Healthy flooring for people with chemical sensitivities

The floors of a house, apartment, school, clinic or business can cause serious problems for people with chemical sensitivities. Fortunately, there are several options available, whether for new construction or modifying an existing home or office.

There are also temporary options that can be used by people who rent apartments or live in camping trailers.

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The problem with floors

The floor of a house, apartment, school or office has a tough job. It has to handle furniture, pets, children and people walking on it with shoes. We also want it to look presentable and still cost as little as possible.

In the western world, carpeting has been the dominant floor covering for more than two generations. The typical carpet is made of plastic fibers and treated with a variety of toxic chemicals to make it durable, colorful and stain resistant. Even premium wool carpets are usually treated with all these chemicals. Underneath is often a spongy pad, also made of plastic and chemicals. Beneath that again is the subfloor, which is often made of some sort of manufactured wood plate (such as plywood) that consists of small pieces of wood that are glued together under high pressure.

A toxic brew of chemical fumes will be given off for years by all these materials.

Dirt, animal dander, mold, pollen and dust mites will accumulate inside and under the carpet. They cannot be fully vacuumed up, even with the most heavy-duty truck-mounted professional equipment. If you pull up the carpet, there will always be dirt underneath.

People coming from the outside with their shoes on can track in various pollutants that will then be rubbed off on the carpet. This can include pesticide pellets applied to nearby lawns, or pesticide-laden dust particles from stores, sidewalks, yards, etc. (Stout 2009).

Mold is a particular problem with older carpets. Mold lives off dust, dead dust mites, and skin flakes trapped in the carpet. If the carpet gets wet and is not fully dried within 24 to 48 hours, the mold can flourish. If the air in the room is humid, the mold can continue to grow, even if the carpet appears to be dry (May 2004).

Then there is the whole issue of using carpet shampoos, which tend to contain another brew of toxic chemicals.

It is no wonder that carpeting is a major problem in sick building syndrome and a big problem for people with environmental sensitivities. Floors cover a large area in any home or office, so it has to be a very inert material to be tolerated by sensitive people. A material that works fine for a few square feet or meters may not work when scaled up to the much larger surface of a floor.

What to do with a toxic floor

If you already have a toxic floor, there are these options to consider:

- Replace it
- Wait for it to air out
- Cover it up
- Move away

Which method to use depends on the situation.

Replacing the floor is often the best option, and if you own your home it may be a good long-term investment since healthy materials are usually also more durable. But it costs a lot of money up front.

If you rent your home, replacing the floor may not be possible, since the landlord must approve it. The landlord is not obligated to help with the expense and once you move away your investment is lost.

We will cover the various materials and their benefits and limitations later on in this article.

If the flooring is new, it may be possible to seal off the room and leave the window open to air it out over time. It can take a year or more for carpets or laminated floors to air out enough for the room to be usable with precaution. Open windows are essential for offgassing — air cleaners will not do it. Even several super-duty special formaldehyde air cleaners are not enough.

If the flooring is older than a year, then covering it up may be sufficient. This won't work with fresh flooring as any form of seal will be leaky. It is hard to seal in gases, especially volatile gases like formaldehyde and solvents. Any sort of covering will just slow down the emissions and will not fully contain them.

Sometimes a toxic place is not salvageable. It may make more sense to find something better elsewhere. Many, many people with chemical sensitivities (MCS) have had to face the reality that their home will never work for them.

Covering up a toxic floor

If the floor is covered with carpeting consider one of the special carpet sealers, which are sprayed on to seal the fibers. Try it in a small area of the carpet first, preferably in an area where a stain would not be too visible. We do not have any experience with these kinds of products and don't know how effective or tolerable

they really are. Be cautious. Sealers never provide a perfect seal; they can only reduce the offgassing.

There are sealers that are designed for covering hard surfaces, such as wooden planks and plywood. Like all sealers, they reduce the offgassing but are not air tight. The sealer itself may also not be tolerable, or at least will need some weeks or months of offgassing.

A more effective method is to cover the floor with an air tight membrane.

This can even be done on top of carpeting, though it is necessary to use soft shoes or bare feet when walking on it.

The most popular membrane among people with MCS in North America is the Tu-Tuff product. It is marketed as a vapor barrier for house construction (the more common "house wrap" is not a vapor barrier). Tu-Tuff is made of polyethylene (PE) plastic, which is similar to what is used for disposable water bottles (PET).

Simply roll it out and cut to size, with a large overlap between pieces. It is durable and odorless.

Bedroom in a rented apartment. The floor is covered with laminated aluminum foil. Carpeting is still underneath as it could not be removed.

An alternative is to use laminated aluminum foil. This is made of kraft paper (or a plastic film) that is covered with aluminum foil on both sides. Aluminum foil by

itself is not strong enough to last. In the United States such a product is sold as Dennyfoil, which is also marketed as a vapor barrier.

A benefit of these aluminum foil products is that they will also shield microwaves coming from a downstairs neighbor's mobile phones and wireless network. However, if you use wireless products yourself, the foil will also reflect your own microwaves back at you.

Galvanized steel plates cover the floor of this bedroom. The carpet was removed so the plates rest on the plywood subfloor.

A third option is to use steel plates to cover the floor. This is likely to cost more and be more work to transport and install. Galvanized steel plates tend to be more tolerable than raw steel and much cheaper than stainless steel or aluminum. You may need to wash the plates with hot water and dish soap to remove oils from the manufacturing.

Steel plates will shield and reflect microwaves like aluminum foil does. In addition, they will also dampen low-frequency magnetic fields from electrical wiring under the floor (but don't expect too much).

The insulation product that is made of plastic "bubble-wrap" encapsulated in aluminum foil will not work well for long-term use. The bubbles will burst and the aluminum is so thin it will wear off and expose the plastic. This product is sold in the United States under brand names Reflectix and Astro Foil.

Removing the carpet

Another low-cost option is to fully remove the carpet, including any pad and tack strips, so the subfloor is exposed.

This works well if the subfloor is concrete, but can also work for subfloors of wooden sheets (plywood etc.) if the house is several years old.

The subfloor could be sealed by several coats of a painted-on non-toxic sealer. Make sure to test for tolerance first. Each coat must be fully cured before applying the next coat.

The subfloor can also be covered with a membrane, such as galvanized steel plates, laminated foil or tolerated plastic.

It is not pretty, but people have lived with such flooring for many years.

Floor in a camping trailer that is covered with Tu-Tuff plastic and then with loose porcelain tile on top. The carpeting was removed.

Some people have placed tile loosely on top of the membrane to create a more durable and better looking surface. Porcelain tiles are better than ceramic tile, as they are less prone to cracking.

Expect to have to pull up the tiles and vacuum beneath once a year.

Installing new flooring or replacing an old floor

There are many healthier alternatives to a carpet. We present them here in three categories of tolerability.

Most tolerable flooring

The most tolerable flooring materials are all hard surfaced and heavy. The benefit is that they have minimal offgassing and most of them are resistant to dirt, mold, stains and wear.

These floors are heavy, so they may not be possible to install in upstairs rooms in wood-framed buildings. Their hard surfaces mean that they are harder to walk on, unless using well-cushioned shoes or throw rugs. They are also noisy to walk on, especially with hard soles, which can be really annoying for those living below.

The hard surface is also a hazard for people to fall on. Elderly people with osteoporosis can break bones if they fall on such a hard floor (this has actually happened).

These floors will feel cooler than lighter materials. That is a bonus in a hot climate, but less pleasant in cold winters unless they are on top of a radiant floor heating system, in which case they are very pleasant to walk on with bare feet.

The floorings we consider the most tolerable are:

- ceramic and porcelain tile
- stone tile
- sealed concrete
- bricks-in-sand

If you are highly sensitive, these are your safest options.

Tiled floor installed as a retrofit in an apartment living room.

The ceramic and porcelain tiles are the most popular floor covering in the MCS communities in the United States. They can be installed in most existing and new housing. They are beautiful, durable, low maintenance and odorless, if installed well.

The tiles are installed with grout and thinset, which are mostly sand and cement. Commercial mixes all have chemical additives that some chemically sensitive people do not tolerate, but you can make your own.

Glazed and unsealed ceramic tile and porcelain tile all work well, though unsealed tiles will absorb spills.

Tile must be installed on a rigid subfloor, such as concrete or concrete boards. If your subfloor is made of wood products, it will need to be replaced or covered with cement boards to prevent the tiles from cracking and loosening.

Tiles cannot be used in trailers or mobile homes in the normal way, as they will crack when moved and the floors may not be rigid enough anyway. People have successfully used porcelain tiles placed loose on top of engineered-wood floors covered with Tu-Tuff plastic (see picture earlier).

This web site has a detailed article about the use of ceramic tile in healthy houses, including recipes for chemical-free grout and thin-set. See www.eiwellspring.org/saferh/Tile.htm

Stone tiles are cut out of natural rock. They are installed like ceramic tile, but are heavier and costlier. Some natural rocks give off the odorless radioactive gas radon, which can cause lung cancer. Make sure to get radon-free tiles.

If you are building a new home, you can make the floors out of concrete. The concrete mixer can add natural pigments to give the concrete a variety of warm colors that will never fade. The contractor will use a special buffing machine on the nearly-hardened concrete to give it a smooth surface. Once the concrete is fully cured, a sealer will give the floor a durable maintenance-free surface.

This kind of floor is cheaper than a tile floor, but you'll have to find a safe and durable sealer. Sodium silicate can be used as a sealer, but it tends to wear off after a few years.

Concrete floor with added natural pigments and a clear sealer. This floor is twelve years old and looks like new, but the sealer used is no longer available.

Ordinary fired clay bricks set in sand make this beautiful floor.

The bricks-in-sand method is simply fired clay bricks set in a layer of sand. It is labor intensive, but can be done by someone who can't tolerate wet cement. This may be a good option for a do-it-yourself floor.

The drawback is that it will soak up any spills and it is so heavy it can only be installed directly on the ground or on top of a sturdy concrete subfloor.

The bricks can be sealed, but spills can still leak between the bricks.

This method may not work in areas where moisture can rise up from the soil (placing a membrane below the bricks could trap spills).

Other options are to use various types of patio pavers. These are usually make of concrete.

Second tier of flooring

Most of these flooring materials have been used successfully in several healthy homes, but are less universally tolerable. They may need more offgassing or maintenance, but they are also a bit softer to walk on and not as cool in the winters:

- solid hardwood
- natural linoleum
- vinyl (also called “linoleum”)
- non-laminated cork
- mud floor

Genuine (solid) hardwood is hardwood planks sawn out of a tree. They are laid across wooden supports and nailed down. A sealer is usually applied on top, either by the manufacturer or by yourself.

Genuine solid hardwood floor. Photo credit: Erika L. Nestor.

This type of floor is common in old houses, but rarely used in newer homes. Cost has nearly killed off this type of flooring. Most "wood flooring" today are laminates, which we'll get to later. Make sure to check any product you intend to buy, as advertising blurs what the material really is.

Also be sure to avoid softer woods, such as pine, as they are less tolerable and not as durable.

Wood gives off natural gases, called terpenes. Terpenes give off the smell of a pine forest. Turpentine used to be made from pine terpenes. Hardwoods give off

less terpenes than softwood, but some sensitive people cannot live with any kind of wooden floor. The smell of terpenes will never go away.

If you buy pre-finished wood, consider ordering a baked-on finish and then air the material in a garage or outside before installing.

Avoid products that come with a built-in glue or foam backing. It is safer to install by nailing the boards to wooden supports underneath.

Wood expands and contracts with changes in temperature and humidity. The change can be as much as 14% of the length of a board. This can be a problem in climates that are very dry some of the year and wet in others, such as parts of the American West. Cabins that are not regularly heated are especially prone to warped floors.

Natural linoleum is made of linseed oil, pine resins, ground cork, wood flour and other natural fillers. It comes in squares that are glued to a subfloor. It is a non-toxic product, but some people are sensitive to the slight smell that will never stop. It is installed with glue, which will need to offgas.

Natural linoleum is flexible and lightweight so it can be installed in homes that cannot support tiles, and it is softer to walk on. It is durable and water resistant; its main use until the 1950s was in kitchens and hallways.

Today the main producer is the British company Forbo Flooring Systems, which export linoleum to several countries. In the United States they use the brand name Marmoleum.

Vinyl floor in the sauna area of the Environmental Health Center–Dallas. This floor has to handle wetness and high traffic, including exercise equipment.

Vinyl flooring has largely replaced natural linoleum, even to the point that vinyl is often referred to as "linoleum." Vinyl is mostly PVC plastic with a printed surface and various additives to make it soft. These additives can make up from 10 to 60 percent of the tile, and be semi-volatile so they'll slowly offgas over time (Benning 2013). The plasticizers show up in the urine of people who live with vinyl flooring, even when the floor is many years old (Hammel 2019).

Vinyl flooring was used in the sauna area of the original Environmental Health Center in Dallas, Texas. This was a high-traffic and wet area with exercise equipment, where a tile floor would not work well. They used a vinyl product that is no longer available, but came from a Canadian vendor who imported it from France. Even this product was not tolerated by some people when it was new.

Look for vinyl products that are hard, as they will have fewer plasticizers.

Non-laminated cork is thin tiles of cork that are glued to the subfloor. This can be a durable, soft and non-toxic floor once the glue has offgassed.

Cork does have a natural smell to it that never goes away and is bothersome to some people. It also has to be waxed regularly to protect its surface, or it has to be permanently sealed. This is probably the safest material with a soft surface. Cork

absorbs noise, is gentler to walk on for arthritic knees and also provides thermal insulation

There are other cork products, which we'll get to later.

We have heard that a few natural builders install mud floors that are fixed with linseed oil. We have never seen one or heard of anyone with MCS who has such a floor. Linseed oil does have a natural smell that never offgasses and we're also concerned about cleaning such a floor and especially mold issues.

Third tier: laminates and engineered materials

These flooring materials are all manufactured by pressing the materials together with glue under high pressure. The glue usually contains urea-formaldehyde, but even formaldehyde-free glue is problematic.

Expect these materials to need offgassing for a long time, possibly more than a year.

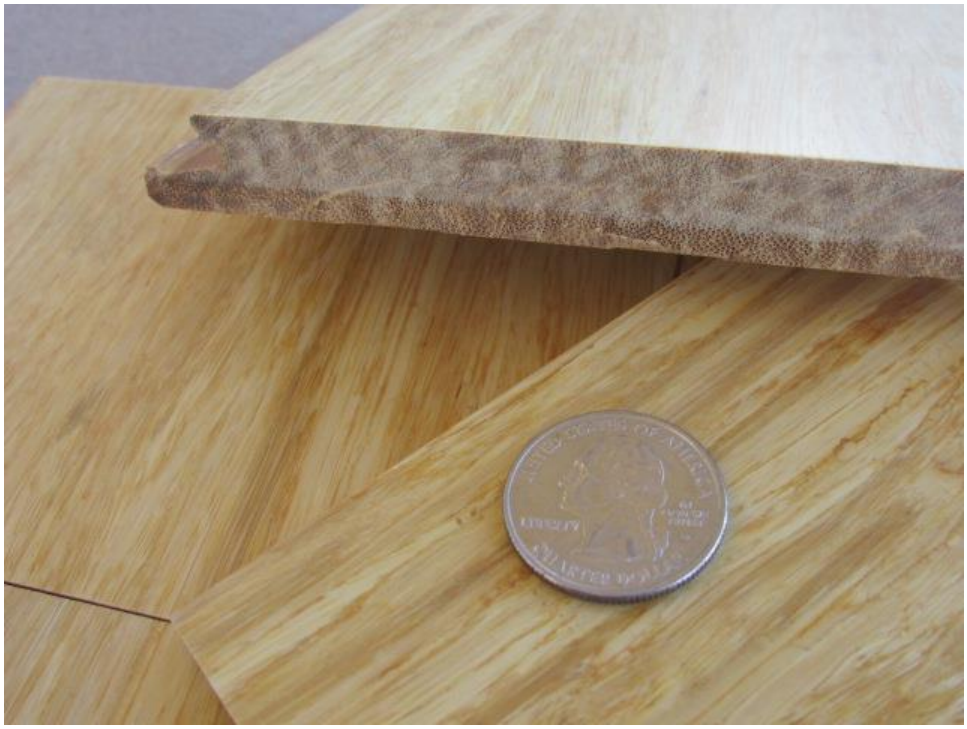
The benefit of these products is that they can be mounted to create a softer floor to walk on, that is not as cold as a tile floor.

These materials may cost more to buy than cheap ceramic tiles, but they are faster and easier to install. There will be less labor cost and a handy homeowner may be able to do the installation.

What is marketed as "natural bamboo flooring" appears to be the healthier option in this group of products, but the term "natural" is quite relative.

Bamboo grows in long round rods that can't be used to create a flat, even surface. True bamboo floors are used in rural parts of Asia, but are too airy, rough and uneven for Western needs.

Bamboo floor



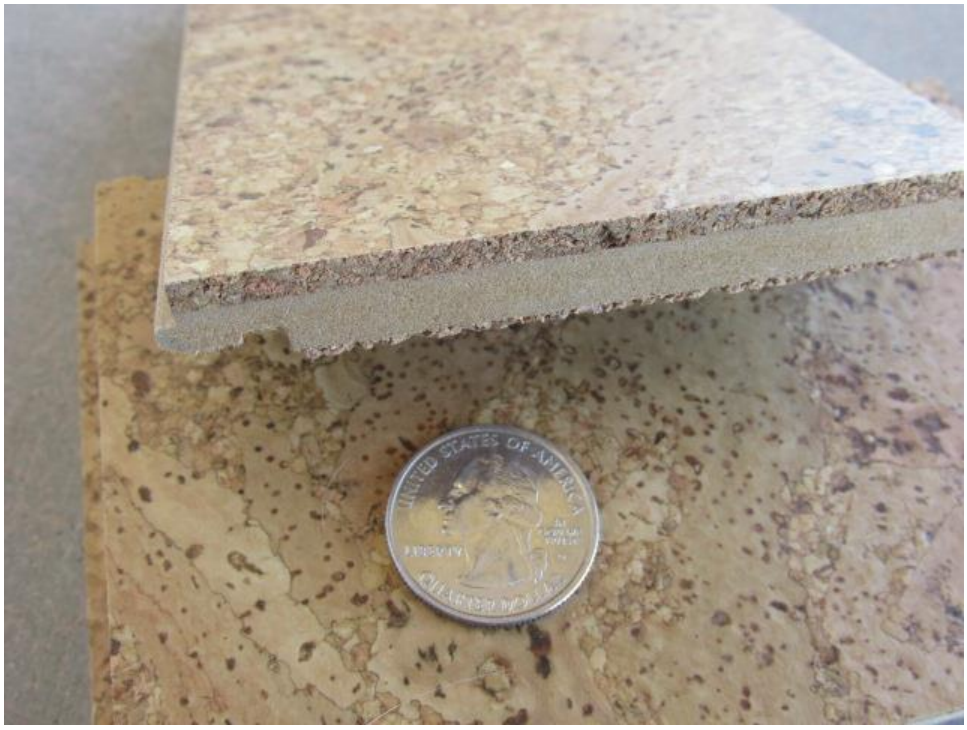
Bamboo floor product seen on edge, where the individual glued pieces can be seen.

The products sold as natural bamboo flooring in the United States are planks manufactured from bamboo. In the factory the bamboo is cut into strips or small pieces that are glued together under high pressure. The strips are usually arranged horizontally, but some products have them vertically, so what you see are the ends of all the small pieces.

We bought six samples of natural bamboo flooring and offgassed them for seven months. They still had a distinct odor at that time, though it wasn't strong. Most natural materials do have some permanent odor to them.

Laminated flooring consists of multiple materials that are glued together as a layered plank. The bulk of the plank is typically plywood or medium density fiberboard (MDF) for strength. This layer is made of wood strips or fibers that are glued together under pressure.

On top of that is a thin layer of decorative material, which can be cork, bamboo or wood. In many cases it is simply paper with a decorative print. A hard plastic seal protects the decorative material underneath.



Cork laminate. A thin layer of cork is glued on top of an MDF board. Cork is porous, so the glue fumes will not be sealed in.

There is very little that's natural about these products.

These planks are usually installed on a soft underlayment that gives the floor its "springy" feel and also dampens noise. This underlayment can be made from a variety of materials, some of them recycled, which means the possibility of unknown contaminants, including mold.

The healthiest option for underlayment appears to be sheets of cork.

Laminated "wood" flooring, consisting of a thin veneer on top of plywood.

Floors made of planks should not be installed in areas that may have spills or need wet mopping, such as kitchens and bathrooms. Spills will seep through the cracks and into the cavity below and create a haven for mold and bacteria. The underlayment material is usually treated with some sort of anti-microbial chemical, which is another health hazard to consider.

Laminated and engineered floor planks will expand and contract a little with changing temperature and humidity, but not as much as solid wood. The all-bamboo planks are said to do this more than the veneered planks.

Consider buying the flooring well in advance and store it in a garage or rented space with lots of ventilation. If possible, install spacers between each plank for better ventilation.

If pre-offgassing is not possible, consider sealing off the room and keep the windows open continuously for at least several months.

Medical facilities, schools and offices

Carpeting is used extensively in offices, schools and medical facilities in the United States. A major reason is that carpets help absorb noise. This is particularly an issue if several people are working in one room, but much less so for individual offices or clinic rooms.

This author went through three different schoolhouses, then a college and a university, which all had hard-surface floors. It was not a problem since just one person spoke at a time during the lessons. Some of these classrooms did have acoustic tiles on the walls or ceilings, though these can cause their own trouble with emissions.

If noise dampening is necessary, consider installing cork wall tiles. They are sometimes marketed as frameless bulletin boards with small self-adhesive pads in each corner. They do not need waxing or sealing.

Other noise dampening can come from furniture with removable cushions, drapes or other soft hangings. Area rugs can also help.

Clinics that serve people with chemical sensitivities all use hard-surface floors and simply put up with the extra noise (this author has visited four such clinics).

Removable area rugs

Area rugs (also called “throw rugs”) are rugs that are placed on top of a finished floor and cover just a part of it. They can be rolled up and removed for cleaning.

Area rugs offer these benefits:

- softer to walk on
- dampens noise
- insulation against cold floor
- washable/cleanable
- can easily be removed again
- visual appeal

Stylish house in Texas with small area rugs on the tile floor.

Such a removable rug can be aired out before it is taken into the house and there is a wide choice of materials to use.

Floors above basements or crawlspaces

If the floor is above a basement or crawlspace, there are extra issues to consider. Such spaces are often poorly heated and thus prone to mold growth. Consider installing a vapor barrier or other membrane below a new floor to keep mold problems confined — even if there are no problems right now.

If a carpet is replaced with a harder material, the floor will lose insulation value. It will be cooler to walk on the floor and the room may also feel cooler, if the space below is not heated well. If the floor is cold, humid air may condense and make it moist, especially if there is a cavity between the floor and the sub-floor (such as below a plank floor). This can create mold problems.

Consider installing insulation below the new floor. This may simply consist of stapling insulation to the ceiling below, using foam boards or aluminized "bubble wrap" insulation (avoid exposed fiber glass, which is more prone to mold growth, and also less tolerable to people with chemical sensitivities).

Be aware that some insulation materials are also vapor barriers (such as the aluminized bubble wrap and some foam boards). There should be no more than one layer of vapor barrier, to prevent trapping moisture.

If you use a separate vapor barrier, it should be placed on the cool side of the insulation. In this case, it should be below the insulation.

Pesticided soil below floor

Beware then in areas where termites my infest houses, it is common to literally soak the soil below a house with long-lived pesticides.

This can be a problem if you rebuild a floor directly on the soil or above a crawlspace.

Formaldehyde

The World Health Organization has determined that formaldehyde can cause cancer. Formaldehyde is a gas that can come from a wide range of building products including paint, caulk and glue. Pressed-wood boards, such as plywood, particleboard, medium density fiberboard (MDF) and oriented strand boards (OSB) are glued together under high pressure and are likely to emit formaldehyde.

Some flooring materials are also made by pressing materials together with glue, such as the laminated or engineered products.

In 2016 *Consumer Reports* in the United States tested the formaldehyde emissions from various floor products. They concluded that solid wood, vinyl and tile gave off the least formaldehyde, and that the engineered wood and laminate products all had higher levels. They also determined that offgassing some laminates for 8 to 9 months helped tremendously for some samples and barely at all for others. It was impossible to know in advance which laminates offgassed sooner (Perratore 2016).

If a product must be made with glue it can be made without formaldehyde, or with less formaldehyde, but there will still be glue in the product giving off fumes. Just because a product is labelled “formaldehyde free” doesn’t mean it is safe. It’s just that formaldehyde is in focus right now and other nasties are not.

Also be aware that formaldehyde can be created when various chemicals react with each other. Hence, some manufacturers’ claims of “no formaldehyde added” doesn’t mean the product is formaldehyde free or is healthier to use.

Fumigation

Products imported to the United States from overseas are sometimes fumigated to kill exotic insects. A few other countries, such as Australia, also do this.

This author knows of someone who ordered a load of ceramic floor tiles which were made in China. They arrived reeking of pesticides and had to be returned.

Certification programs

There are certification programs in many countries to help consumers looking for less-toxic carpets, laminated flooring and other building products. These programs are generally not of much value to people with chemical sensitivities.

Many of these programs are controlled by the industry and they tend to be lenient on what products can earn their certification.

Independent certification programs may be better, but they are unlikely to consider the needs of those with chemical sensitivities. And how many of these programs are truly independent? It is expensive to do proper testing of products and where does that money come from? In most cases, the manufacturers pay for the testing and they won't do that if most of their products fail the test.

It would be impossible to finance a test program if the criteria are so stringent that just a few products would pass — unfortunately, that is the kind of test many people with severe chemical sensitivities would need.

Small producers of specialty building products may not be able to pay for any testing and these companies may have superior products that never get certified.

There are certifications of "green buildings" in at least 30 countries, but they tend to focus on energy efficiency, sustainability and the use of recycled materials or waste products, all of which can make the indoor air quality worse (Steinemann 2017).

In general, any sort of "health" or "green" certification does not mean the product is safe for people with chemical sensitivities. There is no substitute for careful inspection and testing of the materials.

More information

This website has many other articles about how to build or convert a healthy house: www.eiwellspring.org/saferhousing.html.

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For general information about floor materials and how they are manufactured, we can recommend the Wikipedia entries for "flooring," "carpet," "linoleum," "bamboo floor" etc.

2018 (updated 2021)