Chameleon-inspired coating could cool and warm buildings through the seasons

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As summer turns to fall, many people will be turning off the air conditioning and firing up heaters instead. But traditional heating and cooling systems are energy-intensive, and because they typically run on fossil fuels, they aren't sustainable. Now, by mimicking a desert-dwelling chameleon, a team reporting in *Nano Letters* has developed an energy-efficient, cost-effective coating. The material could keep buildings cool

in the summers—or warm in the winters—without additional energy.

Many desert creatures have specialized adaptations to allow them to survive in harsh environments with large daily temperature shifts. For example, the Namaqua chameleon of southwestern Africa alters its color to regulate its body temperature as conditions change. The critters appear light gray in hot temperatures to reflect sunlight and keep cool, then turn a dark brown once they cool down to absorb heat instead.

This unique ability is a naturally occurring example of passive temperature control—a phenomenon that could be adapted to create more energy-efficient buildings. But many systems, such as cooling paints or colored steel tiles, are only designed to keep buildings either cool or warm, and can't switch between "modes."

Inspired by the Namaqua chameleon, Fuqiang Wang and colleagues wanted to create a color-shifting coating that would adapt as outside temperatures fluctuate.

To make the coating, researchers mixed thermochromic microcapsules, specialized microparticles and binders to form a suspension, which they sprayed or brushed onto a metal surface. When heated to 68 degrees Fahrenheit, the surface began to change from dark to light gray. Once it reached 86 degrees, the light-colored film reflected up to 93% of solar radiation. Even when heated above 175 degrees for an entire day, the material showed no signs of damage. Next, the team tested it alongside three conventional coatings—regular white paint, a passive radiative cooling paint and blue steel tiles—in outdoor tests on miniature, doghouse-sized buildings throughout all four seasons.

- In winter, the new coating was slightly warmer than the passive radiative cooling system, though both maintained similar temperatures in warmer conditions.

- In summer, the new coating was significantly cooler than the white paint and steel tiles.
- During spring and fall, the new coating was the only system that could adapt to the widely fluctuating temperatures changes, switching from heating to cooling throughout the day.

The researchers say that this color-changing system could save a considerable amount of energy for regions that experience multiple seasons, while still being inexpensive and easy to manufacture.

More information: "Warm in Winter and Cool in Summer" Scalable Biochameleons Inspired Temperature Adaptive Coating with Easy Preparation and Construction, *Nano Letters* (2023). DOI: 10.1021/acs.nanolett.3c02733

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