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The Chemicals on Our Carpets and Textiles

The array of water-, dirt-, and mold-repellent chemicals added to carpeting and fabrics is dizzying. Which are causes for concern, and how can we minimize exposure?

by Brent Ehrlich

COMMERCIAL CARPETING AND textiles are subjected to dirt, spilled drinks, pathogens, cleaning chemicals, and a variety of other abuses. Fibers can absorb liquids or allow them to pass through into cushioning beneath, making cleaning difficult, particularly for furniture. Manufacturers add treatments that repel water and oils; antimicrobials to keep mold, mildew, and pathogens at bay; and flame retardants for safety. For architects and designers, specifying these products and understanding their complex chemistry and manufacturer claims is daunting.

Treatments may help prolong a product's life, but the long-term health and environmental impacts of those chemicals are unknown, and in some cases may be cause for concern. An in-depth look at some of these chemicals and how they are used can help us untangle when and where certain treatments may be superfluous or even pose unnecessary risks, and which applications might necessitate certain treatments despite the associated risks.

Surface Protection: Perfluorochemicals

Perfluorochemicals (PFCs), or perfluorinated compounds, are used to repel water and oil and are the active ingredients in the carpet and textile treatments Scotchgard, Crypton, GreenShield, and NanoTex (as well as in electrical wiring and other building products, and some nonstick cookware, cosmetics, firefighting foams, and fast-food wrappers).

When used as fabric treatments, PFCs reduce the surface tension on the textile so that liquids and oils, which have higher surface tensions, bead up rather than spreading out and soaking through the fibers.

(continued on p. 8)

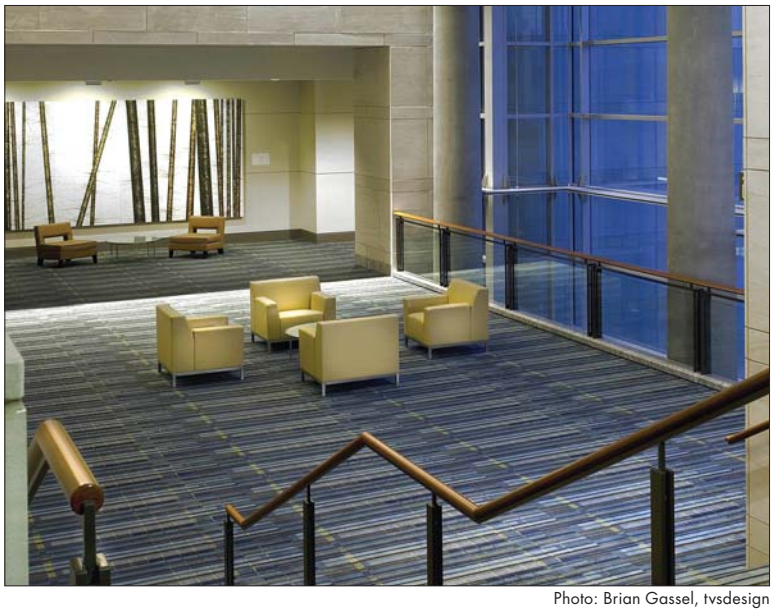

Photo: Brian Gassel, tvsdesign

To protect it from soils and stains generated by heavy foot traffic in the Raleigh Convention Center, tvsdesign specified Beaulieu carpeting, which is protected with topical perfluorochemicals and stain repellents.

Celebrating Our 20th Year

In This Issue

Quote of the month:

"Designers can catalyze a movement towards dramatically reducing the embodied greenhouse gas emissions (GHG) of the product sector."

– Ed Mazria, FAIA, on his organization Architecture 2030's new 2030 Challenge for Products

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What's Happening

A 2030 Challenge for Building Products

The 2030 Challenge has just broadened its scope. Formerly focused on the climate impact of building operations (operational carbon), the nonprofit Architecture 2030 has now issued an additional challenge regarding the climate impact of building products (embodied carbon).

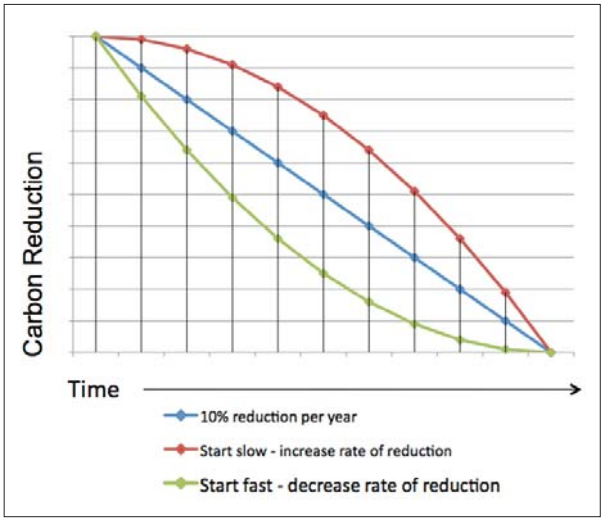
The 2030 Challenge for Products aims to reduce the embodied carbon (meaning the carbon emissions equivalent) of building products 50% by 2030. According to the organization, 5%–8% of total energy consumption and greenhouse gas emissions in the U.S. result from the manufacture and transport of building products and the construction of buildings. Cutting those emissions in half would be like permanently shutting down 222 coal-fired power plants.

The 2030 plan

With more than 100 different product categories to be addressed, the 2030 Challenge for Products has a lot of details to sort out. Architecture 2030 plans to spend the next two years finalizing *product category rules* (PCRs), including product-specific carbon benchmarks based on current life-cycle averages, a process the organization hopes will lead to "a harmonization of standards."

As with the 2030 Challenge for buildings, the 2030 Challenge for Products has started by setting broad guidelines and interim targets. These goals, says Architecture 2030, apply to all new developments, new buildings, and renovations:

- The carbon footprint of covered products should be reduced 30% by 2014; 35% by 2015; 40% by 2020; 45% by 2025; and 50% by 2030.
- Manufacturers wishing to participate will commission a life-cycle assessment (LCA) of at least one product, calculating the carbon footprint; LCA results will be submitted to moderators developing the PCRs for each category, so current industry averages can be established for benchmarking starting in 2014.
- LCAs will be cradle-to-grave profiles and use measurements from actual local energy sources.
- Once benchmarks are established, manufacturers will commission



Source: Adapted by Larry Strain, FAIA, from "Heat," by George Monbiot

Reducing carbon emissions rapidly within the next 20 years is critical to averting disastrous climate change. Because carbon impacts of building products are disproportionately high over the first 20 years of a building's life (they become less significant compared to operational carbon over 100 years or more), a focus on products could help "front-load" carbon reductions in the building sector.

Environmental Product Declarations (EPDs), which standardize data across product categories, in order to track their progress toward embodied carbon goals.

- Carbon footprint data for individual products will be available to designers, planners, specifiers, and builders through a variety of channels, including BuildingGreen's *GreenSpec* database of products and the Pharos online screening tool.
- Architecture 2030 will not certify products; participation requires manufacturers' own reporting based on commissioned EPDs.

High stakes

The process may be long and difficult, given the number of product categories under review, but the stakes are high, according to Architecture 2030's founder Ed Mazria, FAIA. PCRs and the related LCAs are not currently standardized, and this effort could go a long way toward establishing comprehensive, industry-wide norms for a variety of product categories. "Architects and designers have an opportunity to promote low-carbon building products for the projects they design and the hundreds of thousands of products they specify," Mazria said. "By requiring that building products undergo a rigorous, scientific analysis of their carbon-equivalent footprints, designers can catalyze a movement towards dramatically reducing the embodied greenhouse gas emissions (GHG) of the product sector."

Once the operational carbon of a building is reduced, as many are working to do, the relative importance of embodied carbon increases. Embodied carbon represents a small percentage (about 10% for a typical office building) of the lifetime carbon footprint of a conventional building, but it represents virtually the entire carbon footprint of a so-called "net-zero" building.

Larry Strain, FAIA, of Siegel & Strain Architects in California, told *EBN* that carbon from products is of more importance than is commonly recognized. Due to the dynamics of climate change, "The next 10–20 years are going to be critical years in addressing GHG emissions," he said. "If you look at embodied carbon versus operational carbon over the life of a building—say 100 years—the embodied carbon might represent 10%–15% of the overall carbon. But if you consider embodied carbon over the next 20 years, it represents more like 30%–60% of total carbon emitted."

"Using the power of the pen," Mazria says, "designers can provide the necessary demand to move this field forward quickly. This is critical in helping us meet the GHG reduction targets established by the scientific community to avert dangerous climate change."

– Paula Melton

For more information:

Architecture 2030
www.architecture2030.org

Sherwin-Williams Zero-VOC Claim Misleading, Says BBB

In a move that could prompt industry-wide changes to claims about volatile organic compounds (VOCs), the Better Business Bureau's National Advertising Division (NAD) has told Sherwin-Williams it should stop marketing its Harmony line of paints as "zero-VOC."

Paints must have fewer than 5 grams per liter (g/L) of VOCs to officially qualify as "zero VOC," and the Harmony *base coat* meets that threshold, according to tests. However, the typical colorants used to tint the paint can be much higher in VOCs. Harmony base paint tinted with conventional colorants can result in VOC levels as high as 112 g/L, according to tests commissioned by a competitor for the NAD. Since Sherwin-Williams advertises only tinted varieties of Harmony paint and consumers are likely to buy only tinted varieties, says NAD, the zero-VOC claim is misleading.

In a statement, Sherwin-Williams said it "will accept the NAD's decision and will take the NAD's findings into consideration in its future advertising for Harmony." A Sherwin-Williams spokesperson declined to comment to *EBN*.

"We felt like consumers are still confused about a lot of the claims out there," said Dana Autenrieth of Benjamin Moore, the Sherwin-Williams competitor that brought the zero-VOC claim to NAD's attention. The universe of low-VOC paint advertising "is a tough world to navigate if you're coming into it for a few days to buy some paint and then leaving again," he argued. Consumers who seek out zero-VOC paint expect to take zero-VOC paint home with them, Autenrieth said, and if they unwittingly purchase a high-VOC paint instead, "we are doing them a disservice as an industry." Benjamin Moore has invested significant resources into developing and marketing its Natura line of paints, which uses zero-VOC colorants, Autenrieth added, and now it wants "other paint companies to play fair."

When asked if Benjamin Moore would take action against other companies making similar claims about zero-VOC base coats, Autenrieth said he was unsure but added that it would probably not be necessary. "Historically, a ruling like this in any green industry will prompt other companies to take notice and change" their labeling and advertising.

In the meantime, he said, paint buyers seeking low-VOC or zero-VOC paints should ask if the product they are buying still meets the desired standard after tinting.

– Paula Melton

USDA Biobased Label: What Does It Tell Us?

Image: U.S. Department of Agriculture

A new Biobased Product label could begin appearing in spring 2011 on certain building products. Does the label imply environmental sustainability? Not necessarily. According to Kate Lewis at the U.S. Department of Agriculture, the label will identify products that "increase our energy independence," and consumers should not mistake that for comprehensive sustainability. "We are *not* an eco-label," Lewis said.

What It Does	What It Doesn't Do
Identifies products with at least 25% biological material—but products in categories already defined by USDA can be grandfathered in at lower levels.	Will not be used for food, feed, or fuel, or for energy produced by biomass.
Requires that products be tested for biobased content by a third-party lab.	Cannot be applied to products long made of cotton, wool, wood, paper, or other biobased materials.
Shows percentage of biobased content.	Does not require life-cycle analysis.

UL Environment Buys Greenguard

For the second time in four months, UL Environment, a division of Underwriters Laboratories (UL), has acquired a major brand in the green building products certification field. In February it announced its purchase of the Greenguard indoor air quality certifications and the two organizations behind them. The announcement follows on UL Environment's August 2010 acquisition of Canada's EcoLogo, one of the oldest eco-labels in the field.

UL Environment's acquisition of Greenguard accompanied its purchase of both Air Quality Sciences, Inc. (AQS) and the Greenguard Environmental Institute (GEI). AQS, founded in 1989, is a product emissions testing laboratory that launched the Greenguard label in 2000 as a way of recognizing products that AQS tested and found to have low emissions of indoor air pollutants. In 2001, AQS sought to give the Greenguard program more independence by creating the nonprofit GEI to run it.

Together AQS and GEI have made Greenguard one of the most recognized indoor air quality labels in the building products industry. According to a press release from Greenguard, the program has 350 manufacturer participants, and more than 10,000 certified products. Greenguard has two widely recognized product certifications: the basic Greenguard Indoor Air Quality, and the far-more-stringent Greenguard Children and Schools, both of which cover building materials, finishes, furnishings, electronic equipment, and cleaners.

UL, an independent product safety certification group founded in 1894, launched its environmental unit in 2009. While the long-term impact of the move is still to be seen, *EBN* noted at the time that UL's history and brand recognition could help address widespread confusion in the green products certification world (see "Underwriters Laboratories to Validate Environmental Claims," *EBN* Jan. 2009). As it now also flexes financial and business muscles, UL Environment may be closer to doing that.

UL Environment performs its own environmental claims validation and is working to develop several new standards for specific green building product categories, including drywall. When it acquired EcoLogo and Terrachoice, the organization behind it, UL Environment said that it would maintain the EcoLogo brand and programs, while synchronizing EcoLogo's efforts with its own. UL has not yet signaled whether it will take a similar approach with Greenguard.

The combined acquisition of AQS and GEI highlights the murky relationship between the two organizations. AQS's role as a consultant to manufacturers compromised its ability to provide independent third-party certification. That's why it made sense for AQS to hand off Greenguard to GEI in 2001, but the relationship between AQS and GEI remains very close, and competing testing labs complained that GEI resisted defining its standards clearly enough for companies other than AQS, which helped develop the standards, to use.

– Tristan Roberts

Newsbriefs

New Plaintiffs Join Amended LEED Lawsuit—A federal lawsuit filed in October 2010 against the U.S. Green Building Council (USGBC) and other defendants, focusing on allegedly fraudulent claims of the LEED rating system, has been amended. Filed February 7th, 2011, the amended complaint has been boiled down to a claim of false advertising, and Gifford has added other professionals as defendants, rather than pursuing a class-action suit. As with the original lawsuit (see "USGBC, LEED Targeted by Class-Action Suit," EB*N* Oct. 2010), the amended version focuses on a critique by Henry Gifford, a mechanical systems consultant, that USGBC falsely claims that LEED guarantees energy savings in LEED-certified buildings. The suit claims that Gifford and other professionals are, in the words of the complaint, "losing customers because USGBC's false advertisements mislead the

consumer into believing that obtaining LEED certification incorporates construction techniques that achieve energy-efficiency." The suit seeks an injunction and damages against USGBC. Legal observers see the suit as flawed and USGBC will likely move to dismiss it by April 7th, its deadline to respond, but the suit could move toward a discovery phase, in which internal communications at USGBC could be made public. *EBN* has more coverage of this story at BuildingGreen.com/amendedlawsuit.

Federal Judge Upholds Washington Energy Codes—A federal judge in Tacoma, Washington, has upheld the state's right to regulate the overall energy efficiency of buildings, even if complying with such codes could involve the purchase of equipment that is more efficient than federal regulations require. According to federal law, states may set building codes, but the federal government sets efficiency standards for appliances, such as HVAC equipment; states may not preempt the federal government by setting appliance codes that exceed federal standards. While the new Washington building efficiency rules passed in November 2009 do not directly preempt federal appliance codes, the Building Industry Association of Washington filed suit against the Washington State Building Code Council in May 2010, claiming that the updated codes effectively set higher-than-federal standards on HVAC equipment. The judge disagreed, however, saying that there are other ways to comply with the code aside from purchasing high-efficiency equipment, such as improving insulation. The new state standards apply only to new construction and are expected to increase both residential and commercial building efficiency 15%–18%.

UL Launches Environmental Product Declaration Program—UL Environment, the environmentally focused subsidiary of international product-testing organization Underwriters Laboratories (UL), has launched an Environmental Product Declaration (EPD) program. The EPD program will provide a multi-attribute label documenting the life-cycle impact of a product, including such indicators as greenhouse gas emissions and use of primary energy. The label will be standardized across many product categories and will require third-party-verified life-cycle assessment—meaning that the EPD accounts for environmental impacts from acquisition of raw materials through disposal or recycling. According to UL Environment's website, its EPD product categories so far include structural steel, laminate flooring, carpet tiles, window films, and a variety of other building materials, lighting products and textiles. For more information, visit www.ulenvironment.com.

$100 Million in Grants Offered to New York Data Centers—The State of New York is offering technical assistance and grant money to help data centers achieve greater energy efficiency. Data centers are notoriously energy-intensive, requiring large quantities of electricity to power computers as well as HVAC equipment to keep the computers cool—often during hours of peak demand. The incentive program, funded and managed by the New York State Energy Research and Development Authority (NYSERDA) in partnership with utility Con Edison and technology giant IBM, will provide up to $5 million per facility per year (up to 50% of the total cost) for energy-efficiency projects, which may include facility renovations and IT equipment upgrades. According to NYSERDA, New York has the second-highest concentration of data centers in the country. The program aims to cut total energy use by 55,000 megawatt-hours per year, representing savings of $8 million for the data centers.

Southern California Slashes VOC Limits for Paints and Coatings—The South Coast Air Quality Management District (SCAQMD), which sets policy in four Southern California counties, is updating its standards regarding volatile organic compounds (VOCs) in paints and other coatings. The proposed changes would cut maximum VOC limits in half for primers, special primers, sealers, and undercoaters from 100 grams per liter (g/L) to 50 g/L, and would also slash VOC maximums for a number of specialized coating types. Another proposed change would limit VOCs to 50 g/L in colorants that are added to

Photo: IBM

Data centers are notorious energy hogs, but IBM has been an industry leader in developing energy-efficiency measures for its server centers, like this cloud computing center in Southbury, Connecticut. IBM will partner with the State in providing technical assistance as part of a new program for data centers.

base paint at the point of sale. Even when base paints have low levels of VOCs, many tints, which are currently unregulated, can elevate VOC levels in the final product. While the proposed changes apply only within SCAQMD, the new standards will have an impact throughout California and even the entire U.S., because large paint manufacturers will need to change their formulas in order to sell products in densely populated Los Angeles, Orange, San Bernardino, and Riverside counties, and because the influential LEED rating system references the standards. The measure will come to a vote April 1, 2011, and many of the changes, if approved, would take effect in January 2012.

Obama Introduces 'Better Buildings' Plan—President Obama recently put forward the Better Buildings Initiative, an incentive program designed to stimulate spending on energy-efficient retrofits for commercial buildings. The initiative not only promotes efficiency but also aims to create jobs in the building and manufacturing industries hit hardest by the crash of the construction sector. Despite the long-term economic benefits of energy efficiency, building owners often have trouble raising capital to make improvements. To solve this problem, while aiming to increase the efficiency of commercial buildings 20% by 2020, Obama's initiative proposes loan guarantees and corporate tax credits, and aims to reward local and state governments for taking a leadership role in requiring better building performance. Business and political leaders and industry groups have praised the initiative, saying it will create green jobs in the design, construction, and manufacturing industries for years to come.

Photo: Empire State Building

In his announcement about the Better Buildings Initiative, an incentive program for energy-efficient upgrades to commercial buildings, President Obama discussed the high-profile green retrofit of the Empire State Building. The renovations have created local jobs and are expected to reduce the venerable structure's energy use by 38% when completed.

STAR Green Community Rating System Launching This Year—The STAR Community Index, a livability and sustainability rating system for communities, is launching this year with ten participating "beta communities." Developed by ICLEI–Local Governments for Sustainability in partnership with the U.S. Green Building Council and the Center for American Progress, the STAR rating system is inspired by the LEED rating system but goes beyond measures of buildings and even neighborhoods to look at healthcare access, affordable housing, and green jobs, among other measures. STAR defines 81 sustainability goals and employs a variety of sustainability metrics considering policy, practices, and performance benchmarks in the categories of environment, economy, and society. The ten beta communities, chosen for their commitment to sustainability and their already-developed resources for tracking performance and progress, will help launch the program by providing feedback and by helping design online tools for use across the U.S. Other towns, cities, and counties will be able to participate in the STAR rating program beginning in 2012.

STAR Beta Communities	
Atlanta, Georgia	Austin, Texas
Boulder, Colorado	Cranberry Township, Pennsylvania
Chattanooga, Tennessee	Des Moines, Iowa
King County, Washington	New York, New York
St. Louis, Missouri	Washington, D.C.

Source: ICLEI-Local Governments for Sustainability

The STAR Community Index defines sustainability and livability goals for communities. These ten beta communities will help develop performance benchmarks and online tools, and the rating system will be opened up to other towns, cities, and counties in 2012.

Infrastructure Rating System Coming from Engineering Group—We've seen numerous green rating systems for buildings, but there is currently no comprehensive way to rate the sustainability of structures like bridges and water treatment plants. Now three engineering organizations have joined together to form the Institute for Sustainable Infrastructure (ISI) in order to develop a rating system for infrastructure projects. Set to launch this summer, the new rating system will evaluate environmental and social impacts of projects ranging from roads and bridges to energy and water systems. According to the American Society of Civil Engineers, which founded ISI along with the American Council of Engineering Companies and the American Public Works Association, the Web-based tool will focus on performance and will be adaptable based on project size and complexity in order to maximize its utility for both federal and local projects. The rating system will also allow users to opt for either self-assessment or third-party certification. For more information, visit www.asce.org.

Product News & Reviews

AirRenew Wallboard Absorbs Formaldehyde from Indoor Air

Forget zero-VOC: *EBN* is seeing more "negative-VOC" interior products. With its new AirRenew wallboard, CertainTeed aims to actually remove volatile organic compounds (VOCs) from the room where the product is installed. It won't remove all VOCs, but the company claims that it does a good job with one of our most prevalent—and troubling—VOCs, formaldehyde (as well as other aldehydes).

An additive in the AirRenew board reacts with formaldehyde from indoor air, trapping it in the gypsum core in a form that makes the formaldehyde "chemically harmless after absorption," even in a landfill or during recycling, according to CertainTeed's Ashwin Himat. CertainTeed sees potential for AirRenew as a specialty wallboard for childcare centers, schools, and hospitals. When specifying this board, designers should be aware that AirRenew incorporates the company's "M2Tech" treatment, which includes an undisclosed antimicrobial biocide for mold prevention.

While we at *EBN* are excited about the prospect of a relatively standard building material removing a significant indoor contaminant, the proof is in the pudding. We look forward to reviewing test data that demonstrates reduced formaldehyde levels in indoor air during actual use over a long period of time.

– Paula Melton and Alex Wilson

Photo: CertainTeed

CertainTeed's new drywall product, AirRenew, absorbs formaldehyde from the air during laboratory testing. The company is marketing the wallboard for special applications such as schools and hospitals.

Sansin and Vermont Natural Coatings Debut Low-VOC Stains

Two new low-VOC interior wood stain systems are arriving on the market: Vermont Natural Coatings' zero-VOC Woodtone Series Concentrated Tints with a zero-VOC base, and Sansin's Purity Interior 0-VOC Stain base with low-VOC Eco-Tone Color System tints. Both systems offer low-VOC options in a category known for high-VOC products.

Vermont Natural Coatings

Vermont Natural Coatings' new Woodtone Series Concentrated Tints meet South Coast Air Quality Management District (SCAQMD) zero-VOC criteria and neither the stain base nor the tints contain any hazardous air pollutants (HAPs).

Currently, Vermont Natural Coatings recommends the tints be mixed with water, oil, or one of its PolyWhey base products (see "Whey-Based Floor and Furniture Finishes," *EBN* June 2008). When mixed with PolyWhey, the stain contains between 118 g/L and 180 g/L VOCs (depending which PolyWhey product is chosen) and covers 500–600 ft^2 per gallon—with multiple coats achieving a darker color. The Woodtone Series Concentrated Tints come in eight colors, and custom colors are available for large orders.

Photo: The Sansin Corporation

When mixed with their Eco-Tone Color System tints, Sansin's Purity Interior 0-VOC Stain base offers competitive performance in a low-VOC product.

In spring 2011, Vermont Natural Coatings is adding a water-based, zero-VOC, non-grain-raising stain base to its lineup, according to Andrew Meyer, Vermont Natural Coatings' president. Meyer told *EBN* that demand for alternatives like these is growing as professionals become more aware of the dangers of solvent-based products. Meyer said that Vermont Natural Coatings' waterborne product achieves "the same look and color" of conventional finishes and has been well received.

Sansin

Sansin's new product, Purity Interior 0-VOC Stain base with Eco-Tone Color System tints, also meets current SCAQMD VOC limits. According to Sjoerd Bos, vice president of Sansin Corporation, the stain is most appropriate for "any interior wood surface, particularly dry wood, cabinets, furniture, and flooring," but not woods with higher moisture content.

According to Sansin, Purity Interior 0-VOC Stain is UV-resistant, dries quickly, is non-flammable, and can be applied with a sprayer. Eco-Tone Color System uses MicroFine tints—very finely ground "pure pigments"—which bond closely with the stain base and, according to Sansin, penetrate into the wood deeply.

Once mixed, Sansin's Purity Interior 0-VOC Stain system contains, at most, 7 g/L of VOCs, depending on the color, and covers about 400 ft^2 per gallon. The Eco-Tone Color System tints come in 16 colors, and custom colors are available. The product is water- soluble and low-odor, but appropriate ventilation should always be used.

"There is a buzz about this product," said Darryl Janzen, store manager at Janzen's Paint & Decorating in Manitoba, Canada. "It's nice that people can get a product that is low-VOC and has the performance," he said, adding that the Sansin product is one of the best wiping stains he has seen.

– Emily Catacchio

For more information:

Sansin Corporation
Strathroy, Ontario, Canada
877-726-7461
www.sansin.com

Vermont Natural Coatings
Hardwick, Vermont
802-472-8700
www.vermontnaturalcoatings.com

Cooling Giants Introduce Smaller Thermal Storage Units

Thermal energy storage (TES) is mostly used in our largest buildings, but that may finally change. Two major manufacturers of rooftop air conditioning units, Trane and Carrier, have teamed up with Ice Energy to offer "ice-ready" equipment compatible with Ice Bear TES technology. The "plug-and-play" equipment will allow owners of small and medium-size commercial buildings to save money by using off-peak power for cooling. In addition to saving money, using off-peak power for cooling often offers environmental benefits as well—both by reducing the need for utilities to fire up supplemental power plants and by making it easier to incorporate renewable energy sources into the mix. If significant wind power is generated at night today, there is often no market for it; with greater use of TES, the market for nighttime wind power could grow.

The Ice Bear TES system does most of its chilling at night during off-peak hours; the energy is stored as ice, which is used during the heat of the day to cool the building (See "Buildings on Ice: Making the Case for Thermal Energy Storage," *EBN* July 2009). Ice Energy's integrated air-conditioning units have been on the market for more than six years, but its new partnerships with mainstream manufacturers are expected to spur more widespread adoption of TES. According to Ice Energy, the first eleven ice-ready units were installed with Trane equipment on the roof of a new Social Security Administration building in Redding, California, in the fall of 2010.

– Paula Melton

For more information:

Ice Energy
www.ice-energy.com

Photo: Ice Energy

Ice Bear thermal energy storage units are now "plug-and-play" compatible with mainstream rooftop units from Trane and Carrier—bringing this important technology to a much wider market.

The Chemicals on Our Carpets and Textiles *(from page 1)*

Dirt and oils sit on the surface of the fibers, where they can be easily wiped away. The advantage of such surface treatments is clear: fewer cleaning chemicals are required, and the fabric or carpet lasts longer, saving resources. But are the potential hazards worth it? The answer is not clear-cut, but data on long-term health and environmental impacts of PFCs gives us some clues.

What are perfluorochemicals?

PFCs are man-made chemicals created using perfluoroalkyl acids (PFAA) (see the table on page 14 for a guide to chemicals discussed in this article). These chemicals do not exist in nature but start out as hydrocarbons, which have carbon-hydrogen bonds, and undergo various manufacturing processes that replace the hydrogen with fluorine.

The structure that remains has a carbon "backbone" of between 4 and 14 carbon atoms, with the fluorine attached to them. These PFAAs are known as C4–C14. Those with eight (C8) or more carbon atoms are often called "long-chain" PFCs—perfluorooctane sulfate (PFOS) and perfluorooctanoic acid (PFOA) are two of the most common C8s. Those with fewer than eight are called short-chain PFCs. The carbon-fluorine bonds in these chemicals are *very, very* strong and are resistant to high temperatures, acidic and alkaline solutions, and other environmental factors. In general, the longer the carbon chain, the more potent and persistent the chemical. The same chemistry that makes these chemicals so potent and useful also means they stick around for a long time in the environment and have the potential for wide-ranging and long-term health and environmental effects.

Past as prologue?

We're entering a new phase in our use of PFCs. Today's PFC treatments

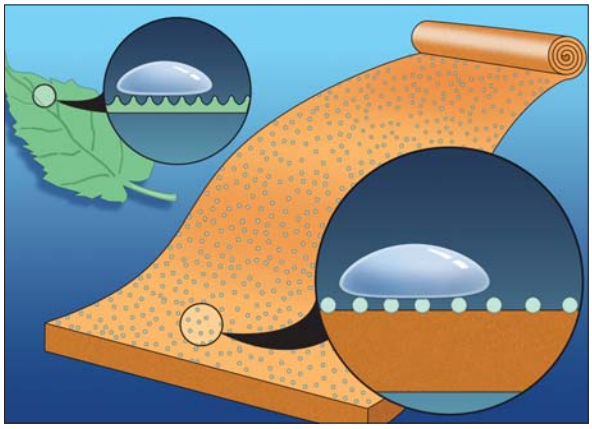


Illustration: GreenShield

GreenShield uses nanotechnology along with PFCs to create a rough surface that it claims works like a leaf to repel water and oils.

are advertised as PFOS- or PFOA-free, but why is that important? Some history can help provide context. PFOS and PFOA were first produced by 3M beginning in the late 1940s as both stand-alone industrial chemicals and as by-products (or degradation products) of manufacturing. These C8 chemicals were some of the most effective water, oil, and stain repellents available, and PFOS was used in Scotchgard, a popular stain and water repellent that was used in fabric and carpet treatments and sold in aerosol cans for consumers. But in the late 1990s the company discovered that PFOS was found in blood samples around the world, and after negotiations with the U.S. Environmental Protection Agency (EPA), 3M stopped producing all PFOS and PFOA in 2002—including PFOS-based Scotchgard, despite its being one of the company's most profitable products. 3M later reformulated Scotchgard with a different PFC.

As it became apparent that PFOS was persistent in the environment, all C8 chemicals came under scrutiny, and in 2004 EPA fined DuPont, a manufacturer of PFOA, $10.25 million for failing to "report information to EPA about substantial risk of injury to human health and the environment" regarding PFOA production. After more than 40 years of use, PFOS, PFOA, and related chemicals are now found in surface water, soil, and wildlife throughout the world, including remote island bird populations. Small amounts of these chemicals have been found in every person tested for them in the U.S.

Carpet and textile treatments no longer contain these specific compounds—instead they use related chemicals (see below). These chemicals haven't received as much scrutiny, so environmentally aware designers may wonder if we are substituting the devil we don't know for the devil we know.

Environmental impacts of PFCs

High doses of PFOA and PFOS have been linked to a number of health problems in animals, including weight loss, thyroid disease, immune suppression, and developmental and reproductive problems. But in humans the evidence is less conclusive. A 2010 report analyzing Centers for Disease Control and Prevention (CDC) data of approximately 4,000 U.S. residents does show an "association" between PFOA in humans and thyroid disease, but this type of report only shows patterns and not cause and effect.

One of the main challenges in extrapolating PFC data from animals to humans is that different animals seem to react differently to these chemicals. For instance, the amount of time it takes for PFOA levels to drop by 50% in animals, known as the *elimination rate*, ranges from about 5 days in rats to 3.8 years in humans; for PFOS it is 100 days in rats and 5.4 years in humans. Other related chemicals have elimination rates in humans varying from one month to 8.5 years.

Why these chemicals bioaccumulate at different rates is not well understood, but studies show they are carried across the umbilical cord, placenta, and through breast milk in humans. A 2005 EPA risk assessment said that PFOA fit the criteria to be labeled a "probable carcinogen," but it has made no formal recommendation. However, according to Christopher Lau, Ph.D., a leading biologist at EPA, "There have not been any 'smoking-gun' reports in humans saying people are ill because of exposure to these chemicals," and the workers who made these chemicals have been studied extensively.

With no solid data, Lau is reluctant to call PFCs "toxic," but he acknowledges, "We don't quite understand how these animal data translate to humans." Arlene Blum, Ph.D., executive director of the Green Policy Institute, takes a more cautionary approach to PFCs: "If we know that a substance causes problems in animals, then it's highly probable that we'll find problems in humans as well."

Evidence suggests that PFCs do not break down in the environment, which is cause for concern. Because of the concern over long-chain PFCs in general, eight of the primary manufacturers of PFOA and other C8 chemicals in the U.S. have worked with EPA to develop the PFOA Stewardship Program, under which the companies pledged to reduce emissions and the amount of PFOA found in products by 95% (based on 2008 baseline data) by the end of 2010 and eliminate PFOA altogether by 2015. According to EPA, all eight companies met their 2010 goal. But similar chemicals with unknown effects are still in widespread use for carpets and textiles.

Shorter-chain PFCs: Are they really safer?

As C8 PFCs are phased out, C6 and C4 chemistries have quickly replaced them. These chemicals are considered safer because they are

not as persistent or bioaccumulative as C8. 3M was the first to move away from C8 technology, replacing the PFOS in Scotchgard with perfluorobutane sulfonate (PFBS), a C4 chemical. But now the carpet and textile industries more commonly use C6 (PFHA) technology, which is eliminated even faster (1.5 days) than PFBS (4.0 days) in monkeys.

The carpet industry switched over to C6 technology in 2007, and most textile finishers have as well. According to Bob Buck, technical fellow at DuPont, which makes its Capstone carpet and textile treatments based on C6, "PFOS is a firm, persistent, bioaccumulative toxin [PBT] by regulatory criteria." But by contrast, he says, "what we've found is that short chains don't have the PBT problems the longer chains have—they might be 'P' but they are not 'B' and definitely not 'T.'" It may be too soon to write off bioaccumulation and toxicity altogether, though, according to Lau. He agrees that short-chain PFCs are not as bioaccumulative as C8s, but he cautions that there is little human data to draw other conclusions.

Making It Stick: Even More Chemicals in the Cocktail

PFCs don't make a durable carpet or textile treatment by themselves, so other chemicals are added to get them to bind to the fibers. DuPont's Capstone products are made for both textiles and carpet. "These products are built onto polymer backbones, such as polyurethane or polyacrylates—delivery systems that, when applied to the surface of carpet or fabric, are built to stay there and be really durable," said Buck. Textiles are typically dipped in a solution that contains the PFC, the polymer, cross-linking agents, and sometimes antimicrobial compounds. Heavy rollers then push the solution into the fibers and squeeze out any extra before heat is added to cure the treatment. Due to the amount of yarn and moisture involved, carpet treatments are usually only sponged before rolling and curing, but the rest of the process is similar. (The exception is Signature's new Crypton carpet, which is fully immersed and cured.)

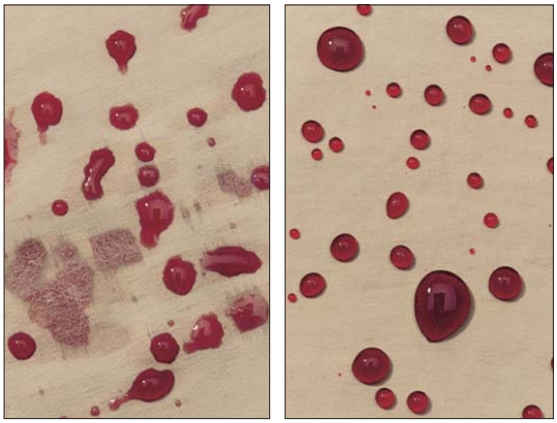


Photo: E. I. du Pont de Nemours and Company

The fabric on the right was treated with a PFC, lowering the surface tension on the fabric so that water and oils bead up and run off without soaking through.

This is a simplified version of the process, of course. The chemistry used in each solution is complex and tailored to the fiber type and end use. Polypropylene, nylon 6, nylon 6,6, and polyolefin require different mixes. And the amount and use of these PFCs can be determined by whether the fiber is used in an area that requires significant protection, such as in healthcare or senior living applications, or less protection, such as in an office.

Down and Dirty: Stain Repellents

PFCs are sometimes called stain repellents, particularly when used with fabrics, because the chemicals are used to keep water- and oil-based stains and soils away from the fibers. With carpeting, the PFC treatment is applied so that the surface of the carpet is protected, but it may not penetrate throughout all the fibers, leaving them vulnerable to staining. Most true stain repellents used in carpeting are actually integral to the fiber and are not based on PFCs. Carpet stain treatments, such as Antron StainResist or Interface ProTect, help resist staining at the fiber level. "Historically, protection has been a two-fold coating, one containing sulfonated aromatic compounds (SAC) and the second containing fluoros [fluorinated compounds, or PFCs]," said Brendan McSheehy, director of innovation at Universal Fibers, maker of textile and carpet fibers. "The SAC actually binds to the dye sites on the surface of the nylons, so the sites are already bound up when other dyes [staining fluids] come along."

Essentially, stain treatments work like clear dyes that fill small cracks and keep stains from binding to the fibers. They are particularly important for protecting fibers that have been dyed at the mill or "post-dyed." Solution-dyed fibers, which have dye mixed into the fiber during manufacturing, can provide some protection on their own, but if coffee or wine remains on any fiber for too long, there is a chance a topical stain treatment will not fully protect the fiber. But fiber manufacturers Universal Fibers and Aquafil offer solution-dyed nylon 6,6 and nylon 6 with the stain protection built into the fibers themselves so they do not require a stain treatment—or PFCs (more on this later).

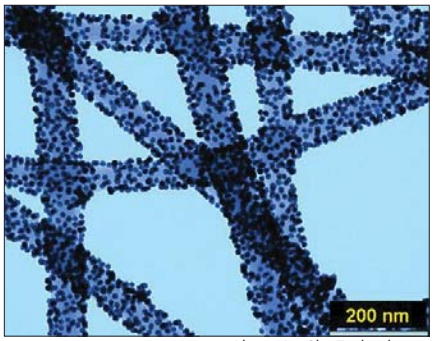


Photo: BigSky Technologies

A close-up of fibers treated with GreenShield, which uses nanotechnology to lower the amount of PFCs required to provide stain protection

Carpet companies often use the terms "dirt repellent" or "soil repellent" to refer to their PFC treatments. The amount of PFCs contained in these compounds is not regulated, and varies depending on manufacturer and fiber, but the industry has worked to bring overall levels down. Carpet mills sometimes use their own unbranded PFCs, but branded fibers, such as Ultron or Antron, require minimum levels of PFCs to ensure that their products perform. "Our scientists have come up with a proprietary technology that works along with the fluorine," said Dianne O'Sullivan, global marketing director for Antron, "so we are able to use a much lower level while maintaining the same efficacy as before."

Invista now requires 400 parts per million (ppm) of its C6-based DuraTech soil repellent in order for their carpets to be branded "Antron" (150 ppm for residential), but this is down from the 800 ppm they used just a few years ago. According to O'Sullivan, "There are a lot of people who depend on the efficacy of our products," so the company's new technology underwent significant testing to make certain there was no performance loss.

Carpet mills like Shaw or Interface apply these finishes to their carpets and test them for durability. O'Sullivan claims that there is still an effective level of DuraTech after 1 million foot traffic (each "foot traffic" equals one step, or 500,000 people, based on the company's lab simulation), which is tested after light vacuuming and hot water extractions at 350,000 and 700,000 foot traffic. Paul Evans, vice president of Tandus Technologies, says Tandus—which uses Antron—treats carpets so they'll cover warranties extending to 25 years. But how long all PFC treatments last in the field is difficult to assess. According to Stuart Jones, vice president of research and development at Interface, which offers both Antron and sulfonated products, "These treatments last anywhere from two to five washings and they are gone." Any PFCs coming off the carpet are then captured in the water and go down the drain and into the environment—a major blow to any sustainability argument for carpet treatments.

Into the Future: Textile Treatments and Nanotechnology

PFCs are available as branded products, such as Crypton Green, or generic, unbranded treatments sold through fabric finishers. These PFC treatments may also combine other technologies to improve the performance of the fabric, including nanotechnology. Nanotechnologies are incredibly small particles of 1–100 nanometers (1 nm = one billionth of a meter). Nanomaterials typically behave differently from their regular-size cousins. The zinc oxide found in suntan lotion, for instance, is normally opaque but can be transparent at nano scale. Because a substance's characteristics can change so dramatically depending on size and shape, their effect on the environment is difficult to predict, and many people have adopted a cautious approach toward nanotechnology. (For more, see "Is Nano a No-No? Nanotechnology Advances into Buildings," *EBN* Mar. 2008.)

Nanotechnology has been applied in textiles to lower the amount of PFCs in treatments. Nano-Tex, NanoSphere, and GreenShield all use C6 chemistry that is engineered using nanotechnology. The minute, rough surfaces of these products increase the effectiveness of the chemical treatments, according to the companies, so they can get the same result using a fraction of the compounds.

Photo: Carnegie Fabrics

Non-PVC impermeable upholstery can be used in hospital waiting-area chairs in place of woven textiles that require PFCs.

According to Nano-Tex, the company engineers its treatment atom-by-atom using nanotechnology, creating "whiskers" on the surface of the fabric, but the company also claims that the resulting treatment contains normal chemical structures, and there are no tiny nanoparticles in the treatment that can get into the environment. The company told *EBN* that it can treat virtually any fabric type, and that its treatment is available with Bio-Am antimicrobials—as previously mentioned—and they can provide DuraBlock, a breathable, waterproof, antimony-free polyester laminate backing (independent fabric finishers offer this as an option as well).

The Swiss company Schoeller Technologies offers NanoSphere, whose PFC coating is supposed to mimic the surface irregularities of lotus leaves at a nanoscale to produce a

surface that sheds water, oils, and dirt. NanoSphere was developed using the "bluesign" textile standard for air and water emissions at the factory as well as consumer and occupational health and safety. And, according to the company, tests run on NanoSphere by the Hohenstein Research Institute in Germany, which conducts testing for the textile industry, show that the nanoparticles in NanoSphere are not biologically active and are unlikely to be toxic.

Another nanotechnology treatment provider, GreenShield, also compares its product to a nanoscale leaf surface. According to Bob Daily, a chemist at GreenShield, the company uses an amorphous silica nanoparticle base that has been "surface modified" to give a roughness that reduces the surface tension without affecting the feel of the fabric. GreenShield has a certification from Scientific Certifications Systems showing it requires eight times fewer PFCs than standard treatments. All three of these manufacturers claim their treatments offer superior abrasion resistance and durability over traditional PFC treatments, and that their nanotechnology-enabled products are bound to both the fabric and the treatments, making them safe.

Two of the most popular PFC fabric treatment options are Crypton and Crypton Green, which include PFCs, antimicrobials, and backing. These do not use nanotechnology, and unlike most finishes, the backing is standard and the treatments are applied at the company's processing facilities instead of at a textile finisher. Crypton Green uses the same treatment but contains at least 50% recycled content and up to 100% in some products. Crypton is available through most major American textile mills, selling more than 7.5 million yards of fabric a year, mainly to the healthcare and hospitality industries. According to Craig Rubin, founder of Crypton, its fabrics first undergo an immersion in a bath of C6 PFCs, silver ion technology, and cross-linkers. After heat curing, the fabrics are then coated twice with an acrylic-based backing that contains stain blockers and biocides. The result is a moisture-proof fabric that resists stains on both the surface and the backing. "We don't want anything that is not going to perform to high-quality standards," said Rubin.

Photo: Carnegie Fabrics

Crypton Green fabric uses PFCs, has two coats of waterproof backing, contains silver ions as an antibacterial, and is made from post-consumer recycled polyester.

Selecting environmentally responsible treatments for textiles is challenging. The companies that make these treatments tout the safety of the new short-chain PFCs, but the stringent Cradle to Cradle program no longer certifies any products that contain PFCs. With conflicting information and no regulations or standards, it can be difficult for the designer to make informed decisions. And for many professionals, design comes first, so if they want to use woven materials, it is hard to avoid PFC treatments. "In a perfect world, I'd be using a solution-dyed fabric to avoid staining, put a backing on it so it's waterproof, and call it a day," said Chris Youssef, interior designer at Perkins+Will. But, he conceded, "Sometimes you can't avoid these treatments." He said, "Their use is being driven by owners and hospitals, because if someone spills something on an upholstery, that mess is not going to be cleaned up right away." Holt echoed those sentiments: "Many public products are not cleaned, so a fluoro [PFC treatment] offers that extra protection so the stain will roll off and not become part of the fiber."

Antimicrobials: A Must Against That Musty Smell?

The use of antimicrobial chemicals is a source of contention and confusion among designers as well as manufacturers. Antimicrobials typically work by disrupting the cell membranes of organisms and are registered as pesticides with EPA. For textiles, antimicrobials are typically used in healthcare applications, presumably with the intention of limiting the spread of pathogens. Even though there is no evidence that the antimicrobials used on finishes work in this capacity, companies like Nano-Tex have implied this connection in their marketing materials. (The National Advertising Division of the Better Business Bureau recently advised Nano-Tex to stop making these claims). For carpets, antimicrobials are used to keep mold and mildew from forming at the base of the fibers and backing. But there are a lot of questions regarding both applications and how effective they turn out to be during actual use.

The CDC report *Guidelines for Environmental Infection Control in Health-Care Facilities* concludes that there is little evidence that antimicrobial use in textiles or carpet helps control disease or infection. Antimicrobials simply cannot penetrate far enough into infected substances like blood to be effective. For textiles, the CDC recommends proper cleaning and sanitizing procedures instead. The report acknowledges that bacteria and fungi grow in wet or soiled carpet, where disinfection is nearly impossible.

But CDC is not alone in thinking that cleaning is probably more effective

than treating with pesticides that eventually end up in groundwater—without having done a very good job in the first place. While some antimicrobials are added to carpets to provide protection against mold, most are incorporated into the backing to protect the water-based latex against bacteria and breakdown as well. Bacteria and fungi cannot survive on the synthetic fibers without both dirt and moisture, and the Carpet and Rug Institute (CRI) points out that antimicrobials are no substitute for vacuuming and proper carpet maintenance.

Some common antimicrobials include silver-based compounds (found in Milliken carpets, Crypton fabrics and carpets, Trivera textiles, and many other non-branded treatments); silane-based antimicrobials, such as Aegis' Microbe Shield, which is branded as Bio-Am and used in Nano-Tex fabric treatments; and zinc pyrithione, which is incorporated in carpet fibers from Universal Fibers. Interface uses its proprietary Intersept in the backcoating of its carpet. "Intersept is derived from a coconut fatty acid and has the same human toxicity as table salt," according to Interface's Jones. (Comparing the toxicity of a chemical to table salt is a practice with dubious precedent—it is a favorite ploy of PVC promoters.)

All of these manufacturers claim that their antimicrobials are safe for humans and remain on the fibers for the life of the product, but their impact on aquatic systems and other organisms is unknown. There is concern that organisms could build up a resistance to some of these compounds. Jones says he can understand not using traditional antimicrobials, and that Interface can make its carpet without Intersept.

Healthcare giant Kaiser Permanente no longer specifies carpet with antimicrobials, and a growing list of architects and designers have joined them. "I don't use them," said Youssef. He suggests that the use of antimicrobials is being driven by owners and hospitals: "People have the perception that it takes seconds to disinfect, but it actually takes minutes." (…If it is effective at all: *EBN*'s in-depth look at this issue revealed that the hygienic benefits of these chemicals are overestimated and do not substitute for basic cleaning and prevention—see "Antimicrobial Chemicals in Buildings: Hygiene or Harm?" Aug. 2007.)

Tandus's Evans doubts the effectiveness of antimicrobials, and Tandus has taken a stand against their use in any of its carpet. "Over 60% of what we recycle is not our own products," he said. Tandus tested these returned carpets before recycling and found that "they may work well in the lab, but we've tested products that are 18 months old that no longer have antimicrobial effectiveness." According to the company, Tandus has a number of carpet and non-carpet flooring options, so it can select products based on end use, which helps them avoid the use of antimicrobials in carpet.

From Health to Safety: Flame Retardants

Like PFCs and antimicrobials, many of the flame retardants added to synthetic fibers are persistent and bioaccumulative, and cause a range of health problems in animals. Though halogenated flame retardants have been found in residential carpet padding, this padding is not typically used in commercial applications. Flame retardants are not much of a concern with commercial carpet, since some of these products can meet the requirements for flame spread and smoke density without the use of any additives. For those that can't, the most common treatment is alumina trihydrate, a low-toxicity flame retardant that gives off water when burned.

Textiles, however, are more complicated. The flame-retardant chemistry used on them can vary from low-toxicity boric acid treatments to halogenated decabromodiphynyl ether (decaPBDE). Other flame retardants include hexabromocyclodecane (HBCD), phosphates, sodium borate, alumina trihydrate, antimony, and melamine cyanurate. For more on halogenated flame retardants, see "Flame Retardants Under Fire" in *EBN* June 2004.

For most designers, navigating the chemistry of these flame retardants is daunting. "Flame treatments are one of the most difficult aspects of

Photo: Carnegie Fabrics

The drapes in this Swiss hotel use Trevira CS, which has non-halogentaed flame retardants built into the fiber.

Chemicals Applied to Carpets and Textiles: An Overview

Chemical	What It Is	Risks	Applications	Alternatives
PERFLUORINATED COMPOUNDS (PFCS)				
PFCs are a class of chemicals that use perfluoroalkyl acids (PFAA). PFAAs are a group of chemicals that have a "backbone" of between 4 and 14 carbon atoms with fluorine attached to them. PFAAs are known as C4–C14 for the length of the carbon chain. All PFAAs are persistent in the environment.				
Perfluorooctane sulfate (PFOS)	A PFC with an eight-carbon chain (C8)	A persistent, bioaccumulative toxin found in wildlife and humans around the world	Used in Scotchgard treatments until the early 2000s	In carpet, purchase sulfonated, solution-dyed carpets with alternative dirt-release agents, or use alternative flooring; in textiles, choose waterproof backings and solution-dyed fabric or use non-woven, non-PVC upholstery.
Perfluorooctanoic acid (PFOA)	A PFC with an eight-carbon chain (C8)	Persistent; negative health effects in animal studies, but no direct evidence of human health impact; long-term environmental impacts unknown	Stain and dirt repellent but phased out of carpet treatments; Found in small amounts in some fabric finishes	
Perfluorohexanoate (PFHA)	A PFC with a short, six-carbon chain (C6)	Persistent but far less bioaccumulative than C8; no direct evidence of negative human health problems but not yet studied extensively	Stain and dirt repellent used in most carpet and textile treatments: Capstone, DuraTech, GreenShield, Nano-Tex, Crypton, etc.	
Perfluorobutane sulfonate (PFBS)	A PFC with a short, four-carbon chain (C4)		Used as stain and dirt repellent in some textile treatments, including Scotchgard	
ANTIMICROBIAL COMPOUNDS				
Silane	Uses an electric charge to attract and impale microbes	Bonds well to materials and breaks down in the environment, appears relatively safe.	Not used in carpeting, but appears in textiles including a Nano-Tex treatment	Used in building products to protect the product from moisture and degradation. Hygiene or health benefits to occupants are sometimes stated or implied but are not supported by science. Antimicrobials do not substitute for proper product selection, design, and operation to avoid moisture exposure, and proper cleaning and maintenance.
Zinc pyrithione	Common fungicide and pesticide	Appears to be safe at levels found in building products	Found in many consumer goods as well as carpets and textiles	
Intersept	Proprietary	Interface claims that Intersept has the toxicity of table salt.	Used in Interface carpeting	
Silver	Interferes with bacterial cell membranes	Some negative environmental effects from silver treatments	Common in carpet and textile treatments	
NANOTECHNOLOGY				
Various nanotechnology-based treatments	Tiny particles or chemicals are engineered to produce desired material properties.	Little is known about the long-term environmental impacts of nanotechnology.	Used in carpet and fabric treatments—Nano-Tex, GreenShield, others; PFCs are typically used but in smaller amounts	As with PFCs, choose waterproof backings and solution-dyed fabric or use non-woven, non-PVC upholstery.
FLAME RETARDANTS				
Decabromodiphynyl ether (decaPBDE).	When heated, they release water vapor and lower-energy halogen radicals that slow down or block ignition.	Evidence of bioaccumulation and impact on behavior, learning, and memory, and some evidence of liver cancer	Used in textiles but not carpets	Flame retardants used in carpet are considered relatively safe. For fabrics, choose non-halogenated flame retardants built into the fibers, as topical treatments can wash off and need to be reapplied. Avoid halogenated chemicals. Safer alternatives include: • Alumina trihydrate • Magnesium hydroxide • Nonhalogenated phosphates • Boric acid • Antimony trioxide • Melamine cyanurate
Hexabromocyclodecane (HBCD)		Evidence of effects on behavior, learning, and memory after neonatal exposure		

fabrics," said Mary Holt, vice president of creative at Carnegie, makers of a number of "green" fabrics. She said that Carnegie prefers non-halogenated flame retardants that are integrated into the fibers rather than as a finish that can wear off and have a clearer path into the environment. The company uses Trevira CS on all its draperies, which contains a halogen-free flame retardant that is permanently bound in the fibers and meets Oeko-Tex 100 textile standards for environmental performance. Invista also makes a flame-resistant polyester under the name Avora FR. For those who still want to use a flame-retardant finish, Bob Beattie of TSG, a textile finisher that operates five plants throughout the U.S., told *EBN* it uses non-halogenated flame retardants, including GreenShield FR, as part of its Balance "planet-friendly" fabric finish process.

Putting It All Together: Precautions and Alternatives

Nanotechnologies, PFCs, antimicrobials, and flame-retardant chemicals pose some of the biggest environmental challenges in the green building industry. All have unknown environmental risks, few are regulated, their paths through the environment are largely unknown, and their utter complexity leads to confusion. Designers who want to avoid antimicrobials can unknowingly specify treatments with antimicrobials when finishes come prepackaged. Crypton Green, for example, contains silver ion technology. And no one knows with certainty what happens to these treatments when the carpet or fabric is recycled in 20 years.

Using the precautionary principle is one way of dealing with these unknowns. This approach entails avoiding potentially hazardous products even though we don't know with certainty the extent of the damage they may cause. Though not always a clear methodology, the precautionary approach is being adopted by more and more building professionals, including Perkins+Will, which has a Precautionary List of 25 chemicals and products. Included on that list are PFCs and some flame retardants. But the process is not perfect. Kaiser Permanente has a policy against antimicrobials, yet has to balance performance with its sustainability goals. "We use Crypton Green [which contains silver ion antimicrobials] as an incremental step toward our 'no antimicrobial' goal until a better product is available," explained Susan McDonough, senior communications consultant at Kaiser Permanente.

Carnegie prefers to select its finishes based on end use, using this philosophy:

- No finish is the best finish. (Select alternative products or avoid PFCs when a stain repellent isn't necessary.)
- Use the least environmentally harmful finish.
- Offer a finish as an option rather than a product (by not offering treatments as standard, designers can select materials based on end use).

New Solutions

Architects and designers are already selecting alternatives to ubiquitous fabric treatments, but selecting carpets with no PFCs has been a challenge until now. In 2010, Interface began using nylon 6,6 and nylon 6 sulfonated fibers from Universal and Aquafil that create the same soil and stain resistance as standard, topically treated carpets. "Our focus has been to get away from these chemistries [PFCs and stain treatments] altogether," said Jones. According to McSheehy, instead of the topically applied two-part stain and PFC treatment, Universal incorporates the stain treatment during the fiber-making process so the fibers are protected all the way through and chemicals cannot wear off. "The chemistry at the mills isn't all that different, but they rely on the permanence of the surface attachment," McSheehy said. Because this is made for commercial foot traffic, "we think it is important to protect it all the way to the core of the fiber."

While the stain treatment is interesting, the company's dirt protection could be a game changer in the industry. "We found a surface protection that is not fluorinated, that is permanent, and that has a high degree of soil resistance," claimed McSheehy. "It is environmentally sound and is based on long-chain ethoxylated fatty acids," he said. Because the technology is proprietary and new, it is difficult to judge its environmental impact and performance, but if it functions as advertised and can avoid the use of persistent chemicals like PFCs, then this is a step in the right direction. Universal does not have a brand name for the fiber yet.

Jones said that two-thirds of Interface's yarns are now sulfonated and that they are not applying any topical treatments to them. How well do they work? Universal's test results show an AATCC TM 175 rating of 8 for Red 40 dye stain resistance, the same as Antron's. According to Jones, "What the customer cares about is the warranty, and our warranty conditions have not changed." And anyone who has purchased non-Antron Interface carpet in the last year is using these fibers.

Great strides have been made toward lowering the toxicity and amount of treatments being used on carpets and fabrics. The amount of PFOS and PFOA in humans dropped significantly between 2000 and 2006, but these chemicals, along with some flame retardants and antimicrobials, are going to be with us for a long time. Minimizing the amount of these materials used in building products and entering our environment is a good step forward.

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BackPage Primer

From Sunlight to Electricity: How Solar Cells Work

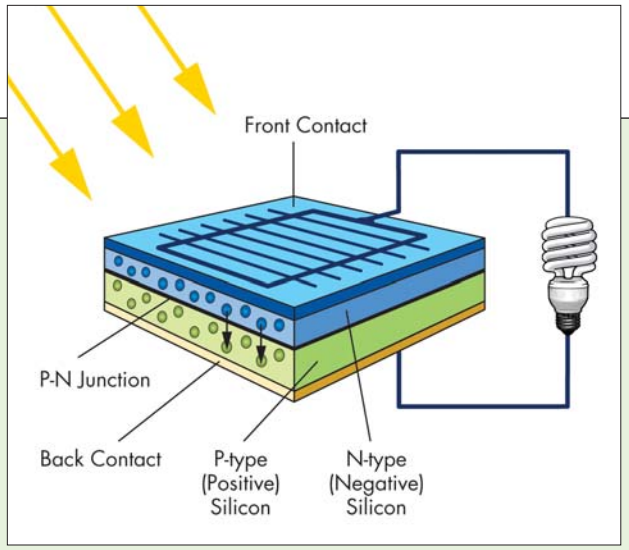

Illustration: Peter Harris

Nearly all of our electricity generation options involve converting mechanical energy into electrical energy—usually using a dynamo or turbine. The significant exception is *photovoltaics,* in which sunlight is converted directly into electricity—with no moving parts.

Photovoltaic (PV) cells use a phenomenon called the *photovoltaic effect* to generate electricity. A cell is made of a *semiconductor* material—a material that conducts electricity but whose electrical conductivity can be altered by adding small quantities of other elements (a process referred to as *doping*). Crystalline silicon is the most common semiconductor used, though other materials are being used as well, including amorphous silicon, cadmium-telluride (CdTe), gallium arsenide (GaAs), and copper indium gallium (di)selenide (CIGS). Most of these alternatives are being tried in an effort to reduce costs.

In manufacturing PV cells, thin wafers or strips of the semiconductor material are created, but these cells have two different layers. The top side is doped with an element that has an extra electron, usually phosphorous, to give it a negative charge (N type), while the back side is doped with a different element, usually boron, that is shy an electron, giving it a positive charge (P type). The *cell junction* separates these two layers.

When photons of sunlight strike the PV cell, electrons in the N layer are excited and jump across the P-N cell junction. This creates a charge imbalance, with electrons wanting to return to the N layer of the cell. By connecting the two sides of the cell with a wire, electrons are able to return to the N layer—and that electron flow is the electric current that we are able to make use of. While electrons move around in this process, there are no "moving parts" to wear out—as there are in nearly all other electrical generation systems.

Numerous individual PV cells are wired together in series to create a *PV module*, which increases the current flow, and then multiple modules can be combined to create a *PV array*. A PV system includes an array as well as various *balance of system* components, including charge controller, inverter (if direct current is to be converted into alternating current), and—depending on the application—batteries for storing the solar-generated electricity.

Refinement of the photovoltaic process and improvements in PV efficiency are the focus of a tremendous amount of research going on worldwide today. While the efficiency of the best crystalline silicon PV modules is now above 20%, much of the leading research is focused on lower-cost, thin-film technologies that have lower efficiencies, but that offer the promise of significantly lower-cost PV power.