Electronic Supplementary Information

Hybrid cotton-anatase prepared under mild conditions with high photocatalytic activity under sunlight

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1. Supplementary Figures

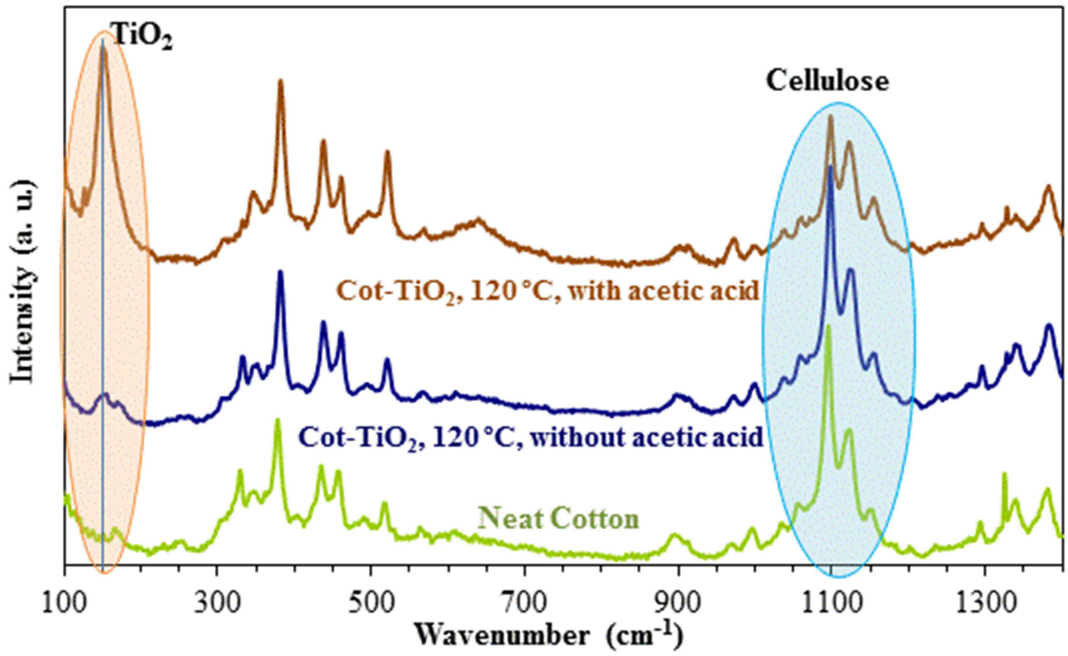


Figure S1. Raman spectra of neat cotton and cotton-TiO_2 after hydrothermal treatment at 120 °C in presence of acetic acid and in the absence of acetic acid. (Acetic acid was added during the first phase of the treatment).

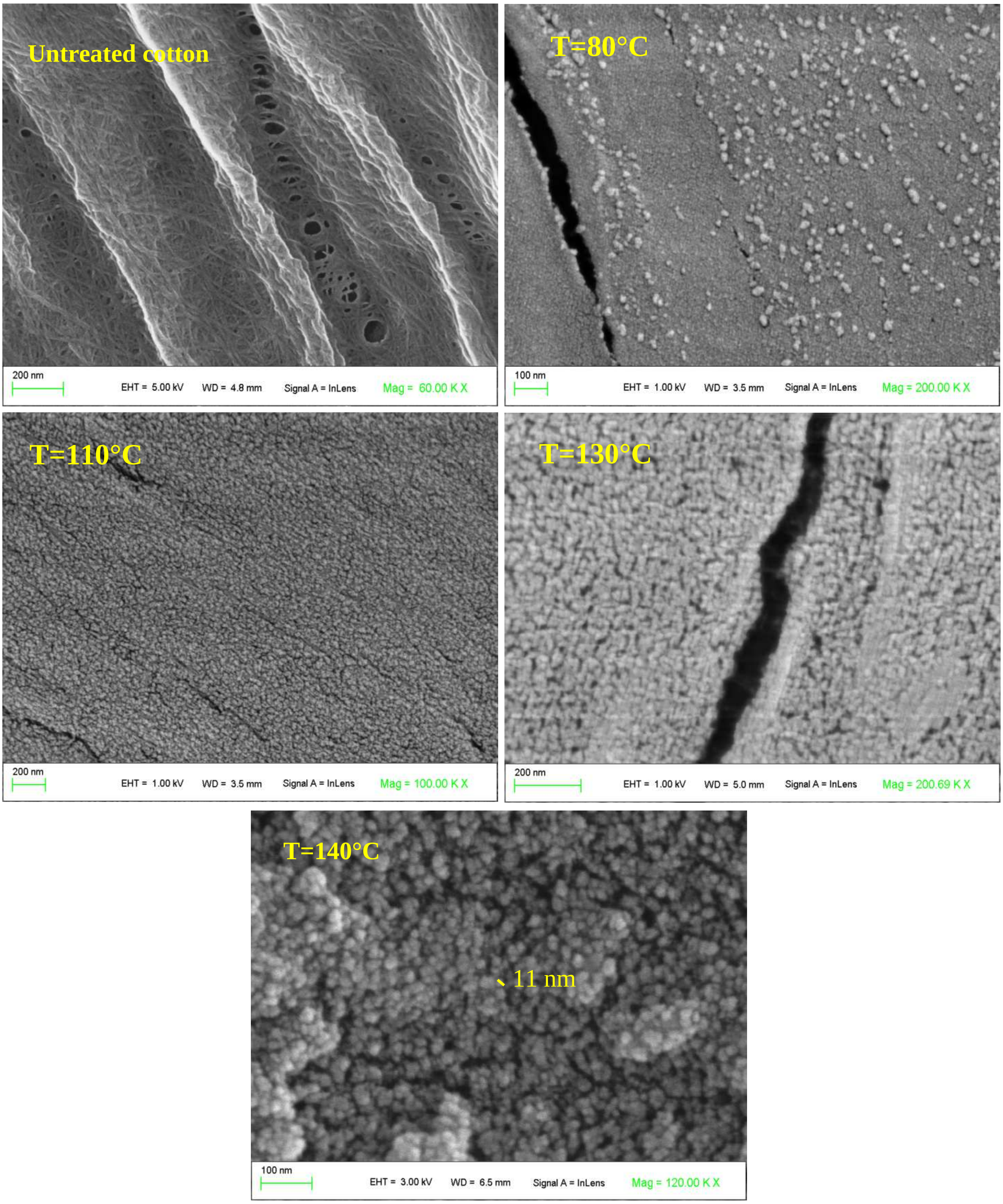


Figure S2. FE-SEM images samples of untreated cotton and functionalized with TiO_2 NPs prepared with hydrothermal treatments held at different temperatures: 80 °C, 110 °C, 130 °C and 140 °C.

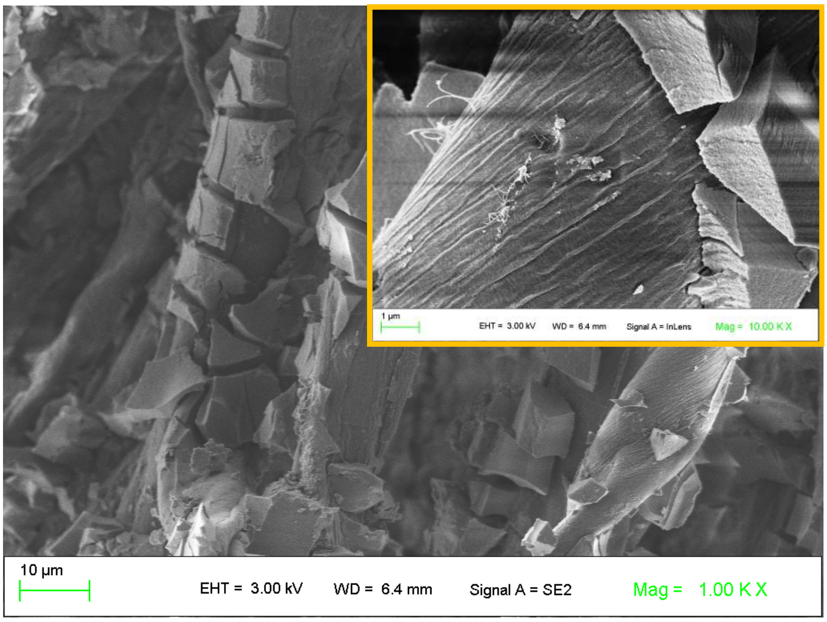


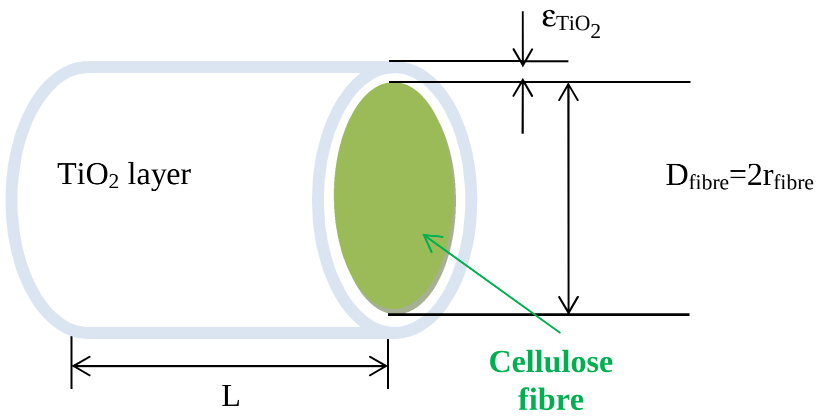
Figure S3. SEM observation of cotton fibres treated with $Ti(OBu)_4$ in tert-butanol at 1 wt.% for 12 h without acetic acid, followed by a hydrothermal treatment at 120 °C during 3 h.

2. Estimation of the thickness of the TiO_2 layer from TGA data

Thermal analysis reveals that:

$$\frac{m_{TiO_2}}{m_{cellulose}} = 0.025$$

It is assumed, for cellulose fibres, a cylindrical shape, an average diameter D_{fibre}, a cellulose density, ρ_{cell}, and a TiO_2 NP density ρ_{TiO_2}. It is also assumed that the fibre is covered with a uniform thin layer formed by TiO_2 nanoparticles with a thickness ε_{TiO_2} and with a compact packing (fraction of occupied space, f_{os}~0.74), as represented in Scheme S1:



Scheme S1. Cellulose fibre covered with a thin layer formed by a compact packing of TiO_2 nanoparticles.

The following Equation may, then, be written:

$$\frac{m_{TiO_2}}{m_{cellulose}} = \frac{\rho_{TiO_2} V_{TiO_2} f_{os}}{\rho_{cell} V_{cell}} = \frac{\rho_{TiO_2} \pi L \left[(r_{fibre} + \varepsilon_{TiO_2})^2 - r_{fibre}{}^2 \right] f_{os}}{\rho_{cell} \pi L \, r_{fibre}{}^2} \qquad \text{Eq. S1}$$

Simplifying Equation S1:

$$\left[\left(1 + \frac{\varepsilon_{TiO_2}}{r_{fibre}} \right)^2 - 1 \right] = \left[\left(\frac{\varepsilon_{TiO_2}}{r_{fibre}} \right)^2 + 2 \frac{\varepsilon_{TiO_2}}{r_{fibre}} \right] = \frac{m_{TiO_2}}{m_{cellulose}} \frac{\rho_{cell}}{\rho_{TiO_2} f_{os}} \qquad \text{Eq. S2}$$

Since $\varepsilon_{TiO_2}/r_{fibre} \ll 1$, a further simplification is possible giving:

$$\frac{\varepsilon_{TiO_2}(nm)}{r_{fibre}(\mu m)} = \frac{m_{TiO_2}}{m_{cellulose}} \frac{\rho_{cell}}{\rho_{TiO_2} f_{os}} \frac{10^3}{2} \qquad \text{Eq. S3}$$

Assuming that the TiO_2 NP have the same density as the crystalline TiO_2 (ρ_{TiO_2}=3.9 g/cm^3), ρ_{cell}=1.5 g/cm^3, and that cellulose fibres have diameters of 15 µm, we get ε_{TiO_2}=48.75 nm.

3. Photocatalytic studies

For each temperature, absorption spectra were acquired each 30 min. Figure S4 shows spectra of Cotton-TiO_2 samples with hydrothermal treatments at 80 ºC and 110 ºC .

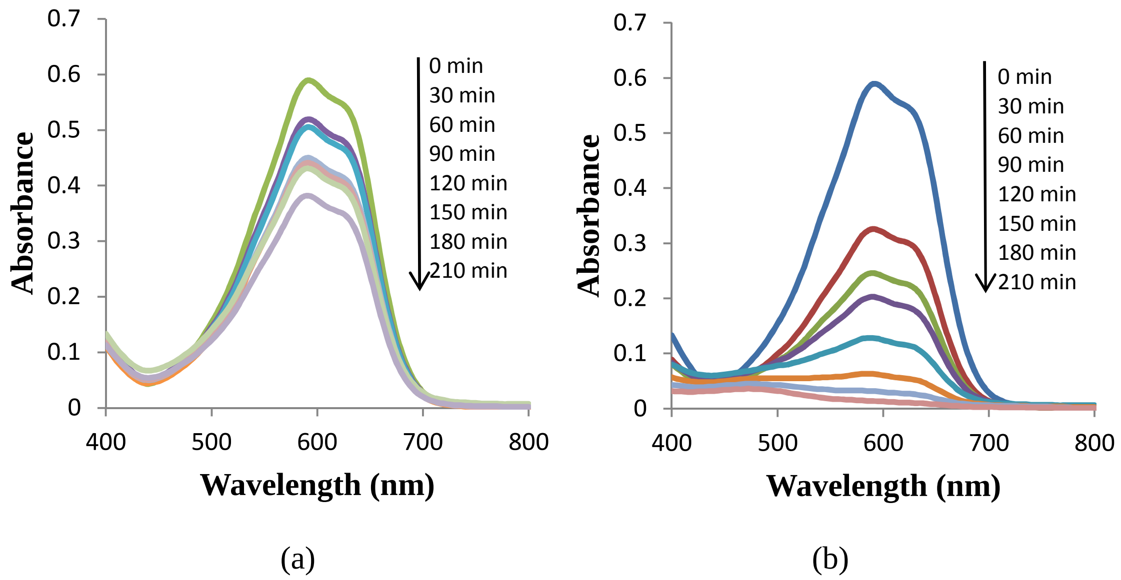


Figure S4. Absorbance spectra for the dye Remazol Brilliant Blue R in the presence of the Cotton-TiO_2 samples heated at (a) 80 ºC; (b) 110 ºC. "0 min" means the time of the irradiation starting. The contact between the samples and the dye solution started 60 min before.