Supplementary Information

TiO_{2-x} prepared by RF thermal plasma: Optical switch of hydrophilic and hydrophobic used in the efficient recovery of photocatalysts

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Tio_{2-x} was oxidized in low temperature O₂ atmosphere to obtain a TiO₂ control group

without oxygen vacancy

Due to the non-thermodynamic equilibrium reaction in RF-Plasma torch, TiO₂ powders without oxygen vacancy can't be directly prepared. Therefore, an oxidation process of TiO_{2-x} in a tubular furnace(Beijing Flame, BFG-16A) with low temperature(300 $^{\circ}$ C), O₂ atmosphere and long oxidation time(12 h) was designed to fill the oxygen vacancies, obtaining TiO₂ without oxygen vacancy as the control group to discuss the effect of oxygen vacancies in this work.

In this treatment, the low temperature is to prevent phase transition, crystal growth and sintering. These are all adverse factors affecting the comparability. Moreover, the O_2 atmosphere and long reaction time is to make sure the complete oxidation, so as to greatly or even completely remove the oxygen vacancies.



Figure sp1. UV-vis absorption spectra of TiO $_{2-x}$, P25 and TiO $_{2}$

Table sp1. Band Gap of TiO $_{2-x}$, P25 and TiO $_2$ caculated by UV-vis absorption spectra

Samples	Band Gap	
TiO _{2-x}	2.85 eV	
P25	2.98 eV	
TiO ₂	3.23 eV	

g value calculation of EPR

g factor as EPR characteristic value in the spectral line needs to be calculated by the abscissa corresponding to the midpoint of characteristic peak, as shown in **Equation. Sp1**, where β represents the Bohr magneton (9.27410×10⁻²¹ g/Gauss), Hr represents the resonant magnetic field intensity (Gauss),h is Planck constant (6.26620×10⁻²⁷ g/s) and v is the microwave frequency (Hz).

$$g = \frac{\beta Hr}{h\nu} \tag{sp1}$$

Quantitative calculation of EPR

The area surrounded by the spectral absorption peak is proportional to the spin number in the tested sample, so the problem of EPR quantification can be transformed into the determination of the area surrounded by the spectral absorption peak. By choosing a standard sample with known spin number to compare the area, the quantitative value of the electronic spin number of the measured sample can be obtained.



Figure sp2. (a) Color change trends of methylene blue degradation using the catalysts of TiO_2 and TiO_{2-x} in the full spectrum. (b) floating small balls cannot form during the degradation using the catalyst of TiO_2 . (c) Concentration degradation curves and (d) degradation rate curves of TiO_2 and TiO_{2-x} for photocatalytic methylene blue degradation in the full spectrum.



Figure sp3. (a) Color change trends of methylene blue degradation using the catalysts of TiO_2 , P25 and TiO_{2-x} in the full spectrum without ultraviolet. (b) Concentration degradation curves and (c) degradation rate curves of TiO_2 , P25 and TiO_{2-x} for photocatalytic methylene blue degradation in the full spectrum without ultraviolet.



Figure sp4. Morphological change under slight and strong force disturbance.