

Supporting Information

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Flexible and robust dual-network supramolecular elastomer with solvent resistance and brilliant structural colors

Jia Wu, Wenbin Niu, Shufen Zhang*, Suli Wu, Wei Ma, Bingtao Tang

1. Fourier Transform Infrared Spectroscopy (FTIR)

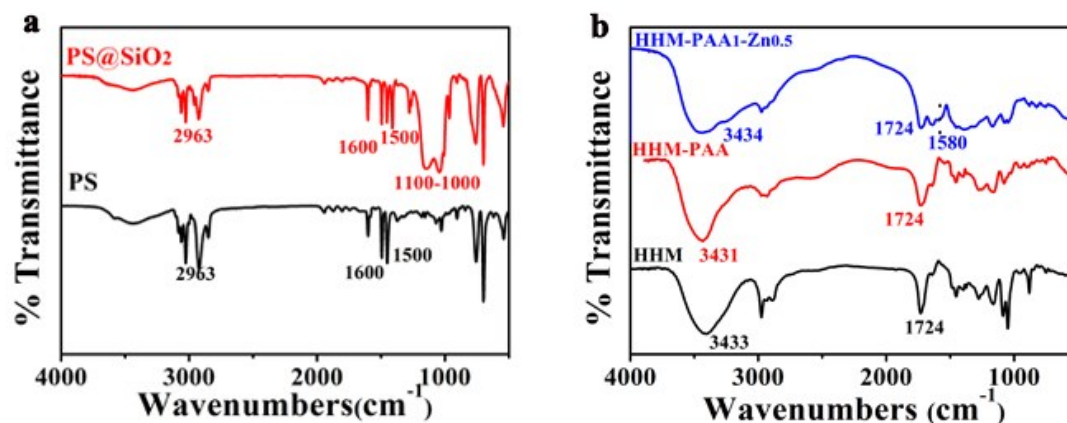


Figure S1 Fourier transform infrared spectra for (a) PS and PS@SiO₂ nanospheres and (b) HHM copolymer, HHM-PAA composite and HHM-PAA₁-Zn_{0.5} supramolecular elastomer.

2. Thermal analysis

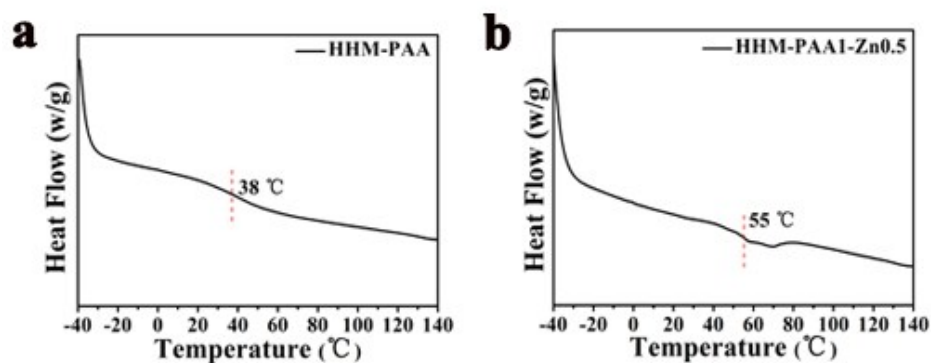


Figure S2 Differential scanning calorimetry analysis for (a) HHM-PAA composite, (b) HHM-PAA₁-Zn_{0.5} supramolecular elastic material.

3. SEM images of the PS and the PS@SiO₂ nanospheres

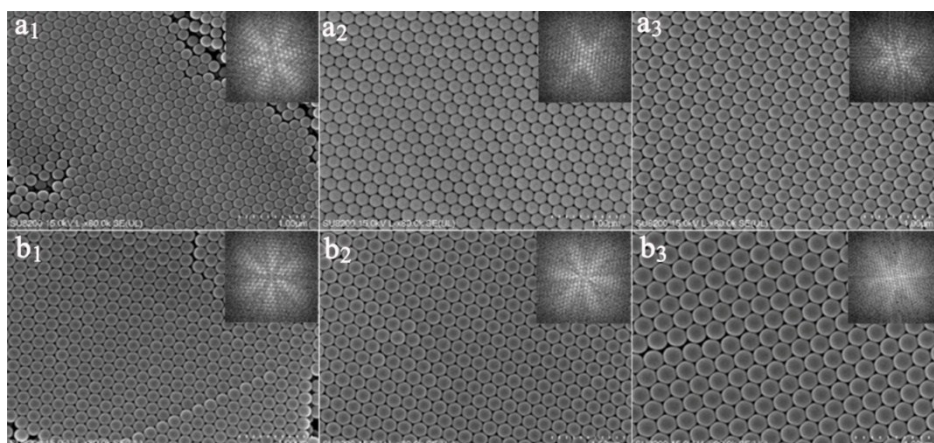


Figure S3 SEM images of the PS nanospheres with diameters of (a₁) 150 nm, (a₂) 178 nm, and (a₃) 193 nm. SEM images of the PS@SiO₂ nanospheres with diameters of (b₁) 178 nm, (b₂) 205 nm, and (b₃) 237 nm. Corresponding FFT power spectra were displayed at the top right-hand corner of each figure.

4. TEM images of the PS@SiO₂ nanospheres

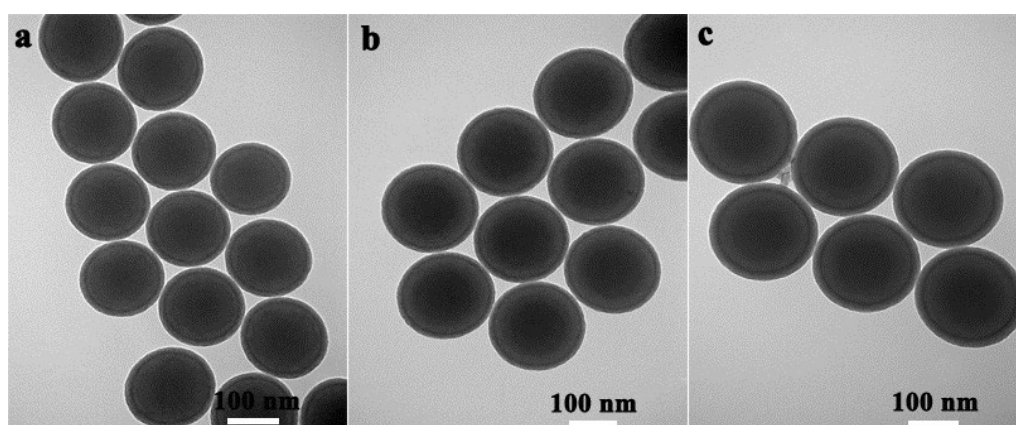


Figure S4 TEM images of the PS@SiO₂ nanospheres with diameters of (a) 178 nm, (b) 205 nm, and (c) 237 nm.

5. Energy dispersive X-ray spectroscopy(EDX)

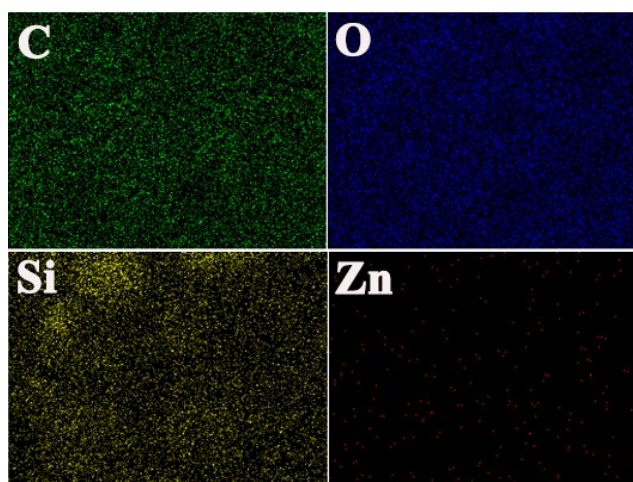


Figure S5 Energy dispersive X-ray (EDX) scans of green HHM-PAA₁-Zn_{0.5} structural color film cross-sectional area. The HHM-PAA₁-Zn_{0.5} structural color film show four elements: C, O, Si, Zn. Area scans of the nearby regions confirm uniformity.

6. Optical photograph of the PS@SiO₂ colloidal photonic crystals

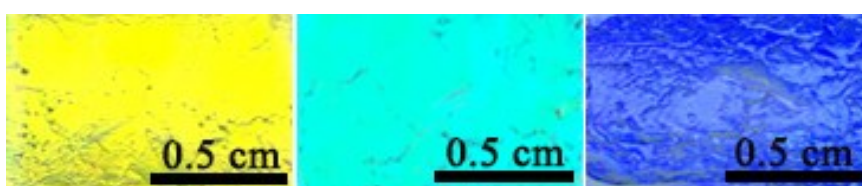


Figure S6 Optical photograph of the PS@SiO₂ photonic crystals with diameters of 237 nm, 205 nm and 178 nm from left to right.

7. Reflection spectra of the PS@SiO₂ photonic crystals

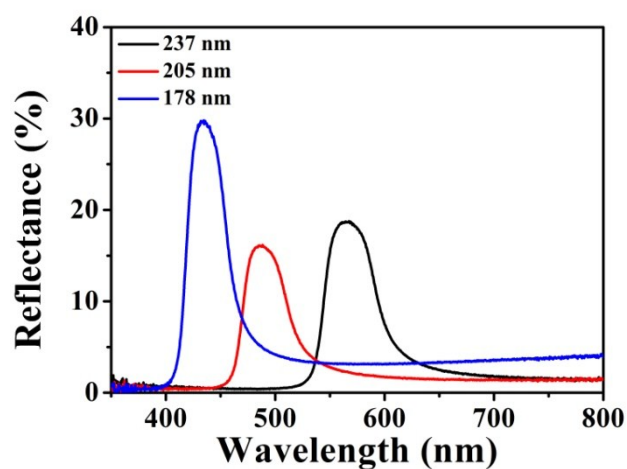


Figure S7 The reflection spectras of the PS@SiO₂ photonic crystals with diameters of

237 nm, 205 nm and 178 nm.

8. Cross-sectional SEM images of red and blue HHM-PAA₁-Zn_{0.5} structural color films

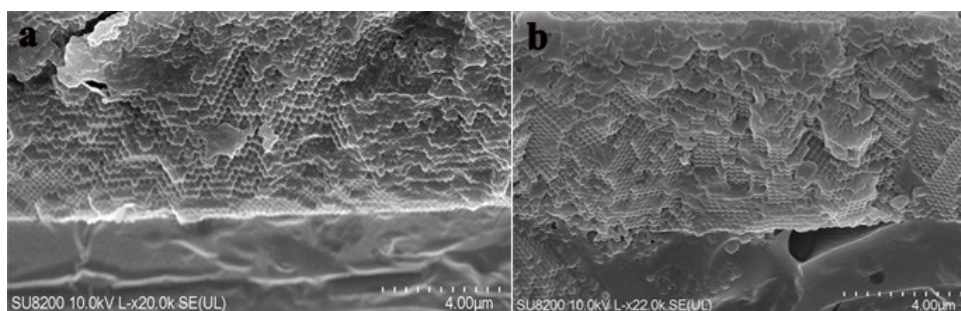


Figure S8 SEM images of the red (a) and blue (b) structural color films.

9. SEM image of surface section of the green structural color film after loading-unloading for 100 cycles

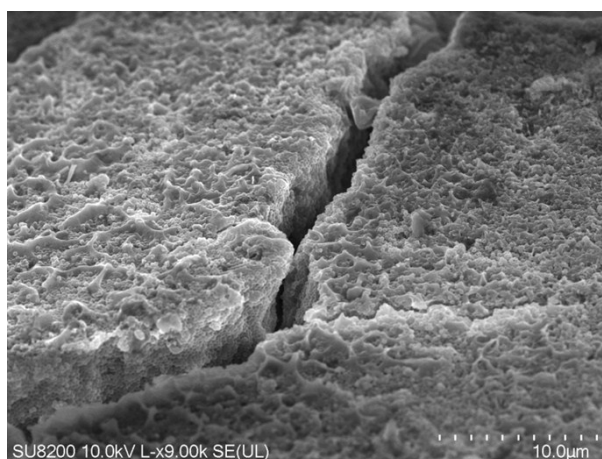


Figure S9 SEM image of the surface section of the green HHM-PAA₁-Zn_{0.5} structural color film (after loading-unloading for 100 cycles, the film was promptly frozen by liquid nitrogen, and structural color film was promptly coated with palladium for 45 s to capture the surface section with scanning electron microscopy).

10. The effective refractive index and calculation of the reflection peaks of the red, green and blue structural color films

Bragg's Laws is as follows:

$$\lambda_{max} = (8/3)^{1/2} D (n_{eff}^2 - \sin^2 \theta)^{1/2} \dots\dots\dots ①$$

$$n_{eff}^2 = \sum_{i=1}^n X_i^2 Y_i = n_i^2 \phi_i \dots\dots\dots ②$$

$$n_{PS} = 1.59 \quad n_{SiO2} = 1.46 \quad \phi = 0.74$$

$$n_{sphere} = n_{PS} \frac{V_{PS}}{V} + n_{SiO2} \frac{V_{SiO2}}{V} \dots\dots\dots ③$$

$V = V_{PS} + V_{SiO2}$ V_{PS} and V_{SiO2} are the volumes of PS and SiO₂ spheres

$$n_{eff} = \left(n_{PS} \frac{V_{PS}}{V} + n_{SiO2} \frac{V_{SiO2}}{V} \right)^2 \times 0.74 + n_{polymer}^2 \times 0.26$$

Table. S1 Parameters of the red, green and blue HHM-PAA₁-Zn_{0.5} structural color films

| | n_{eff} | D | $\sin \theta$ |
|-------|-----------|-----|---------------|
| blue | 1.7074 | 178 | 0.03 |
| green | 1.7128 | 205 | 0.03 |
| red | 1.7009 | 237 | 0.03 |

n_{eff} is the effective refractive index of the HHM-PAA₁-Zn_{0.5} structural color films

D is the diameter of the nanoparticles

θ is the angle between the incident light and the reflective surface

Table. S2 The calculated value and measured value of the reflection wavelengths of the red, green and blue HHM-PAA₁-Zn_{0.5} structural color films

| | Calculated value | Measured value |
|-------|------------------|----------------|
| blue | 493 | 489 |
| green | 565 | 544 |
| red | 654 | 634 |

11. Digital photo of the red HHM-PAA₁-Zn_{0.5} structural color films after stretching

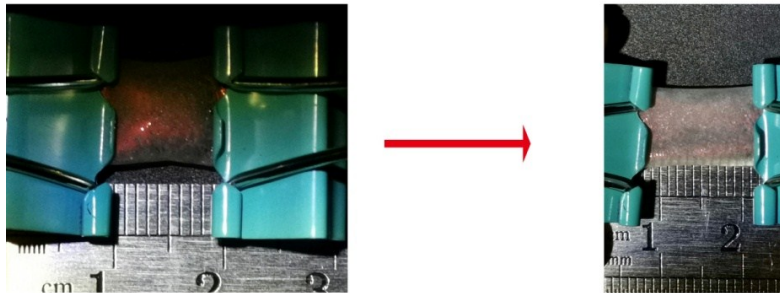


Figure S10 Digital photo of the red HHM-PAA₁-Zn_{0.5} structural color films at a strain of 44% of the original state.

12. SEM image of the green HHM-PAA₁-Zn_{0.5} structural color film after compression fatigue

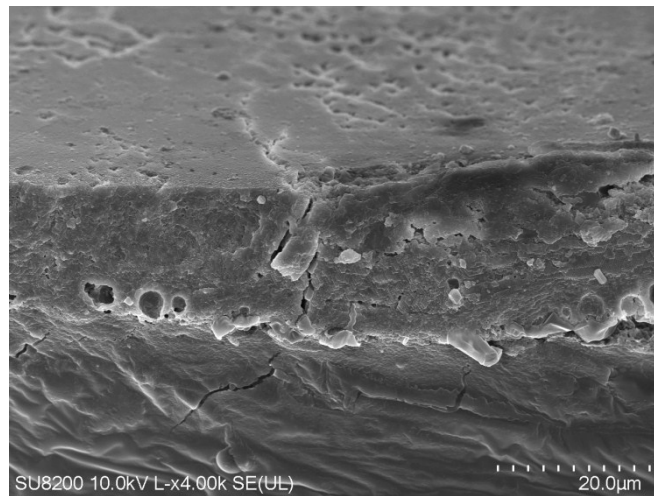


Figure S11 SEM image of the green structural color film after compression fatigue.

13. Self-recovery of compression mode of the green structural color film

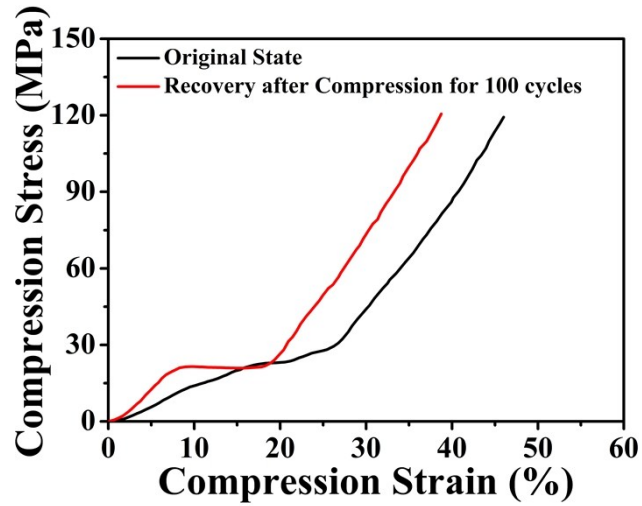


Figure S12 The compression stress of original state (black line), The compression stress was measured after compression for 100 cycles at a rest for 5 min (pressure= 119 MPa).

14. Reflection spectra of the original state and the green structural color film which was placed in saturated water vapor

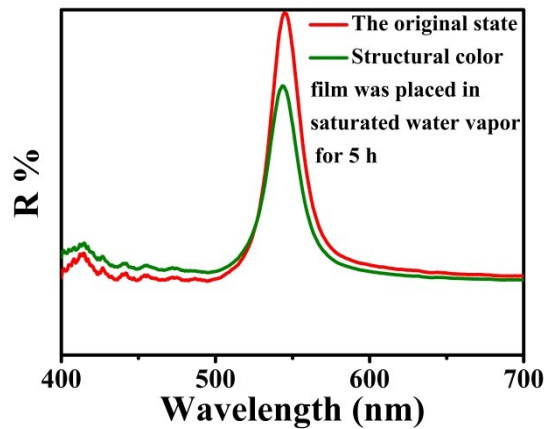


Figure S13 Reflection spectra of the green structural color film (red line); The green structural color film was placed in saturated water vapor for 5 h (green line).