Supplementary Information

Self-Assembly of Amorphous Bio-Photonic Nanostructures by Phase Separation

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Supplementary Methods and Figure Captions

Methods. Feathers were prepared for electron microscopy following [6,7]. Small angle x-ray scattering data were collected at Beam line 8-ID at the Advanced Photon Source Argonne National Labs using a 15 μm beam width, which is approximately the width of a single medullary cell.

We measured the intensity of light reflected or scattered by the bird feather as a function of wavelength, scattering angle, incident angle and the sample orientation. The experimental setups are shown in Figs. S1A and S1B. The bird feather was mounted on a goniometer stage. The incident beam consisted of collimated white light from a UV enhanced Xe lamp. Light was incident onto the feather sample at an angle ϕ from normal to the sample surface. The white light spot size on the sample surface was about 1 mm in diameter. Light scattered into the direction θ from the incident direction was collected by a lens and focused to a fiber bundle which is connected to a spectrometer. The angular resolution, which is determined mainly by the collection angle of the lens, was about 5˚. The spectral resolution was 1 nm. All spectra of the scattered light are normalized by the spectrum of the incident light.

In the first experiment (Fig. S1A, S2), the feather orientation was fixed, and the incident angle ϕ is set at 0˚. We measured the spectra of scattered light as θ is changed from 10˚ to 60˚ in 10˚ steps. In the second experiment (Fig. 2A-B; S1B), θ was fixed at 10˚, and ϕ was varied from 5˚ to 65˚ in 10˚ steps by sample rotation.

Fig. S1: (A) Sketch of experimental setup for measurement of scattered light spectra as a function of scattering angle θ, from 10˚ to 60˚. The feather sample is fixed, and the incident angle $\phi = 0$˚. Results shown in Fig. S2. (B) Sketch of experimental setup for spectral measurement of light scattered in the backward direction as the feather sample rotates. θ is fixed at 10˚, and ϕ is varied from 5˚ to 65˚ in 10 steps. Results shown in Figs. 2A-B and S3.

Fig. S2. The measured reflectance spectra of light scattered by structurally colored back feathers of (A) Eastern Bluebird *Sialia sialis* and (B**)** Plum-throated Cotinga *Cotinga maynana* in which ϕ was held constant and θ was varied from 10˚ to 60˚. As θ increases, the spectral peak in the scattering spectra shifts slightly to shorter wavelengths and the peak height decreases. Scattering is strongest in the backward direction.

Fig. S3 . Data from text Fig. 2a-b repeated in line graphs. The measured reflectance spectra of light scattered by structurally colored back feathers of (A**)** Eastern Bluebird *Sialia sialis* and (B**)** Plum-throated Cotinga *Cotinga maynana* in which θ was held constant at 10˚ and ϕ was varied from 5˚ to 65˚. The wavelength of peak reflectance of the backward-scattered light varies little with angle. The height of the reflectance peak also remains nearly constant up to 55˚.