# Electronic Supplementary Information

# Contribution of Lamellar Morphology on Photocatalytic Activity of Alkaline-Hydrothermally Treated Titania in Rhodamine B Photodegradation.

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## S1. Particle Size Distribution

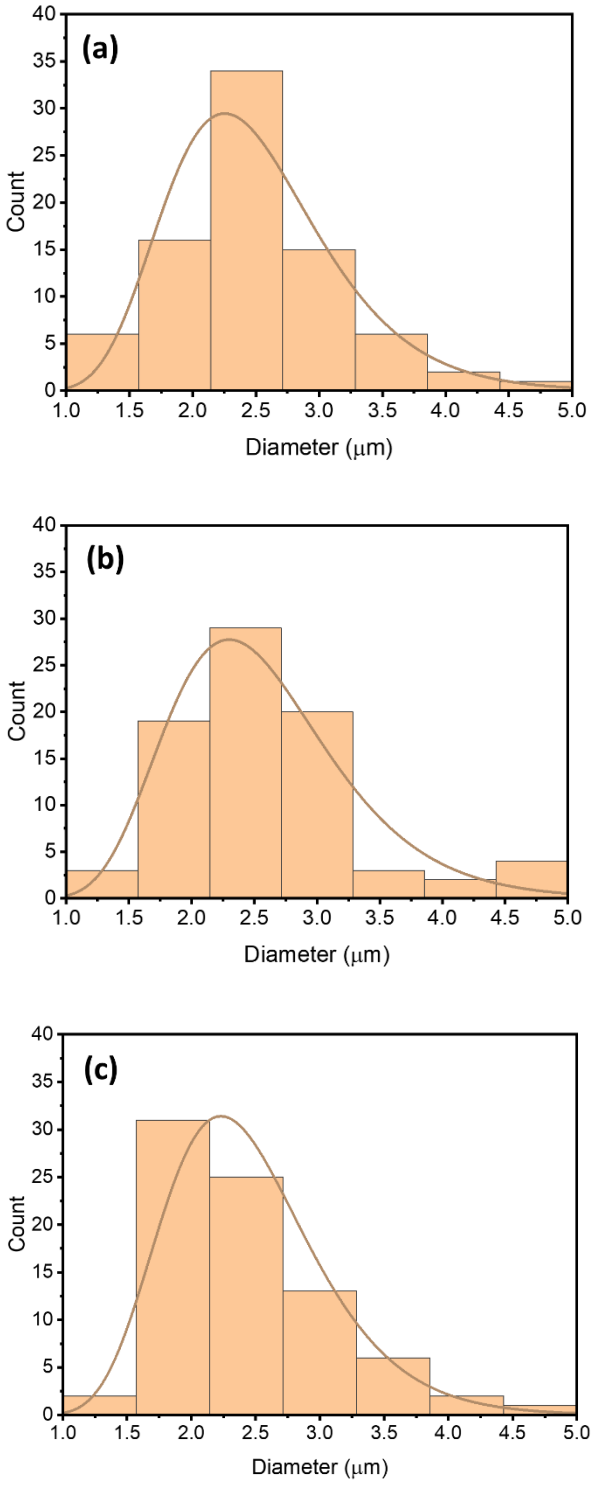


**Figure S1.** Particles Size Distribution of (a) S-AS, (b) S-HT, and (c) S-HT-500.

## S2. Particle Size Distribution

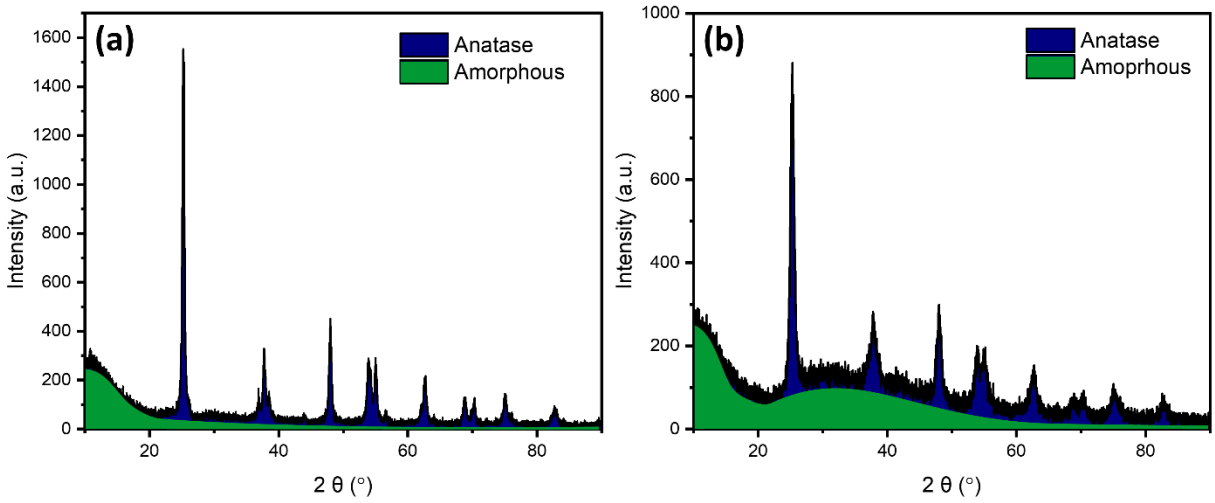


**Figure S2.** XRD pattern of (a) S-500 and (b) S-500-HT. The Blue area represents the anatase phase, while the green area represents the amorphous phase.

## S.3 Determining of {001} facet percentage

The interplanar spacing or *d*-spacing of the anatase crystal can be determined using Bragg's equation:

$$2d_{hkl}\sin\theta = n\lambda \quad \text{(S1)}$$

$$\sin\theta = \frac{n\lambda}{2\,d_{hkl}} \quad \text{(S2)}$$

The first-order reflection from (100) planes occurs at an angle given by:

$$\sin\theta\,(1^{st}\text{order }001) = \frac{1\lambda}{2\,d_{001}} \quad \text{(S3)}$$

The second-order reflection from the same set of planes then occurs at an angle:

$$\sin\theta\,(2^{nd}\text{order }001) = \frac{2\lambda}{2\,d_{001}} \quad \text{(S4)}$$

It is always referred to as the first-order reflection from (200) planes, i.e.

$$\sin\theta\,(1^{st}\text{order }002) = \frac{1\lambda}{2\,d_{002}} \quad \text{(S5)}$$

Similarly, the third and fourth-order reflection from (001) planes is at an angle:

$$\sin\theta\,(3^{rd}\text{order }001) = \frac{3\lambda}{2\,d_{001}} \equiv \sin\theta\,(1^{st}\text{order }003) = \frac{1\lambda}{2\,d_{003}} \quad \text{(S6)}$$

$$\sin\theta\,(4^{rd}\text{order }001) = \frac{4\lambda}{2\,d_{001}} \equiv \sin\theta\,(1^{st}\text{order }004) = \frac{1\lambda}{2\,d_{004}} \quad \text{(S7)}$$

Note that the $d_{001} = 2d_{002} = 3d_{003} = 4d_{004}$, thus we can obtain the $d_{001}$ value by knowing the $d_{004}$value. We have tabulated the calculation result of $d_{\text{hkl}}$ spacing of anatase based on the XRD pattern in Table S3-1.

Table S3-1. The unit cell parameters of samples calculated using Bragg's equation

| **Samples** | $\boldsymbol{d_{004}}$ | $\boldsymbol{d_{200}}$ | $\boldsymbol{d_{001}}$ | $\boldsymbol{d_{100}}$ | **θ** |
|---|---|---|---|---|---|
| S-HT-500 | 2.3783 | 1.8921 | 9.5132 | 3.7842 | 68.3° |
| S-500-HT | 2.3764 | 1.8919 | 9.5056 | 3.7838 | 68.3° |
| A-HT-500 | 2.3758 | 1.8934 | 9.5032 | 3.7868 | 68.3° |
| A-500-HT | 2.3799 | 1.8899 | 9.5196 | 3.7798 | 68.3° |
| P25 Degussa | 2.3810 | 1.8950 | 9.5240 | 3.7900 | 68.3° |

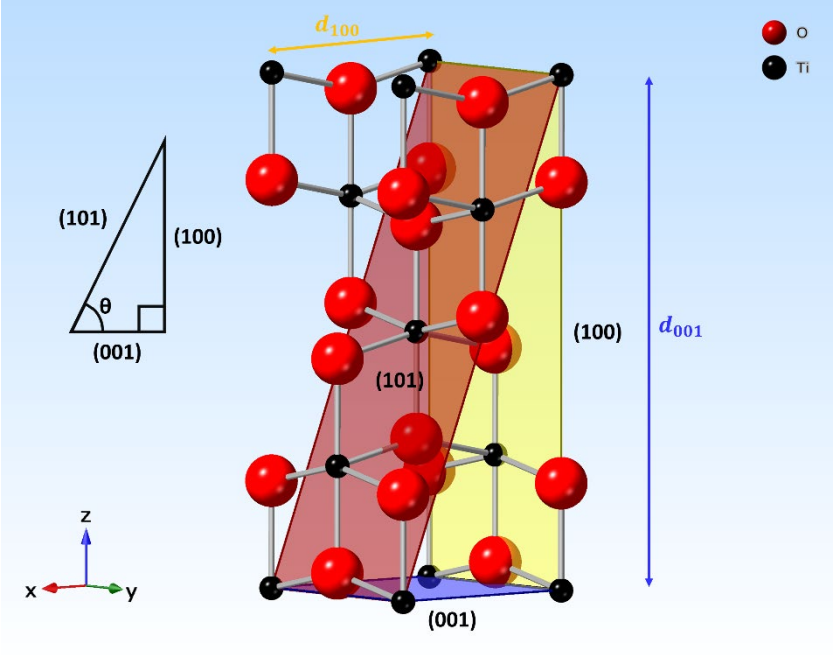


**Figure S3-1.** The schematic of the anatase unit cell.

The crystal system of anatase is tetragonal (I41/amd) with unit cell $a = b \neq c$ ; $\alpha = \beta = \gamma = 90°$, where $a = b = d_{100}$ and $c = d_{001}$. We know θ is the angle between the (101) and (001) planes, as shown in Figure S3-1, where:

$$\theta = \tan^{-1}\frac{d_{001}}{d_{100}} \qquad \text{(S8)}$$

thus, using equation S8, we can calculate θ for each sample as tabulated in Table S3-1.

Since the crystallite consists of several unit cells, thus the ratio of $d_{100}$ to $d_{001}$ is equal to the ratio of the average crystallite size along [100] direction ($D_{100}$) to the average crystallite size along [001] direction ($D_{001}$), which can be written as:

$$\theta = \tan^{-1}\frac{d_{001}}{d_{100}} = \tan^{-1}\frac{D_{001}}{D_{100}} \cong 68.3° \qquad \text{(S9)}$$

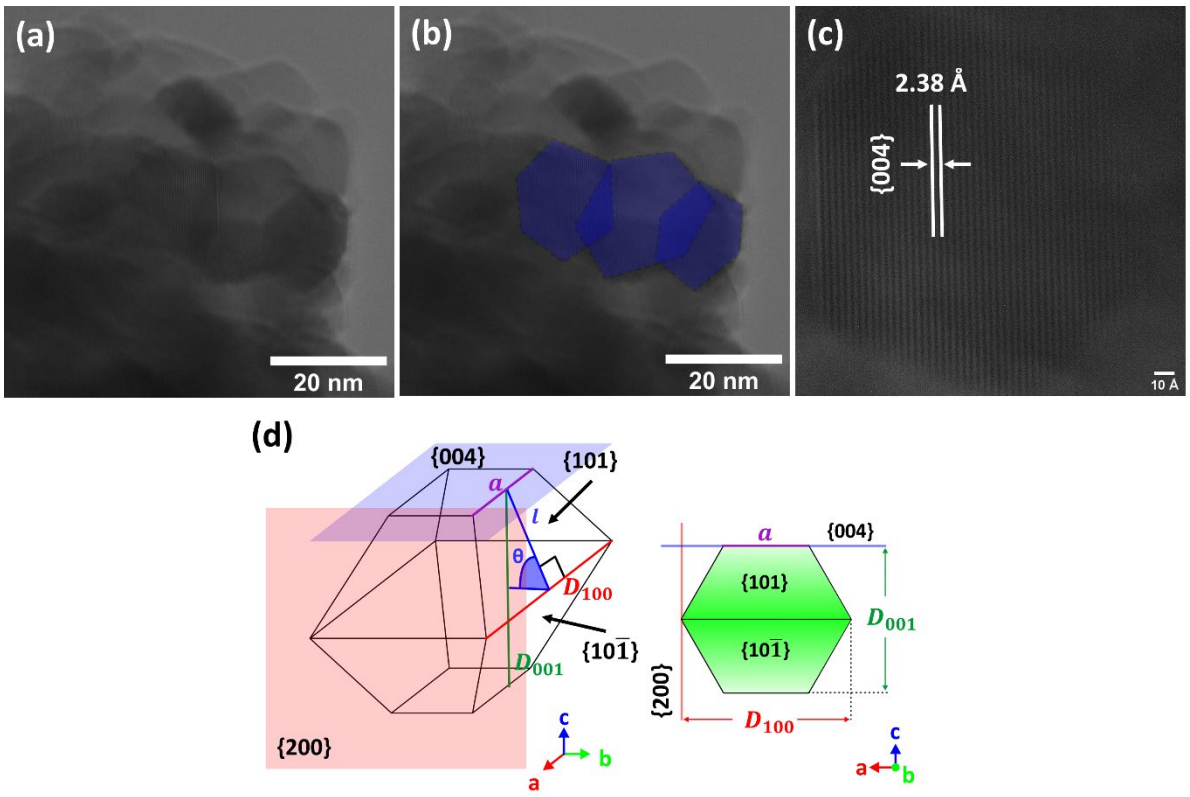


**Figure S3-2.** (a) HRTEM images of the calcined sample show the square−bipyramidal shape of crystallites. (b) Projected crystallites to {010} plane are depicted as blue hexagons and at higher magnification, (c) a hexagonal shaped crystallite shows vertical lattice fringes representing the {004} interplanar distance. (d) The geometric scheme of a truncated square−bipyramidal shaped anatase crystallite.

The percentage of {001} facet can be calculated by knowing the crystallite truncated length ($a$). We use the geometry approach to calculate the $a$ value since it has a relation with $D_{100}$ and $D_{001}$. The average crystallite size ($D_{hkl}$) calculated using the Scherrer equation:

$$D_{hkl} = \frac{K \times \lambda}{B_{hkl} \times \cos\theta_{hkl}} \qquad \text{(S10)}$$

Where $D_{hkl}$ is the mean crystallite size in $[hkl]$ direction, $K$ is a dimensionless shape factor (in this case, we use $K$ = 0.94), λ is the source X-ray wavelength (in this case, we use Cu $K_\alpha$ = 1.540 Å), $B_{hkl}$ is the line broadening at half the maximum intensity (FWHM) of ($hkl$) peak, $\theta_{hkl}$ is the Bragg angle.

As shown in Figure S3-2, we can calculate the values of $a$ and $l$ using the following equations:

$$a = D_{100} - \frac{D_{001}}{\tan\theta} \quad \text{(S11)}$$

$$l = \frac{D_{001}}{2\sin\theta} \quad \text{(S12)}$$

The percentage of {001} facet can be calculated by dividing the area of (001) plane to the crystallite total surface area:

$$A_{\{001\}} = a \times a = \left(D_{100} - \frac{D_{001}}{\tan\theta}\right)^2 \quad \text{(S13)}$$

$$A_{\{101\}} = \left(\frac{D_{100}+a}{2}\right) \times l = \left(2D_{100} - \frac{D_{001}}{\tan\theta}\right) \times \frac{D_{001}}{2\sin\theta} \quad \text{(S14)}$$

$$\%\{001\}\ \text{facet} = \frac{\left(D_{100}-\frac{D_{001}}{\tan\theta}\right)^2}{\left(D_{100}-\frac{D_{001}}{\tan\theta}\right)^2 + \frac{2D_{001}}{\sin\theta}\left(2D_{100}-\frac{D_{001}}{\tan\theta}\right)} \times 100\ \% \quad \text{(S15)}$$

## S4. The Rietveld refinement and the corresponding Williamson-Hall plot

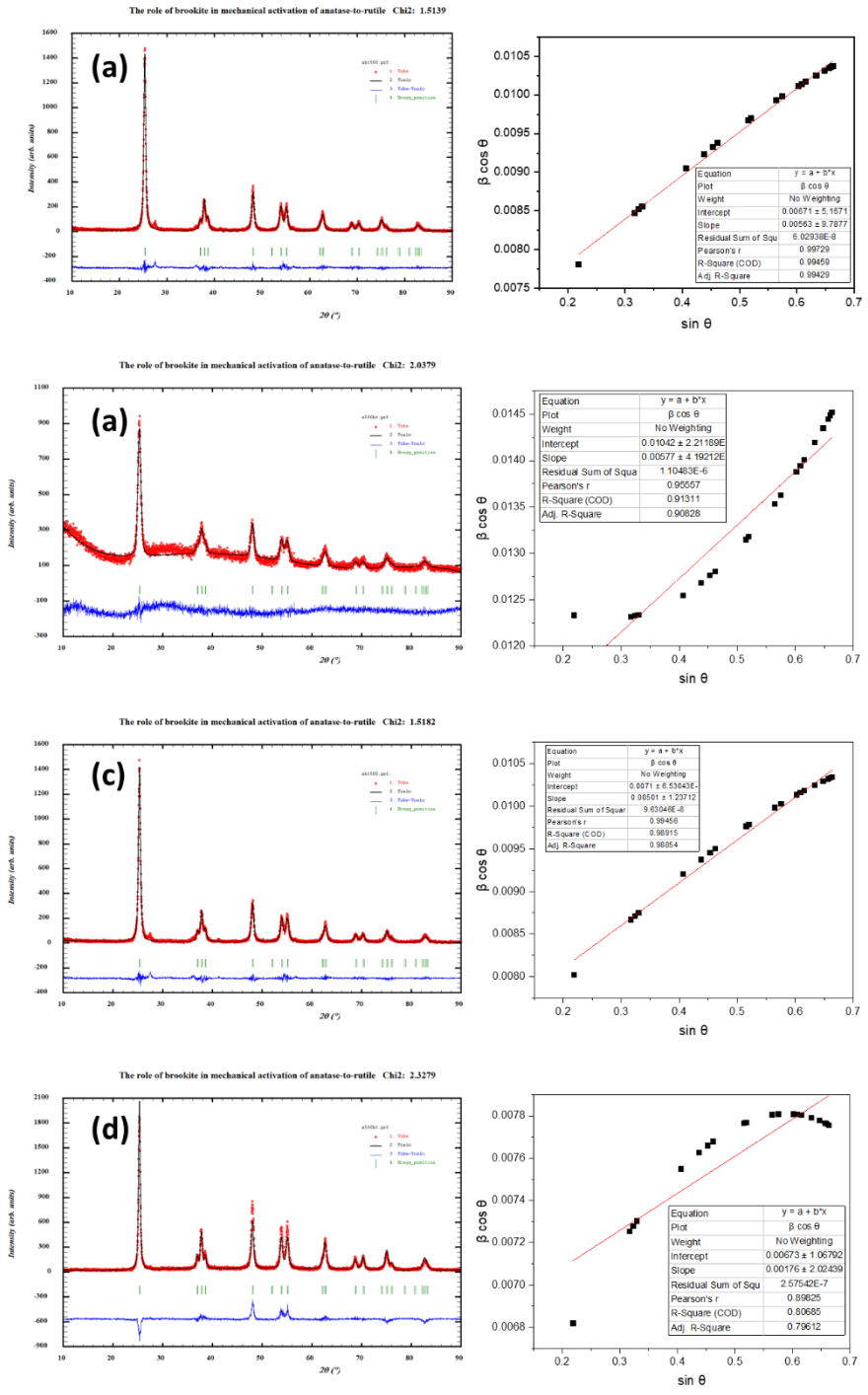


**Figure S4.** The Rietveld refinement results and the corresponding Williamson-Hall plot of (a) S-HT-500, (b) S-500-HT, (c) A-HT-500, and (d) A-500-HT.

## S5. $N_2$ physisorption results

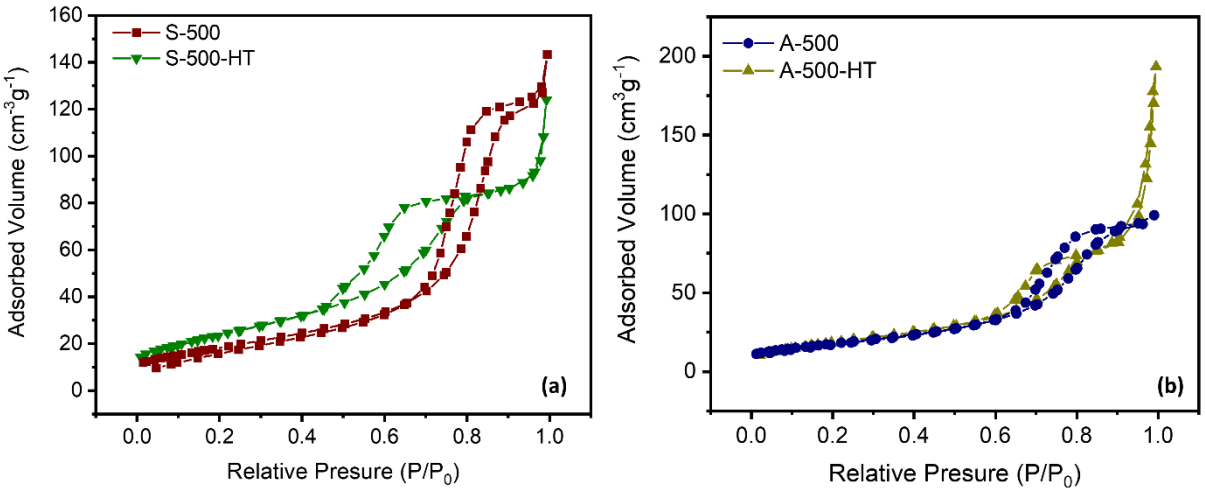


**Figure S5.** $N_2$ physisorption isotherm of (a) S-500 vs. S-500-HT and (b) A-500 vs. A-500-HT.

## S6. HRTEM images of each synthesized step

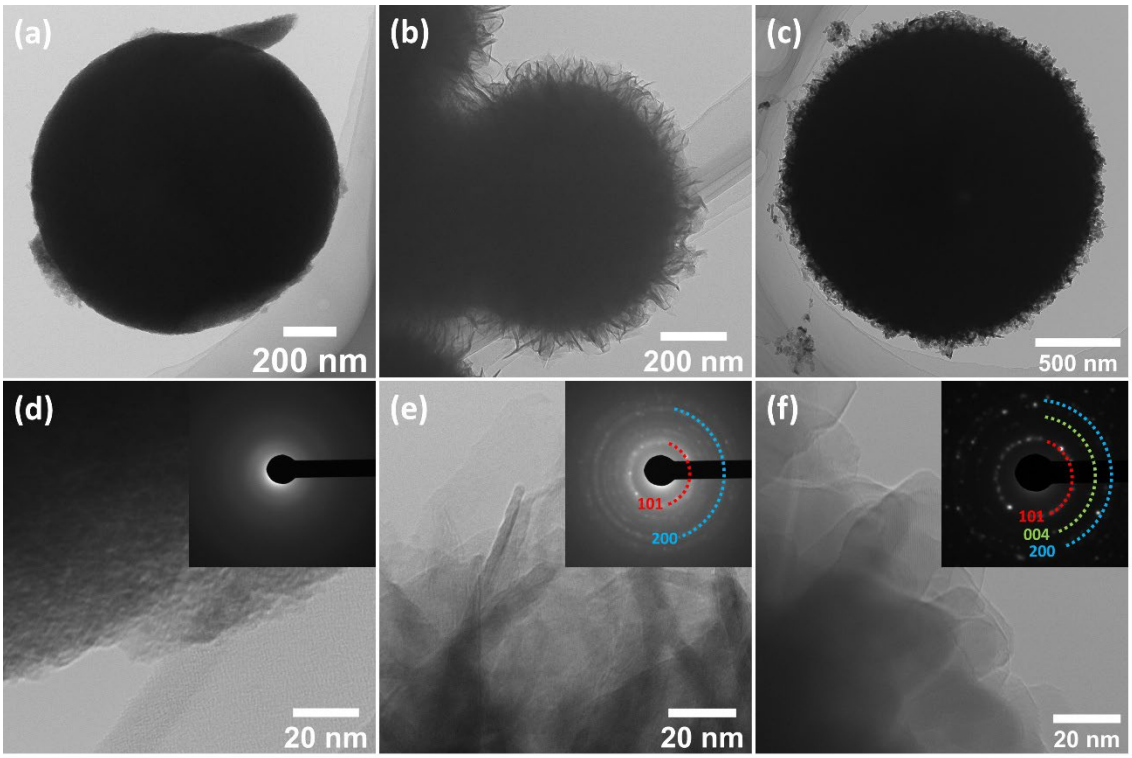


**Figure S6.** (a-c) TEM and (d-f) HRTEM images of samples: (a,d) as-synthesized, (b,e) hydrothermally-treated, and (c,f) calcined samples. The inset of (d-f) is the corresponding SAED pattern.

## S7. Photodegradation of Rhodamine B

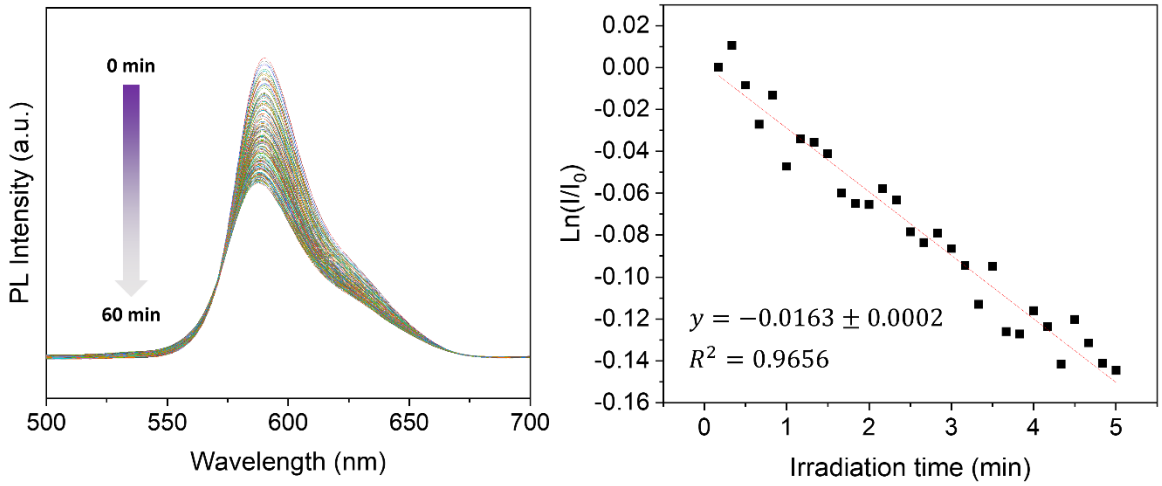


**Figure S7.** Evolution of PL spectra of rhodamine B with respect to the irradiation time and the corresponding first-order kinetic plots.