Supporting information for

Light dependent morphological changes can tune light absorption in iridescent plant chloroplasts: a numerical study using biologically realistic data

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1. Simulations considering a stromal gap

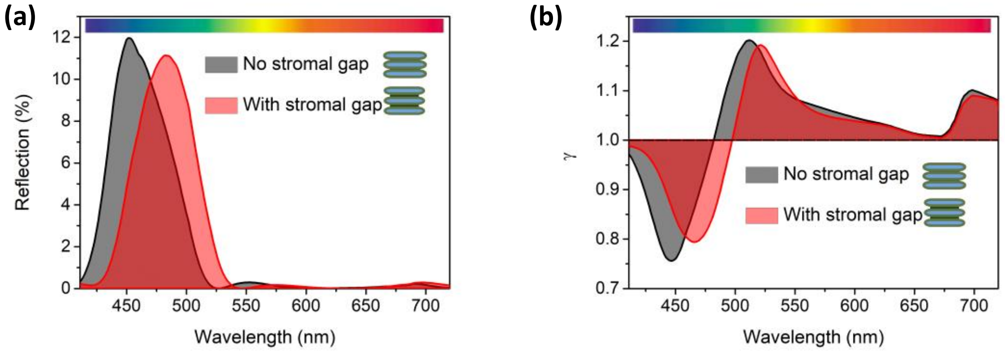

Figure S1. A 3.6 nm stromal gap between two consecutive thylakoid membranes was added for low light conditions and in the ordered situation. The rest of the structure remains unchanged. **(a)** Normal incidence reflection spectrum. **(b)** Absorption enhancement factor (γ) of iridoplast compared to chloroplast. Comparing the two photonic structure, we find that there is a 30 nm redshift in reflectance. Slow light effects however show a much a less attenuated consequence where the enhancement factor (γ) with stromal peaks at 520 nm, representing a 10 nm redshift compared to the simulations without this gap. These redshifts of the photonic properties are a consequence of the increase of the photonic lattice size. Considering the stromal gap, the total absorption enhancement factor $\gamma_{total} = 1.05$, very similar when not considering the gap: $\gamma_{total} = 1.06$. This thickness was taken from ref.[1] and it's likely an overestimate since, in the iridoplast, two thylakoid membranes and the stromal gap have a combined thickness of 6.7 nm[2] while in the former reference these amounted to 11.6 nm (4.0+4.0+3.6). With this, even considering an overestimation of the stromal gap, we obtain similar conclusions and it is therefore safe to consider the stromal gap negligible.

2. Effects of a varying refractive index of the thylakoid membrane

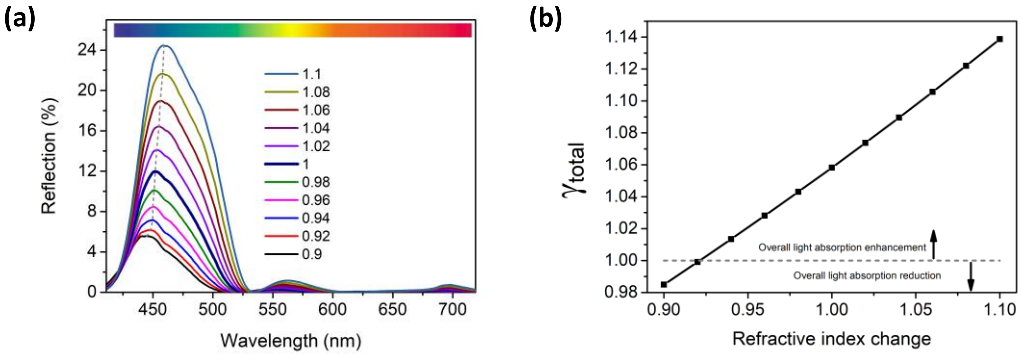

Figure S2. We repeat the simulations for the reflection and total absorption enhancement factor (γ_{total}) with a refractive index ranging from 90% to 110% of its expected value (shown in figure 1 (d) of the paper) by multiplying each individual point at a specific wavelength by the same multiplier. (a) Reflection of the iridoplast under varying refractive index. It is calculated under the same conditions as in the paper, with no disorder considered ($\Delta = 0$). The legend shows the multiplier of the refractive index, e.g.: the bottom one shows the reflection of an iridoplast if the refractive index at each wavelength is multiplied by 0.9. The grey dotted line follows the maxima of each plot which shows that between the expected refractive index and its extremes (± 10%), there is a negligible shift of ~ ±7nm. (b) Total absorption enhancement under the forest canopy compared to a chloroplast with the same refractive index changes, shown in the horizontal axis. An increase in the refractive index contrast between the layers will increase the absorption enhancement. However, it is observed that even under large refractive index changes the reflection central wavelength shifts by a negligible amount (~ ±7nm) compared to those shifts caused by the morphological changes (≈ 100 nm).

3. Polarisation dependent reflection of iridoplasts

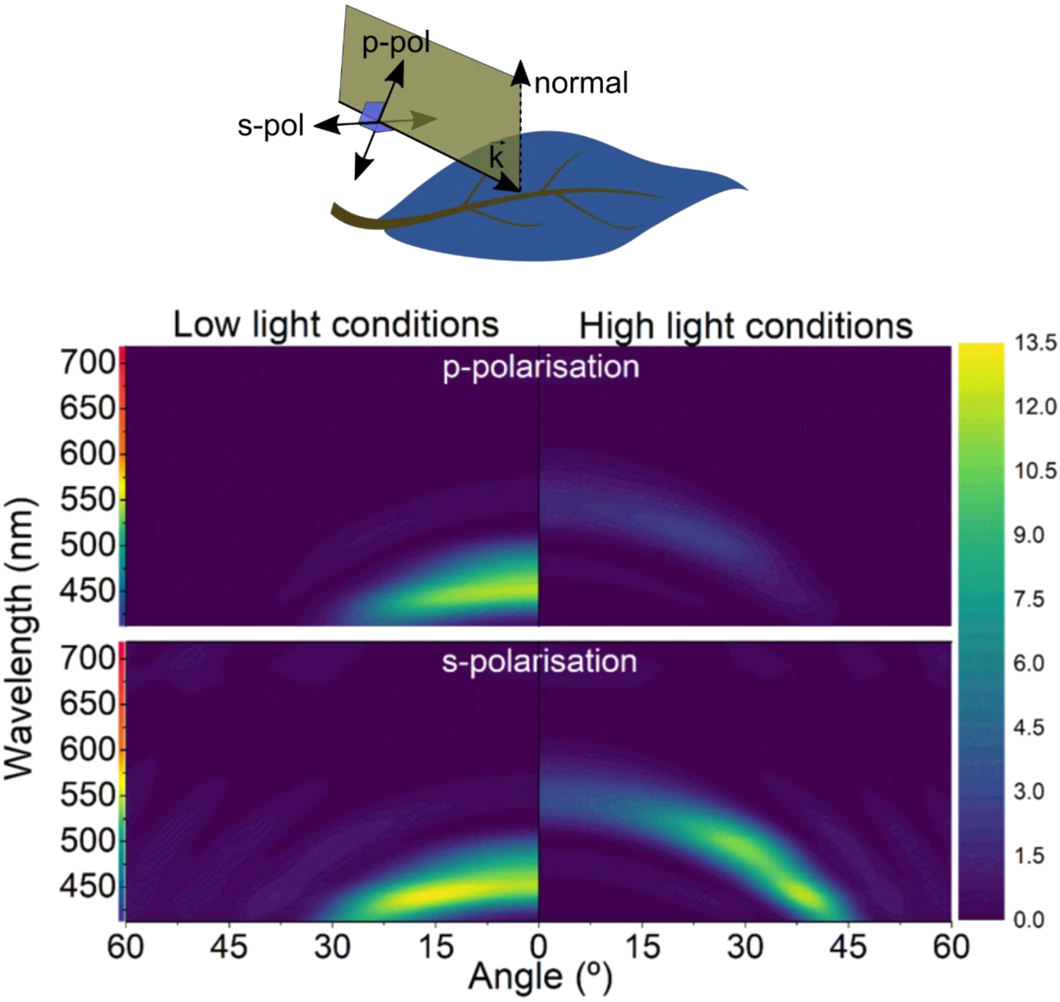

Figure S3. Angle dependent reflection (in percentage) spectrum of the iridoplasts with no disorder (Δ = 0) under low and high light conditions for S- and P-polarisations.

4. Effects of disorder on iridoplasts

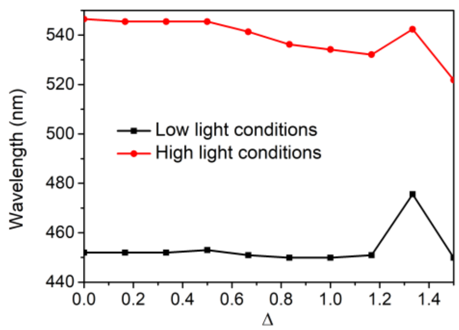

Figure S4. Reflection peak wavelength of the iridoplast at normal incidence for different disorder levels (i.e. varying Δ). By inspection, we have a nearly constant reflection wavelength peak at low light along different levels of disorder and a blue shift of >10 nm for high light.

5. Effects of disorder on bizonoplasts

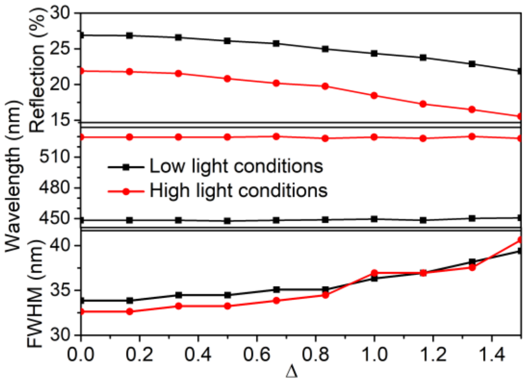

Figure S5. From top to bottom: maximum absolute reflection, reflection peak wavelength and full width at half maximum (*FWHM*) at normal incidence for different disorder levels (i.e. varying Δ). Similar to the iridoplast, increasing level of disorder in the bizonoplast: reduces absolute reflectance, keeps the reflection peak wavelength unchanged and increases the *FWHM*.

References

(S1) Kirchhoff H, Hall C, Wood M, Herbstová M, Tsabari O, Nevo R, et al. Dynamic control of protein diffusion within the granal thylakoid lumen. Proc Natl Acad Sci U S A. 2011 Dec 13;108(50):20248–53.

(S2) Jacobs M, Lopez-Garcia M, Phrathep OP, Lawson T, Oulton R, Whitney HM. Photonic multilayer structure of Begonia chloroplasts enhances photosynthetic efficiency. Nat Plants. 2016;