Sampling Carpets and Soft Surfaces for Fungal Contaminants

What the Attorney Should Know About Sampling and the Clean v. Discard Dilemma

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One of the biggest areas of disagreement in mold remediation often involves personal possessions: should they be cleaned or discarded? Defense wants to just HEPA-vacuum the surfaces of the items, while plaintiff wants all soft-surface items to be discarded. But why do these disagreements occur so frequently? Part of the reason may be due to the selection of the sampling method. If the sampling method cannot differentiate between "contamination" and "colonization," then sample results may be difficult to interpret.

Let's define "contamination" as mold spores simply lying on a dry surface. This can occur when airborne spores settle onto a soft-surface item, such as a couch or chair. Since this often occurs during mold-related incidents, HEPA-vacuuming and cleaning soft-surface items as part of mold remediation is a prudent practice. Generally, soft-surface items that are contaminated in this way are easily cleaned. Unless the user is especially sensitive, a thorough cleaning by HEPA-vacuuming the item is often sufficient.

However, we have to be aware that such items, when exposed to water in either the liquid or vapor form (high relative humidity), can accumulate enough moisture to promote the growth of the settled spores. If a soft-surface item becomes wet, then colonization can occur. I will define"colonization" as mold growth within materials such as fabric, cushions and particle board. Once colonization has occurred, it becomes almost impossible to clean the item to acceptable levels. Discarding the item then becomes the most cost-effective solution.

If, in general, we can say that contaminated items can be cleaned, but that colonized items should be discarded, then we have the basis for a rational decision. Following this logic, we would prefer to use a sampling method that can differentiate between items that are simply contaminated and those that are colonized, since the sample results provided by that method allow us to make a decision.

In order to pursue this logic, I have to make the following assumptions:

Assumption #1

A sampling method that collects the sample from the surface of a soft-surface item is only testing for *surface* contamination. An example is the closed-face cassette depicted in Figure 1.

Assumption #2

A sampling method that collects the sample from below the surface (as well as the surface) is testing for both colonization *and* contamination. The open-face cassette in Figures 2 is an example of this method.

Since the decision to clean or discard is based on colonization rather than contamination, the preferred sampling method would collect the sample from below the surface, from the interior of the material.

Micro-Vacuum Sampling Methods

Ideally, a soft-surface sampling method should satisfy the following goals:

Sampling Goal #1

The soft-surface sampling method should be quantitative. That is, it should have the ability to detect differences in mold concentrations between two or more items (carpets, chairs, etc.).

Sampling Goal #2

The method also should be reproducible. By this I mean there should be a reasonable chance that two field technicians would collect samples in the same way, so that the sample results collected on different projects could be compared.

Sampling Goal #3

Finally, the sample results should allow the investigator to differentiate between items that can be cleaned and those that should be discarded.

In order to meet these goals, the sample results have to be "standardized" (in this case by area), the sampling parameters have to be constants, and the sampling protocol has to be well-defined and simple to implement.

A micro-vacuum sampling method is one that uses a high-volume air sampling pump (suction device) attached to a filter cassette (sample collection device) to collect mold from surfaces. Figure 1 shows a closed-face 25 millimeter (mm) filter cassette being used to collect culturable fungi from a known area of fabric (or carpet). The pump is calibrated at an airflow rate of 20 liters per minute (lpm). A short piece of beveled plastic tubing is attached to the inlet of the cassette. The beveled tip is then brushed across the area of material enclosed by a template for two minutes. The template in this illustration is 30 cm by 30 cm, enclosing 900 cm^2 of surface area. This method primarily samples the surface of an item.

Figure 2 illustrates sampling a carpet for culturable fungi and/or bacteria using an open-face 25 mm filter cassette. The open face of the cassette has an area of about 5 cm^2, so sampling 20 different spots yields a sample area of 100 cm^2. This method samples both the surface and the interior of the material.

If the objective is to sample for culturable fungi, then a standard 25 mm filter cassette can be used as the collection device. If a fast turn-around spore count is required, or if both total spores and culturable fungi are being sampled, then a dual-trace Bi-Air cassette may be used as the collection device. The sample results are reported on an area basis (mold per 100 square centimeters of carpet) [mold/100 cm^2], for example.

Sampling Carpets

The carpet is sampled by attaching a filter cassette to a high-volume pump, calibrating the airflow rate, and firmly holding the open-face cassette against the carpet for 5 seconds. This applies a reproducible suction force to the carpet, and collects spores from deep within the carpet and backing. The cassette is lifted from the carpet and firmly placed onto a second area of carpet. This is repeated until a known area of carpet has been sampled, typically 100 cm^2 with a 25 mm filter cassette and 20 cm^2 when using a Bi-Air cassette. The sampling parameters are detailed in Table 1.

Figure 1
Using a closed-face cassette to sample from the surface of a soft-surface item.

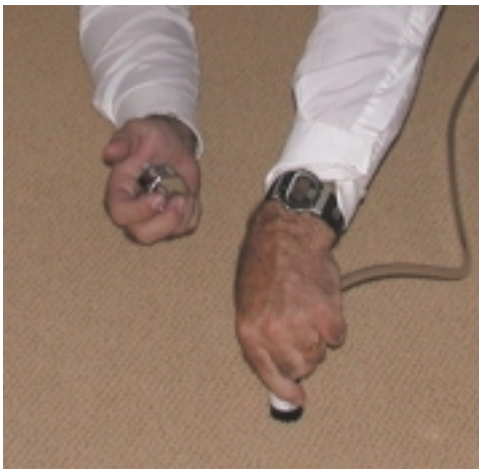

Figure 2
Using an open-face cassette to collect the sample from below the surface as well as from the surface of a soft-surface item.

Table 1: Sampling Parameters for Collecting Carpet Dust

Sampler	25 MM Cassette	Bi-Air Cassette
Number of spots sampled	20	10
Airflow rate	10 liters per minute	2 liters per minute
Contact Time per spot	5 seconds	5 seconds

This sampling method is simple to implement - just hold the cassette against the carpet for 5 seconds, then repeat. In addition, the sampling parameters are constants rather than variables, so two field technicians collecting samples on different projects can apply the method reproducibly. A key point is that this sampling method was developed to detect colonization by collecting the sample from deep within the material.

The sample results may be interpreted in two ways. First, even though numerical guidelines are presented in this article, professional judgment is the fulcrum for evaluating industrial hygiene data, and is primary in assessing the data. Second, the condition of the carpet can be assessed by evaluating both the concentrations and types of fungi detected.

Based on previous work using this method, I use the criteria in Table 2 to interpret the sample results. The numerical guidelines in Table 2 are helpful in assessing the condition of a carpet, especially if limited sampling was performed, or if comparison data are not available. However, as previously stated, pro-

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fessional judgment is the primary criterion for evaluating the sample results.

Environmental fungi include *Cladosporium*, *Epicoccum*, and *Alternaria*, while contaminant fungi include *Aspergillus*, *Penicillium*, and *Stachybotrys*.

Sampling Soft-Surface Items

The same sampling methods that were described for sampling carpets can be used to sample soft-surface items such as couches, chairs and bedding. As with carpets, the objective is to determine if those items can be separated into two groups: "contaminated" or "colonized." The goal is to decide if the items, in aggregate, can be cleaned or if they should be discarded.

The best way to address this issue is to discuss some actual data. Approximately 19 soft-surface items were sampled by Leila Brickus, Ph.D., CIH (Clark Seif Clark, Inc., Chatsworth, CA). Her data are a direct comparison of the two sampling methods illustrated in Figures 1 and 2, the closed-face cassette and the open-face cassette. My intent is not to present her data here, but to offer my opinion on the interpretation of the summarized data.

The 19 items that were sampled had been HEPA-vacuumed, removed from the subject property, and stored in a warehouse operated by a restoration company. The question: were the items in a suitable condition to be returned to the owner, or should they be discarded?

I based my recommendation on the data summarized in Table 3 using the following four assumptions:

1. The closed-face cassette with beveled tip primarily sampled the surface of an item.

2. The open-face cassette sampled the surface as well as the interior of an item.

Table 2: Criteria for Evaluating Carpets (cfu/100 cm²)

Concentration	Dominant Fungi	Comments
Less than 100	Environmental fungi	Cleaning optional
100 - 300	Environmental fungi	Cleaning optional, but recommended
100 - 300	Contaminant fungi	Cleaning recommended
Greater than 300	Environmental fungi	Clean, possibly discard
Greater than 300	Contaminant fungi	Discard

Table 3: Median Concentrations of *Cladosporium* and *Aspergillus/Penicillium* Type Spores (spores/100 cm²)

Spore Type	Closed-Face Cassette	Open-Face Cassette
Cladosporium	283	378
Aspergillus/Penicillium	75	6,193

3. *Cladosporium* species are common environmental fungi, the spores are almost always present in the air, and those spores settle onto surfaces.

4. *Aspergillus* and *Penicillium*, when detected at elevated concentrations in soft-surface items, are contaminant fungi resulting from a water intrusion incident.

Both sampling methods produced similar results for *Cladosporium*, with concentrations of 283 spores/100 cm² (closed-face) and 378 spores/100 cm² (open-face). Therefore, about 75 percent of the *Cladosporium* was detected on the surfaces of the items. These results suggested that the *Cladosporium* was due to the settling of airborne spores. The data suggest that either method could be used to sample the surfaces of items.

The closed-face cassette did not detect the presence of elevated concentrations of *Asp/Pen* type spores, indicating that *Asp/Pen* type spores were not present on the surfaces of the items in significant concentrations.

However, there was a dramatic difference in the concentrations of *Asp/Pen* type spores between the two sampling methods. The closed-face cassette detected a median concentration of 75 spores/100 cm², while the open-face cassette was able to detect a median concentration of 6,193 spores/100 cm² of *Asp/Pen* type spores. The median concentration detected using the open-face cassette was over 80-times greater than with the closed-face cassette.

The data obtained with the open-face cassette indicated that the *Asp/Pen* spores, which were assumed to be contaminant spores, were located primarily in the *interiors* of the items, not on the surfaces of the items.

The sample results from the closed-face and open-face cassette led to completely opposite conclusions, and decisions. The decision based on the results from the closed-face sampling method was that the items were in an acceptable condition and could be returned to the owner. The results from the open-face cassette showed high concentra-

tions of residual contaminant spores, the items had not been adequately cleaned, and were not in an acceptable condition.

Therefore, using the closed-face cassette is the "defense method," while using the open-face cassette is the "plaintiff method."

However, the unbiased approach would be to use both sampling methods in what is referred to as "differential sampling." Use the closed-face cassette to sample the surfaces of the items, and the open-face cassette to sample both the surfaces and the interiors of the items. The difference in sampling results could provide a rational basis for classifying items as either contaminated (i.e., appropriate for cleaning) or colonized (i.e., should be discarded).

Clean or Discard?

One question that has not been addressed is: why discard colonized items? Why not just clean them too? Again, I can best address this issue by presenting and discussing sample results. The data in Table 4 were collected from office chairs and padded office dividers as part of a mold investigation in a commercial building.

Fortunately, one wing of the facility had not been involved in the water intrusion incident, and items from that wing served as controls. The *Penicillium* concentrations in the soft-surface items from that wing were considered to be typical of "clean" office furniture. The items in the remainder of the facility, the contaminated area in Table 4, had been exposed to either direct contact with water or high humidity for an extended period.

The sample results in Table 4 were post-cleaning. Each of the soft-surface items had been HEPA-vacuumed three times by a professional restoration contractor and sprayed each time with an antimicrobial agent prior to sampling.

Based on the results for the closed-face cassette, the average concentration of *Penicillium* was about 6-times greater (4 v. 24 cfu/100 cm^2) in the items from the contaminated area. However, the contractor characterized the difference as "not significant" and the owner was asked to accept the furniture for re-use.

Table 4: Concentrations of Culturable *Penicillium* in Soft-Surface Items (cfm/100 cm^2)

Control Area		Contaminated Area	
"Closed"	"Open"	"Closed"	"Open"
0 - 4	4 - 14	23 - 25	560 - 1,970

I was then asked by the owner to re-sample the items, which I did using the open-face cassette. The *Penicillium* concentration, even after HEPA-vacuuming three times, was about 140-times greater (9 v. 1,235 cfu/100 cm^2) in the items from the contaminated area compared to those in the control area, and the owner decided not to accept the items for re-use.

The concept that soft-surface items, once colonized by mold, cannot be adequately cleaned is generally accepted within the community of microbial indoor air quality consultants. The items in Table 4 had been HEPA-vacuumed three times by a professional contractor prior to sampling. Was it worth HEPA-vacuuming them a fourth time? Probably not. Once a soft-surface item has been characterized as colonized by mold, the most cost-effective approach may be to discard the item rather than try to clean it.

Conclusion

This article describes micro-vacuum methods for sampling mold in carpets, and soft-surface items such as bedding and fabric-covered couches. The advantages of these methods are that they are often able to differentiate between items that are simply contaminated and those that are actually colonized by mold. If an item can be placed into one of these two categories, then a rational decision can be made as to whether it can be cleaned.

There is an old adage that is applied to computer-generated data: garbage in, garbage out. This same concept applies to sample results. If the sampling method is not appropriate for the intended task, then we start with "garbage in." The sampling methods described in this article are not the "standard" methods with which many of you are familiar. Rather, they have been developed with specific tasks in mind.

Once the decision has been made to collect samples, the selection of sampling methods is crucial and should be done with careful consideration of the intended use of the data. This is nicely illustrated by the data in Table 4. However, my experience tells me that the methods used to collect mold samples are often selected by one person observing another person, and copying what the other person did to collect their samples. Sampling methods selected using such criteria may be difficult to defend.

For those interested in the technical details of the sampling methods described in this article, such as example data and validation data, go to Mold Inspection Products.com [http://www.moldinspectionproducts.com/] and then "Archives" to access additional information about sampling methods for mold.