

Supplementary data for

**Degradation acetaminophen in aqueous
solution under visible light irradiation
by Bi- modified titanate nanomaterials:
morphology effect, kinetics, and
mechanism**

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SUPPORTING FIGURE CAPTIONS

1. TNs synthesis
2. Characterization of titanate nanomaterials
3. Cycling experiments

Fig. S1. The schematic diagram of the experimental setup.

Fig.S2. FTIR curves of: (a) Bi-TNS and TNS; (b) Bi-TNT and TNT; (c) Bi-TNR and TNR; (d) Bi-TNR and recycled Bi-TNR.

Fig. S3. Kinetic analysis for photocatalytic degradation of ACT (a) at various initial ACT concentration, (b) at various catalyst dosages.

Fig. S4. Zeta potential of ACT and Bi-TNR in deionized water with different pH.

1. TNs synthesis

1.1 Synthesis of unmodified titanate nano-bulks (TNB)

Titanate nano-bulks with high specific surface areas have been successfully synthesized using hydrothermal method. Specifically, 1.2 g TiO₂ (P25) and 29 g NaOH were mixed and dispersed in 66 mL deionized water. After the mixture was heated in a Teflon reactor at 130°C for 72 hours, the product was washed to neutrality with deionized water and dried at 80°C overnight.

1.2. Unmodified titanate nanosheets (TNS) synthesis

0.8 g P25 was dispersed in 50 mL 10 M NaOH solution under vigorous stirring and the mixture was transferred to a 100 mL Teflon-lined autoclave and treated at 130°C for 3 hours. Using cold water to cool down the autoclave to room temperature immediately. The resulting white powder was then rinsed with deionized water until neutral conditions were obtained and then dried at 70°C for 12 hours. The dried powder grinding spare, that is, TNS.

1.3 Synthesis of unmodified titanate nanoribbons (TNR)

Taking P25 10 g, add NaOH (10 mol/L) 60 ml, the mixed solution was sonicated and stirred for 30 min, the mixed solution was transferred to a hydrothermal kettle, 200°C for 72h. After that, the powder is washed to neutral with deionized water and dried at 70°C overnight. The obtained powder is ground and reserved to obtain sodium titanate nanoribbons (STN).

1.4. Bi-modified titanate nanomaterials with different morphologies

Take Bi(NO₃)₃ • 5H₂O 2.0425 g, add 100 ml of deionized water and stir for 30 min until Bi(NO₃)₃ • 5H₂O is completely dissolved; Then add Na₂Ti₃O₇ nanobelts powder (Or TNB, TNS) to the solution of Bi(NO₃)₃ • 5H₂O 0.3775 g, ultrasonic and stirring for 30 min. Afterwards, washed with deionized water to neutral powder, dried overnight at 70°C. The dried powder is put into a muffle furnace for sintering (500°C) and incubated for 2h to obtain Bi-TNR heterojunction nanobelts, Bi-TNB and Bi-

TNS, respectively.

2. Characterization of titanate nanomaterials

The sample of the powder to be tested was placed on a glass substrate and compacted with a glass plate. The phase composition of the sample was analysed by XRD (X' Pert PRO X-ray powder diffraction, PA Nalytical Co., Ltd., Holland). The radiation source was Co target $K\alpha$ line, $\lambda = 1.5418 \text{ \AA}$, graphite monochromator with a voltage of 35 kV, a current of 35 mA, a scanning step of 0.02° , a scanning speed of $5^\circ/\text{s}$, a scanning range of $5 - 80^\circ$, and then a Cu target. The surface morphology, size and dispersibility in the microscopic of the samples were observed by scanning electron microscopy (SEM, S-4800 Scanning Electron Microscope, Japan, Accelerated Voltage: 5 - 10 kV). The infrared spectrum of the sample was measured by Fourier transform infrared spectroscopy (FT-IR, Nicolet 6700, Thermo Fisher Scientific Co., Ltd., USA), which was previously prepared by KBr pelletizing, with a range of measurement and a separability of $4000 - 400 \text{ cm}^{-1}$ and 4 cm^{-1} . The concentration of ACT in the solution was analyzed using a Shimadzu 10A Series high performance liquid chromatography system (Shimadzu, Japan).

3. Cycling experiments

For the first cycle, 100 mL of 0.7 mg/L ACT solution was photocatalytic removed by 1.0 g/L of Bi-TNR heterojunction nanoribbons for 3 h under visible light irradiation. Later, after each cycle of the photocatalytic reaction, Bi-TNR heterojunction nanoribbons were separated and recycled from the solution by centrifugal collection, then washed thoroughly with deionized water to remove residual pollutants and dried in an oven at a temperature of 60°C , and the resulting nanocomposites were used in the succeeding.

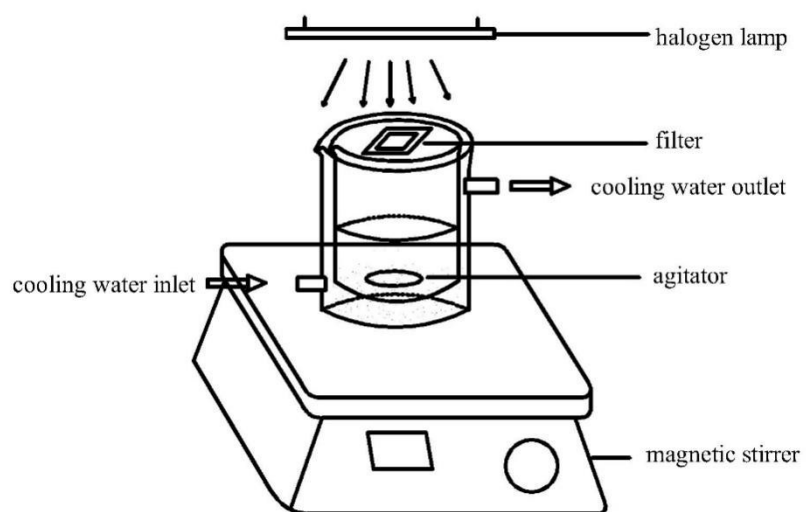


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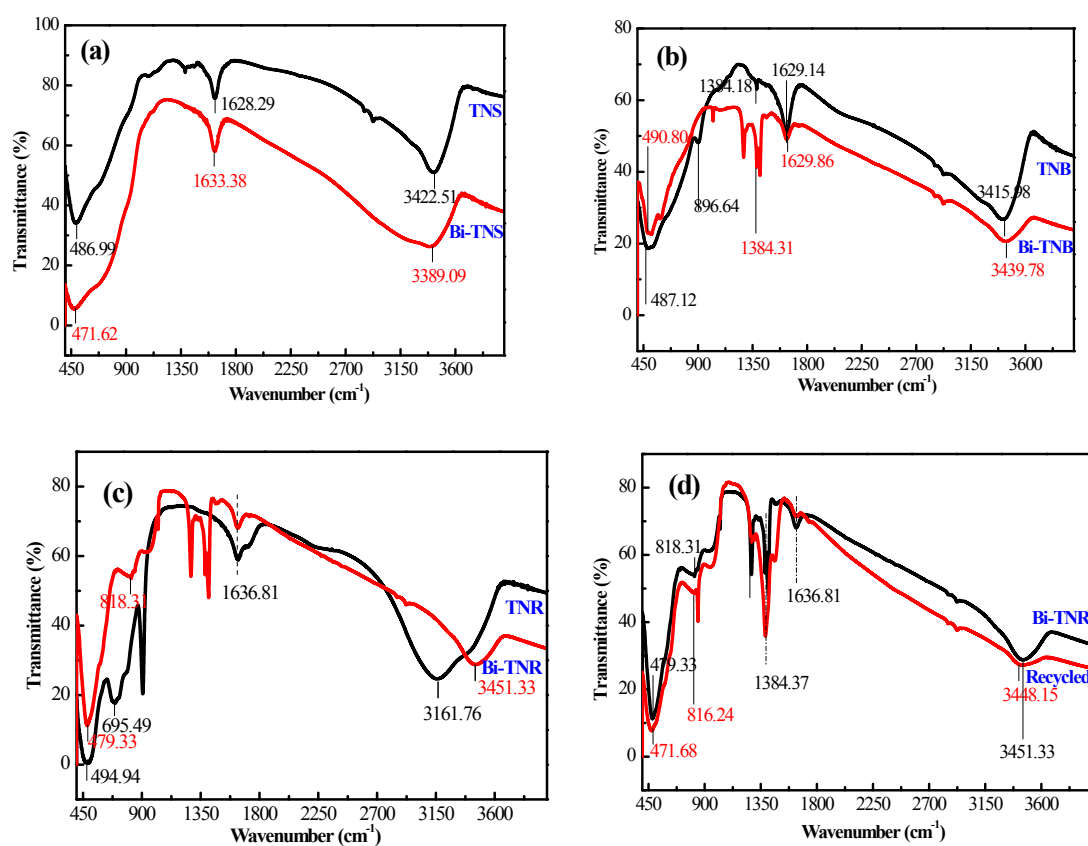


Fig. S2. FTIR curves of: (a) Bi-TNS and TNS; (b) Bi-TNB and TNB; (c) Bi-TNR and TNR; (d) Bi-TNR and recycled Bi-TNR.

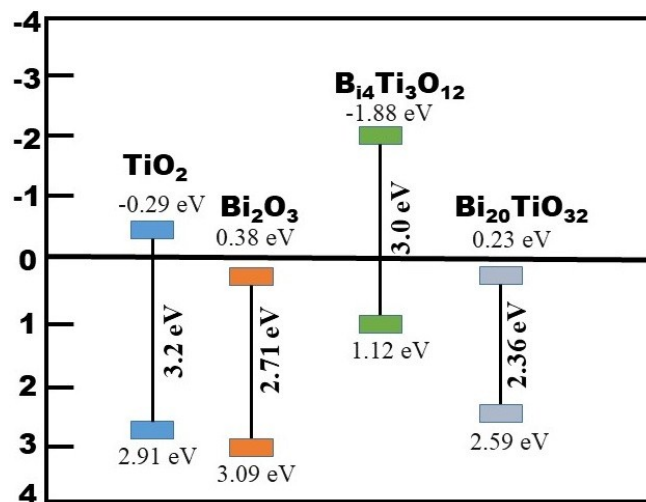


Fig. S3. Energy band structure of TiO_2 , Bi_2O_3 , $\text{Bi}_{20}\text{TiO}_{32}$ and $\text{Bi}_4\text{Ti}_3\text{O}_{12}$.¹

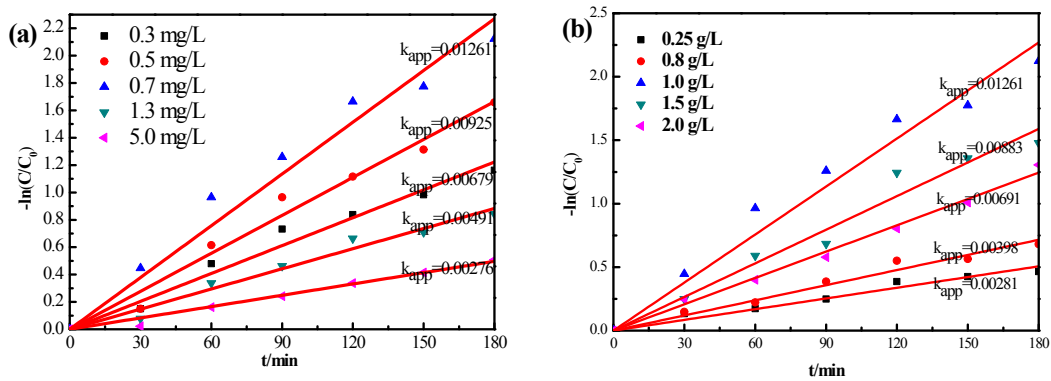


Fig. S4. Kinetic analysis for photocatalytic degradation of ACT (a) at various initial ACT concentration, (b) at various catalyst dosages.

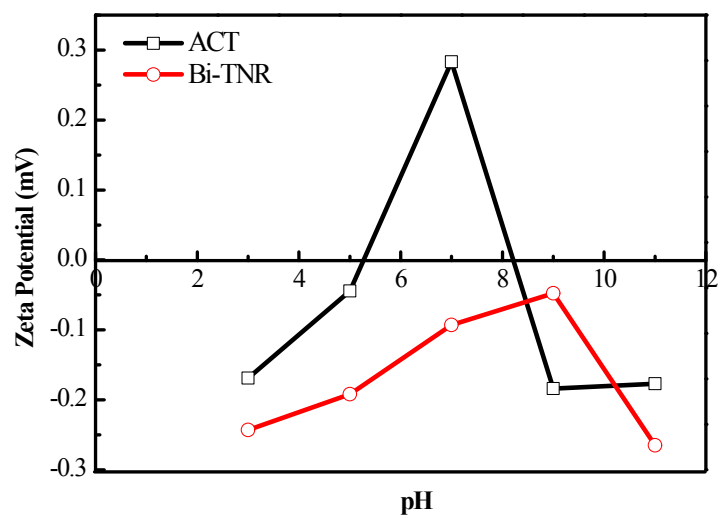
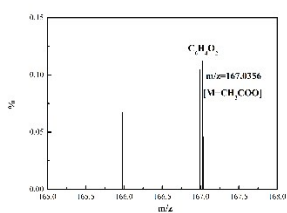
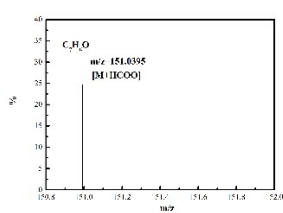


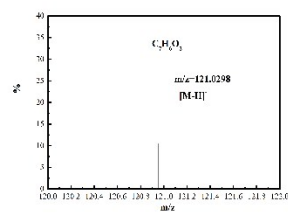
Fig. S5. Zeta potential of ACT and Bi-TNR in deionized water with different pH.



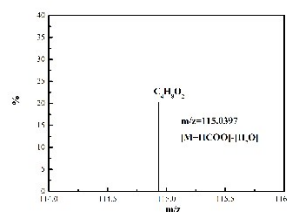
Benzoquinone



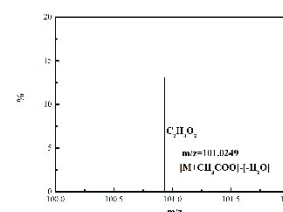
Benzaldehyde



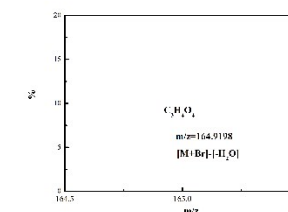
Benzoic acid



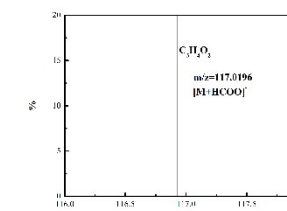
Butanoic acid



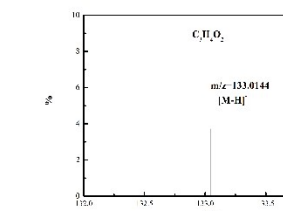
Acetic acid



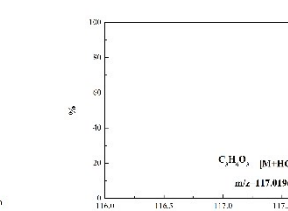
Malonic acid



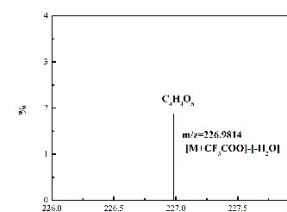
Acrylic acid



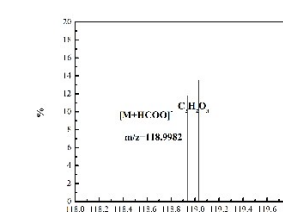
Malic acid



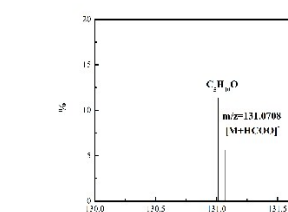
Lactic acid



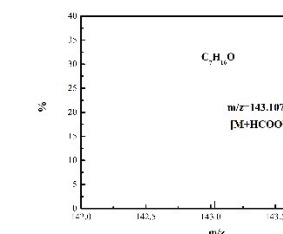
Oxaloacetic acid



Glyoxylic acid



1-Penten-3-ol



4-Heptanol

Fig. S6. HPLC mass spectrogram of ACT transformation samples

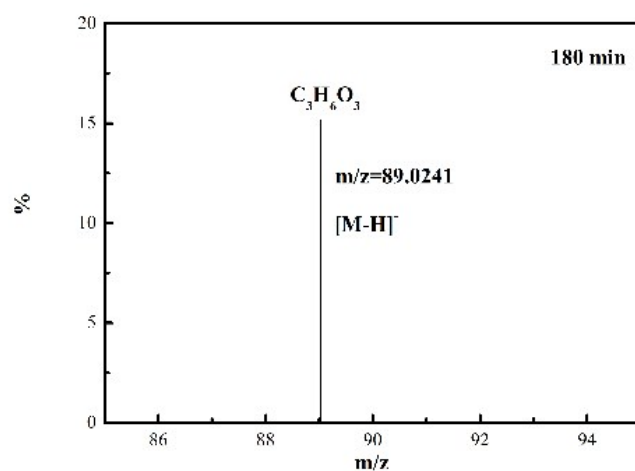
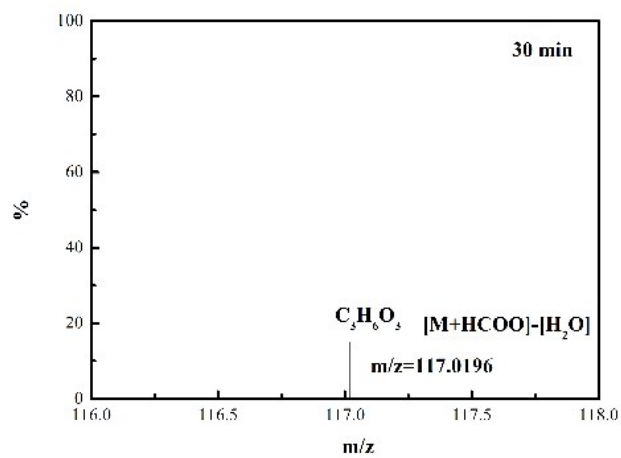


Fig. S7. Mass spectrum of lactic acid content as a function of time:(a) 30 min; (b) 180 min

References:

1. Jiang, H, Chen, Z, Shi, W, C, J, Appl Catal B-Environ., 2016, 180, 698-706.