INNOVATION

All-natural elephant skin-inspired fungi tiles offer upto 70% more cooling for buildings

The bumpy surface of these tiles improves cooling by 70% in wet conditions compared to flat mycelium tiles.

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NTU scientists and bioSEA have developed 'fungi tiles' to cool buildings without energy use. Nanyang Technological University

A team of scientists from Nanyang Technological University, Singapore (NTU Singapore) has developed an innovative wall tile made from mycelium, the root network of fungi. These “fungi tiles” could provide an energy-free solution for cooling buildings.

The tiles combine mycelium with organic waste to form a biomaterial that enhances insulation. Previous research has already shown that mycelium-bound composites outperform conventional insulation materials like expanded vermiculite and lightweight expanded clay aggregate.

To enhance its cooling capabilities, the NTU Singapore team collaborated with local design firm bioSEA. They designed the tile's surface to mimic elephant skin, which is naturally structured with wrinkles and crevices to regulate heat.

Laboratory tests revealed that the elephant skin–inspired texture improved the cooling rate by 25% compared to a flat mycelium tile. It also reduced the heating rate by 2%. Additionally, the cooling effect increased by 70% under simulated rain conditions, making these tiles highly suitable for tropical environments.

Mycelium tiles as an eco-friendly insulation alternative

With the construction industry contributing nearly 40% of energy-related emissions globally, sustainable insulation materials are a growing priority. NTU's Associate Professor Hortense Le Ferrand, who led the study, emphasized the significance of this development.

"Insulation materials are increasingly integrated into building walls to enhance energy efficiency, but these are mostly synthetic and come with environmental consequences throughout their life cycle," said Le Ferrand.

"Mycelium-bound composite is a biodegradable material that is highly porous, which makes it a good insulator. In fact, its thermal conductivity is comparable to or better than some of the synthetic insulating materials used in buildings today."

The research team worked closely with bioSEA to integrate natural design principles into the tile. The result is a proof of concept that demonstrates efficient and sustainable cooling in hot and humid conditions.

Dr. Anuj Jain, Founding Director of bioSEA, explained the inspiration behind the tile's elephant skin–inspired design. "Elephants are large animals that live in hot and sometimes humid tropical climates. To withstand the heat, elephants evolved to develop a skin that is heavily wrinkled, which increases water retention and cools the animal by evaporation."

Improving thermal performance through bio-inspired design

To create the tiles, scientists cultivated mycelium on organic waste materials such as bamboo shavings and oats. The mixture was packed into hexagonal molds designed with an elephant skin–like texture using computational modeling. The tiles were grown in darkness for two weeks, removed from the mold, and allowed to mature further before being dried in an oven at 118.4°F (48°C) for three days.

Tests demonstrated that the textured mycelium tile absorbed heat more slowly than a flat one. When placed on a 212°F (100°C) hot plate for 15 minutes, researchers tracked temperature changes using an infrared camera. The temperature of the textured tile increased by 41.02°F (5.01°C) per minute, whereas the flat tile heated up at a rate of 42.53°F (5.85°C) per minute, demonstrating its resistance to heat absorption. As a comparison, another flat mycelium tile used as a control heated up at 41.20°F (5.11°C) per minute.

The cooling effect of the tile was also tested by heating one side at 212°F (100°C), then exposing it to ambient conditions (71.6°F/22°C, 80% humidity). The elephant skin–inspired tile lost heat at a rate of 4.26°C per minute when heated from the flat side, demonstrating its superior heat dissipation.

Water further enhanced the cooling properties of the tiles. Under simulated rain conditions, the textured tile lost 45.09°F (7.27°C) per minute—a 70% improvement over dry conditions. This occurs because mycelium's hydrophobic nature retains water droplets on its surface, promoting evaporative cooling.

Furthermore, the NTU team is working with local start-up Mykílio to scale up the production of these mycelium tiles and test them on building façades. However, challenges remain in expanding their use, particularly the time required for mycelium growth, which takes three to four weeks.

"We've developed a promising eco-friendly alternative that transforms waste into a valuable resource while rethinking conventional thermal management materials," said Le Ferrand. "This opens the pathway for more elephant skin–inspired designs and the use of different mycelium strains to overcome the challenges that come with using mycelium tiles as an alternative construction material."

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