Supporting Information

# A literal elytral rainbow: Tunable structural colors using single diamond biophotonic crystals in *Pachyrrhynchus congestus* weevils

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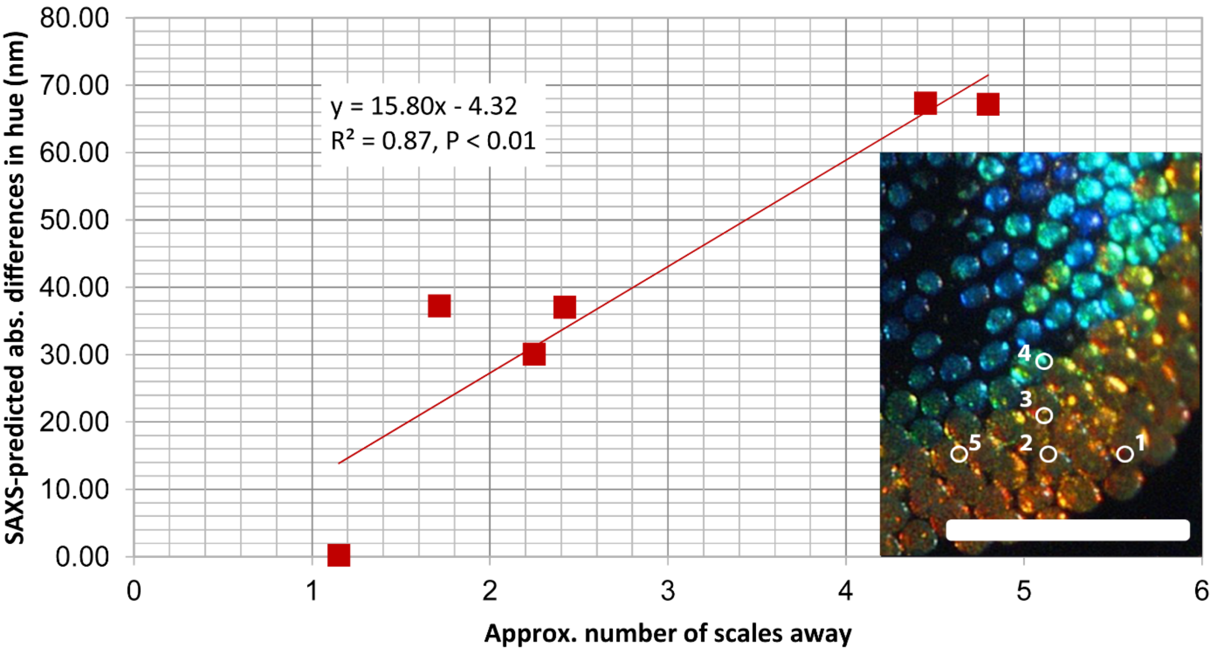


**Figure S1.** Structural basis of color tuning in multi-colored scales of a *P. c. pavonius* elytral rainbow spot assayed using synchrotron SAXS. The difference in the SAXS predicted optical hue (assuming an average RI of 1.17) of any two scales is plotted against the pairwise distance between them expressed as the approximate number of scales that a given neighbor is away (Euclidean distance divided by the average dimensions of a rainbow-spot scale). Inset: A schematic depicting the relative location of the 6 scales assayed using SAXS. We omit scale 5 from the distance analyses as its position is tangential, rather than radial. The image of the rainbow spot in the inset background is not of the actual spot but shown for reference only. Scale bar: 500 µm.

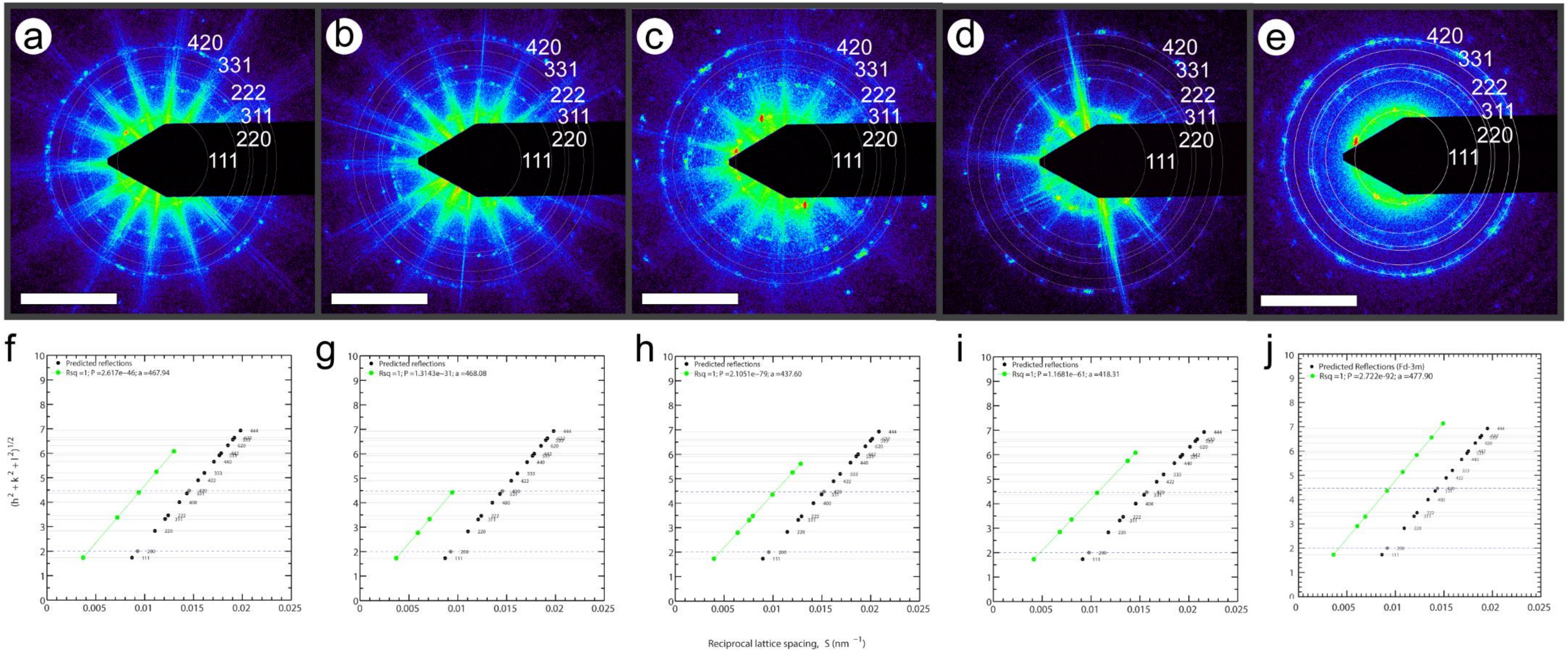


**Figure S2.** (**A-E**) SAXS diffraction patterns from rainbow spot scales of the weevil *P. c. pavonius*, shown unmasked in false color and logarithmic scaling. The radii of the concentric circles are given by the peak scattering wave vector ($q_{pk}$) times the moduli of the assigned hkl indices of permitted Bragg reflections of a single diamond space-group. Scale bars: 0.05 nm$^{-1}$. (**F-J**) Indexing the peaks of the azimuthally averaged profile of the corresponding SAXS patterns in Figures 3A, S2A, C, D and E using the plot of the moduli of the *hkl* Miller indices of the Bragg peaks against the corresponding reciprocal lattice spacing *S*. The observed peaks (solid green circles) are shown alongside the theoretically allowed reflections for the single diamond (*Fd*-3*m*; black circles) and f.c.c. (*F*4-3*m*; gray + black circles) crystallographic space group symmetries. The linearity and zero intercepts of the plot confirm the cubic aspect of the nanostructure, and the slope gives an estimate of the lattice parameter.

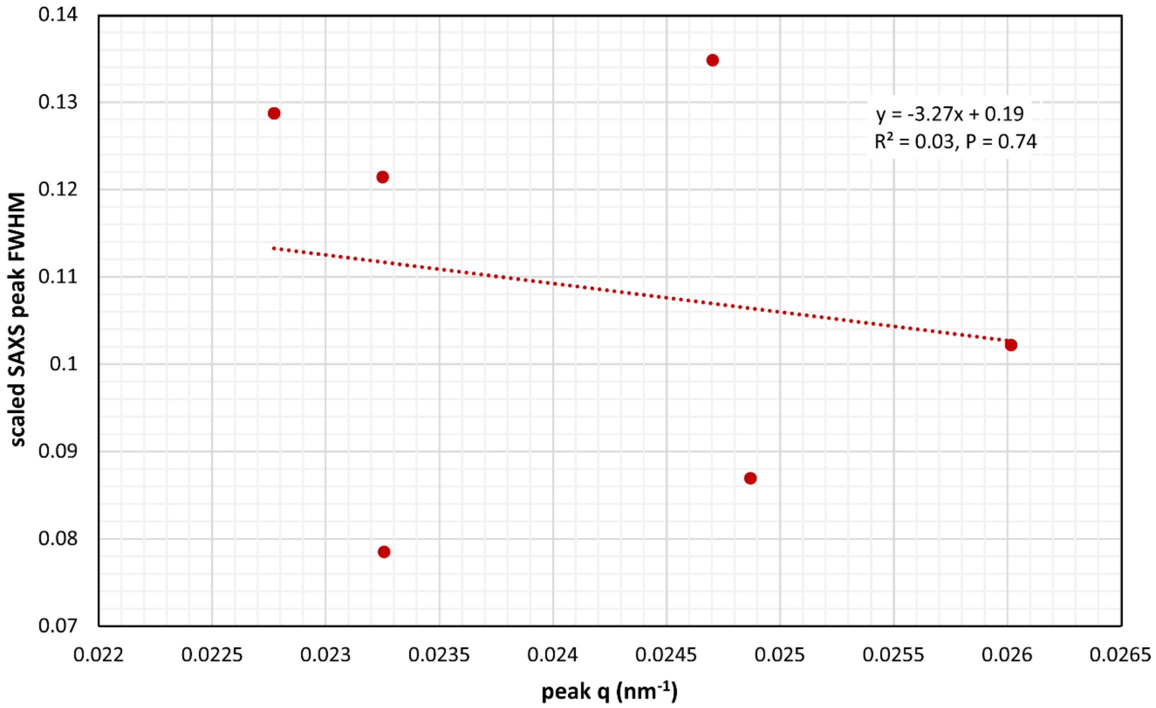


**Figure S3.** A regression plot of the scaled structural bandwidth (FWHM/$q_{pk}$) of the structural correlation peak against its peak wave vector ($q_{pk}$) for the 6 rainbow spot scales assayed using SAXS.

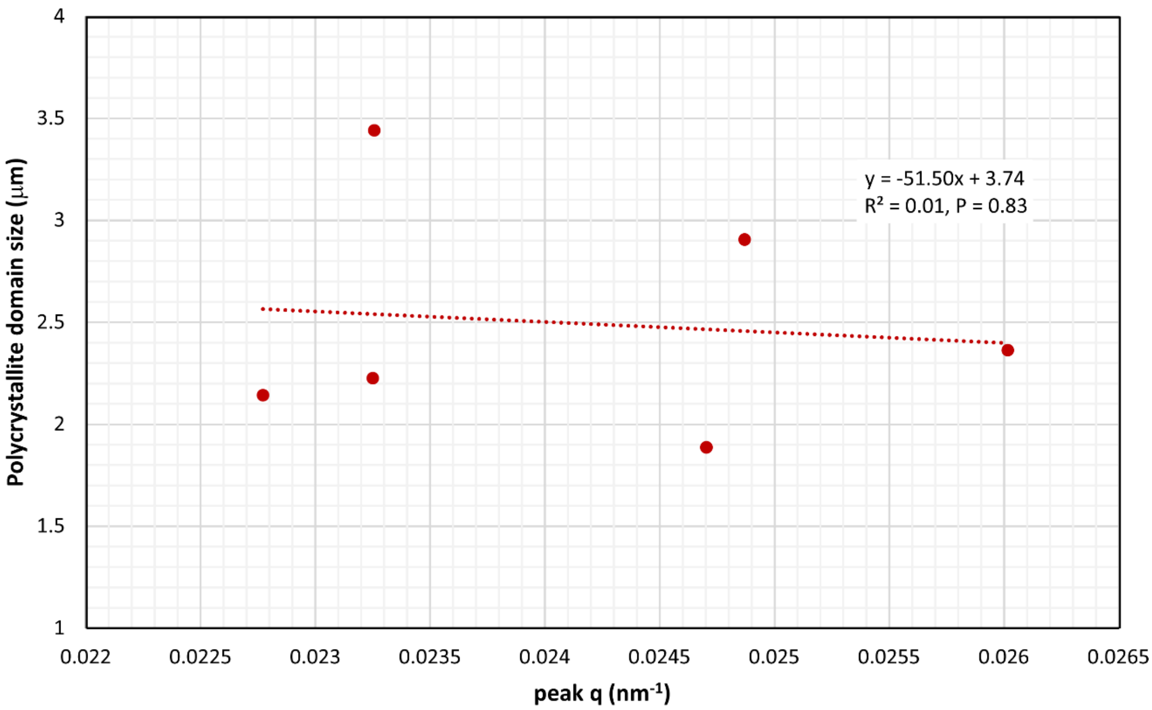


**Figure S4.** A regression plot of the coherence lengths or the approximate ensemble-averaged polycrystalline domain sizes (ξ ~2π/FWHM expressed in µm) against the peak wave vector ($q_{pk}$) of the 6 rainbow spot scales assayed using SAXS.

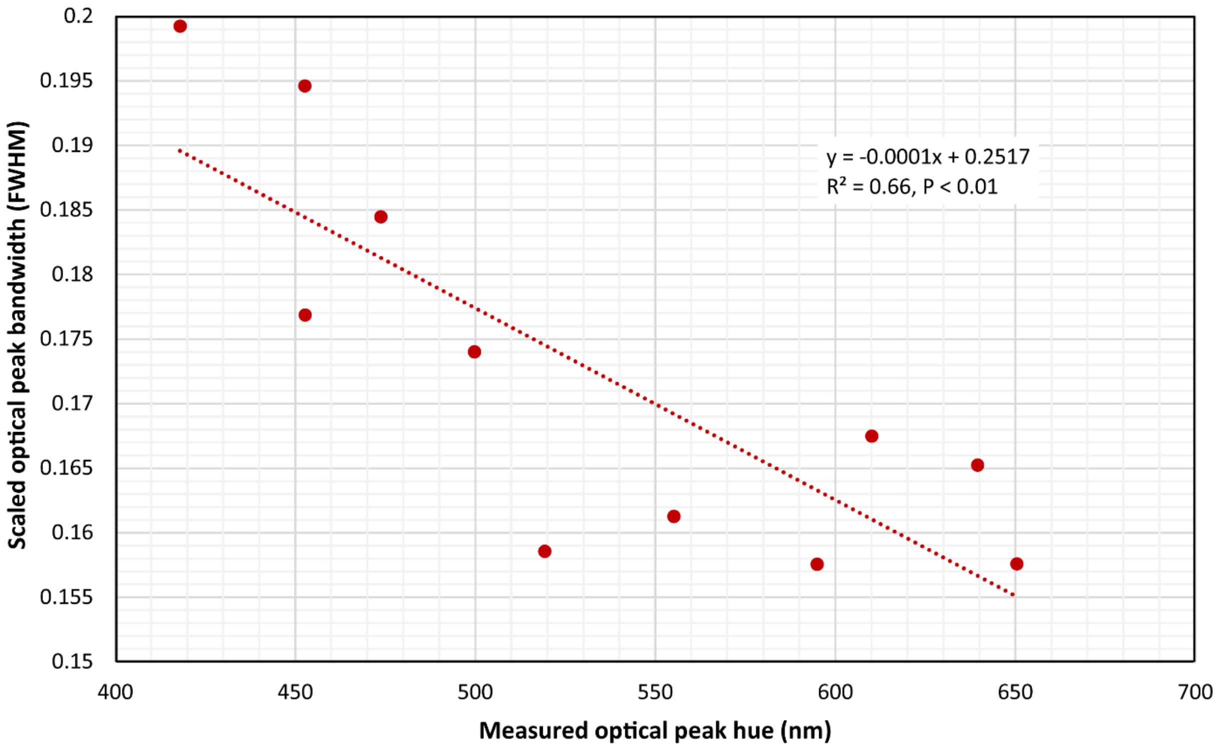


**Figure S5.** A regression plot of the scaled optical peak bandwidth (FWHM/$\lambda_{pk}$) of the reflectance peak against the hue or peak position ($\lambda_{pk}$) of the rainbow spot scales measured using microspectrophotometry.

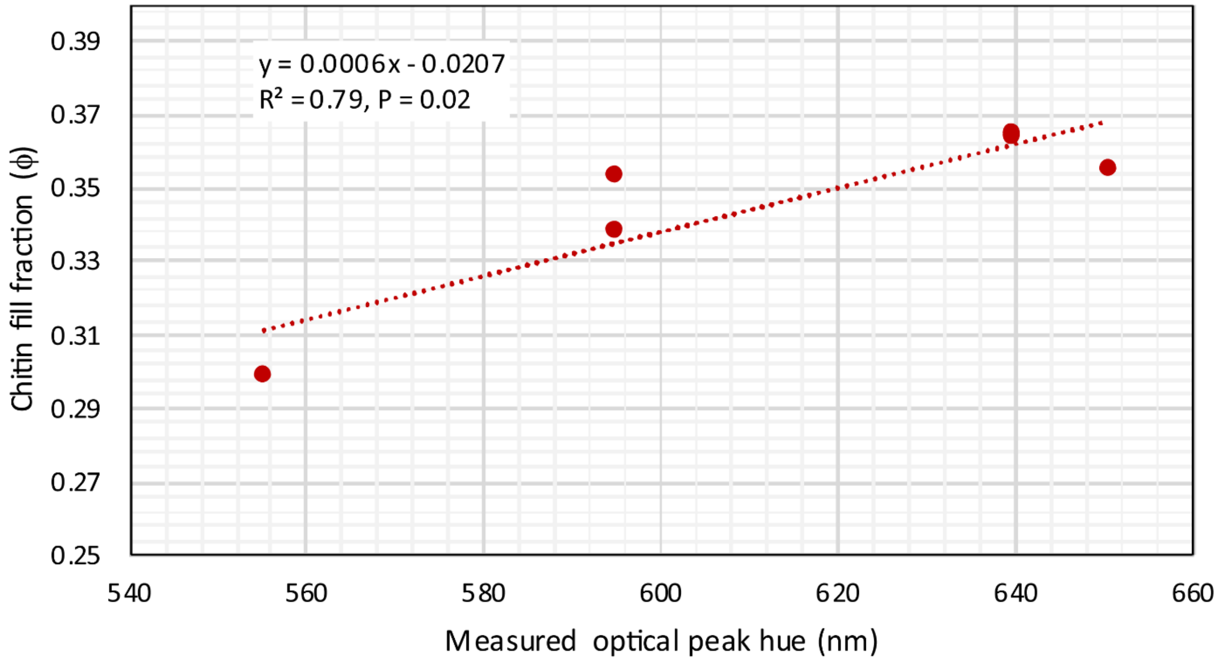


**Figure S6.** A regression plot of the chitin filling or volume fractions (ϕ, estimated using Maxwell-Garnett effective medium approximation theory) against the measured optical hue of the 6 rainbow spot scales assayed using SAXS. See main text for details.

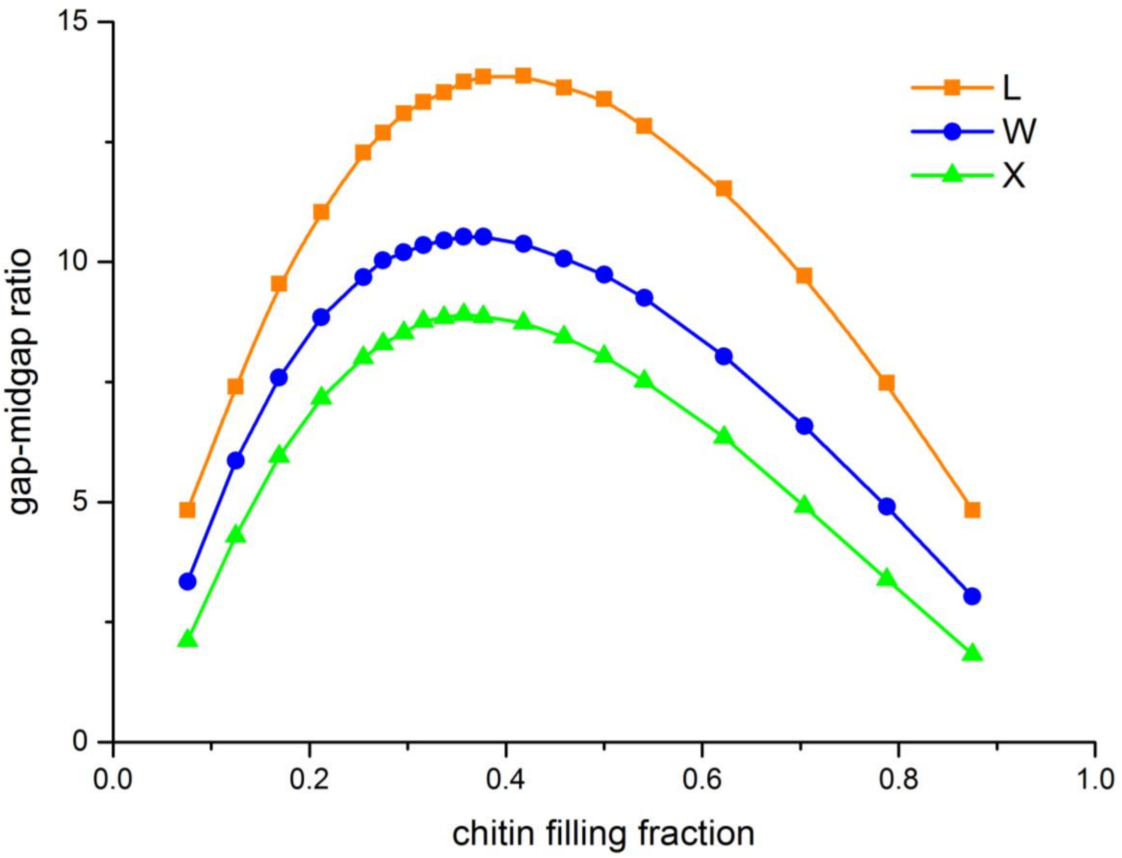


**Figure S7.** Dependence of the gap-midgap ratio for single diamond-type photonic crystals with different chitin filling fractions.

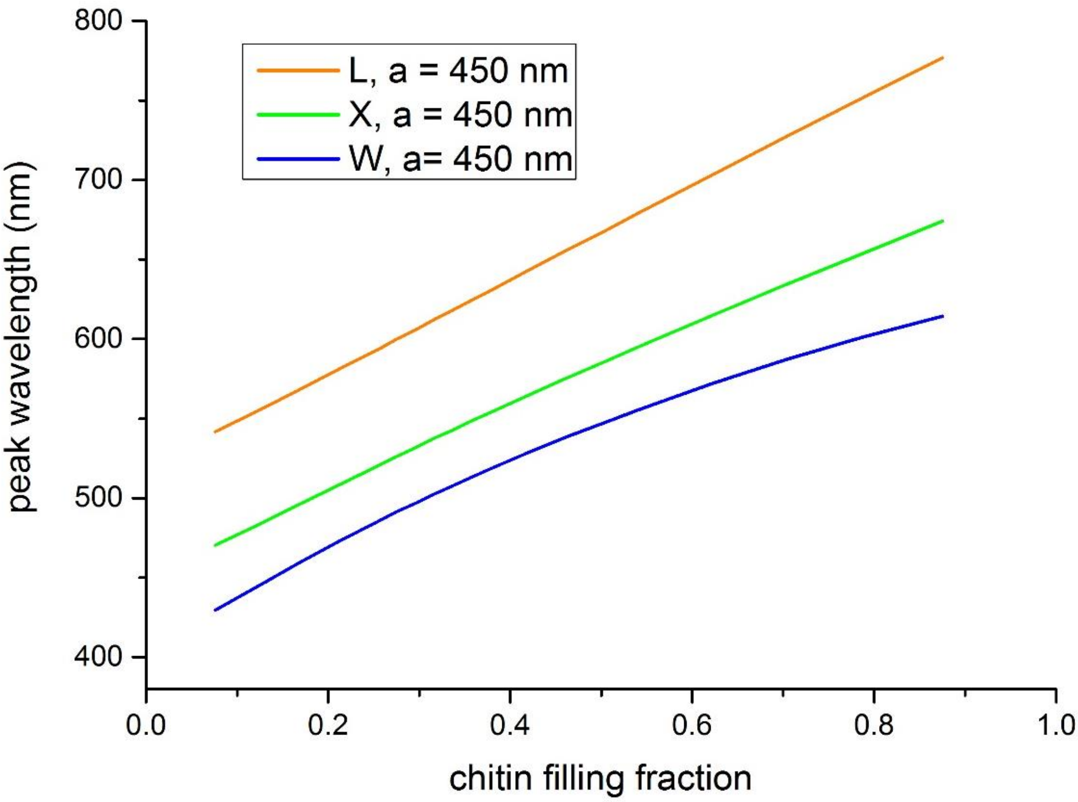


**Figure S8.** Dependence of peak reflected wavelengths for a 450 nm unit cell single diamond-type photonic crystal as a function of chitin filling fraction.