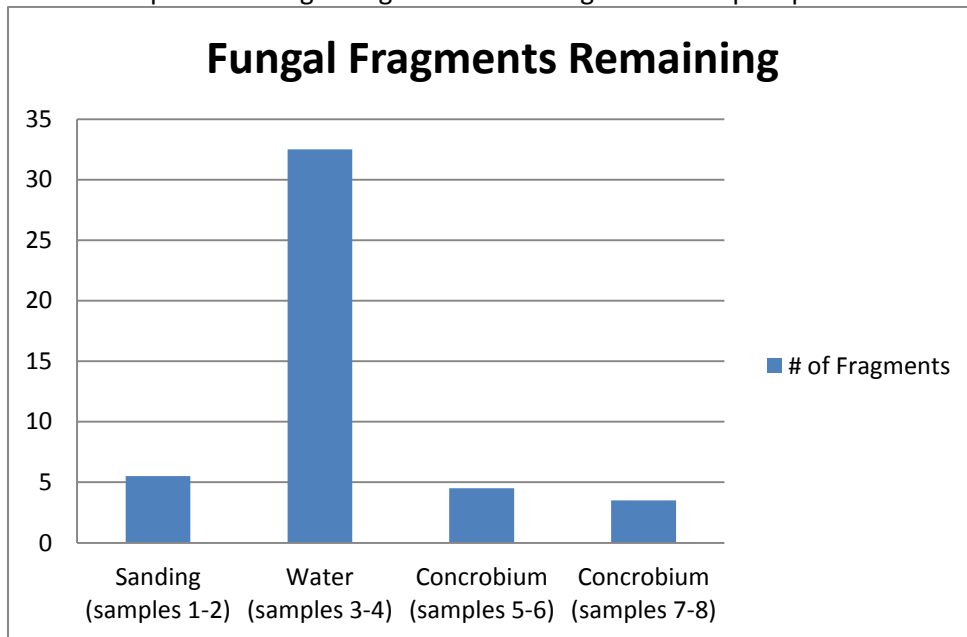
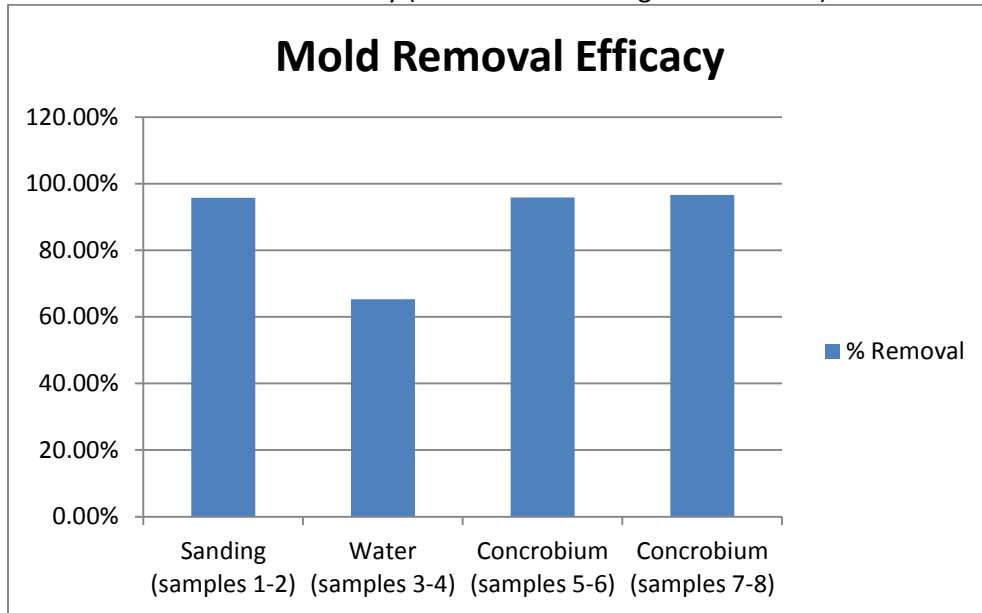


Chart 2: Mold Removal Efficacy (% surface mold fragment removal)



Phase I study conclusions

The results confirmed that the effective mold removal for PHASE I of CMSR Mold Remediation, based on oxidative chemistry:

- CMSR mold remediation is effective in removing mold from structural surfaces
- For Concrobium CMSR no physical abrasion is needed.
- Liquid PHASE I CMSR Oxidative after cleaning particle counts, match and / or are slightly superior to the post physical abrasion counts.

PHASE II: A NOVEL LIQUID TRI-PHASIC SIMULTANEOUS MOLD AND STAIN REMEDIATION

Laboratory Investigation

Objectives

To demonstrate and confirm that Concrobium Mold and Stain Remover (CMSR) simultaneously removes mature, tough mold growth and removes well developed tough staining.

To test and compare the effectiveness of the **CMSR** process in liquid phase mold remediation for PHASE I and PHASE II: Simultaneous mold stain removal by **CMSR** on samples with mature mold growth and tough stains

Study procedure

One package of CMSR (Figure 1) was dissolved in 4.7 liters of warm tap water. The dissolved CMSR was sprayed on three mold and stain samples. After one hour of contact time the samples were rinsed with tap water and all mold and stains were removed. All samples were dried at room temperature overnight and then photos were taken of the pre-treatment and post CMSR-treatment samples for observation and comparison.



Figure 1: CMSR

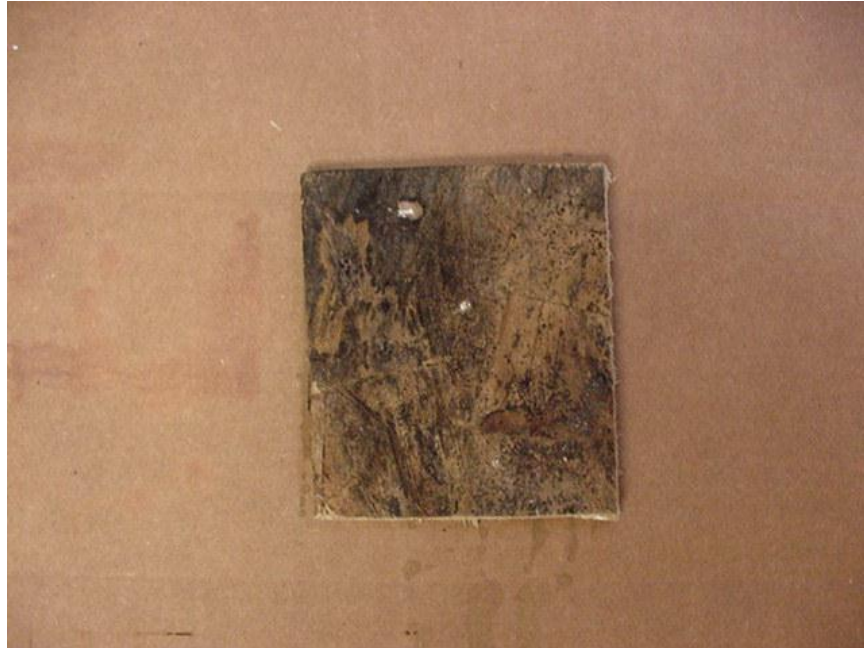


Figure 2: Wood Board composite with heavy mold growth and stain, before CMSR



Figure 3: The same composite Wood Board, after CMSR showing no mold or stain



Figure 4: Painted drywall sample covered in heavy mold and stain, before CMSR.

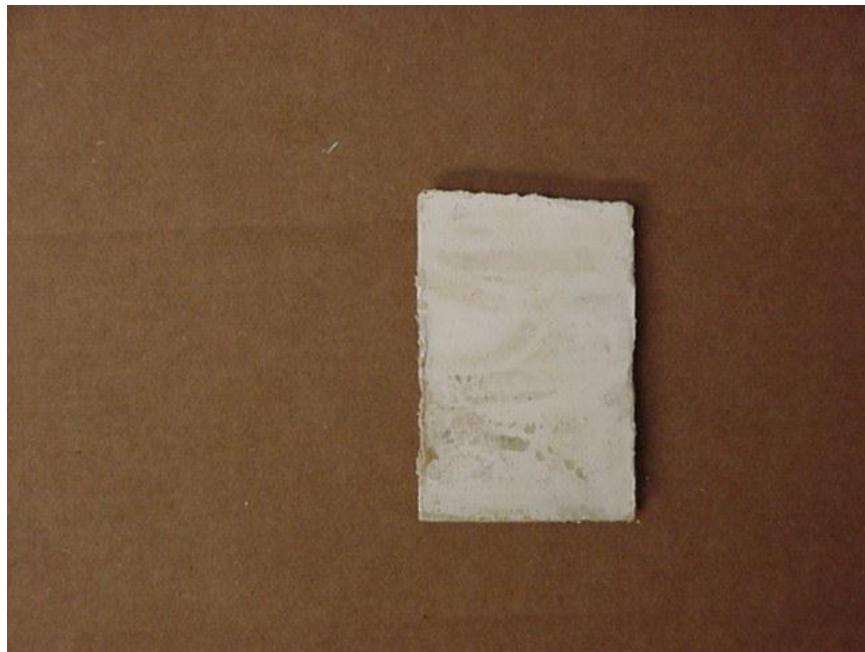


Figure 5: The same painted drywall sample, after CMSR with no mold or stain



Figure 6: A siding sample with mold and stain, before CMSR.

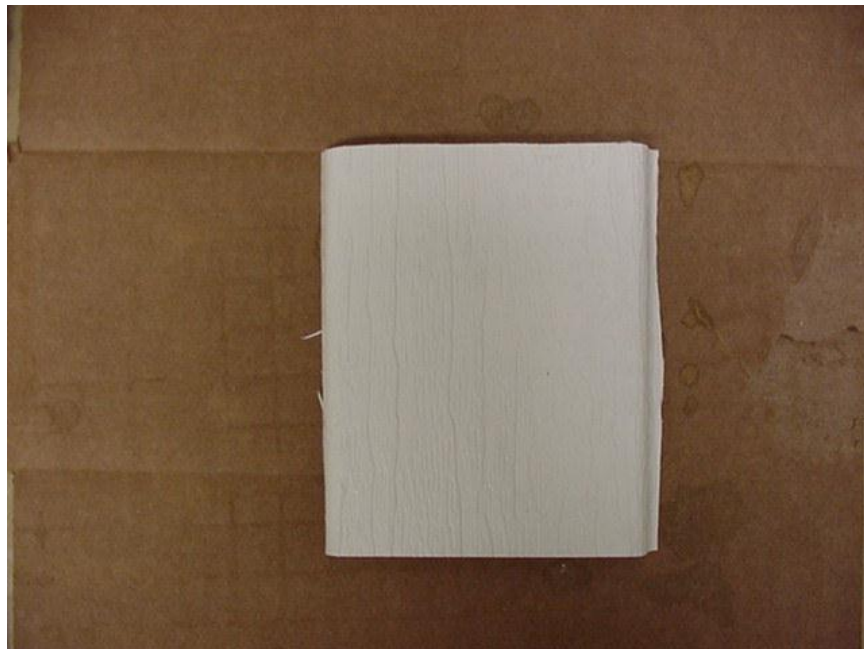


Figure 7; The same siding sample, after CMSR with no mold or stain

Phase I and II Study conclusions

The following conclusions can be made for (PHASE I) and (PHASE II) of the liquid tri-phasic simultaneous mold and stain remediation:

- Simultaneously eliminates and removes mold (PHASE I) CMSR AND stain (PHASE II) CMSR.
- More effective mold remediation.
- For Concrobium CMSR no physical abrasion is needed.
- Compliance with the S520 standard.
- Simultaneous Liquid PHASE I and PHASE II CMSR Oxidative Mold Remediation results match and outperform physical abrasion methods.

PHASE III: EXTENDED SURFACE PROTECTION POST NOVEL LIQUID TRI-PHASIC SIMULTANEOUS MOLD AND STAIN REMEDIATION AND CONCROBIUM MOLD CONTROL

Objective

To demonstrate and confirm simultaneous (PHASE III), extended anti-microbial surface protection against future mold growth post CMSR remediation, and that CMSR provides options to spray coat with **CONCROBIUM MOLD CONTROL (CMC)** for extended anti-mold and anti-microbial protection.

Laboratory Investigation

Comparison of renewed mold growth on CMC treated pine wood samples after CMSR cleaning.

Testing for mold growth in ASTM Environmental Cabinet: custom engineered according to ASTM D3273-00 specifications. After adding water and top-soil, the environment is equilibrated and maintained at 32⁰C, at >90% humidity. Challenging molds are *Aureobasidium pullulans* ATCC 9348, *Aspergillus niger* ATCC 6275 and *Penicillium citrinum* ATCC 9849. Viability of mold growth has been checked by placing control agar plates into the cabinet, and full mold growth confirmed by high level mold spore concentrations.

Procedure

- After a week, physically-cleaned samples had mold growth on all wood surfaces not pre-treated with CMSR.

CMSR Liquid PHASE exposed wood surface remediation:

- No mold re-growth was observed, at 4 weeks, in designated wood surface areas treated with CMSR and Concrobium Mold Control (CMC) (samples 5-8) when incubated in the high mold spore content generated in the ASTM incubator.

Results

On Samples which had been cleaned by sanding/vacuuming (Samples 1 and 2), mold re-growth was observed on wood surfaces under normal incubator conditions, Figure 8.

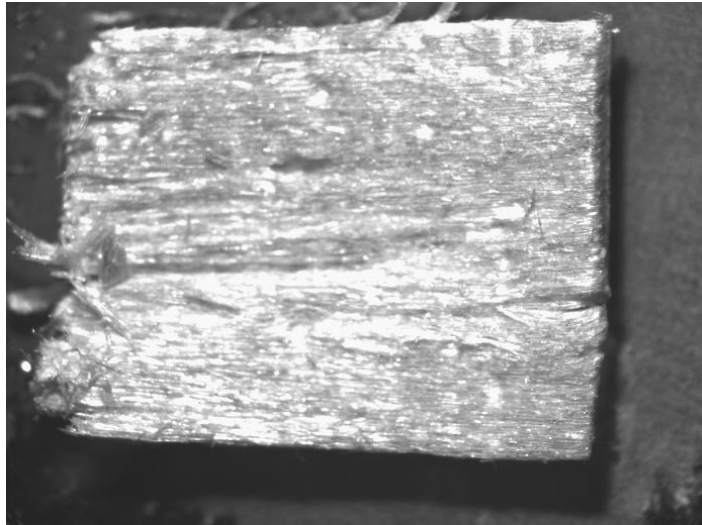


Figure 8: Wood sample with CMSR / CMC extended protection

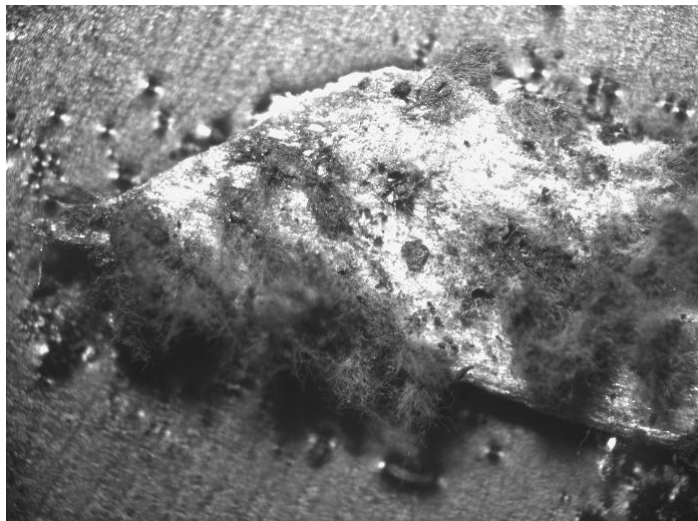


Figure 9: Wood sample without extended CMSR / CMC protection

Phase III study conclusions

Concrobium Mold and Stain Remover (CMSR) provides:

- Simultaneous (PHASE III), extended surface protection against future mold growth post CMSR remediation.
- Options to spray or coat with **CONCROBIUM MOLD CONTROL (CMC)** for extended mold and anti-microbial protection.

Overall summary and conclusions

This study was undertaken to confirm a multitude of anecdotal results observed at mold remediation projects carried out in the field using the Siamons International two-product Concrobium Mold Remediation System.

It was specifically demonstrated that Concrobium Mold Stain Remover facilitates the physical removal of fungal growth from wood structural surfaces (termed “Phase I” in this study) on a par with physical abrasion (sanding) currently recommended in mold remediation guide documents. Although more specific studies are needed in order to confirm these results, it is not difficult to envision circumstances where a liquid product would produce superior results to sanding. Some examples might be: difficult-to-reach places, crevasses such as where structural components meet, and rough or uneven surfaces. The authors therefore contend that Concrobium Mold Stain Remover facilitates physical removal of fungal growth from wood surfaces better than physical abrasion (sanding).

Further, efficacy was demonstrated for another important element of mold remediation; stain removal (Phase II). Except in the case of especially deep mold staining in wood, physical abrasion whether by sanding or media blasting does an excellent job of removing mold staining and improving the appearance of structural surfaces. This is the area in which most oxidative liquid products fall short. However, Concrobium Mold Stain Remover has been shown to be very effective in removing mold staining in most cases in the field. This study confirms that Concrobium Mold Stain Remover can completely remove heavy, deep mold staining on a variety of surfaces.

In addition to removing mold stains and facilitating physical removal of mold fragments, CMSR appears to significantly reduce the amount of short-term regrowth on samples returned to the incubator. Whether this is due to a reduction of viability in the few spores and/or hyphae left behind or some resistance to metabolism of new settled spores is unknown. Further studies will be needed to explore this unexpected result.

The possibility of post-remediation fungal regrowth of contaminants has led to the development and sale of a variety of antimicrobial or fungistatic/fungicidal surface treatment and coating products. These products make varying claims regarding long-term prevention of microbial regrowth. Several of the currently available products have varying degrees of concerns regarding toxicity, longevity, vapor permeability, appearance, V.O.C. emission, and other issues. Concrobium Mold Control is completely non-toxic, does not contain or emit V.O.C., does not affect the surface permeability (i.e. ability for structural components to “breathe” normally), and does not change the appearance of surfaces to which it is applied.

This study has demonstrated the fungal regrowth prevention (Phase III) efficacy of Siamons International’s Concrobium Mold Control in a reasonable “field-like”

application. Laboratory studies performed previously have also confirmed that Concrobium Mold Control is effective in preventing fungal regrowth on surfaces.¹ Considering these controlled studies and its unique features, it can reasonably be concluded that Concrobium Mold Control is a choice superior to most antimicrobial coating products currently in common use for mold remediation.

The results of this small study support evidence from the field that Siamons International's two-product Concrobium Mold Remediation system is a viable and, in many cases, a superior method of mold remediation.

¹ An example of a published laboratory study establishing the antimicrobial and prevention effect is: Ultrastructure Changes Induced by Dry Film Formation of a Trisodium Phosphate Blend, Antimicrobial Solution; P. LEA, S.-F. DING, S.B. LEMEZ; UMEDIK Inc., Toronto, Ontario, Canada)

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Peter has obtained multi million dollar research grants, published 93 papers, 2 books, 5 Chapters; and has delivered more than 100 invited International presentations. He has invented, patented and developed new biotechnology concepts including blood processes and ceramic technology, and co-invented and patented inorganic anti-microbial polymers and their applications.