Docket #: S18-067

Photonic Thermal Management of Outdoor Colored Objects such as automobile and building exteriors

Stanford researchers at the Fan Lab have proposed a comprehensive approach for controlling the heating and cooling of outdoor coatings, such as paint on automobiles or buildings, without affecting its exterior color. This is achieved by controlling three properties simultaneously, metamerism, infrared solar absorption, and radiative cooling. Previous works have focused on one of the three aspects, for example, only radiative cooling.

Theoretical calculations show a large possible tunable range of radiative thermal load for objects with the same color (680-866 Wm^{-2}). An experimental demonstration showed that two photonic structures with the same pink color could differ by over 47 ^{o}C and can be 20 ^{o}C either cooler or hotter compared with a commercial paint with a comparable color. These results indicate the potential for tailoring the radiative thermal load for thermal management of vehicles and buildings in outdoor conditions, without affecting the visual perception, while improving energy efficiency.

This work is an extension of a previous invention from the Fan Lab S13-404 “Color-preserving daytime radiative cooling”

Figure

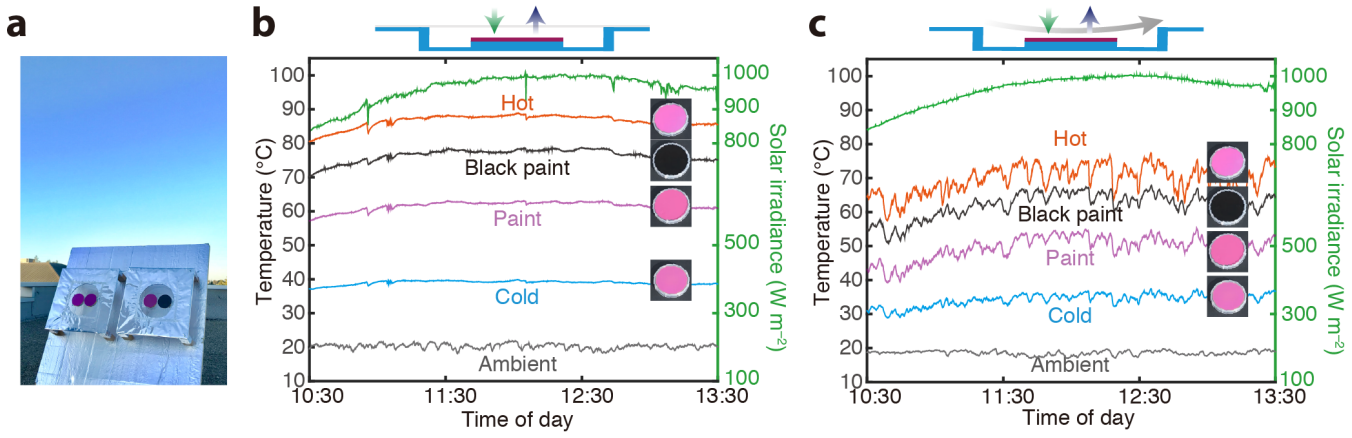

Figure description - Outdoor temperature performances of two photonic structures with same color. These structures can have their temperatures differ by 47.6 °C under sunlight and are over 20 °C either cooler or hotter compared with a commercial paint with a comparable color. Furthermore, the hotter pink structure is 10 °C hotter than a commercial black paint, in contrast to the conventional notion that a darker color tends to get hotter under the sun.

Stage of Research

- Experimental demonstration

Applications

- Thermal managment of outdoor objects such as **automobiles, buildings and clothing**
- In **multilayer structures, colored paints and coatings** (such as paint for the building or automotive industry)

Advantages

- **Retains color**, thus retains visual aesthetics
- **Higher energy efficiency**,
- **Controls all three effects simultaneously**, - metamerism, infrared solar absorption and radiative cooling. – previous work only focuses on one effect
- **Large tunable range**, – 680-866 Wm^{-2}

Publications

- Wei Li, Yu Shi, Zhen Chen & Shanhui Fan. "Photonic thermal management of coloured objects". *Nature Communications* 9, 4240 (2018).

Patents

- Published Application: 20210024143
- Issued: 11,919,574 (USA)

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