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Supporting Information

Photocatalytic Decomposition of Benzene Enhanced by the Heating Effect of Light: Improving Solar Energy Utilization with Photothermocatalytic Synergy

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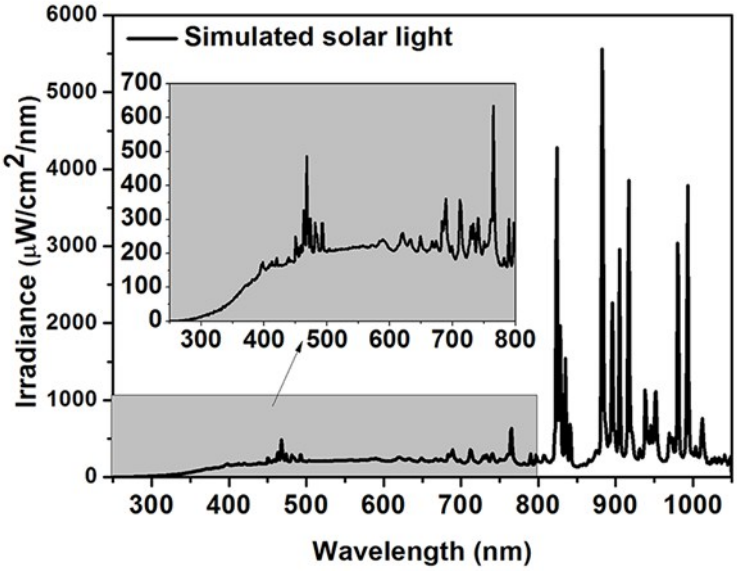


Figure S1. The spectra of irradiance for 500 W Xe-arc lamp as simulated solar light source for the experiment of catalytic activity, inserting the magnified graph within $250<\lambda<800$ nm.

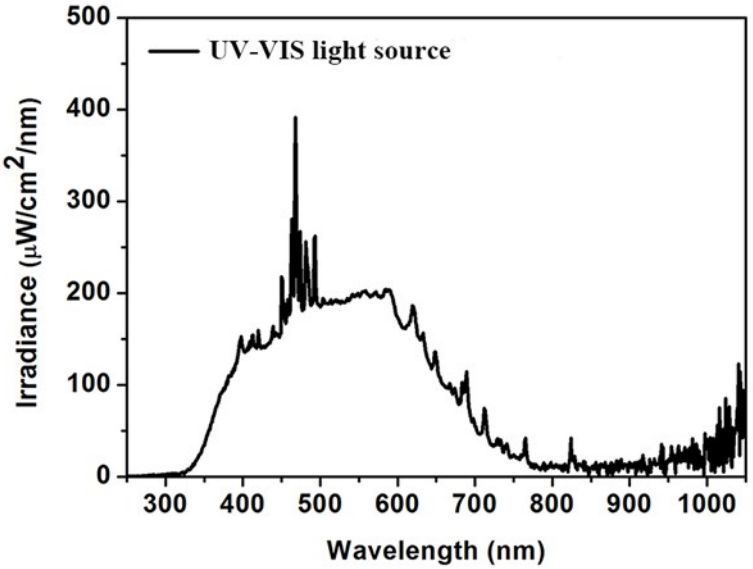


Figure S2. The spectra of irradiation of 500 W Xe-arc lamp equipped with a 300<λ<800 nm filter as the UV-VIS light source for the photocatalytic experiment of ESR.

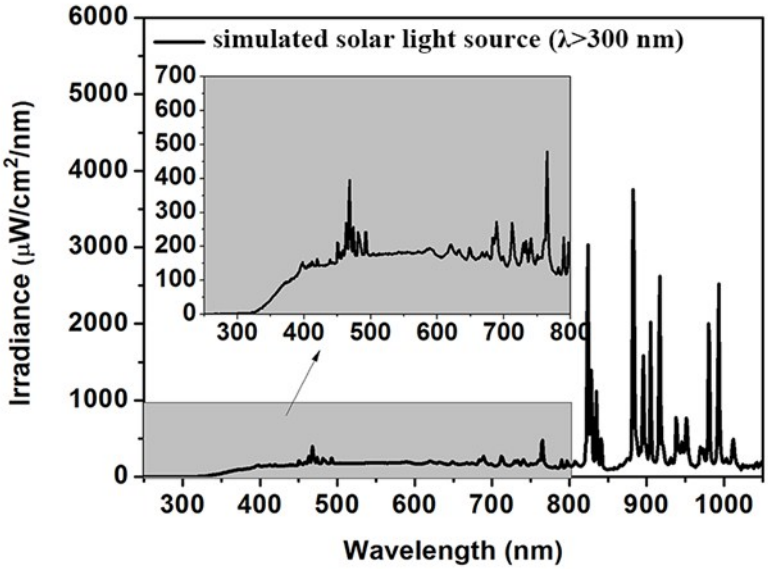


Figure S3. The spectra of irradiation of 500 W Xe-arc lampe quipped with a λ>300 nm filter as simulated solar light source for the photothermocatalytic experiment of ESR, inserting the magnified graph within 250<λ<800 nm.

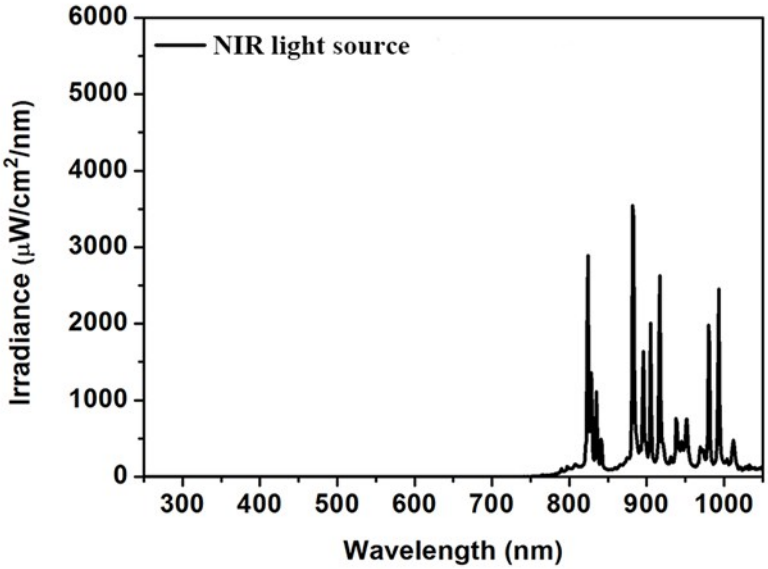


Figure S4. The spectra of irradiation of 500 W Xe-arc lamp equipped with a λ>800 nm filter as the NIR light source for the thermocatalytic experiment of ESR.

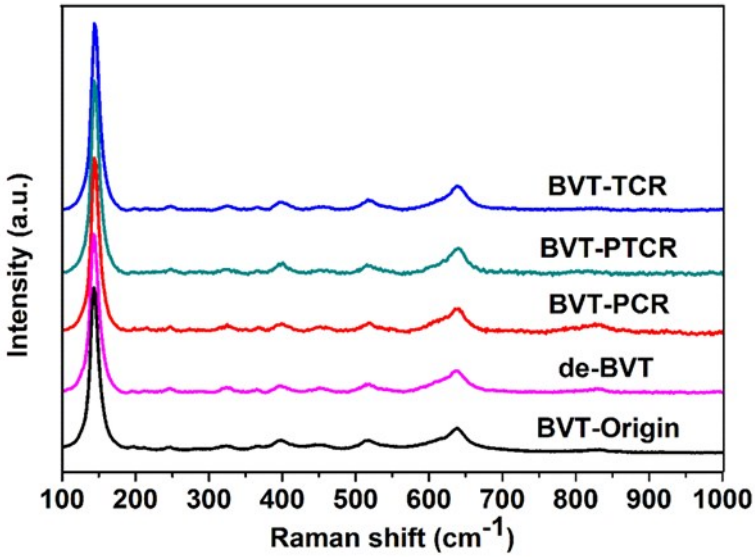


Figure S5 Raman spectra of BVT-Origin, de-BVT, BVT-PCR, BVT-TCR and BVT-PTCR samples

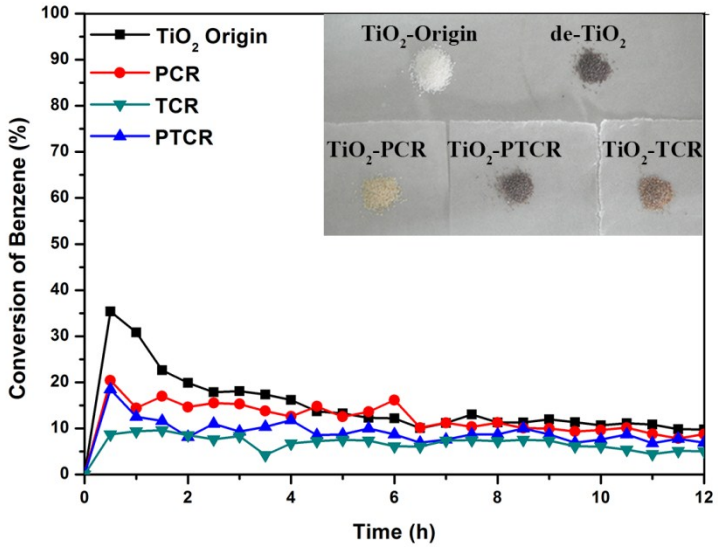
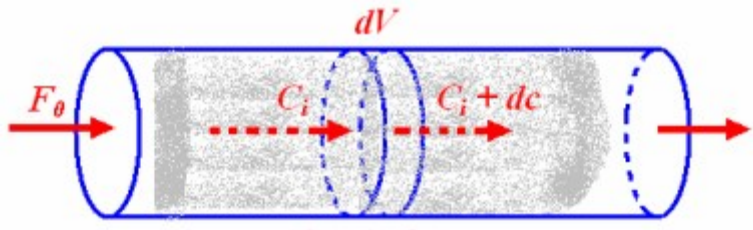


Figure S6 The photocatalytic conversion of benzene versus time over TiO_2-Origin, de- TiO_2, TiO_2-PCR, TiO_2-TCR and TiO_2-PTCR at 30 °C, inserting their color after reaction.

The calculation of apparent rate constant of reaction (k_{app})

The catalyst bed we used can be depicted as follows:



When the steady state is obtained, the mass balance can be depicted as:

$$F_0[C_i-(C_i+dC_i)]=r_idV \qquad (1)$$

F_0:flow rate. C_i: concentration of composition i. r_i: the reaction rate of composition i.

The concentration can be connected with conversion as:

$$x_i=(C_{i,0}-C_i)/C_i \qquad (2)$$

x_i: conversion of composition i.

According to *(1)* and *(2)*, the reaction rate r_i *can be depicted as:*

$$r_i=C_{i,0}dx_i/d(V/F_0) \qquad (3)$$

Order $F= F_0\ C_{i,0}$ and $t=V/F$ which refers to contact time, then *(3)* can be depicted as:

$$r_i=dx_i/dt \qquad (4)$$

The reaction of oxidation of benzene corresponds to first-order kinetics, so

$$r_i=kC_i \qquad (5)$$

k:reaction rate constant.

Combining (4) and (5) and considering the weight of catalyst, the apparent rate constant k_{app} can be depicted as:

$$k_{app} = \frac{\upsilon}{w}\ln\frac{1}{1-x}$$

υ is the flow rate of benzene (20 mL·min^{-1}); w is the weight of catalyst; x is the

conversion of benzene.

The Arrhenius equation here:

$$\ln k = -\frac{E_a}{RT} + \ln A = -B\frac{1}{T} + \ln A$$

k herein is calculated according to the k_{app} above; E_a is the Arrhenius activation energy; R is the gas constant; T is the reaction temperature; A is the pre-exponential factor.

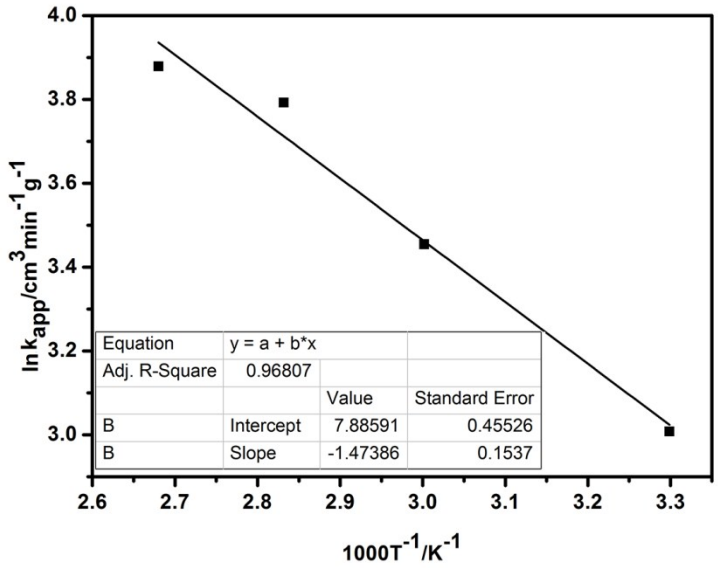


Figure S7 The ln k_{app} versus $1000T^{-1}$ Arrhenius plot for BVT.

*The higher the value of Adj. R-Square, the better linearity.

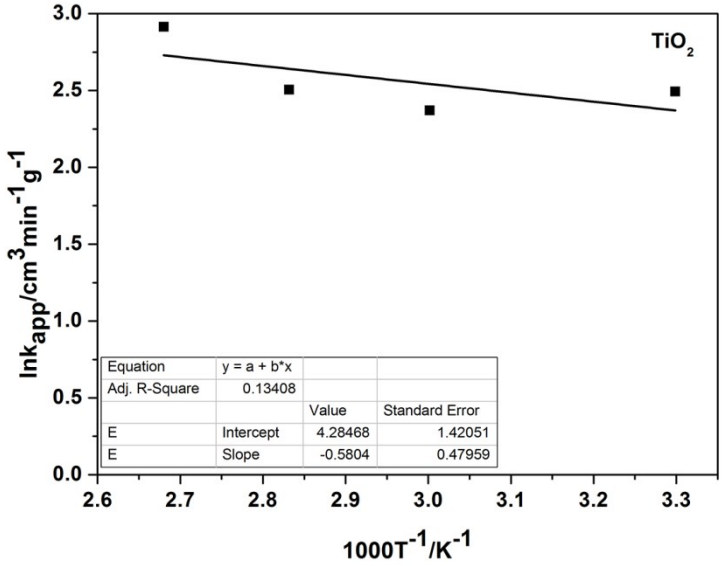


Figure S8 The ln k_{app} versus $1000T^{-1}$ Arrhenius plot for TiO_2.

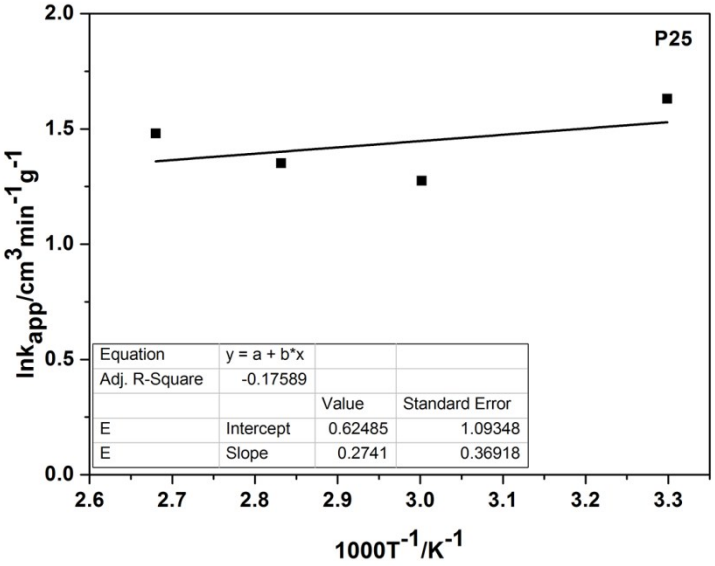


Figure S9 The ln k_{app} versus $1000T^{-1}$ Arrhenius plot for P25.

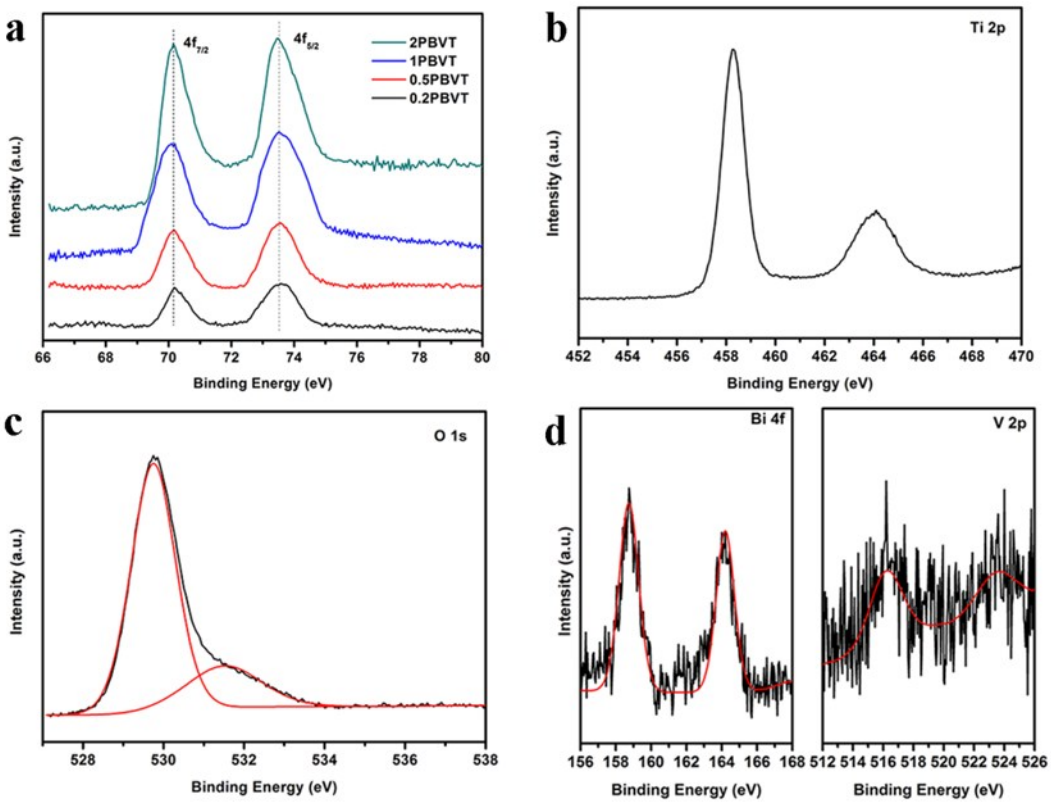


Figure S10 XPS spectra for Pt 4f for 0.2PBVT, 0.5PBVT, 1PBVT and 2PBVT; XPS spectra of Ti 2p (b), O 1s (c), Bi 4f (d) and V 2p (d) for 1PBVT

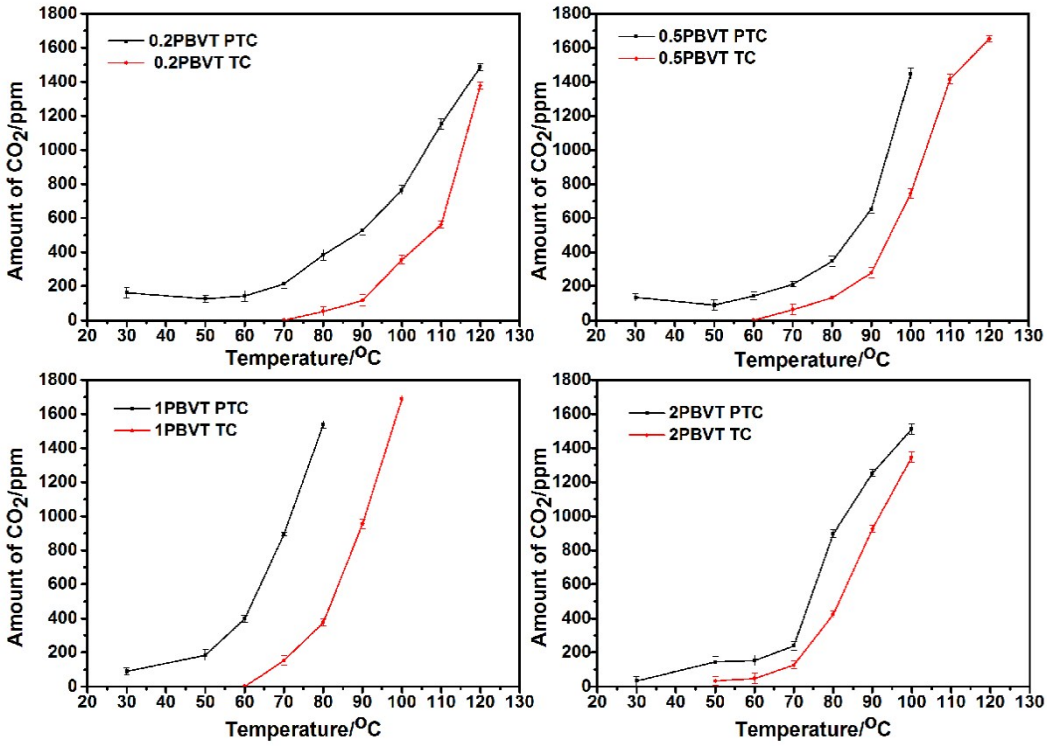


Figure S11 The amount of CO_2 under PTC and TC condition at different temperatures for 0.2PBVT, 0.5PBVT, 1PBVT and 2PBVT.

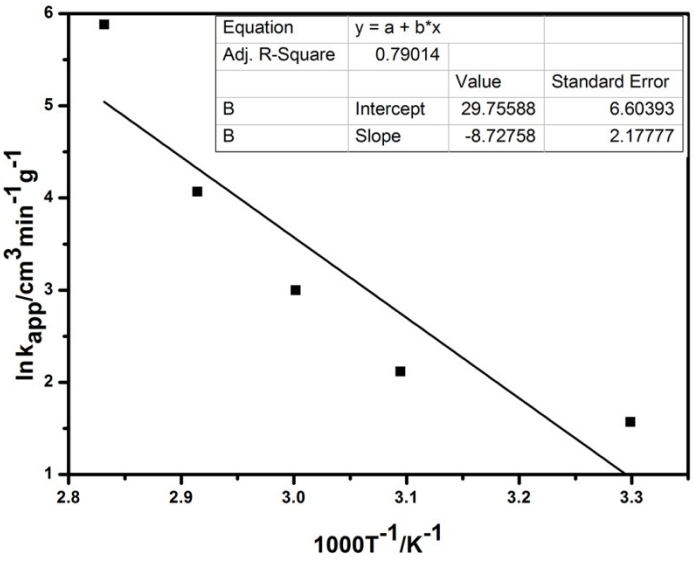


Figure S12 The ln k_{app} versus $1000T^{-1}$ Arrhenius plot for PBVT.

*The higher the value of Adj. R-Square, the better linearity.

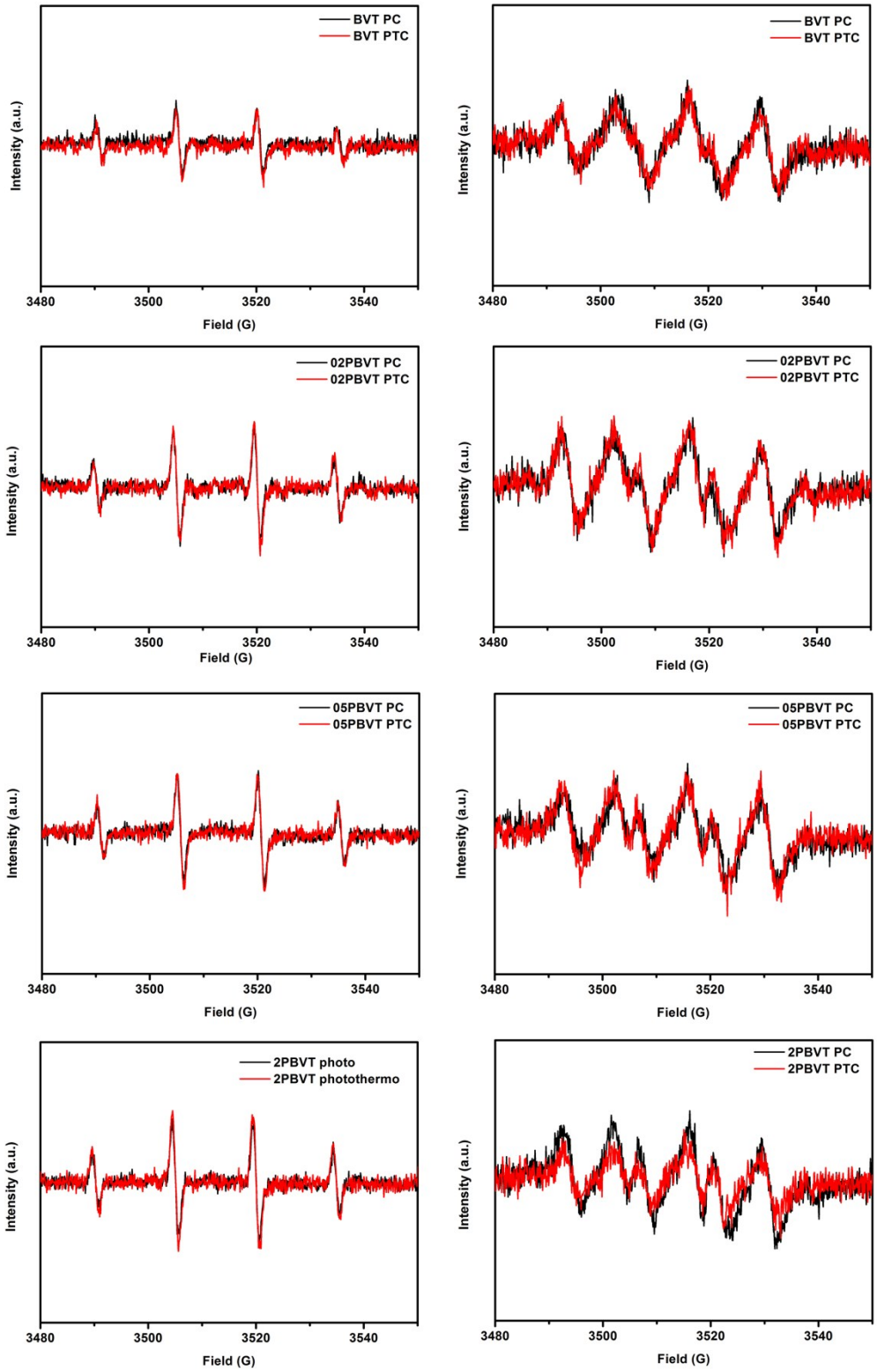


Figure S13 ESR signals of DMPO-·OH and $O_2^{\cdot -}$ of BVT, 02PBVT, 05PBVT and 2PBVT under under PC (photocatalytic, see the irradiation graph in Figure S2) and PTC (photothermocatalytic, see the irradiation graph in Figure S3) condition.

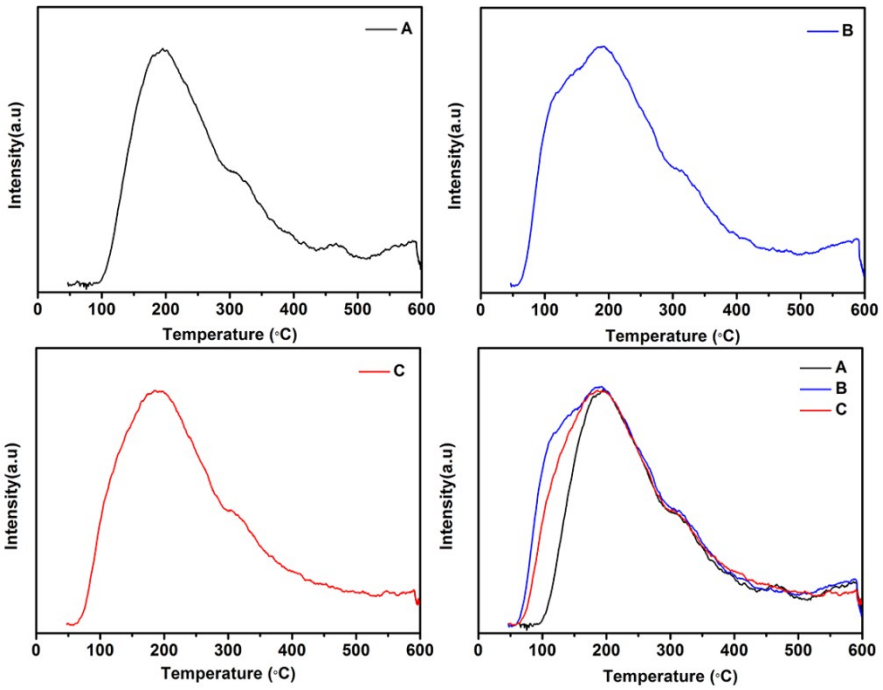


Figure S14 O_2-TPD profile of BVT with the process of oxygen adsorption under (A) 80 °C, (B) UV-vis irradiation (irradiation spectra in Figure S2) at ambient temperature, (C) simulated solar irradiation (irradiation spectra in Figure S3) at 80 °C and the merge image of (A), (B) and (C).