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Materials Science Division

01/23/03

Attention: *Chris Tracy*
Twin Chemicals, Inc.
5010 Hickory Hills Drive
Woodstock, GA. 30188

Project: MICROrid
Ref. Number: 360201164

• Certificate Of Analysis •

Report On MICROrid Fungal Inhibitor

For

Twin Chemicals

Date: 24 January, 2003

Submitted by:

John Newton: _____
Laboratory Manager

Adam Freehoff: _____
Microbiologist

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Report On Fungal Inhibitor Investigation

Conclusions:

The following conclusions have been reached.

1. MICROrid fungal inhibitor successfully inhibits the growth of new mold.
2. MICROrid fungal inhibitor stops the spread of mold and effectively neutralizes existing fungi.
3. No evidence of staining or color leaching of fabrics, carpets or paints was present under moderate use.
4. No delamination of paints, wood or polymer coatings was evident under normal use.
5. Under excessive use MICROrid may cause residue build-up, discoloration or damage to some materials.

Sample Receipt:

The sample for Twin Chemical was delivered to the EMSL Analytical corporate laboratory in Westmont, NJ. on 12/12/02. One liquid sample was submitted for the purpose of determining the effectiveness of the mold inhibiting properties of MICROrid and the any detrimental side effects of its use to various surfaces.

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Procurement of Samples and Analytical Overview:

Several sub-samples were removed, labeled and analyzed using a variety of techniques to characterize the solids content upon evaporation of the liquid media, the effectiveness of the product to inhibit fungal growth and the viability of use pertaining to deterioration and staining of products that come in contact with MICROrid.

Sample Preparation:

Various materials including fabric, carpet, wallboard, wood and agar plates were prepared prior to microbial inoculation. This process was performed by spraying half of each material with MICROrid. A small aliquot of MICROrid was dried and a portion of the resulting residue was placed onto a clean glass slide. Additional residue was placed onto a sample plate for Fourier Transform Infrared Spectrometry (FTIR) analysis and also placed onto an SEM sample holder and coated with gold for Scanning Electron Microscopy and Energy Dispersive X-Ray Spectrometry (SEM/EDX).

Each treated and untreated material sample was placed into a clean environmental chamber. The chamber temperature was maintained at 25^{o}C for 7 days followed by 32^{o}C for 14 days. The humidity was maintained at 78% to 82%. The material samples were incubated in the chamber for the entire duration and periodic sub-sampling was performed to evaluate the mold growth. Additional agar plates were placed into the chamber to evaluate the levels of inoculation from the free-floating fungi within the chamber. This was performed to ensure an elevated spore count within the test environment. The fungal spores used for the analysis are; *Stachybotrys sp., Cladosporium sp., Alternaria sp., Acremonium sp., Trichoderma sp., Aspergillus niger and Aspergillus sp.*

Upon completion of the incubation period portions of the rugs, woods, wall-board and fabrics were sectioned and prepared for analysis by optical and electron microscopy .

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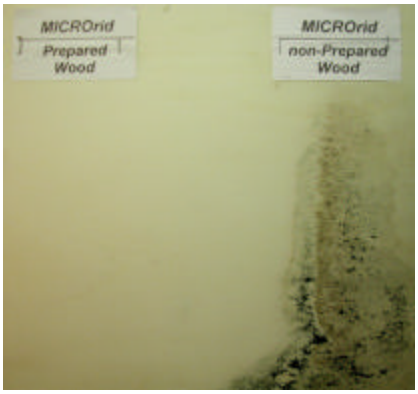
Microscopy:

Analysis of the agar plates, rugs, fabrics, wallboard and wood surfaces by stereomicroscopy and optical microscopy revealed marked differences between the portions treated with MICROrid and the untreated materials. In every instance fungal growth was observed on the untreated material. However, no significant growth was observed on the treated portions. The most obvious example was on raw softwood, which has a characteristically porous surface and acts as a source of natural nutrition for many fungi. (Figure #1).

Figure #1: Prepared wood surface before and after incubation period.

Before incubation

After incubation



To confirm the inhibiting properties of MICROrid, several agar plates were submitted to the same testing process. Agar plates are specifically designed to enable growth of specific molds. Analysis revealed that even though the agar plates are an excellent growth media no fungi were able to grow after inoculation. Furthermore, after application of MICROrid on plates that already displayed mold no further growth was apparent. (Figure #2).

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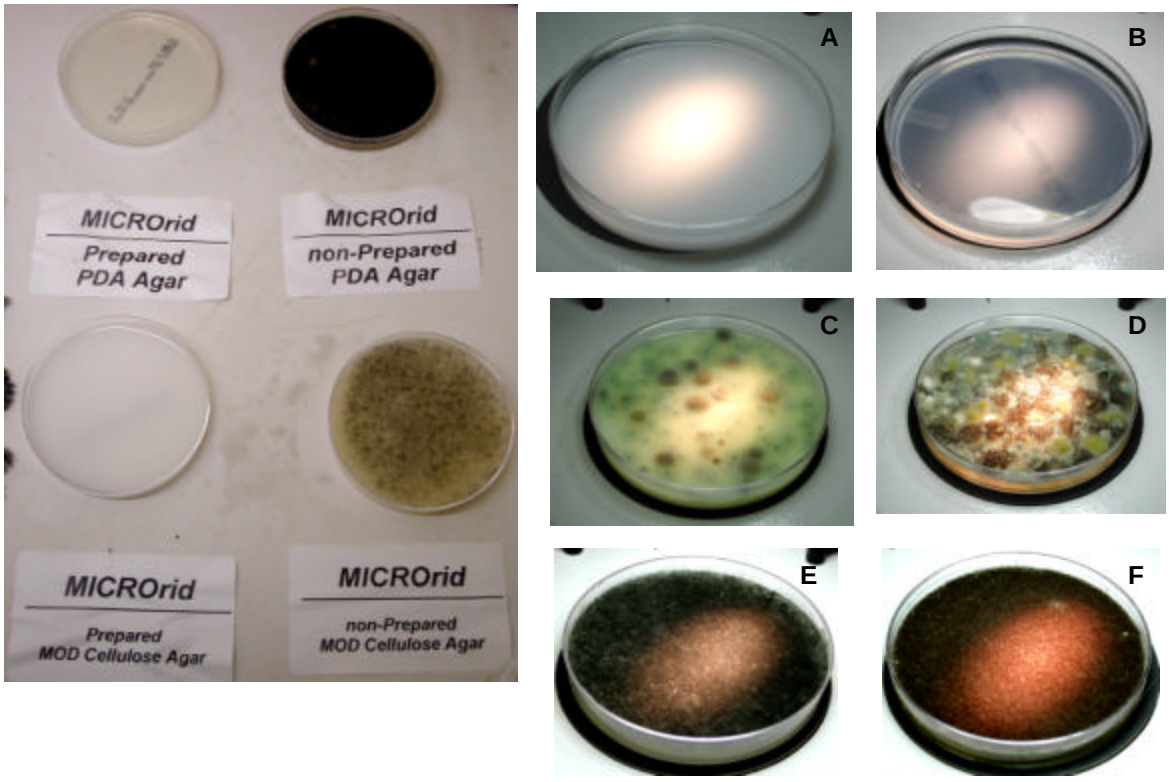
Figure #2: Mold growth on agar plates.



Plates prepared with MICROrid prior to inoculation. (A & B)
Plates prepared with MICROrid after fungal growth began. (C & D)
Plates that were not prepared with MICROrid. (E & F)

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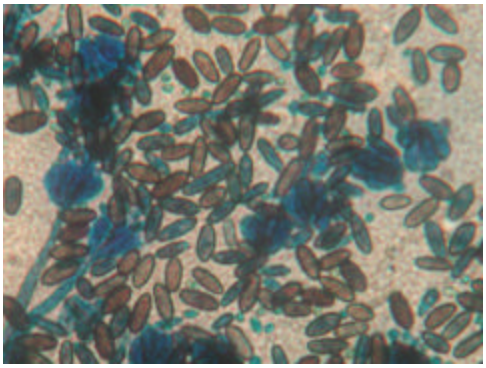
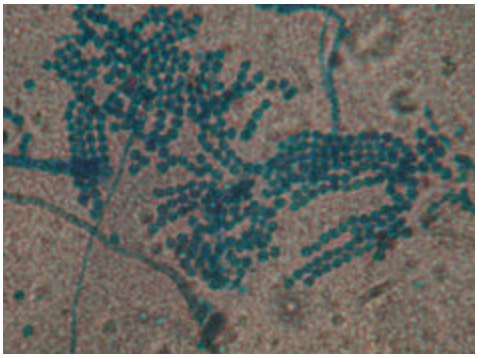
Figures #3: Mold growth on materials. Analyzed via optical microscopy.

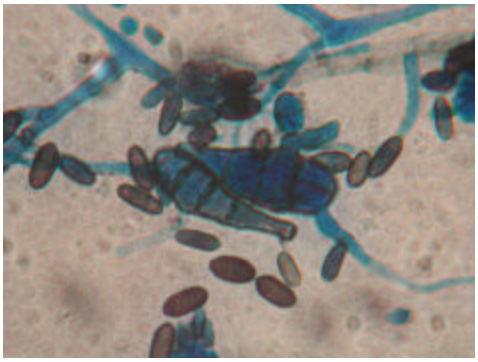
Stachybotrys sp. and *Aspergillus sp.* removed from wood paneling.



Aspergillus niger removed from cotton clothing fabric.



Aspergillus sp., Alternaria sp., and Stachybotrys sp. removed from cellulosic bound gypsum wallboard.



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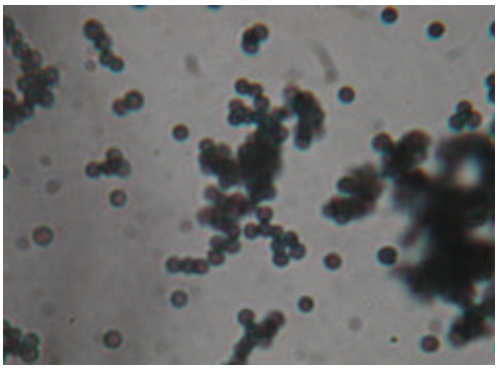
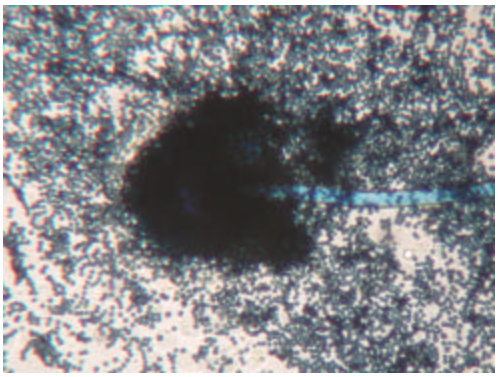
Figures #3: Mold growth on materials. Analyzed via optical microscopy. (cont.)

Aspergillus niger removed from industrial carpet.



Aspergillus niger removed from thick-nap home carpeting.



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Analysis of the product to determine detrimental effects of use to various surfaces was performed on fabric, carpet, wallboard, wood and paint. Testing was performed by spraying the surface of the material with MICROrid and allowing to dry before additional applications. Overall color retention and "bleeding" of colors was performed by stereomicroscopy. The treated and untreated materials were analyzed side by side for comparative purposes. No discoloration or migration of the pigments was evident in any of the material samples. Furthermore, there was no damage incurred to the polymer laminates applied to the paneling tested. One point of interest was an accumulation on the surfaces of all materials after repetitive use. This consisted of a dry film residue from the MICROrid product. (Table #1).

Table #1: Data summary

Material	Mold Growth (Untreated)	Mold Growth (Treated)	Discoloration	Delamination	Build-up (# of treatments)
Industrial carpet	Present	None	None	N/A	50+
Thick-nap home carpeting	Present	None	None	N/A	50+
Poly-blende furniture fabric	Present	None	None	N/A	32
Cotton (white)	Present	None	None	N/A	28
Cotton (various colors)	Present	None	None	N/A	25
Polyester	Present	None	None	N/A	29
Rayon	Present	None	None	N/A	30
Silk	Present	None	None	N/A	27
Raw wood paneling	Present	None	None	None	14
Maple paneling	Present	None	None	None	6
Oak paneling	Present	None	None	None	4
Pine paneling	Present	None	None	None	6
Wall board	Present	None	None	None	9
Acrylic paint (white)	Present	None	None	None	8
Latex paint (white)	Present	None	None	None	8
Latex paint (blue)	Present	None	None	None	8

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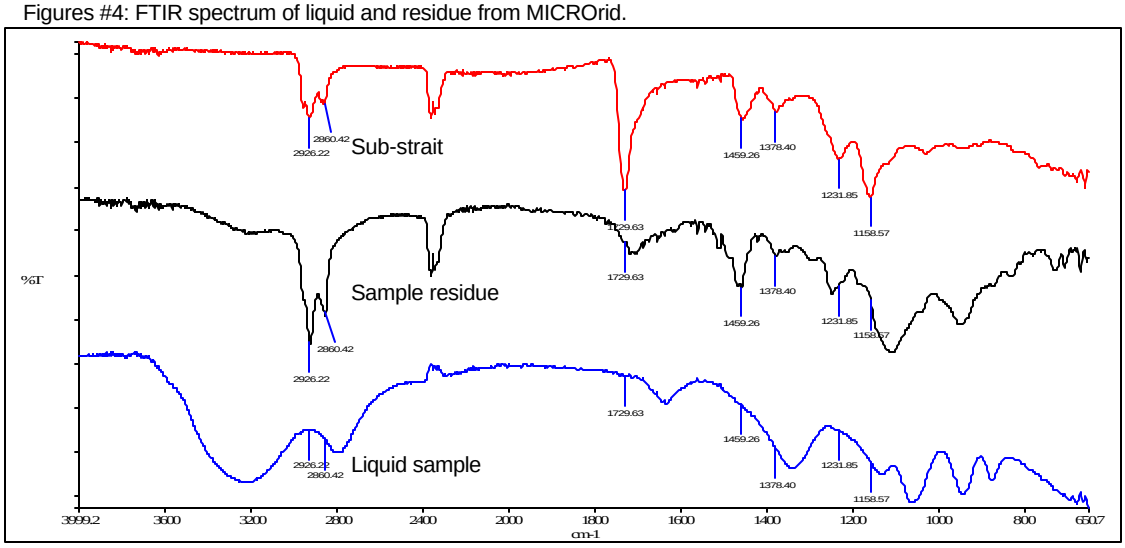
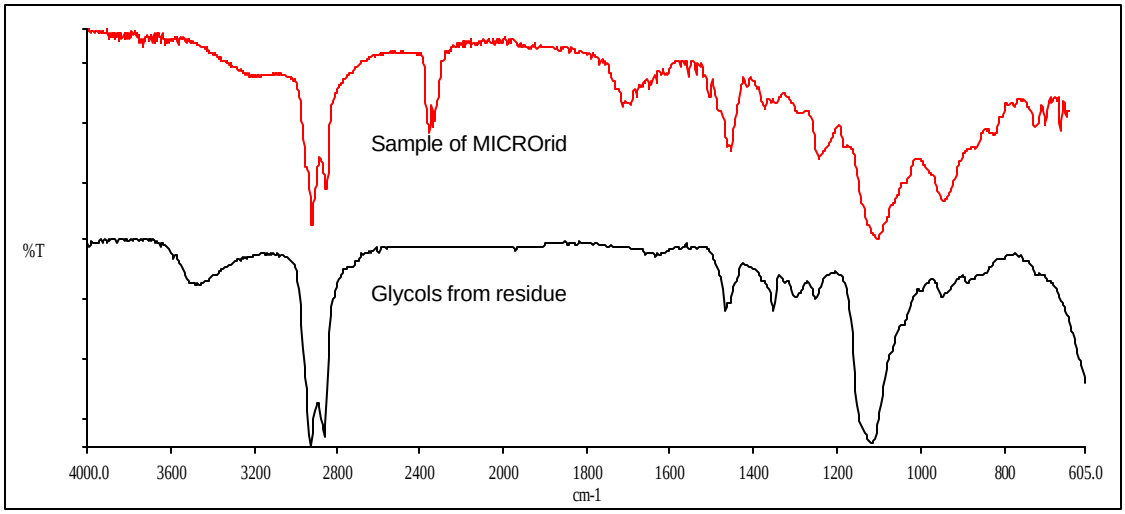
Fourier Transform Infrared Spectrometry (FTIR):

The residue collected after drying MICROrid was tested by FTIR and SEM/EDX to determine the general composition.

Figures #4: FTIR spectrum of liquid and residue from MICROrid.





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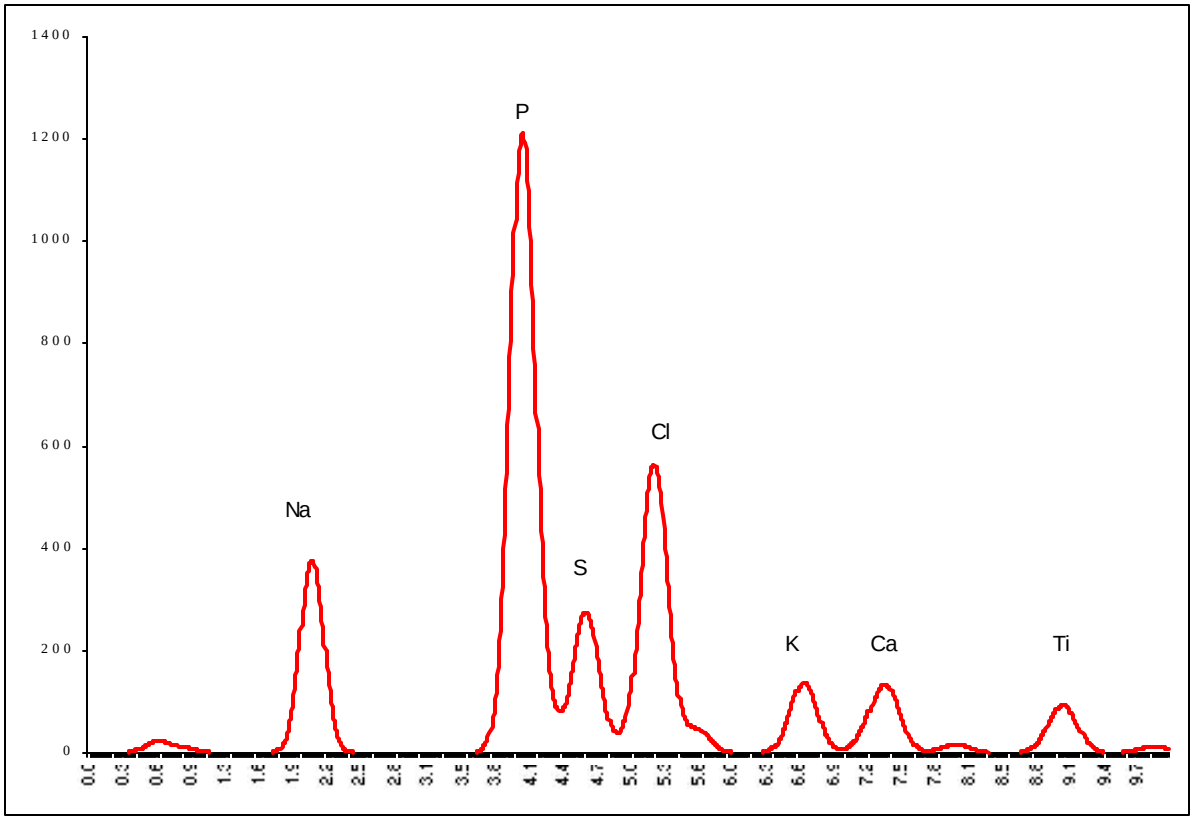
Scanning Electron Microscopy and Energy Dispersive X-Ray Spectrometry:

Figure #5: EDX spectrum of residue from MICROrid.



The dry residue forming build-up on materials due to excessive application of MICROrid is a combination of glycol and water with sodium (Na), phosphorous (P), sulfur (S), chlorine (Cl), potassium (K), calcium (Ca) and titanium (Ti). A definitive match for the chemical residue was not possible at this time however; there is significant correlation to glycols. Due to the corrosive nature of several of these elements it is recommended that the manufacturers instructions include steps to limit the amount of liquid used during application. During laboratory testing it was found that as little as one (1) non-saturating application was effective at inhibiting fungal growth.

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Analysis was performed to determine the depth of penetration for MICROrid into various materials. This data is inconclusive due to several variables; porosity, temperature, barometric pressure, humidity and material surface coatings. However, the following generalizations can be made. (Table #2)

Table #2: Penetration study

Material	Depth of penetration (mm) with 3 applications	Comments
Industrial carpet	2	Loop fibers, penetration from surface of nap
Thick-nap home carpeting	3	Strait fibers, penetration from surface of nap
Poly-blende furniture fabric	Complete	Wicking caused complete contact through material
Cotton (white)	Complete	Wicking caused complete contact through material
Cotton (various colors)	Complete	Wicking caused complete contact through material
Polyester	Complete	Wicking caused complete contact through material
Rayon	Complete	Wicking caused complete contact through material
Silk	Complete	Wicking caused complete contact through material
Raw wood paneling	1.4	Non-coated rough wood surface
Maple paneling	Surface	Paneling coated with urethane laminate
Oak paneling	0.3	Paneling not coated with laminate.
Pine paneling	0.3	Paneling coated with urethane laminate but highly porous
Wall board	0.5	Penetration does not reach gypsum
Acrylic paint (white)	Surface	Non-uniform penetration, porosity dependent
Latex paint (white)	Surface	No penetration
Latex paint (blue)	Surface	No penetration