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This Ultra-White Paint May Someday Replace Air Conditioning

From Smithsonian Magazine by Sarah Kuta

This Ultra-White Paint May Someday Replace Air Conditioning Developed by researchers at Purdue University, the paint reflects 98.1 percent of sunlight

A new coat of paint is an easy way to freshen up your home's curb appeal. Soon, it may also help keep your house cool.

Researchers at Purdue University have developed a new ultra-white paint that reflects 98.1 percent of sunlight and can keep surfaces up to 19 degrees Fahrenheit cooler than their ambient surroundings. This new paint, which may become available for purchase in the next year or two [this article was written in 2021], could someday help combat global warming and reduce our reliance on air conditioners.

The team of scientists in Purdue's mechanical engineering department published the findings of their paint research, funded by the university's cooling technologies research center and the Air Force's scientific research office, in the journal ACS Applied Materials & Interfaces.

"Our paint only absorbs 1.9 percent of the sunlight, whereas commercial paint absorbs 10 to 20 percent of sunlight," says Xiulin Ruan, a Purdue mechanical engineering professor and one of the study's co-authors.

The paint is a marked improvement from current heat-rejecting paints on the market. When struck by the sun's rays, surfaces covered in today's available white paints get warmer, not cooler. At best, these heat-combatting paints can reflect 80 to 90 percent of sunlight, says Ruan.

The new ultra-white paint, which the researchers say is the coolest on record, reflects nearly all of the sun's rays and sends infrared heat away from the surface, providing an average cooling power of 113 watts per square meter. If painted onto the roof of a 1,000-square-foot home, that translates to a cooling power of 10 kilowatts, which is more powerful than most residential central air conditioners, Ruan says.

In tests conducted during sunny, midday hours on the roof of a campus building in West Lafayette, Indiana, the paint kept outdoor surfaces 8 degrees cooler than the ambient surrounding temperatures. At night, the paint kept surfaces 19 degrees cooler than their surroundings.

"Our paint can lose heat by its own emission—it emits heat to deep space," Ruan says. "With such little absorption from the sun, our paint loses more heat than it absorbs. This is really exciting for us. Under the sun, it cools below the ambient temperature and that's hard to achieve."

Heat-rejecting white paints on the market now are typically made with titanium dioxide, which reflects certain wavelengths of sunlight—mainly, the visible light and near-infrared

wavelengths—but absorbs the sun's ultraviolet rays, causing the surface to heat up, Ruan says.

“Commercial white paints are cooler than the other, darker-colored paints, but they are still warmer than the ambient or surrounding temperature,” Ruan says.

These existing paints are better than nothing, but the researchers wanted to experiment with materials that could reflect, rather than absorb, the sun’s UV rays. They tested more than 100 different materials over the past seven years, eventually narrowing down their selection to barium sulfate, a known UV-reflecting compound that was already being used in cosmetics, reflective photo paper, oil paints, x-ray examinations and other applications. (Along the way, they also developed an earlier ultra-white paint made from calcium carbonate that reflected 95.5 percent of sunlight.)

Though barium sulfate was a good starting point, the researchers also took two novel steps to enhance the paint’s ability to reflect light and emit heat: They used a high concentration of barium sulfate particles—60 percent compared to the typical 10 percent in current paints—and they incorporated particles of varying sizes.

“We found that if you put different particle sizes in your paint, then each particle size can scatter and reflect different wavelengths and, all together, they reflect the entire spectrum of wavelengths in sunlight,” Ruan says.

The potential benefits of the ultra-white paint are two-fold. By keeping surfaces cool and reducing the use of air conditioners, which are typically powered by electricity, the paint may help decrease the burning of fossil fuels. What’s more, air conditioners typically work by removing heat from indoor spaces and pushing it outdoors, a method known as convection. This heat transfer, along with other causes, can contribute to the urban heat island effect, a phenomenon that occurs when cities become hotter than the surrounding areas, thus requiring even more air conditioning. The ultra-white paint, on the other hand, uses radiation to transfer heat, sending out types of electromagnetic waves that can pass through the atmosphere and into deep space.

“Air conditioners can cool your house, but they move the heat from inside the house to outside—the heat is still in the city, it’s still on the Earth, in our air,” Ruan says. “So even if you don’t care about the power bills you pay, it’s going to warm up the Earth anyway. Our paint does not use any power but, more importantly, it sends the heat to space. The heat doesn’t stay on the Earth, so that really helps the Earth to cool down and can stop the warming trend.”

Using statistical modeling, the researchers estimated that their ultra-white paint could reduce air conditioning use by up to 70 percent in hot cities like Reno, Nevada, and Phoenix, Arizona. In a rather extreme model, they also found that covering 0.5 to 1 percent of the Earth’s surface—buildings, roads, unused land, just about everything—with the ultra-white paint would be enough to stop the global warming trend.

“It’s a lot of area, but if one day we need to use this approach to help reverse the warming trend, it’s still affordable—the paint is not expensive,” Ruan says.

The researchers have applied for a patent, and they’re doing additional testing to understand the paint’s long-term durability and reliability outdoors as they work toward making the paint available to consumers. They haven’t yet determined an exact price for the paint, but Ruan says he expects the paint to be similar to those on the market now—roughly $30 to $40 per gallon.

In the meantime, it’s easy for sustainable building experts to envision the potential future impacts of this invention.

“When I first heard about it, I was imagining, ‘Wow, this could be utilized in all sorts of different urban conditions in the U.S. and internationally,’” says Elizabeth Thompson, a vice president with the U.S. Green Building Council. “Just that potential is so strong and compelling. It’ll be great to see how this evolves and how the researchers are able to develop its applications.”

The U.S. Green Building Council, a nonprofit that developed the Leadership in Energy and Environmental Design (LEED) rating system for sustainable buildings, offers a heat island reduction credit for buildings working toward LEED certification levels.

One way buildings can earn that credit is to use materials or devices with an initial solar reflectance of 33 percent at installation or 28 percent over three years, Thompson says. With the ultra-white paint’s 98.1 percent solar reflectance, it far exceeds those requirements.

“This is just a whole different ballpark of cooling, which is very exciting,” Thompson says. “It’s hopeful. This is the kind of thing that we all hope scientists and researchers will help us to discover, opportunities that we didn’t know existed for how to live more sustainably.”

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Q: Esteemed Committee, is the chemistry this article describes, known and/or used by alien extraterrestrial civilizations?

C: You are the aliens, both on Earth and to the civilizations who visit you. Thus your question refers to which aliens? We know what you intend to ask, we reply this pedantic way in a small effort to lower the perceived barrier, wall, blockage, parapet or ramparts between humans and visitors to Earth. No such impediments exist but in the mind.

Yes.

Q: Was this chemistry revealed to humans by visitors?

C: No, this is a human discovery, or we should say ***was*** a discovery.

Q: This paint is was discovered sooner than right now?

C: Thermal properties of elements and compounds has been well understood by humans nearly forever, long before the chemistry was. A tree branch insulates well when touching a hot rock.

Q: Do visitors use such coatings on exterior surfaces of space vessels?

C: Yes, including chemistries and elements unknown to humans.

Q: What about heating effect during "winter", when both ultraviolet and regular light reaching building surfaces, outer layers of clothing, human faces, animals is a good.

C: This could be the next development of thermal chemistry for buildings and other objects.

Q: Could be? Why not should or will be?

C: That step is a human decision.

Q: Many people would say it's a "no-brainer" to coat buildings of any and all sizes, plus cars, trains, planes, boats, telephone booths where any are still seen & used.

C: Doing so would disrupt established economic interests possibly to the point of distorting interference, a sin we dare not commit.

Q: Por favor, explain how.

C: Consider recent human history of wrist worn timekeeping devices in the human decade of the 1970s or writing machinery of the 1990s. The arrival and exploding popularity of battery powered watches dealt a serious blow to established manufacturers, many concentrated in a country without offensive military capability, thus economic forces unfolded without combat. As computers & printers became reliable and inexpensive, typewriters disappeared from use. Rotary dial telephones, audio or sound recording devices which use celluloid tape, automobile carburetors and many examples illustrate what occurs.

With technology and chemistry visitors to Earth could provide, humans could begin large scale production of both heat resistive and heat generating exterior paints and coatings within one year. Not only would the established industry scramble to adapt and adopt, but suppliers of fuel, electricity and equipment for heating and cooling of interior air would suffer, as they would see it, drastic and in many cases fatal reductions in sales. Survivors would attempt to control to the point of monopolize the remaining shrinking market, and suffer additionally because of such apparently logical survival and domination attempts.

Much the same would occur if a new electricity generation method might reduce costs or production & distribution expense, thus consumer prices, by half simultaneously as the market shrank. The investor owners, if they could eliminate this threat to asset value and income streams, might even consider assassination. Humans behave is predictably sad ways when money & wealth are involved.

Q: What jumped out at me was how the article did not discuss cold weather surface heating, which is good to have. Painting a house with this new stuff sounds great until the weather gets cold, and….

C: Several methods can be used. In a space vessel, surface heating from ultraviolet light is permanent when proximity to a source might cause problems, so permanent reflection thus neutralization is beneficial.

One method which could become popular on Earth would be an insulated double coating, first one used to retain heat or cold, separated from a top layer designed to resist incoming light, separated by a layer of plastic formulated to insulate.

Another method would be one coating which can be electrically stimulated to produce either retention or reflection effect.

Q: From where does the electricity come?

C: A piezoelectric panel; a small one plus storage battery would be more than sufficient.

Q: How about a single coating that does both? It will get warm and reflect about a certain reading, or retain heat below a certain temperature.

C: This is also a possibility; the decisions will turn on efficiency, reliability, cost to produce and consumer demand.

Q: Such as the brick house owner who cannot stand the thought of painting it. Okay, when can we see this cooling white paint?

C: As soon as consumers are offered the product. The remaining technologies are available if humans request such help from your alien extraterrestrial friends and cousins. Un- or fortunately, because the challenge can be seen both ways, the capital or head-with-sufficient-money will not invest without belief and understanding. We refer to the human named Warren Buffet for an excellent example.

Technology given by visitors will spook the very risk averse billionaire investor, which is redundant. Not such human in control of such money amounts will take perceived risks the size of what might be involved.

Q: Could something similar be done for cars?

C: Yes, and for the glass also, to block the ultraviolet rays. The technology exists to do this now, but consumers do not demand it so manufacturers do not offer it. The technology or more properly chemistry involved would be new and would involve car windows which do not break or shatter the way tempered glass does.

Q: Really? How?

C: A plastic material with a hardened coating, optically similar to glass which eliminates distortion.

Q: The article didn't mention paint colors, it seems as if this stuff would at first be only white, or with the chemistry used, has to be white. Can other colors be produced?

C: Yes, but the color challenge will be solved initially by using two coatings, one white underneath with a different formulation than is mentioned in this article, covered by a color.

The colored top coating visible would have different chemistry related to the paint color and would work in conjunction with the white undercoating.

Q: Is it viable this paint will be popular in climates where the weather is usually warm year round?

C: Yes, however it will be expensive. The producers will seek patent protection and set selling prices based on a reduction of electricity consumption. This high price will inhibit rapid, widespread use of the product when first offered.

Q: Thank you, Esteemed Committee.

C: Our enjoyment to visit, as always. Please one and all do return when we have also.