Electronic Supplementary Material (ESI) for RSC Advances.

SUPPORTING INFORMATION

Preparation of colloidal photonic crystal containing CuO nanoparticles with tunable structural colors

Chun-Feng Lai,*[†] Yu-Chi Wang,[†] Chia-Lung Wu,[††] Jia-Yu Zeng,[†] and Chia-Feng Lin[††]

[†]Department of Photonics, Feng Chia University, Taichung 40724, Taiwan

[††] Department of Materials Science and Engineering, National Chung Hsing University, Taichung 402, Taiwan

*Corresponding authors: chunflai@fcu.edu.tw (Prof. Chun-Feng Lai)

Table S1. Overview of methods to enhance the structural color of CPhCs.

Method	***NPs***	***Remarks***	***Reference***
Mixtures of sedimentation method	Copper (Cu) NPs	Polystyrene colloidal photonic crystal structures containing copper oxide (CuO) NPs present tunable structural colors.	In this work
Shear alignement	Carbon (CB) NPs	Polymeric photonic crystals doped interstitially at very low concentrations of CB NPs were exhibited light absorb and scattering.	16
Mixtures of opal powder with NPs powder	CB NPs	PMMA colloidal crystal particles incorporating CB NPs can absorb and scatter light.	17
Nanocasting method	Porous CB	Brilliant iridescent colors were clearly observed on the CB colloidal crystals, like natural black opals.	18
Mixtures of centrifugation	CB NPs	Iridescent colloidal crystal coatings with variable structural colors were fabricated by incorporating CB NPs into the voids of polystyrene colloidal crystals.	19
Vertical deposition by dip-coating	CB NPs	A small quantity of CB added to the colloidal silica in n-propanol. The doping of CB into silica microspheres can absorb background and scattering light, resulting in vivid structural colors.	20
Infiltration material method	Gold (Au) NPs	Composite metallodielectric inverse opal films with Au-silica core-shell nanoparticles exhibit a distinct Bragg reflectance peak.	21
Vertical deposition by dip-coating	Au NPs	Use of the Au NPs modified three-dimensionally ordered macroporous film as a refractive-index sensor is demonstrated.	22
Dip-infiltrating sol-gel method	Tungsten trioxide (WO_3)	A tunable electrochromic photonic crystal based on WO_3 inverse opal structure has been fabricated by polystyrene colloidal crystal templates.	24
Infiltration material method	Au NPs	Au NPs infiltrated polystyrene inverse opals, which not only preserve localized surface plasmon resonance (LSPR) properties, but also replicate photonic features from templates.	25
Co-assembly method and infiltration material method	Au NPs and silver (Ag) NPs	The preparation methods used inverse opal SiO_2 films containing highly dispersed, plasmonic AuNPs or AgNPs and having both Bragg diffractions and LSPRs.	27

Table S2. Structural parameters for three PS CPhC films used in this study.

Sample	Diameter, D_{PS} (nm)	Normal reflection peak (nm)
A	190	452
B	230	547
C	265	630

Figure S1. Photographs of 5.0 wt.% PS latex (sample B) with 0.0, 0.05, 0.10, and 0.50 wt.% CuO NP content (from left to right).

Figure S2. Raman spectrum of (a) PS CPhC film and (b) CuO film, respectively. Inset shows the optical image of PS CPhC film and CuO film.

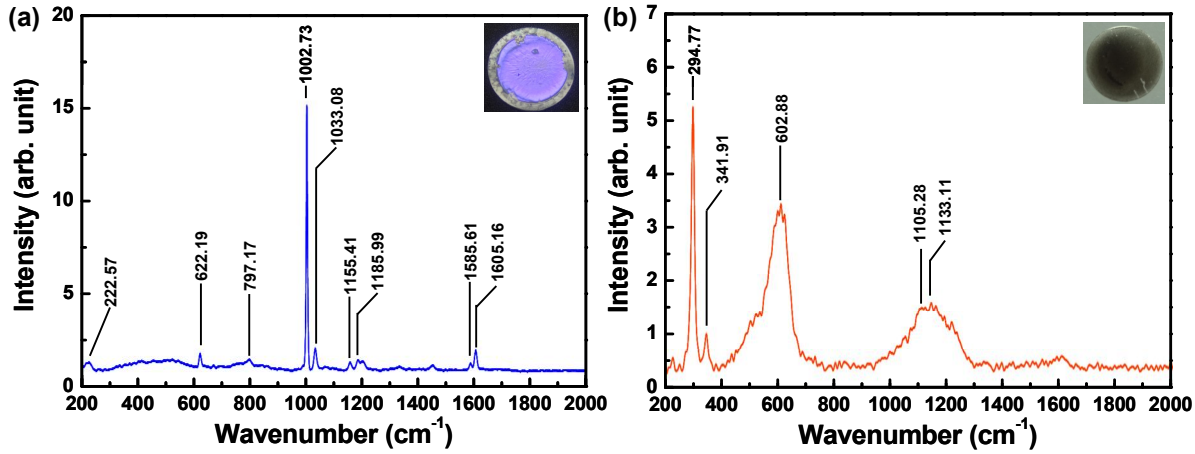


Figure S3. Photographs of PS CPhC films prepared without and with CuO NPs.

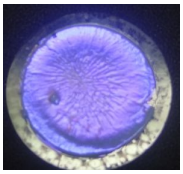
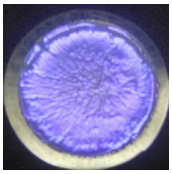
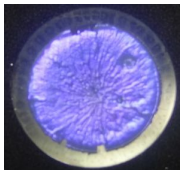
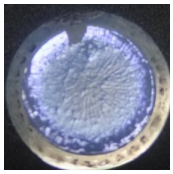
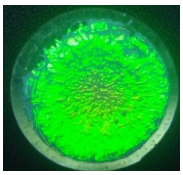
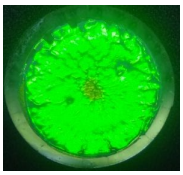
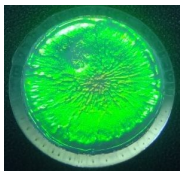
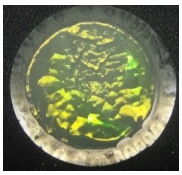
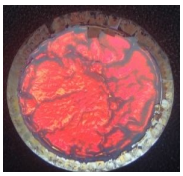
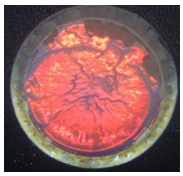
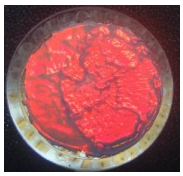
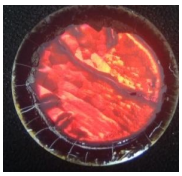
Sample	Standard	0.05 wt.% CuO NPs	0.10 wt.% CuO NPs	0.50 wt.% CuO NPs
A				
B				
C				

Figure S4. Reflection spectra of PS CPhC films without and with CuO NPs, showing (a) sample A and (b) sample C.

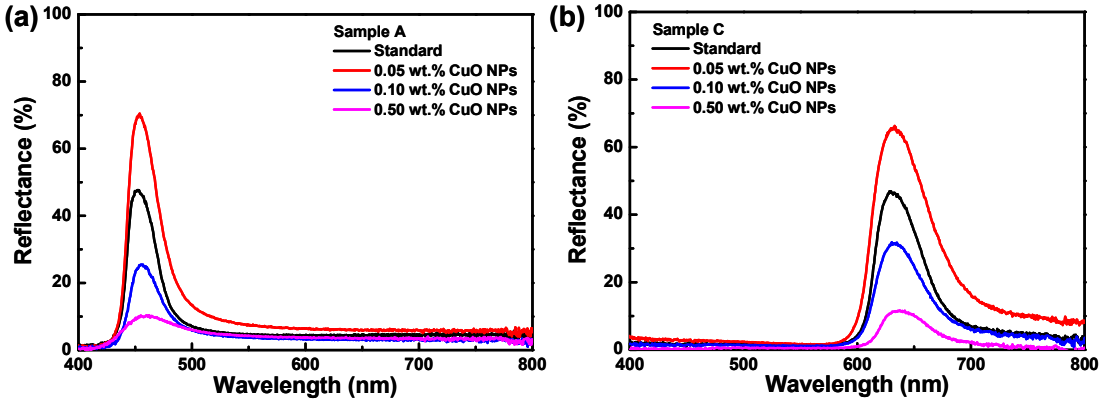


Figure S5. Photographs of PS CPhC films prepared without and with CuO NPs through three months.

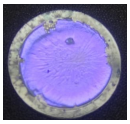
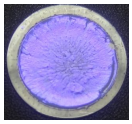
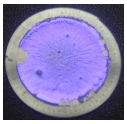
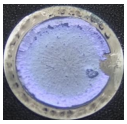
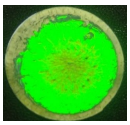
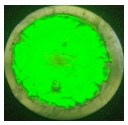
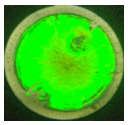
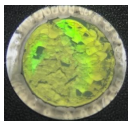
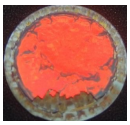
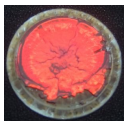
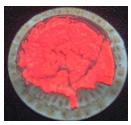
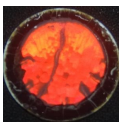
Sample	Standard	0.05 wt.% CuO NPs	0.10 wt.% CuO NPs	0.50 wt.% CuO NPs
A				
B				
C				

Figure S6. Reflection spectra of PS CPhC films without and with CuO NPs through three months, showing (a) sample A, (b) sample B, and (c) sample C. (d) CIE chromaticity diagram of CuO–PS CPhC films with different sample (A–C) and CuO NP contents.