Supplementary material

Superior performance of photo-piezoelectric catalytic using $Bi_{0.5}Na_{0.5}TiO_3$@$BiVO_4$ based cloth

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Characterization

The crystalline phases of all the samples were measured with X-ray diffraction (XRD) in the range of 10°-80° with a step width of 0.02 ° and the scanning rate of 10° min^{-1} using Cu-Kα radiation (D/Max 2250, λ=1.5418 Å, PANalytical Empyren, Netherlands). The scanning electron microscopy (SEM, Oxford x-max 20, tescan mira3) was applied to observe the morphology of the samples. Besides, the UV-Vis spectra of the materials were obtained with a spectrophotometer (PGeneral TU-1901).

The properties of the materials for degradation of RhB were measured by the UV-vis (Evolution 220, USA). PEC performances of all photoanodes were conducted on Chenhua electrochemical workstation with a typical three-electrode configuration. Photocurrent-potential (*J*-V) curves were obtained by linear sweeping voltammetry (LSV) with or without illumination at a scan rate of 20 mV s^{-1}. The platinum foil was used as counter electrode, the Ag/AgCl electrode (saturated KCl) was used as reference electrode, and the working electrodes were prepared as follows: 20 mg catalysts and 50 μL Nafion aqueous solution were dispersed in 2 ml ethyl alcohol and ultrasonication for 30 min, following by annealed at 200 °C for 3 h after dropped onto the surface of FTO glass (2cm × 3cm). The illumination source was 300 W xenon lamp equipped with an AM 1.5 G filter to gain 1 sun illumination (100 mW cm^{-2}). The electrolyte was 0.5 M Na_2SO_4 (pH=7). In the experiment process, the working electrode was irradiated from the back side. The Mott-Schottky plots were measured at different AC frequency of 1 kHz, 2 kHz and 3 kHz without ultraphonic and illumination, respectively. The electrochemical impedance spectroscopy (EIS) was measured under potential of 0.6 V

(vs. Ag/AgCl), with an alternating voltage (AC) perturbation of 10 mV, and the AC frequency was from 10 kHz to 0.1 Hz. Additionally, the working electrode for the Mott-Schottky and EIS measurement are prepared by a glassy carbon electrode (Φ 3 mm) dropped with amount of suspension mixed with 5 mg catalysts, 20 μL Nafion aqueous solution and 1 ml ethyl alcohol ultrasonicatied for 30 min, then dried naturally.

The piezoresponse force microscopy (PFM) is applied to verify the piezoelectric property of BNT nanosphere, as shown in Fig. S1. The polarization switching behaviors and local piezoelectric response are detected at an applied bias field of ±10 V DC. In Fig. S1a, the typical amplitude-voltage butterfly loops were obtained for BNT nanosphere to indicate the piezoelectricity of BNT. The well-defined 180° phase reversal hysteresis loops in Fig.S1b further confirmed the piezoelectric property of BNT. The PFM amplitude and phase reveal the presence of piezoresponse of BNT nanosphere.

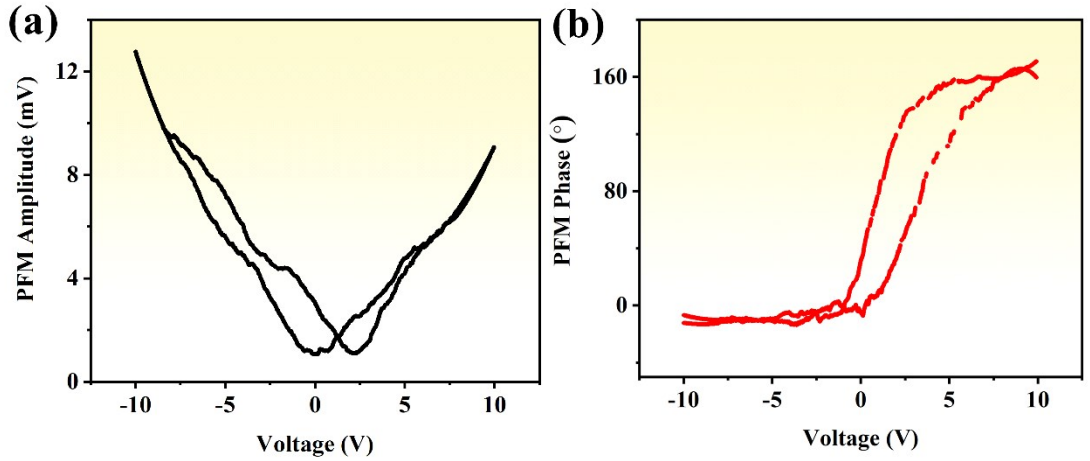

Fig. S1 The piezoresponse force microscopy (PFM) of BNT nanosphere, (a) Amplitude-voltage butterfly loops; (b) phase hysteresis loops.

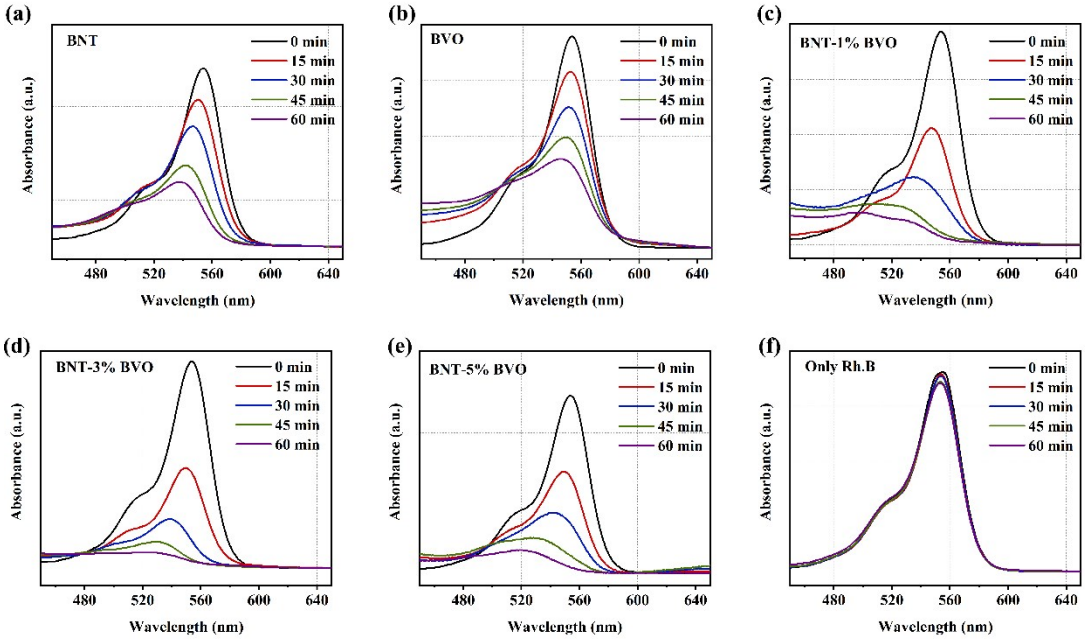

Fig. S2. The Piezo-photocatalytic degradation efficiencies of RhB with concentration of 10 mg/L for (a) pure BNT, (b) BVO, (c) BNT@1%BVO, (d) BNT@3%BVO, (e) BNT@5%BVO and (f) without any calalytics respectively under the simulated sun irradiation together with ultrasonication.

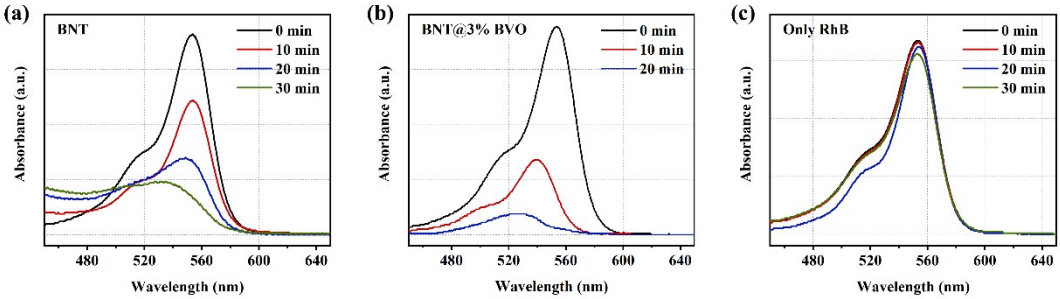

Fig. S3. The Piezo-photocatalytic degradation efficiencies of RhB with concentration of 5 mg/L for (a) pure BNT, (b) BNT@3%BVO and (c) without any calalytics respectively under the simulated sun irradiation together with ultrasonication.

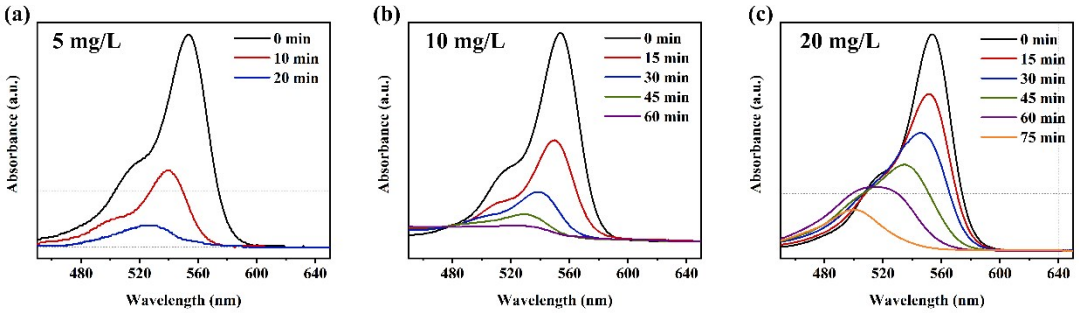

Fig. S4. The degradation efficiencies of RhB with different concentration as (a) 5 mg/L, (b) 10 mg/L and (c) 20 mg/L by using BNT@3%BVO.

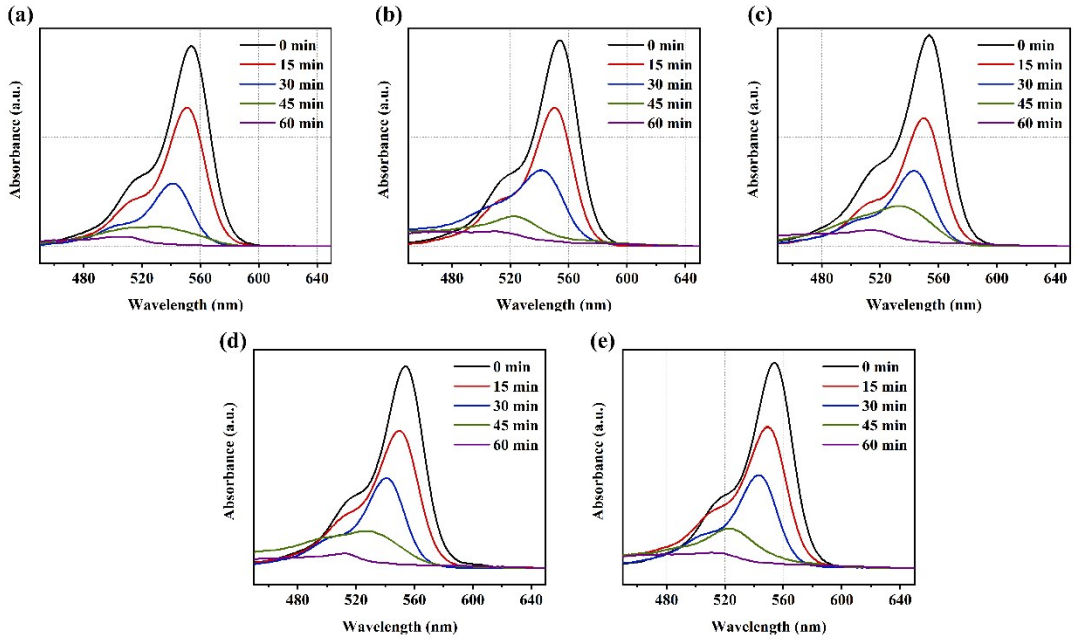

Fig. S5. The five cycle tests of the BNT@3%BVO sample for the piezo-photocatalytic degradation of 10 mg/L RhB.

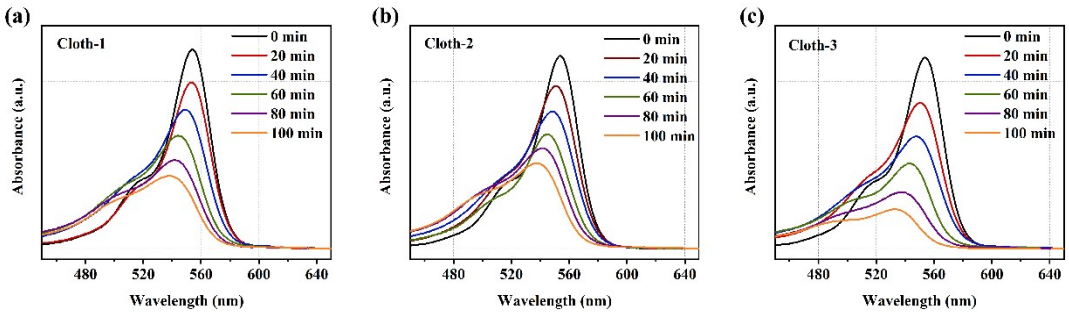

Fig. S6. The degradation of 10 mg/L RhB with (a) cloth-1; (b) cloth-2; (c) cloth-3.

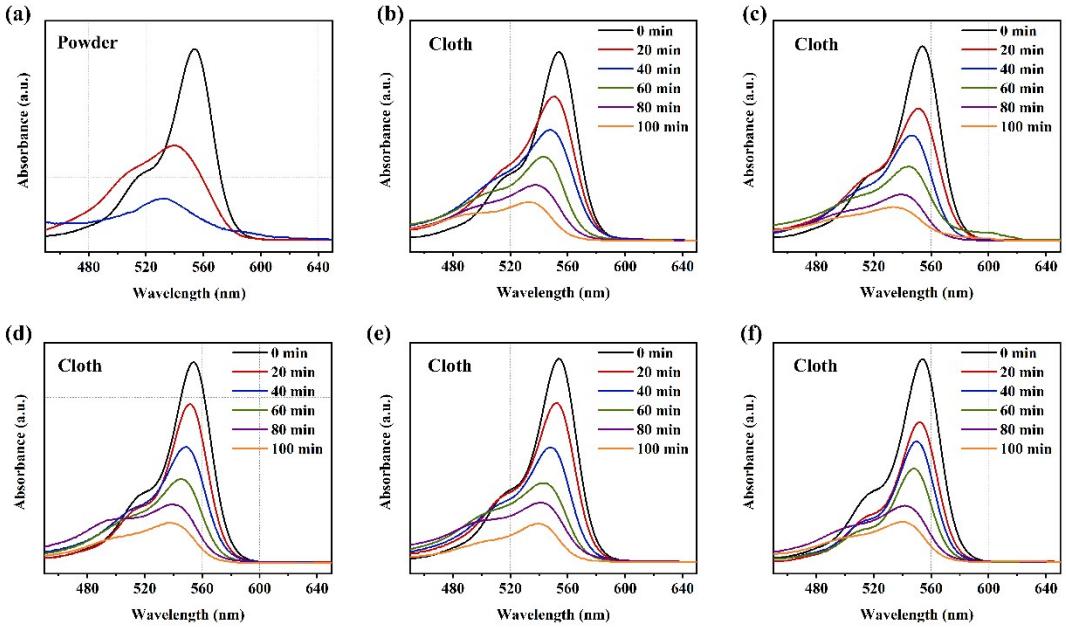

Fig. S7. (a), (b) 0.023 g BNT@3%BVO powder catalyst and cloth-3 were applied to degrade the 50 mL 10 mg/L RhB for comparison; (c)-(f) the same with (b) for the cycle test.

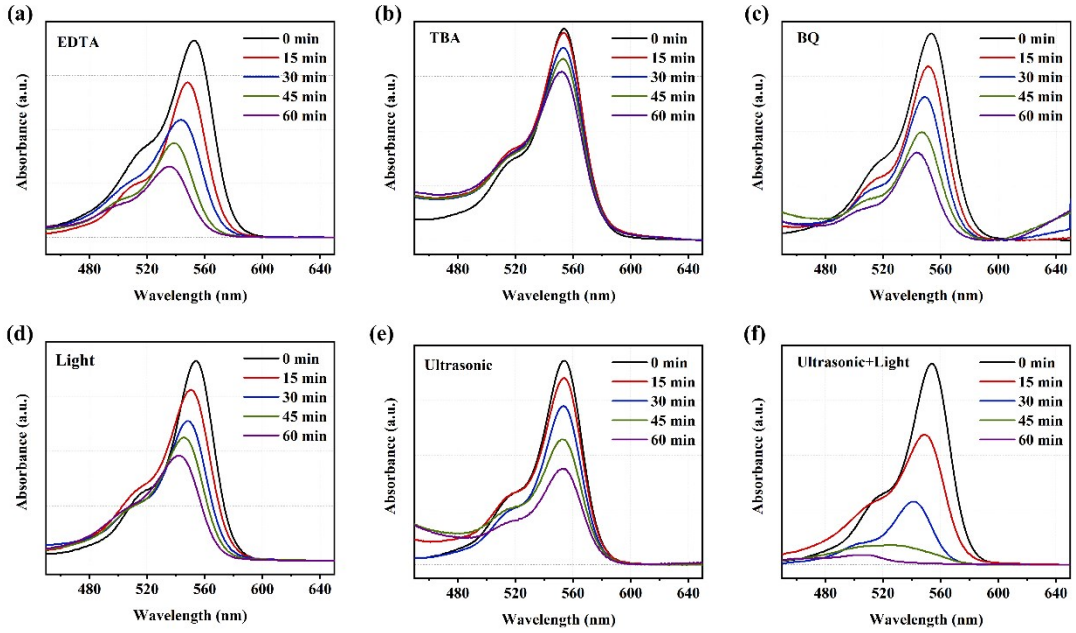

Fig. S8. Time-resolved UV-vis absorption spectra of the RhB solutions (C_0 = 10 mg/L) with (a) EDTA, (b) TBA, (c) BQ as holes (h^+), $^{\bullet}O_2^-$, and •OH radicals scavengers, respectively; with (d) light irradiation, (e) ultrasonic vibration, (f) light irradiation and ultrasonic vibration coefficient in the presence of BNT@3%BVO nanospheres.