3 MATERIALS THAT MAY FOREVER CHANGE THE HOME'S MAKEUP

WITH PRICE SPIKES AND SHORTAGES OF TRADITIONAL BUILDING MATERIALS, IT MAY BE TIME TO START CONSIDERING NON-TRADITIONAL ONES

BY JAMES F. McCLISTER

The materials that compose the construction of a home are not immutable. The composition changes.

Before the 1920s, you couldn't find a single PVC product in a home. They didn't exist. It took a half century after separate, accidental discoveries of the material—by two differnent scientists—before PVC hit the residential market. Now you can hardly find a home without it. There was no aluminum siding before the '40s, no vinyl before the '50s, and no fibre cement (without asbestos) before the '80s. The three are staples today. Meanwhile, asbestos, lead, cadmium, PCBs, and many others are no longer anywhere to be found in new home construction

RISING PRICES

Innovation is an enduring hallmark in construction materials—sometimes it's driven by epiphany, other times by economy.

Since January, the producer price index of gypsum (i.e., the price at which producers sell their product) has increased from about $210 to near $320, according to the Bureau of Labor Statistics. Over the same period, softwood lumber prices jumped from just under $225 to over $400. In October of this year, a survey from the National Association of Home Builders of its remodeling members found that two-thirds experienced at least a 10% increase in material costs—with a quarter experiencing 20% or higher. They also reported shortages in at least 22 material categories, including framing lumber, windows and doors, plywood, and OSB.

Meanwhile, remodelers are experiencing higher prices and protracted lead times

"We got hit with multiple price increases, on everything," says Abby Binder, president and CEO of Abby Windows & Exteriors in Milwaukee.

"Our windows and doors suppliers are experiencing major shortages, but the biggest issue is quality control. That has been really bad." She describes "extended lead times" and receiving "incorrect" and "damaged" products.

COURTESY UNIVERSITY OF STUTTGART

BIOPLASTICS

Remove petroleum and add certain biological substances and you can make a sustainable form of plastic called bioplastic. It's of big interest around the world and particularly at the University of Stuttgart in Germany, where scientists have created several structures using materials derived from the plastics.

Researcher there are using bioplastics as building materials (such as the plank pictured above). They claim the material is durable, fire-resistant, and can be recycled (i.e., more sustainable).

EXPLORING NEW MATERIALS

The pains were the same though for different materials for Seattle deck builder Jason Russell, owner of Dr. Decks. "I've been the victim of material shortages and price increases," says Russell, who also lost upwards of $750,000 in revenue as a result of projects cancelled from COVID. He says that his surrounding timber mills have reduced their output and local homeowners are buying more available stock as they shelter in place. "It seems to be lingering longer than it took to realize the shortage," he says. "I'm exploring new framing materials, or ones that are soon to come to market—steel, pressure-treated LVLs, aluminum framing systems."

Maybe framing lumber won't ever face obsoletion—perhaps demand for vinyl windows is everlasting. But new materials will come into the home and stay.

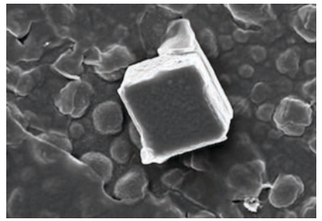
Here are a few that may.

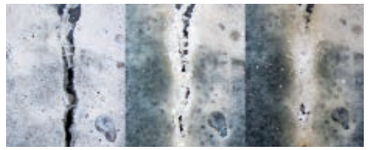
COURTESY DELFT UNIVERSITY

1 SELF-HEALING CONCRETE

Prices of ready-mix concrete rose this year, same as they have every year for the last decade. It remains a relatively affordable material, but even were its price spike to rival lumber's this year, remodelers couldn't very well stop using concrete. In the US, it's used twice as much as all other building material combined, according to a University of Nebraska study. There's no realistic alternative at that scale, just improvements.

Like, what if concrete was self-healing, couldn't stay cracked?





COURTESY MULTISCALE MATERIALS LABORATORY

OH, THE PLACES CEMENT'LL GO

Cement is off to great places.

In Houston, Rice University scientists are figuring out ways to tell cement particles what shapes to take (shown above)—because apparently they prefer to be amorphous blobs. They call it "programmable cement." It allows researchers to change the properties of cement to make it stronger, less porous, less wasteful, and maybe more.

In Switzerland, scientists are creating self-compacting concrete that can move and flow under its own weight without vibrating compaction. It has a secondary benefit of being extremely fire resistent.

And in Singapore, Nanyang Technological Univesity researchers have developed a concrete that instead of breaking under extreme weight, bends.

COURTESY BIOMASON

BACTERIA CONCRETE? HOW ABOUT BIOMASON?

The idea of using microorganisms in building products, while relatively new, is not novel to self-healing cement. North Carolina startup bioMASON uses a bacterium to grow masonry products that are already being installed in commercial and residential structures. BioMASON's bioLITH product, which includes four tile sizes in two colors, is a product remodelers could buy today and install tomorrow. The material's created by combining microorganisms with waste aggregate, which is pressed and cured into tiles. Because it can be produced in ambient temperatures, the material could someday be created on-site.

Structures would be stronger and more resilient. A remodeler could promise a repair-free patio and driveway, and walkway, foundation. And it's not insignificant that cement is responsible for 8% of the world CO2 emissions, and that regenerating concrete is much more sustainable than replacing it.

Researchers at Ghent University in Belgium and at the Netherland's Delft Unveristy of Technology, respectively, are among the scientists pushing the potential of the material. Both have effectively engineered concrete with self-healing properties through means of superabsorbent polymers called hydrogels and bacteria that work in tandem to first block encroaching moisture and further seal a crack completely. See the images of the process and product on pg 65.

An effective test of the material was reported by Ghent University scientists, in which self-healing concrete was transported to a construction site via a mixing truck and a roof slab was cast. The scientist involved considered it an "important step" towards the commercialization of the material.

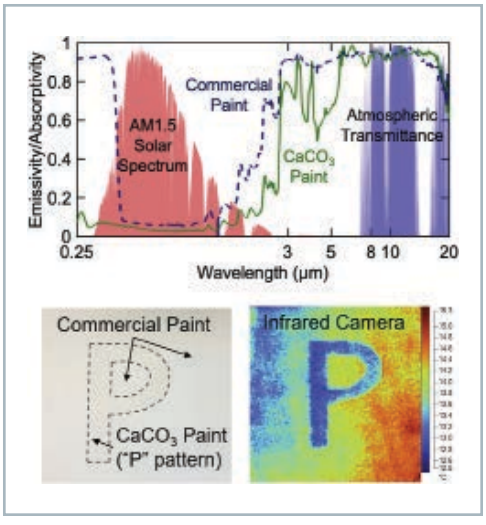
2 RADIATIVE COOLING

Passively cooling a structure by reflecting sunlight (i.e., radiative cooling) has been an ambition of scientists since at least the 70s. Researchers found that by including a compound called titanium dioxide (TiO2) into white paint that it would cool the air around whatever it was coating. The thought was it may be able to replace air conditioners.

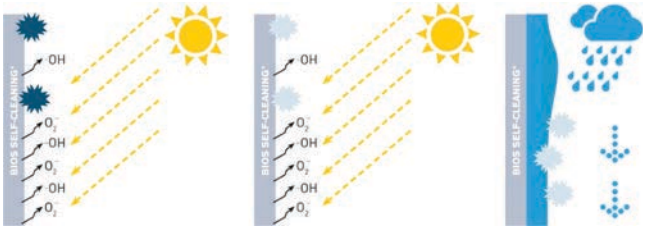
It never worked. Dozens of scientists, including from NASA, tried and none were able to achieve a cooling effect worth pursuing. Even new techniques for improving TiO2's efficacy theorized a maximum potential solar reflectance of 92%—and it was never achieved in tests.

Interest in the science has fluctuated over the decades, with researchers at times believing it impossible. But at the University of Purdue, researchers have continued developing the field, and in October this year they achieved the impossible: a paint that can keep surfaces 18 degrees Fahrenheit cooler than their surroundings at night, and about 3 degrees cooler under peak, direct sunlight. In tests, the paint reflected 95.5% of sunlight.

"Your air conditioning kicks on mainly due to sunlight heating up the roof and walls and making the inside of your house feel warmer," said co-author of the study Joseph Peoples in a statement. "This paint is basically creating free air conditioning by reflecting that sunlight and offsetting those heat gains from inside your house."



COURTESY PURDUE UNIVERSITY, WUHAN UNIVERSITY, HARBIN INSTITUTE OF TECHNOLOGY, AND HUAZHONG UNIVERSITY OF SCIENCE AND TECHNOLOGY



SELF-CLEANING, ANTIBACTERIAL CLADDING AND TILE: A USE FOR TIO2

Titanium dioxide ultimately failed as a means to produce a sub-ambient radiative-cooling paint, but it's applications are not limited to cooling. Italian surfaces manufacturer Casalgrande Padana has been using the compound for its photo-catalytic and hydrophillic properties since 2006.

"When triggered by light, titanium dioxide allows our Bios Self-Cleaning cladding to break up the organic substances and pollutants stuck to the materials surface, says Aldo Magnani, a represenative for the manufacturer. "Because it's hydrophillic, water easily rolls off the surface, further removing loose particulates."

Used on porcelain stoneware, such as with CP's Bios Antibacterial tiles, the manufacturer discovered antibacterial qualities as well. TiO2 naturally eliminate four of the most common strains of harmful bacteria.

COURTESY CASALGRANDE PADANA

3 MYCELIUM

COURTESY ECOVATIVE

There is a stretch of fungus in Oregon's Blue Mountains that, even though you can only see it above ground in clusters of honey mushrooms, extends over nearly four square miles. It is the largest organism on earth and may be 8,000 years old.

That is mycelium. It is expansive, efficient; it can be easily, quickly, and cheaply grown in ample supply anywhere in the world; and as it happens, it's a potential analog, and perhaps improvement, on a number of foam, timber, and plastic building products such as insulation, door cores, paneling, flooring, and cabinetry, according to a recent joint report on engineering mycelium composite construction materials from Australia's RMIT University and the University of Vienna in Austria.

In their tests, researchers combine mycelium with various substrates, such as beech and red oak sawdust, wheat straw, hemp shavings, and cotton fibers, among others, testing the resulting materials' tension, compression, and flexure. They compared their end products to wood, cork, polyethylene, and acrylonitrile butadiene styrene, a thermoplastic used for a range of products from pipe fittings to legos.

A collaboration between furniture designer Sebastian Cox and Ninela Ivanova, who specializes in novel materials, resulted in the creation of these light fixtures, as well as stools (not pictured), which blend coppiced hazel and goat willow woods with mycelium species Formes formentarius and demonstrate the potential of mycelium in an aesthetic application.

"Mycelium composites are particularly well suited for thermal and acoustic insulation applications, exhibiting similar or lower thermal conductivities than commercial thermal insulation materials and 70–75% acoustic absorption or better, outperforming traditional ceiling tiles, polyurethane foams and plywood," reads the report. "They also exhibit better fire reaction and fire safety properties than traditional construction materials, such as extruded polystyrene insulation and particleboard and good termite resistance utilising natural termiticides."

The report's authors admit mycelium composite building materials require additional research to improve their efficacy. However, their conclusion was that mycelium's properties makes it an "effective, cheap and environmentally sustainable technology emerging with the potential to significantly contribute to the future of green construction." PRO

MYCELIUM ON ITS WAY TO MARKET?

Mass-produced, mycelium-based building products may not be so distant a prospect, as New York-based biotech company Ecovative Designs is currently on its way to using mycelium grown in their own facilities to produce foam boards that have the potential for use as both insulation and as a plywood/OSB replacement. Apart from framing lumber and windows and doors, no material is in shorter supply right now than plywood, according to NAHB. Nearly a quarter of remodelers also report insulation shortages.

In only five days, the company can grow, press, and set one of its mycelium foam panels. The process the company employs is a type of farming, said Ecovative CEO and co-founder Eben Bayer in a 2010 TED Talk explaining the process. "It's much faster than conventional farming," said Bayer. He says that because various substrates can be used to grow mycelium foam and its self-assemblage limits the amount of equipment necessary, it's a produt that can be made anywhere. "Our vision is local manufacturing," he explained. "If you're in China, you might use a rice husk or a cottonseed hull. If you're in Northern Europe or North America, you can use things like buckwheat husks or oat hulls."

As testament to the material's promise, the Department of Defense in 2017 issued Ecovative a $9.1 million dollar contract as part of its Engineered Living Materials program, executed through DARPA, the Defense Advanced Research Projects Agency. The program's mission is to "develop design tools and methods for creating programmable, self-healing, living building materials."