coatings

Article

Supplementary Materials: The Utilization of β-Hemihydrate Phosphogypsum Coating with Radiative Cooling and Superhydrophobic Properties for Outdoor Cooling Requirements

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Table S1. EDS element distribution and content of β-HPG@CA/SiO_2@OTS coating.

Element	C	O	Si	S	Cl	Ca	Total
Content(%)	5.17	49.79	38.08	1.79	0.56	4.62	100.00

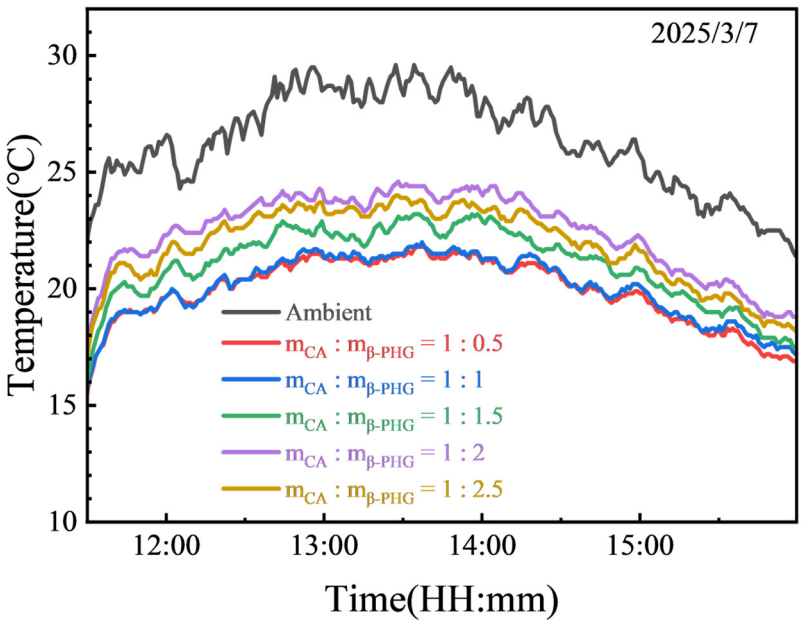


Figure S1. Outdoor temperature curves of β-HPG@CA/SiO_2@OTS coatings doped with CA and β-HPG in different proportions.

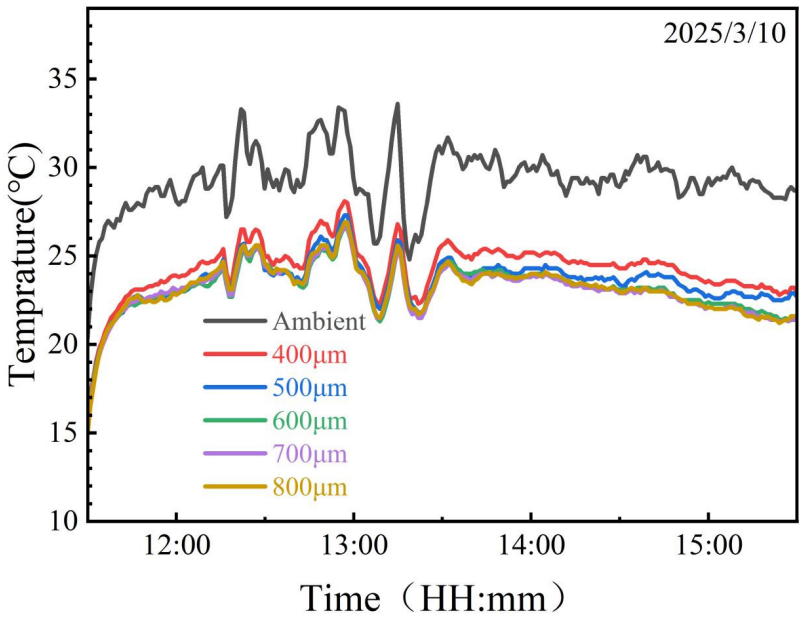


Figure S2. Outdoor temperature curves of β-HPG@CA/SiO_2@OTS coatings with different thicknesses at a CA:β-HPG mass ratio of 1:1.

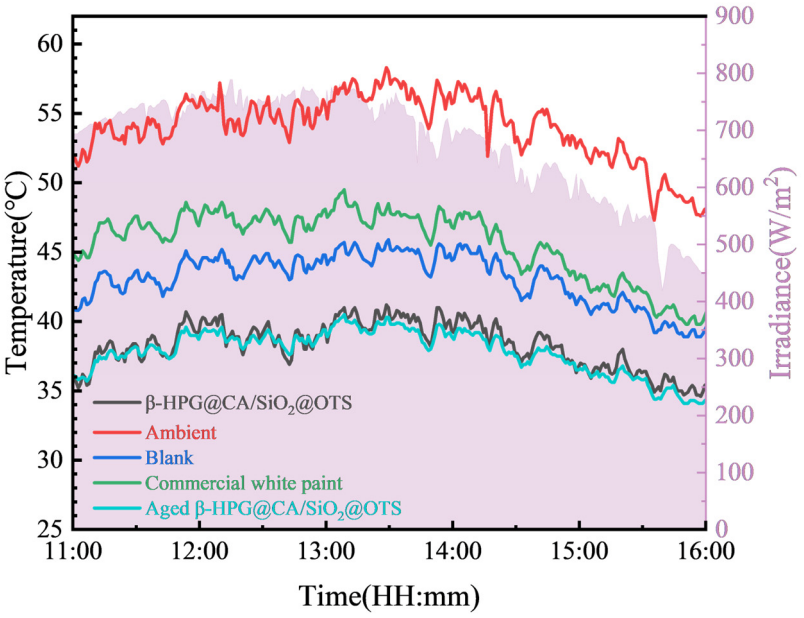


Figure S3. Outdoor cooling performance curves of β-HPG@CA/SiO_2@OTS coating prior to and following UV accelerated aging.

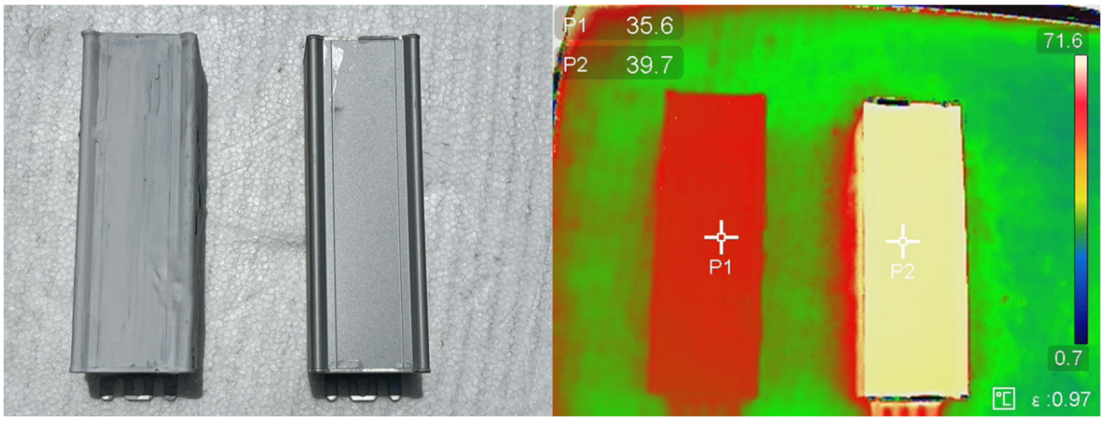


Figure S4. Application of β-HPG@CA/SiO_2@OTS coating on an Aluminum Switch Box and Corresponding Thermal Infrared Image.

Supplementary Note S1:

The net radiative cooling power of the β-HPG@CA/SiO_2@OTS coating was calculated using the following mathematical model:

$$P_{net}(T) = P_{rad}(T) - P_{sun} - P_{atm}(T_{amb}) - P_{cond+conv} \quad (1)$$

In the formula, $P_{rad}(T)$ represents the energy radiated into space, P_{sun} represents the absorbed solar energy, P_{atm} represents the atmospheric radiation energy that is absorbed, and $P_{cond+conv}$ represents the non-radiative power losses due to conduction and convection.

$$P_{rad}(T) = 2\pi \int_0^{\pi/2} \sin\theta \cos\theta d\theta \int_0^{\infty} I_{BB}(T,\lambda)\varepsilon(\lambda,\theta)d\lambda \quad (2)$$

Where $I_{BB}(T,\lambda) = (2hc^2)/(\lambda^5)\left[1/\left(e^{hc/\lambda k_B T} - 1\right)\right]$ is denoted as the intensity of blackbody radiation at temperature T, λ is the wavelength, h is Planck's constant, k_B is Boltzmann's constant, c is the speed of light, and $\varepsilon(\lambda,\theta)$ is the emissivity of the radiator.

Where P_{sun} is the solar radiation absorbed by the radiator and is expressed follows:

$$P_{sun} = \int_0^{\infty} I_{AM1.5}(\lambda)\varepsilon(\lambda,\theta)d\lambda \quad (3)$$

Where $I_{AM1.5}$ is the solar inflow intensity of the standard solar spectral distribution of AM1.5 (Solar radiation = 1000 W/m^2).

$P_{atm}(T_{amb})$ is the absorbed power density, which is affected by atmospheric radiation:

$$P_{atm}(T_{atm}) = 2\pi \int_0^{\pi/2} \sin\theta \cos\theta d\theta \int_0^{\infty} I_{BB}(T_{atm},\lambda)\varepsilon_{atm}(\lambda,\theta)\varepsilon(\lambda,\theta)d\lambda \quad (4)$$

Where $\varepsilon_{atm}(\lambda,\theta)$ is the atmospheric emissivity given by $\varepsilon_{atm}(\lambda,\theta) = 1 - t(\lambda)^{1/\cos\theta}$, and $t(\lambda)$ is the atmospheric transmittance in the zenith direction.

$P_{cond+conv}$ is the non-radiative power density due to heat conduction and convection between the surrounding medium and the radiative cooler, given by the following formula:

$$P_{cond+conv}(T,T_{amb}) = h_c(T_{amb} - T) \tag{5}$$

where h_c is the non-radiative heat transfer coefficient derived from the conductive and convective heat transfer between the heat sink and the surrounding medium, and $h_c = h_{cond} + h_{conv}$. The cooling temperature($\Delta T = T - T_{atm}$)is obtained from where condition where the net power $P_{net}(T) = 0$.