Electronic Supplementary Material (ESI) for Soft Matter

SUPPLEMENTARY INFORMATION

Structural integration design for enhanced photoluminescence in butterfly scales

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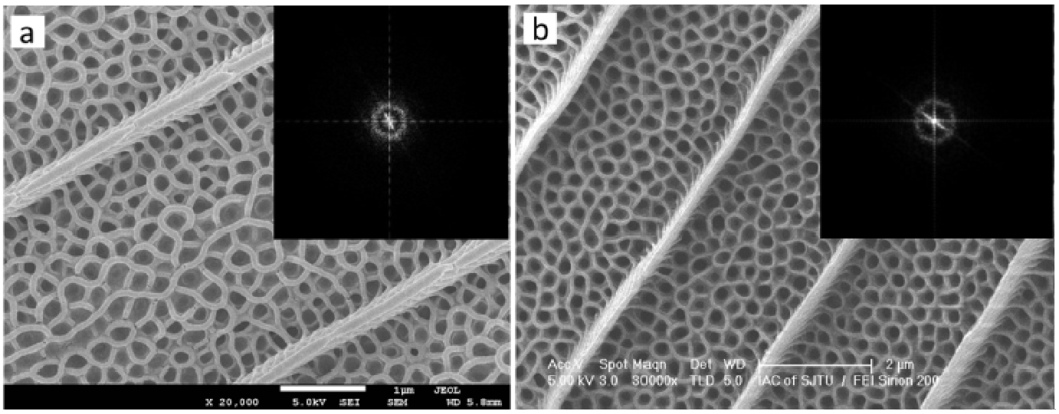

Fig. S1 Two dimensional Frourier transform of a single scale in blue patch of PO and green patch of PN. (a) Two dimensional Frourier transform of a single scale in blue patch of PO, scale bar, 1 μm. (b) Two dimensional Frourier transform of a single scale in green patch of PN, scale bar, 2 μm.

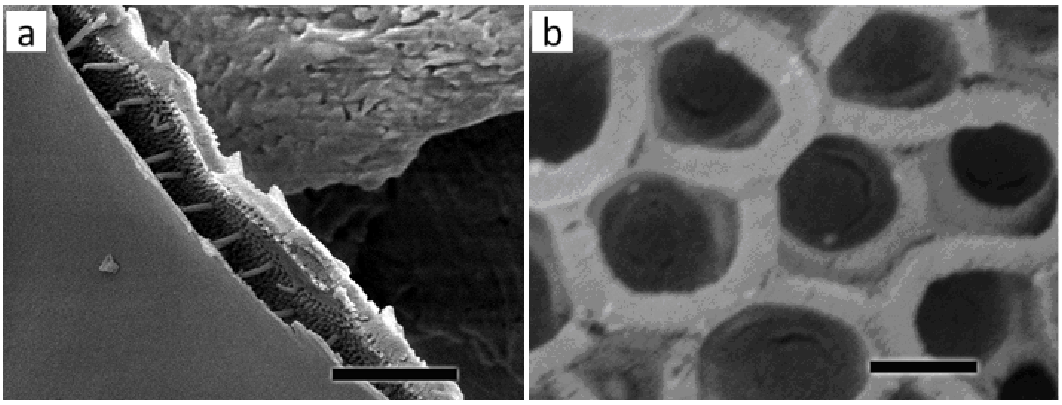

Fig. S2 (a) Lower magnification FESEM image of cross section view of PN scale, scale bar, 5μm. (b) FESEM image of the network from the top view of PO scale, scale bar, 200 nm.

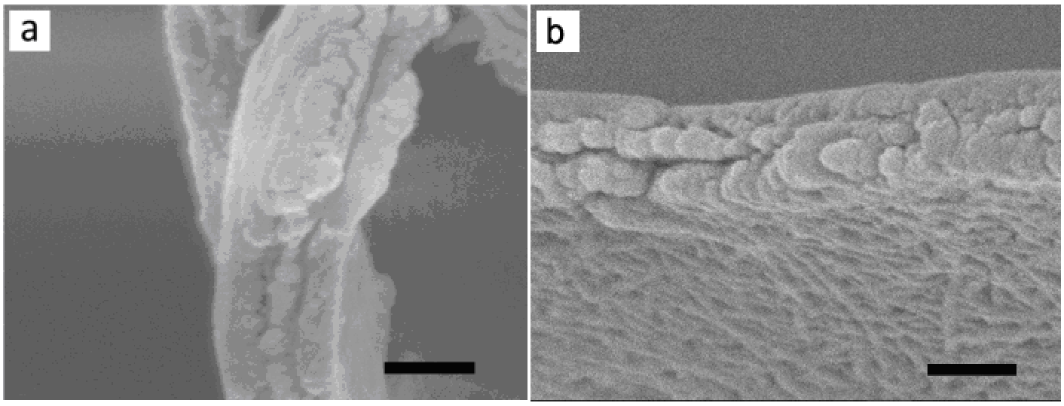

Fig. S3 (a) FESEM image of the cross section of the multilayer structure in the bottom film of PO scale, scale bar, 200 nm. (b) FESEM image of the cross section of the multilayer structure in the bottom film of PN scale, scale bar, 200 nm.

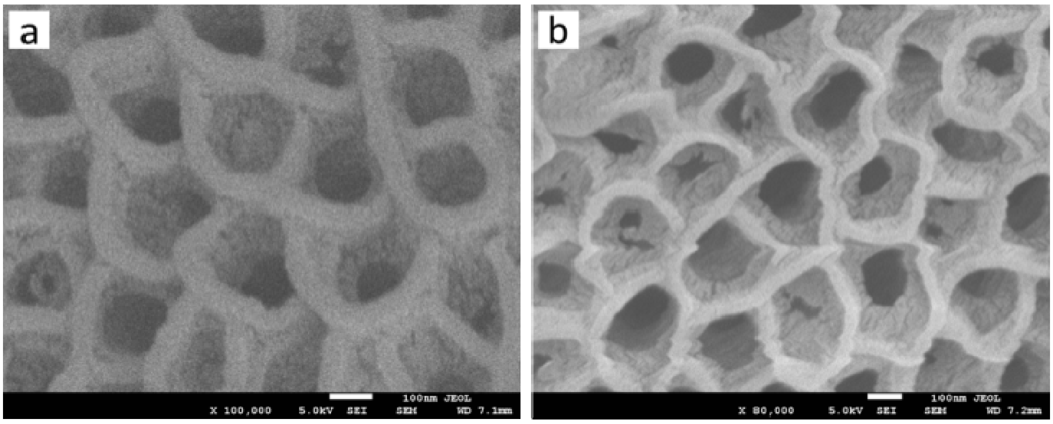

Fig. S4 FESEM images of the PO and PN scales after pigment extraction. (a) FESEM image of the blue scale in PO after pigment extraction from the top view, scale bar, 100 nm. (b) FESEM image of the green scale in PN after pigment extraction from the top view scale bar, 100 nm.

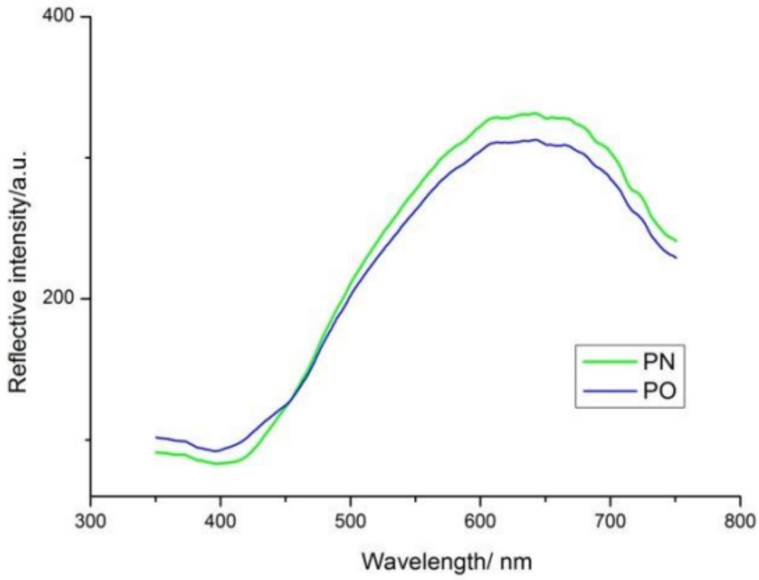

Fig. S5 Reflection spectra of pigment extraction solution

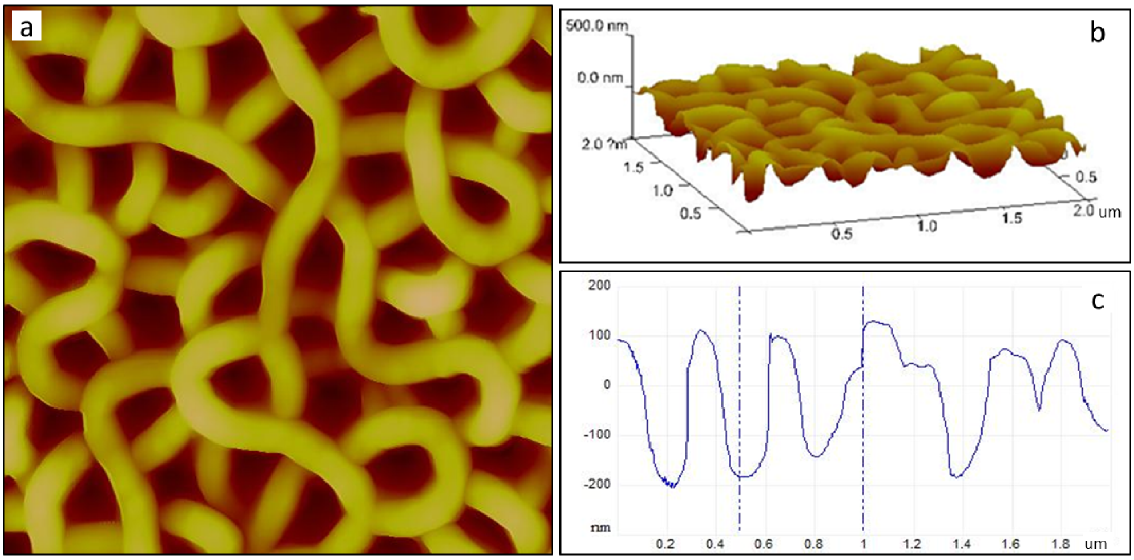

Fig. S6 Results of AFM measurement of PO scale. (a) The AFM image of the top surface of PO scale. (b) The three dimensional reconstruction of the network layer of PO scale. (c) The profile of the cross-section of the network layer of PO scale.

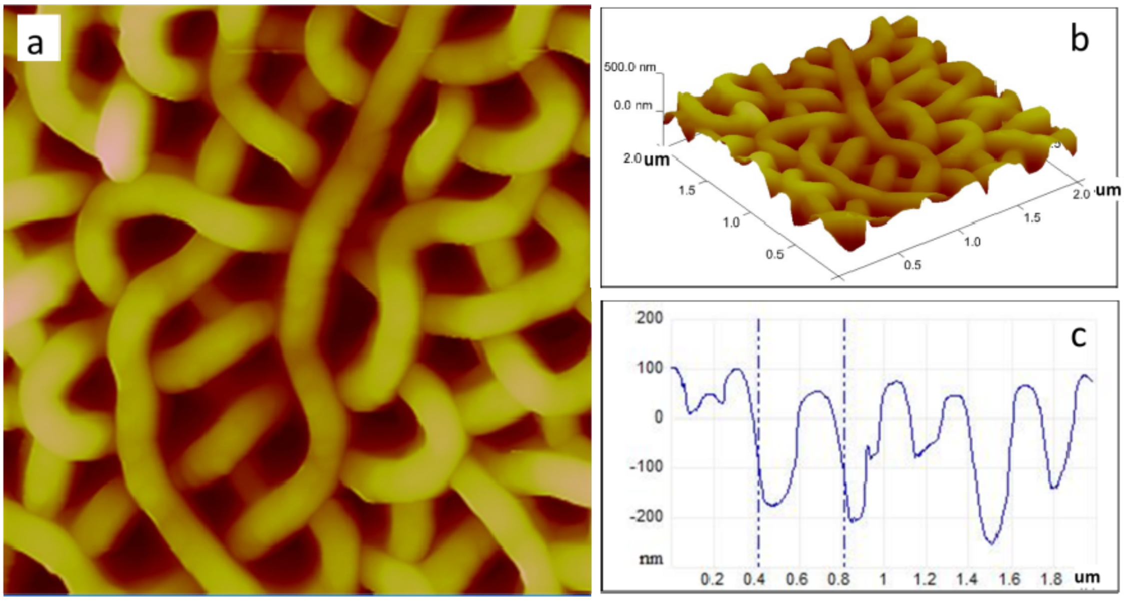

Fig. S7 Results of AFM measurement of PN scale. (a') The AFM image of the top surface of PN scale. (b') The three dimensional reconstruction of the network layer of PN scale. (c') The profile of the cross-section of the network layer of PN scale.

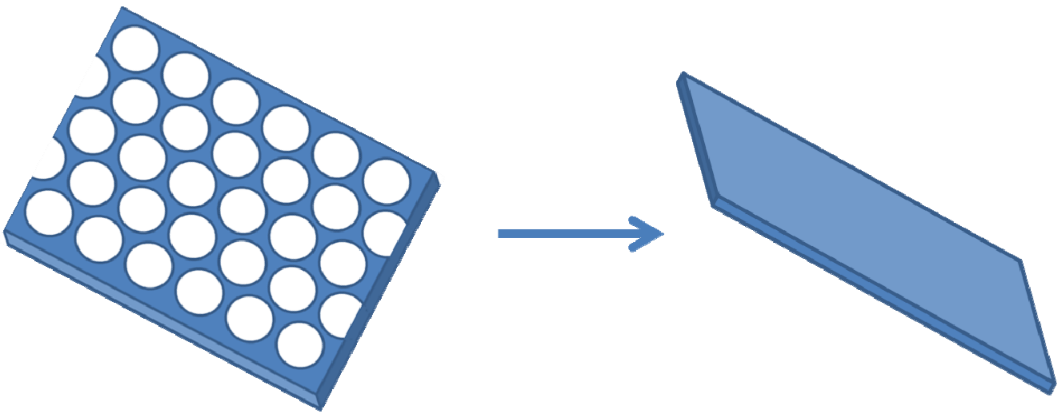

Fig. S8 Scheme of building TF-PO and TF-PN models, to illustrate the network's optical effects, the featureless thin film models TF-PO and TF-PN are respectively built as contrast, with the same projected area and volume as PO and PN network models.

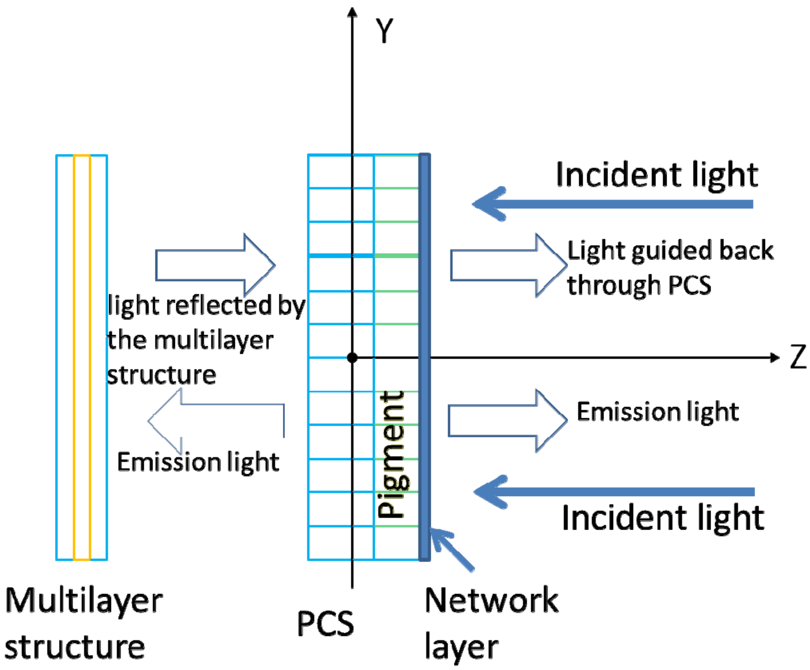

Fig. S9 The working scheme of the elaborate integrated structure.

S10. ***Building TF-160 model***

Based on the optical theory, the network layer provides a gradient refractive index, acting as an antireflection structure. After structural characterization, we reckon that the network layer plays an antireflection role around the blue-green band. To discriminate from the interference effect, a 160 nm thick thin film model, TF-160 model, a thin film with the same refractive index of chitin is introduced for contrast. The specific thickness 160nm is chosen based on the condition for optical interference shown below.

$$2n_b d \cos\theta_b = m\lambda$$

The interference wavelength λ is chosen to be 500nm which is around the boundary between blue and green light bands, as n_b is the refractive index and here n_b=1.56 is adopted. Considering the vertical incidence, $\cos\theta_b$ is equal to one and the thickness d should be about 160 nm at m=1.