Electronic Supplementary Information

for

Biomimetic Intelligent Photonic Crystal Composite Films with Tri-Mode Optical States for Advanced Anti-Counterfeiting and Information Encryption

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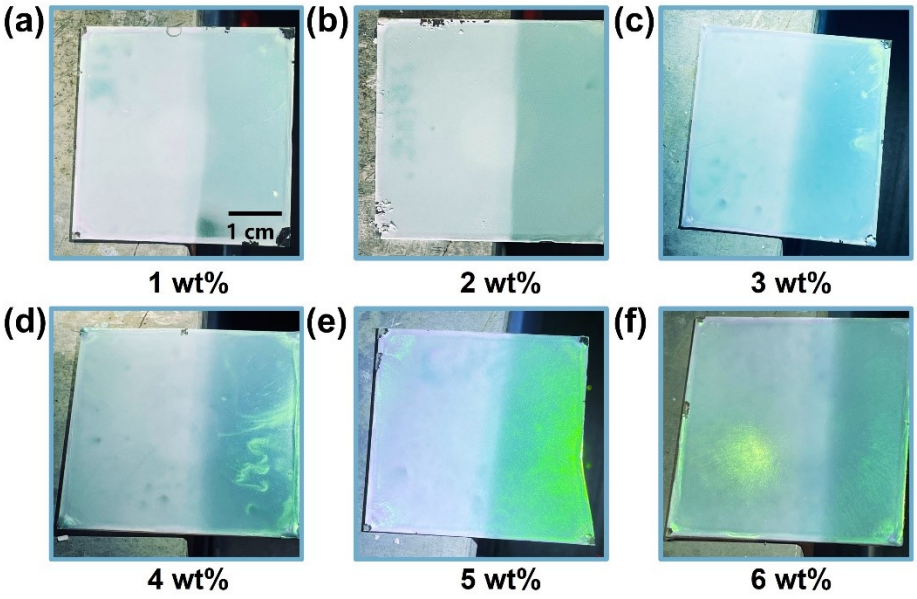

Fig. S1 Photographs of the PCC films with different mass fractions of black thermochromic microcapsules. It can be seen that with the increase of doping content, the color of the PCC films became increasingly saturated, which can be ascribed to the absorbance of incoherent scattering caused by blacker thermochromic microcapsules. However, excessive doping content of microcapsules would affect the long-range-ordered structures and the structural color of the PC. Therefore, we chose 5 wt.% as the optimal doping content for black thermochromic microcapsules in this work.

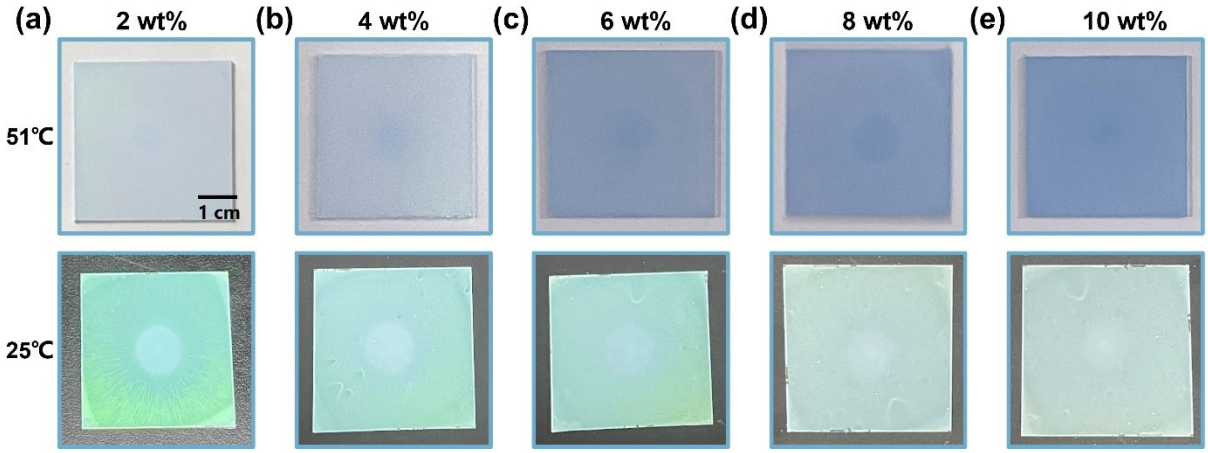

Fig. S2 Photographs of the PCC films with different mass fractions of blue thermochromic microcapsules. It is shown that the color of PCC film displayed both saturated blue color at 51 ℃ and brilliant green color at 25 ℃ when the doping content was 6 wt.%. In this regard, the mass fraction of the colored microcapsules was kept at 6 wt.% if not stated otherwise in this work.

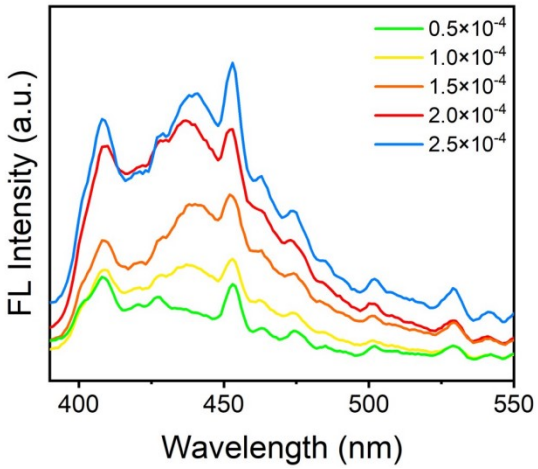

Fig. S3 The emission spectra of the PCC films with different doping content of 2-AC.

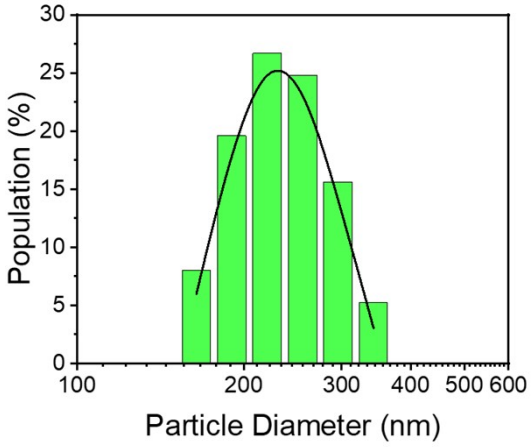

Fig. S4 Particle size distribution of the P(St-MMA-AA) nanosphere. (Mean size: 243 nm)

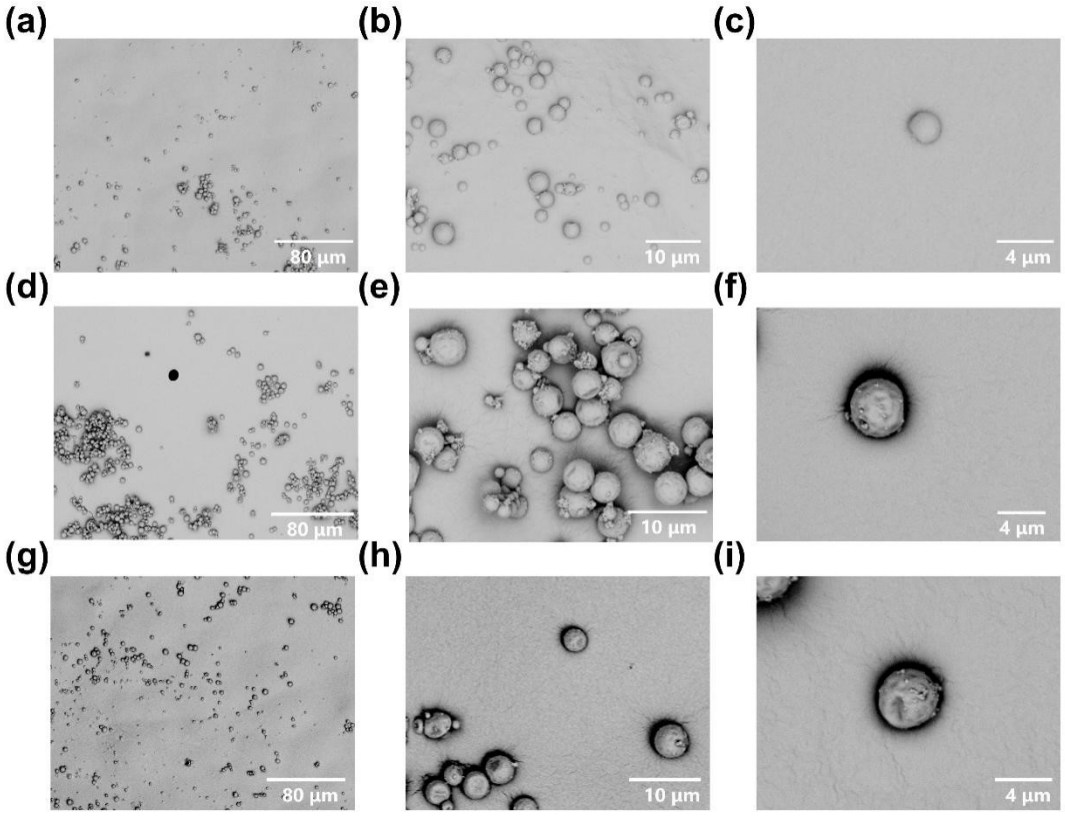

Fig. S5 Top-view SEM images of the thermochromic microcapsules. (a-c) black, (d-f) purple, and (g-i) blue microcapsules.

Table S1 Compositions of different PCC films (spin coating)

PCC film	PC emulsion	Thermochromic microcapsules	2-AC
PCC-(1)	95 wt%	Black: 5 wt%	—
PCC-(2)	94.8 wt%	Black: 5 wt%	0.2 wt%
PCC-(3)	88.8 wt%	Black: 5 wt%, Purple: 6 wt%	0.2 wt%
PCC	82.8 wt%	Black: 5 wt%, Purple: 6 wt%, Bule: 6 wt%	0.2 wt%

Table S2 Compositions of different PCC films (spray coating)

PCC film	PC emulsion	Ethanol	Thermochromic microcapsules	2-AC
PCC-(1)	40 wt%	55 wt%	Black: 5 wt%	—
PCC-(2)	40 wt%	54.8 wt%	Black: 5 wt%	0.2 wt%
PCC-(3)	40 wt%	48.8 wt%	Black: 5 wt%, Purple: 6 wt%	0.2 wt%
PCC	40 wt%	42.8 wt%	Black: 5 wt%, Purple: 6 wt%, Bule: 6 wt%	0.2 wt%

Table S3 Phase transition temperature of different thermochromic microcapsules

Thermochromic microcapsules	Phase transition temperature
Black	31 ℃
Purple	51 ℃
Orange	51 ℃
Pink	51 ℃
Red	51 ℃
Bule-1	51 ℃
Bule-2	61 ℃

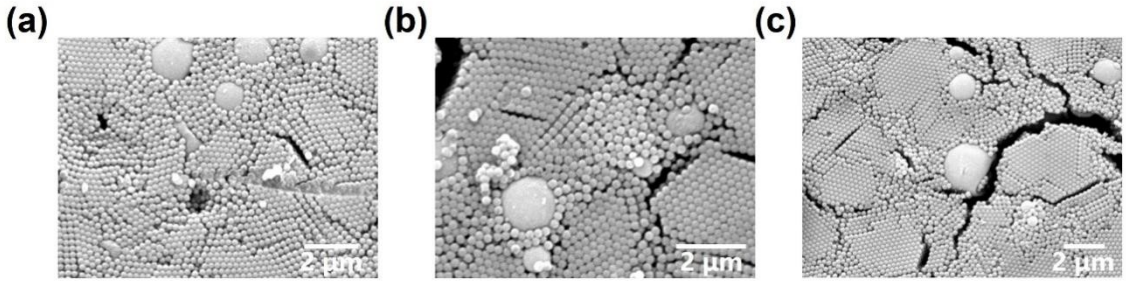

Fig. S6 Top-view SEM images of the PCC film including P(St-MMA-AA) nanospheres, thermochromic microcapsules, and 2-AC.

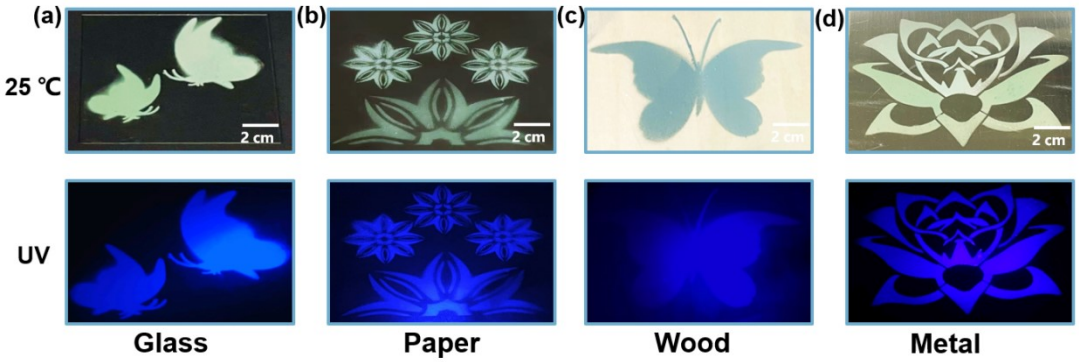

Fig. S7 Photographs of patterned PCC films at 25 ℃ and UV illumination on various substrates. (a) glass, (b) paper, (c) wood, and (d) metal.

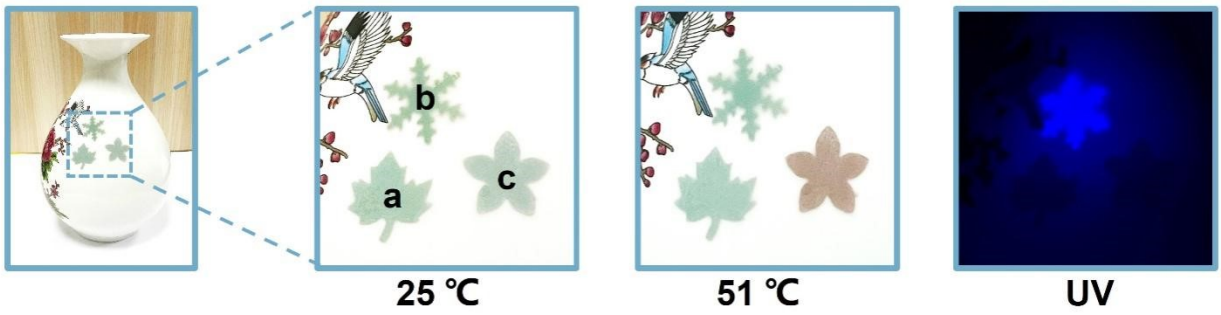

Fig. S8 Photographs showing the three single/dual-mode anti-counterfeiting patterns attached to a flower vase. (a: The "maple leaf" pattern was sprayed with PC ink; b: The "snowflake" pattern was sprayed with ink mixed with fluorescent dye 2-AC and PC; c: The "petal" pattern was sprayed with ink mixed with thermochromic microcapsules and PC)

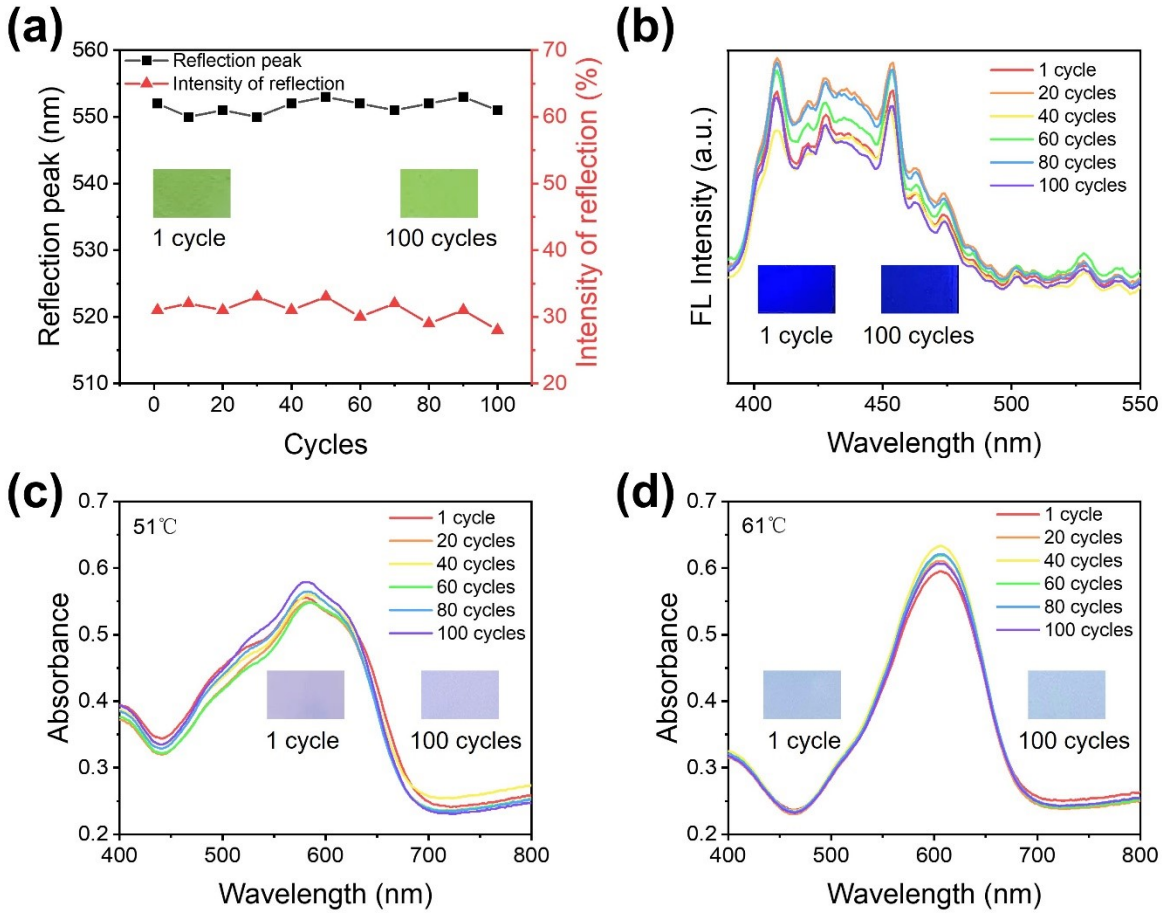

Fig. S9 Reusability and stability of the PCC films after undergoing 100 cycles. (a) Reflection peak and intensity, (b) fluorescent luminescence, (c) absorption spectra at 51 ℃, and (d) at 61 ℃.