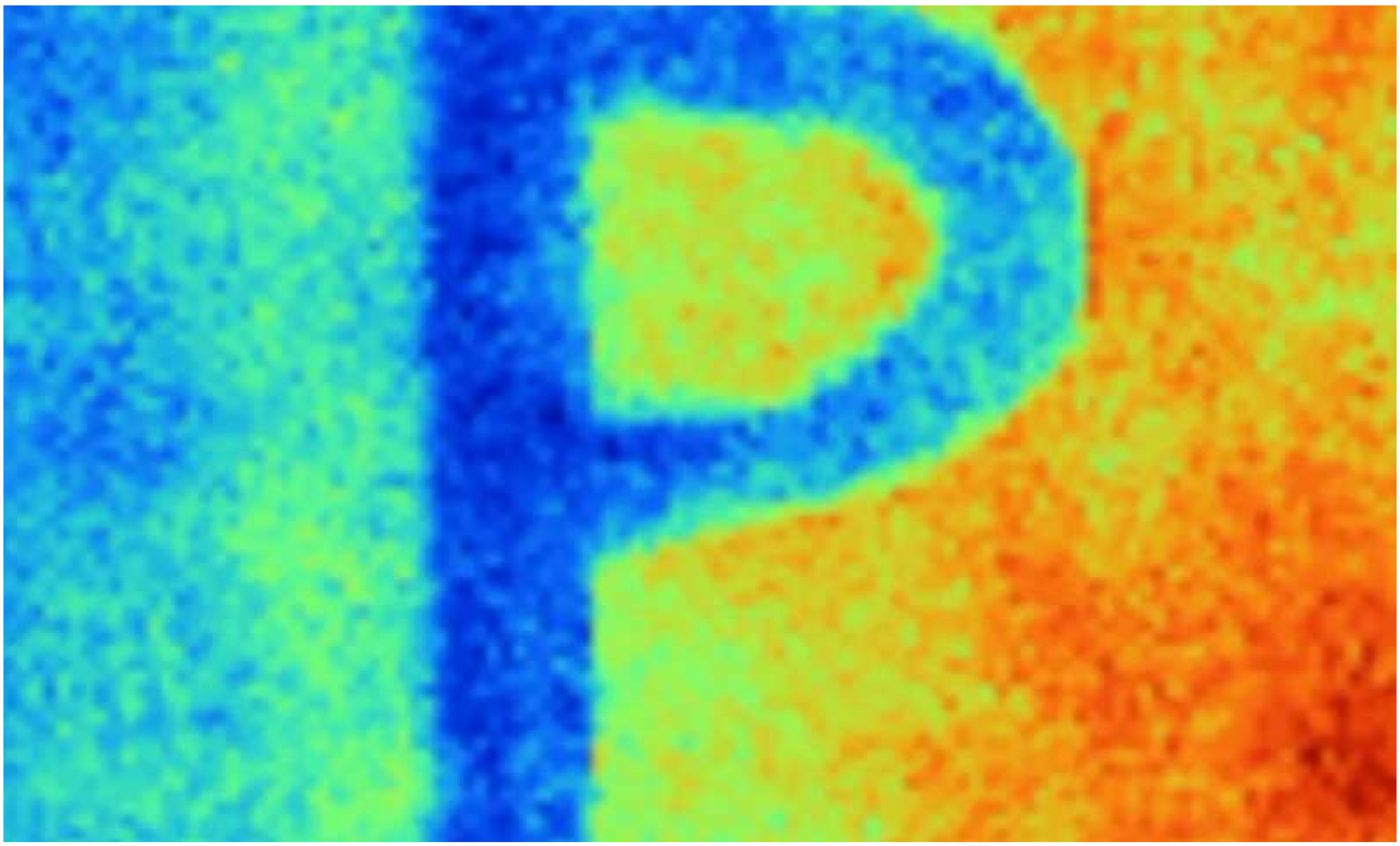
PHYS.ORG

Home / Physics / Condensed Matter

OCTOBER 21, 2020

This white paint keeps surfaces cooler than surroundings, even under direct sunlight

by Cell Press



This infrared image shows that the P pattern pained with the Purdue radiative cooling paint is much cooler than the background painted with commercial paint. Credit: Xiangyu Li, PhD student of the School of Mechanical Engineering at Purdue University

Scientists have developed a white paint that cools below the temperature of its ambient surroundings even under direct sunlight. Their research, published October 21 in the journal *Cell Reports Physical Science*, demonstrates a radiative cooling technology that could be used in commercial paints, that could be less expensive to manufacture, and that passively reflects 95.5% of sunlight that reaches its surface back into outer space. In contrast, commercial "heat rejecting paints" currently on the market only reflect 80%-90% of solar irradiation and cannot achieve below-ambient temperatures.

During the summer months and in regions with warm climates, most buildings rely on conventional air conditioning systems to transfer heat from the inside environment to the outdoors. These systems require energy, emit excess heat that transforms cities into "heat islands," and contribute to the climate crisis. But while scientists have sought to develop radiative cooling paints since the 1970s, previously developed paints have not been capable of reflecting enough sunlight to function as viable, commercializable alternatives to traditional air conditioners.

"It is a persistent task to develop a below-ambient radiative cooling solution that offers a convenient single-layer particle-matrix paint form and high reliability," says Xiulin Ruan, a professor at the School of Mechanical Engineering at Purdue University in Indiana and an author of the study. "This is critical to the wide application of radiative cooling and to alleviate the global warming effect."

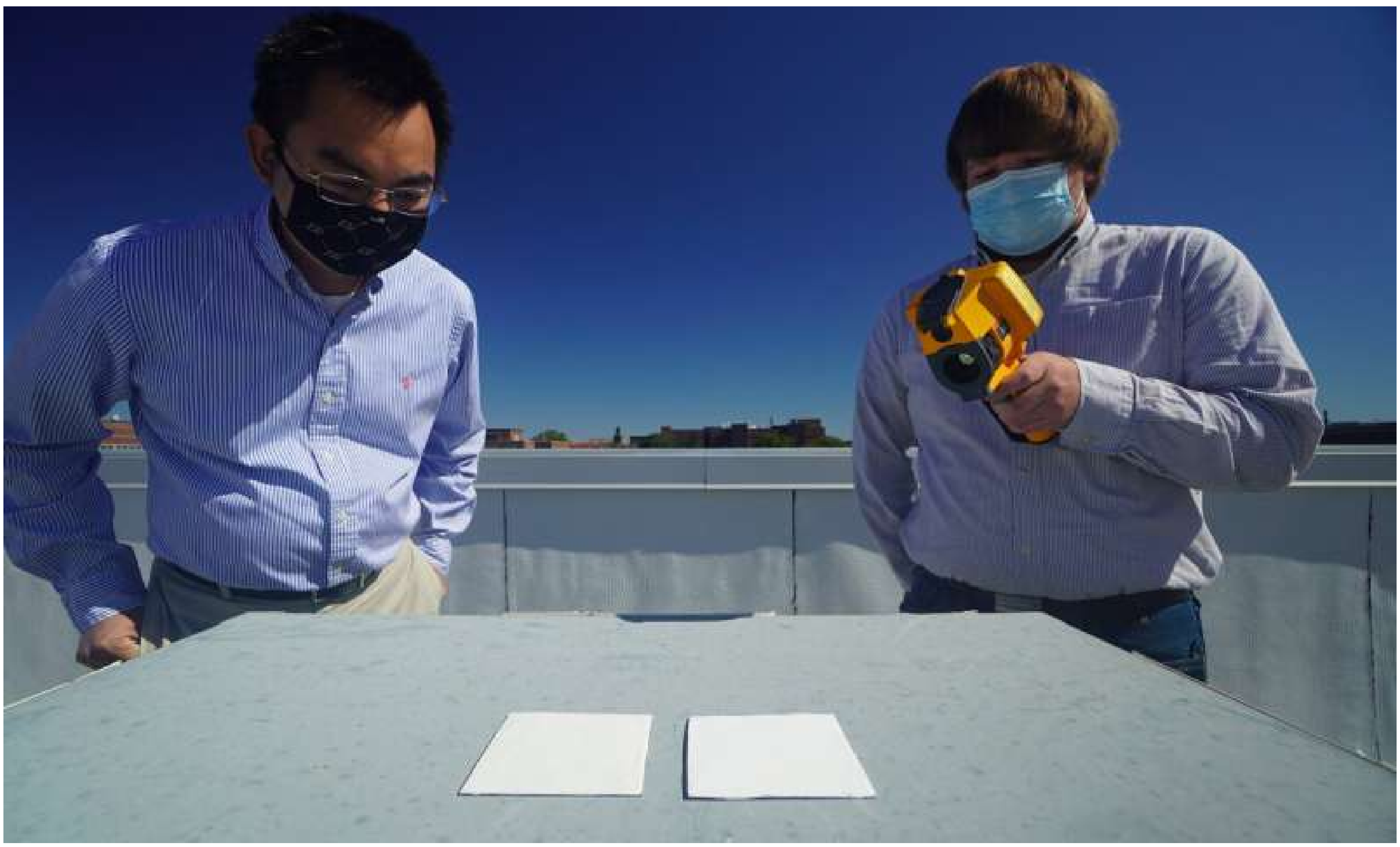
To develop a commercially applicable radiative cooling paint, Ruan and colleagues used calcium carbonate fillers, an earth-abundant compound, instead of standard titanium dioxide particles, since the fillers have large band gaps (energy differences between the valence electron band and the bottom of the conduction electron band) that help minimize the amount of ultraviolet light the paint absorbs. The researchers also leverage a high particle concentration of 60%, which boosts sunlight scattering, as well as a broad particle size distribution instead of a single particle size for efficient broadband scattering.

01:38

The researchers painting swatches and taking temperature readings. Credit: Jared Pike of the School of Mechanical Engineering at Purdue University

To demonstrate how well these modifications enhanced the paint's radiative cooling abilities, the researchers performed cooling tests in West Lafayette, Indiana over a two-day period. The paint sample remained 10 C below ambient temperature at night and at least 1.7 C below the temperature of the ambient surroundings when the Sun was at its zenith. (The cooling power was shown to exceed 37W/m^2 under direct sun.) Ruan and his team then performed a second test in which part of a pattern was painted with the novel paint while another part was painted using a commercial white paint of the same thickness. An infrared camera revealed that the calcium carbonate-based acrylic paint was able to maintain a lower temperature under direct sunlight than its commercial counterpart.

Ruan expects that the technology may benefit a wide range of industries, including residential and commercial buildings, data centers, warehouses, food storage, automobile, outdoor electrical equipment, military infrastructures, and utility vehicles. The paint may be applied directly to buildings to reducing cooling costs. Since the paint lacks metallic components, telecommunication companies may use it to prevent outdoor equipment from overheating, an important step toward enabling a 5G network.



Professor Xiulin Ruan (left) and PhD student Joseph People (right) studying the Purdue radiative cooling paint and the commercial paint samples placed side by side. Credit: Jared Pike of the School of Mechanical Engineering at Purdue University

"This paint may even be used to combat climate change since it rejects sunlight and radiates heat into space," says Ruan.

Next, the researchers plan to perform long-term reliability studies to test the paint's resistance to ultraviolet light exposure, dust, surface adhesion, water, and detergent in order to ensure its function as a commercial product.

"Our paint is compatible with the manufacturing process of commercial paint, and the cost may be comparable or even lower," says Ruan. "The key is to ensure the reliability of the paint so that it is viable in long-term outdoor applications."

More information: *Cell Reports Physical Science*, Li et al.: "Full Daytime Sub-ambient Radiative Cooling in Commercial-like Paints with High Figure of Merit" www.cell.com/cell-reports-phys … 2666-3864(20)30236-8 , DOI: 10.1016/j.xcrp.2020.100221

Provided by Cell Press

Citation: This white paint keeps surfaces cooler than surroundings, even under direct sunlight (2020, October 21) retrieved 25 October 2020 from https://phys.org/news/2020-10-white-surfaces-cooler-sunlight.html