Supporting information

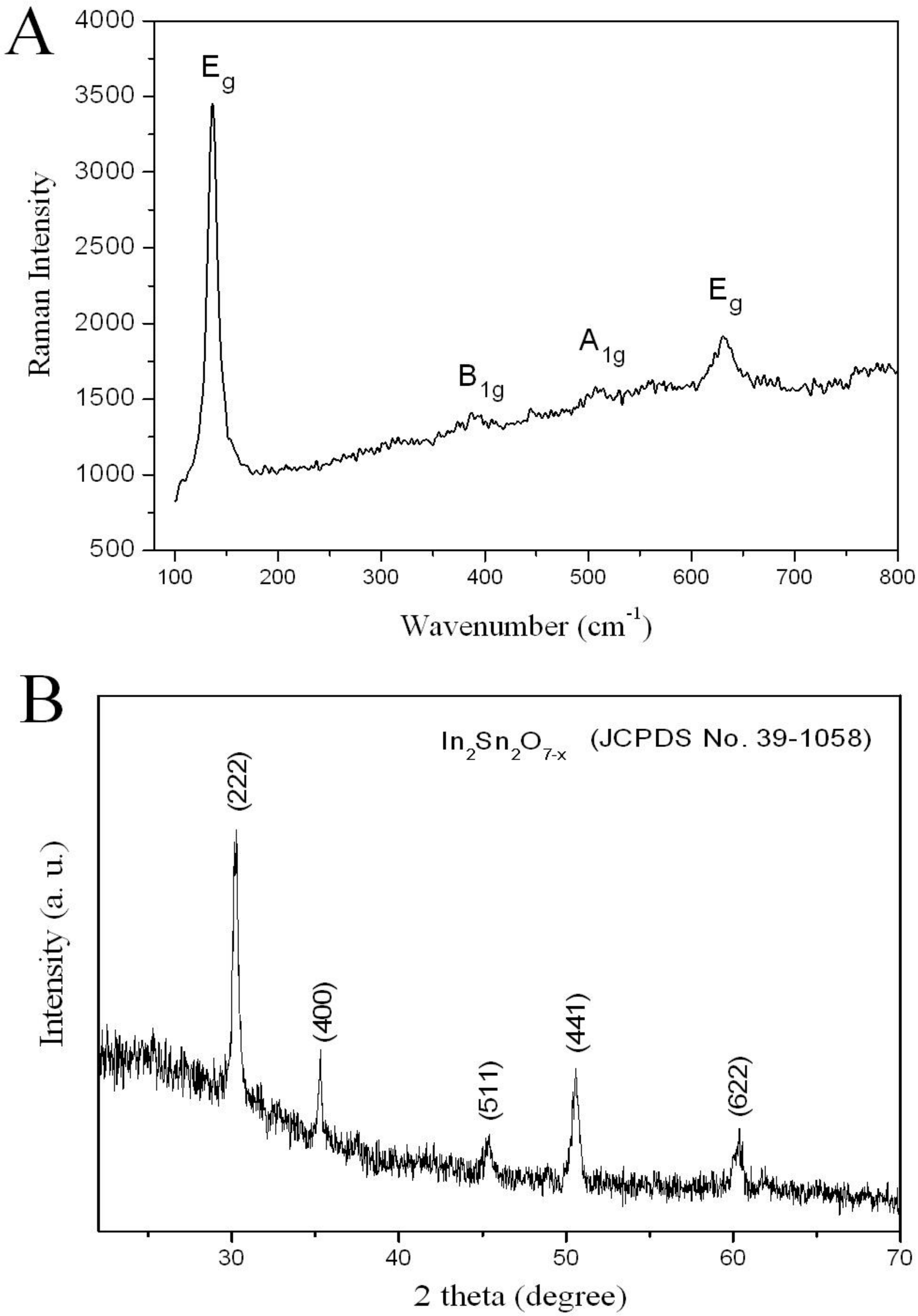

Fig. S1 Raman spectrum and XRD pattern of the THH film by templating of 450 nm PSs.

S1. Calculations of light reflection and extinction through BL THS film-450.

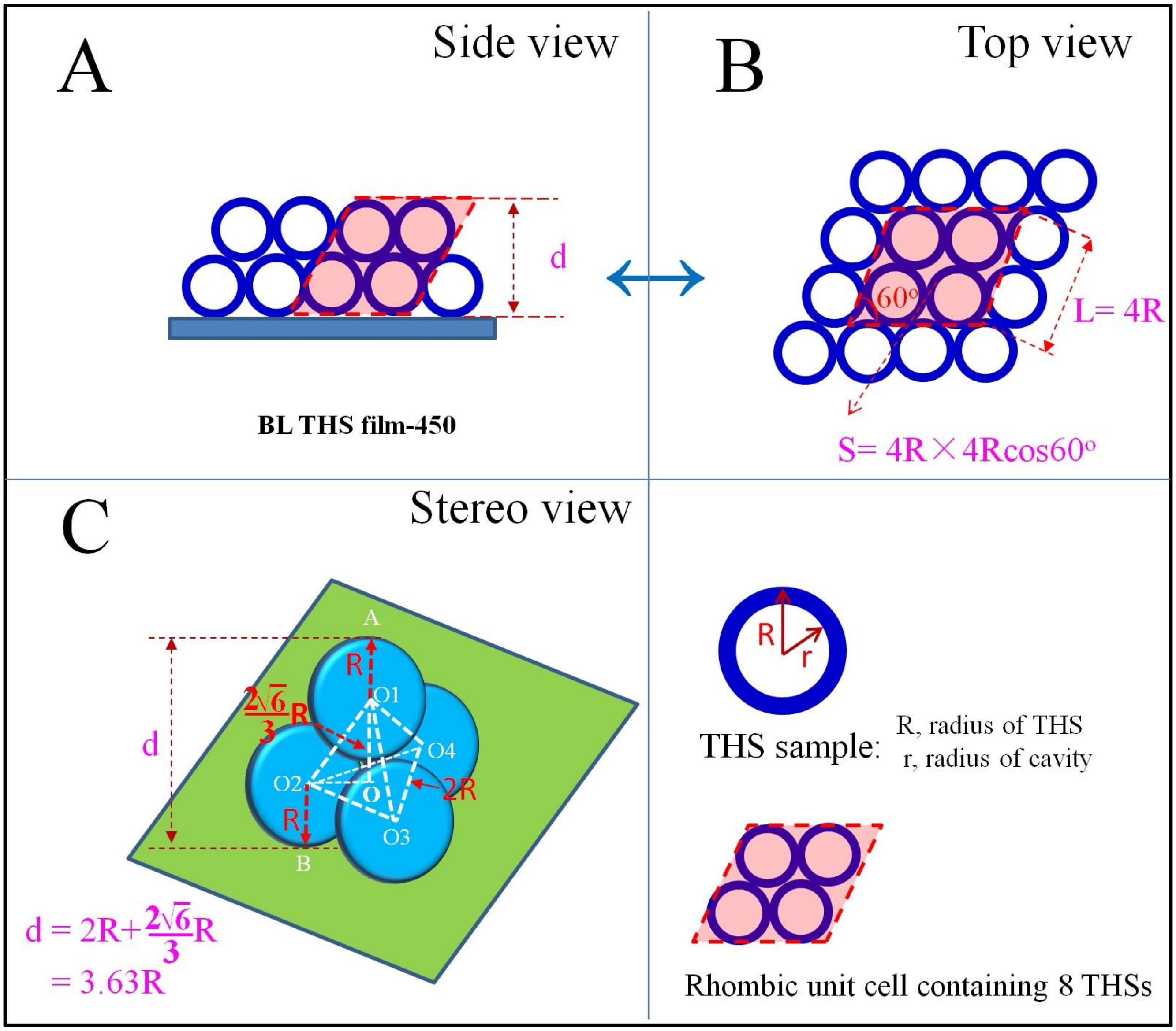

Fig. S2. Multiple views illustrate geometric parameters of the bilayer THS films for calculations.

According to equation (1) and (2) in the main text, to calculate the lights with wavelengths of λ_{max} to be reflected or quenched maximum through the film interference, the values of film thickness (d), volume fraction (f_{TiO_2}) of the TiO_2 hollow spheres in the film for average reflective index (n_{avg}) are required.

As a typical hexagonal close packed structure, the thickness (d, illustrated in side view of Fig. S2A) of the bilayer THS film can be easily calculated out to be 3.63 R (R = 470/2 = 235 nm), as clearly illustrated in its stereo view of Fig. S2C.

To facilitate the calculation of f_{TiO_2}, a rhombohedral unit cell containing 8 TiO_2 hollow spheres was chosen from the THS film, as shown in Figure S1A and B. Therefore, the f_{TiO_2} can be calculated by the formula below according to geometric relationship of the unit cell and TiO_2 hollow spheres.

$$f_{TiO_2} = V_{TiO_2}/V_{cell}$$

because, $V_{TiO_2} = 8\times(4\pi/3)\times(R^3\text{-}r^3) = 8\times(4\pi/3)\times(235^3\text{-}225^3) = 5.32\times10^7\ nm^3$

$$V_{cell} = S\times d = 4R\times4R\ \sin60^o \times 3.63R = (4\times470)^2\times0.866\times3.63\times235 = 2.61\times10^9\ nm^3$$

Therefore,

$$f_{TiO_2} = V_{TiO_2}/V_{cell} = 0.02$$

according to the formula below:

$$n_{avg}^2 = f_{TiO_2}\cdot n_{TiO_2}^2 + f_{air}\cdot n_{air}^2$$

where n_{TiO_2} of anatase is 2.5, $f_{air} = 1\text{-}\ f_{TiO_2} = 0.98$, and $n_{air} = 1$,

so

$$n_{avg} = (0.02\times2.5^2+0.98\times1^2)^2 = 1.051$$

For the reflectance peaks maximum calculation, in term of the equation (1) below:

$$m\ \lambda_{max} = 2\ n_{avg}\ d \qquad (m = 1, 2, 3, 4,\ldots\ldots) \qquad (1)$$

i.e., $\lambda_{max} = 2\ n_{avg}\ d/m = 2\times1.051\times3.63\times235/m = 1842.5\ nm\ /m$

therefore,

when $m = 1$, $\lambda_{max} = 1793.1$ nm

$m = 2$, $\lambda_{max} = 896.56$ nm

$m = 3$, $\lambda_{max} = 597.7$ nm

$m = 4$, $\lambda_{max} = 448.3$ nm

$m = 5$, $\lambda_{max} = 358.6$ nm

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For the extinction peaks maximum, in term of the equation (2) below:

$$m\,\lambda_{max} = 2\,n_{avg}\,d \quad (m = 1.5, 2.5, 3.5, \ldots)$$

i. e.,

$$\lambda_{max} = 2\,n_{avg}\,d/m = 2\times1.051\times3.63\times235 = 1793.1 \text{ nm}\,/m$$

Therefore,

When $m = 1.5$, $\lambda_{max} = 1195.4$ nm

$m = 2.5$, $\lambda_{max} = 717.2$ nm

$m = 3.5$, $\lambda_{max} = 512.3$ nm

$m = 4.5$, $\lambda_{max} = 398.5$ nm

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Hence, in principle, the light (in red) with peaks located at near Uv- and visible-light region are visible in the corresponding reflection and absorption spectra. The calculated results can basically reflect the real reflection and absorption behavior of the THS film.