Supplementary Information

Text S1. Chemicals and Reagents

Ulfuric acid (H_2SO_4, 98%), Sodium hydroxide (NaOH, ≥96%), Ethanol (≥95%), Methanol(≥99.0%),Isopropanol (≥99%), 4-Hydroxy-2,2,6,6-tetramethylpiperidinyloxy free radical (TEMPOL, 98%), Furfuryl alcohol (FFA, ≥99%) Sodium chloride (NaCl, ≥99%), Potassium chloride (KCl, ≥99%), Disodium hydrogen phosphate (Na_2HPO_4, ≥99%), Potassium dihydrogen phosphate (KH_2PO_4, ≥99%), Humic acid (HA, ≥99%), Agar-agar powder (99%) and Yeast extract (99%) were purchased from Sinopharm Chemical Reagent Co., Ltd (Shanghai, China). Sodium bismuthate dehydrate ($NaBiO_3 \cdot 2H_2O$, ≥80%) and Gmultiwalled carbon nanotube were purchased from Sigma Aldrich Co., Ltd. The *Escherichia coli K-12 (E. coli K-12)* was purchased from the American Type Culture Collection, which was chosen as the object of disinfection. The distilled water was used in all experiments. All materials and reagents were used directly without further purification.

Text S2. Antibacterial experiment

Preparation of LB liquid medium: Weigh 2 g of NaCl, 2 g of peptone and 1 g of yeast powder, add 200 mL of ultra-pure water, seal with aseptic sealing film, sterilize in 121 ℃ high temperature sterilization pot for 20 min, and then put in a super clean table for use.

Preparation of PBS buffer: Dissolve 8 g NaCl, 0.2 g KCl, 1.42 g Na_2HPO_4 and 0.27 g KH_2PO_4 in 1000 mL ultra-pure water, and after completely dissolving, sterilize them in 121 ℃ high temperature sterilization pot for 20 min for future use.

Preparation of solid AGAR medium: Weigh 8 g NaCl, 8 g peptone, 4 g yeast powder, 12 g solid AGAR powder, add 800 mL ultra-pure water, seal with aseptic sealing film, sterilize in 121 ℃ high temperature sterilization pot for 20 min, pour them into a disposable sterile petri dish (90 mm) in an ultra-clean table to cool for use.

Text S3. Characterization of photocatalysts

Scanning electron microscopy (SEM) measurements were performed on the ZEISS Sigma 300 emission SEM in Germany. Transmission electron microscopy (TEM) instrument model for the FEI FEITecnaiG2F20, accelerating voltage of 200 kV. Fourier infrared spectrometer (FT-IR, Thermo Scientific™ Nicolet™ FTIR spectrometer) was used to study the molecular structure and chemical composition of substances, with a scanning rate of 4 $cm^{-1}·min^{-1}$ and a scanning range of 500~4000 cm^{-1}. The compositions and valence states of the catalysts were analyzed by X-ray photoelectron spectroscopy (XPS, PHI 5000 Versaprobe type III). The light absorption performance of the catalyst was investigated by ultraviolet visible near-infrared spectrophotometer (UV-Vis, Shimadzu, Japan, range: 200-3000 nm). Electrochemical workstation (Shanghai Chenhua CHI 660E) was used to test the photocurrent response and electrochemical impedance of the catalyst. Electron paramagnetic resonance (EPR) spectroscopy was performed with Bruker EMX plus spectrometer to detect free radicals in the material. The fluorescence spectrometer (PL, Edinburgh FLS1000, Britain) was used to record the photoluminescence spectra at the 340 nm excitation wavelength. The zeta-potentials of catalyst were evaluated by the Zeta potential analyzer (Nano ZS90, Britain).

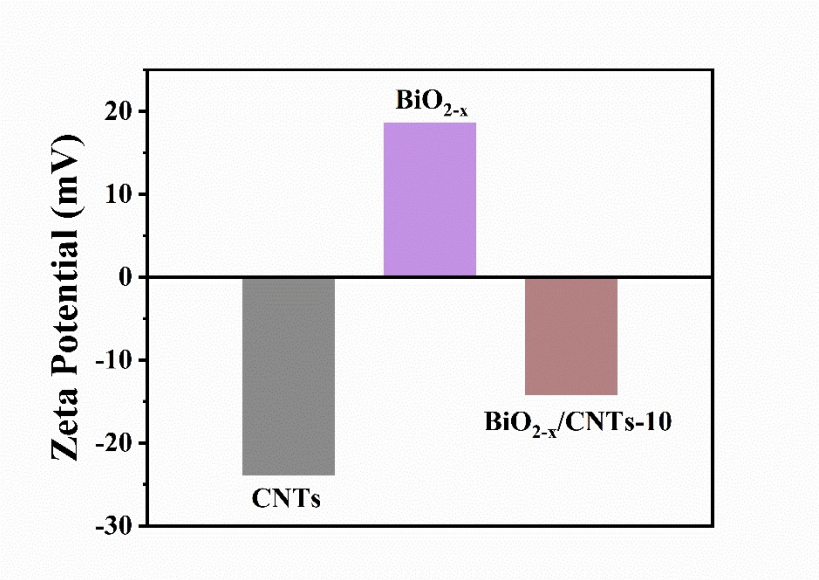

Fig. S1 Zeta potentials of CNTs、BiO_{2-x} and BiO_{2-x}/CNTs-10

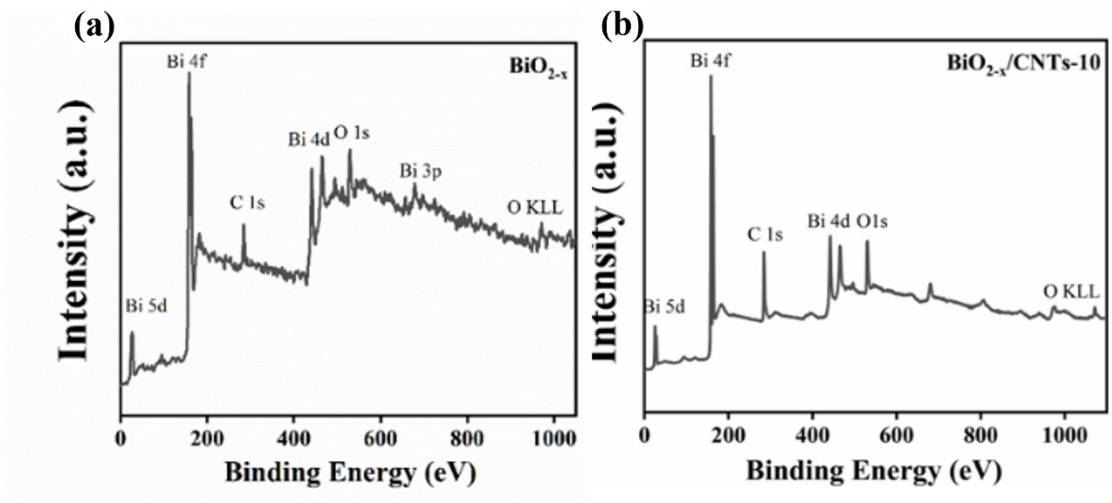

Fig. S2 XPS survey spectra of (a) BiO_{2-x} and(b) BiO_{2-x}/CNTs-10

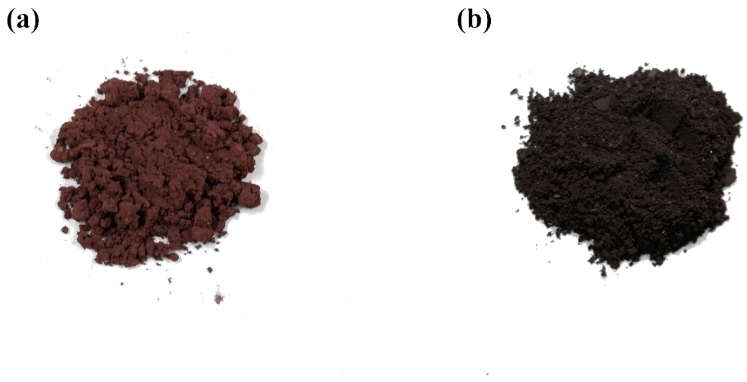

Fig. S3 Color of (a) BiO_{2-x}; (b) BiO_{2-x}/CNTs-10

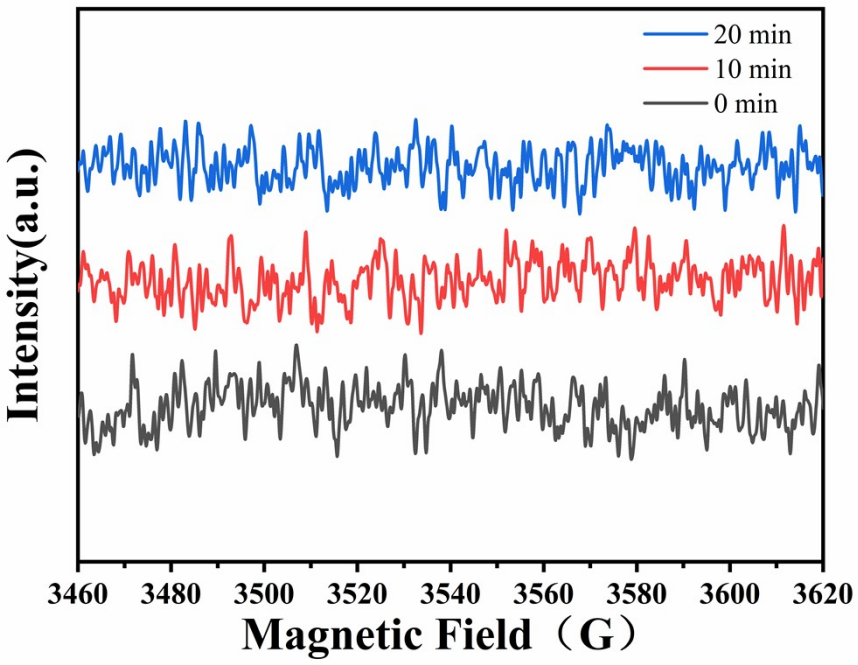

Fig. S4 EPR spectra of ·OH under near-infrared light

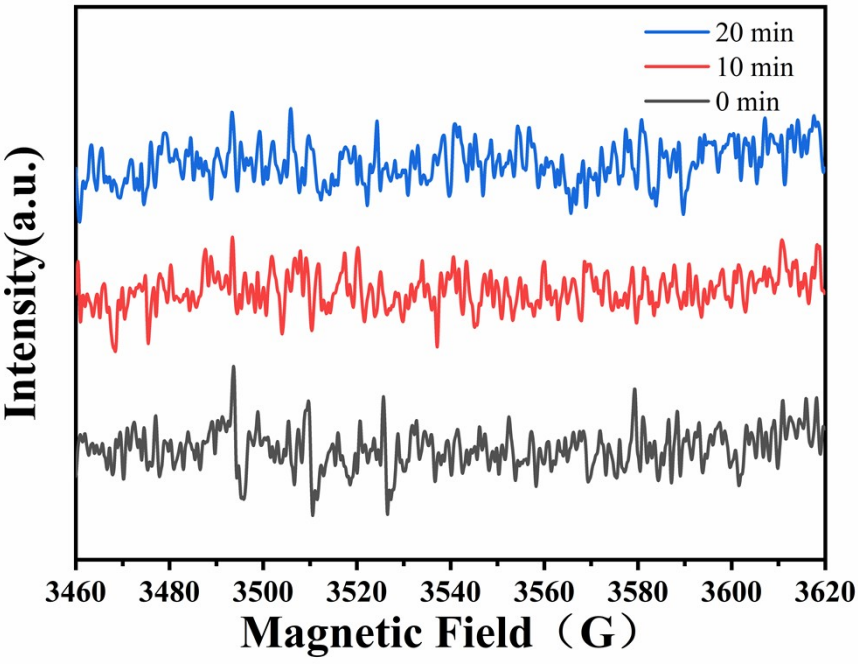

Fig. S5 EPR spectra of $^1O_2$ under near-infrared light

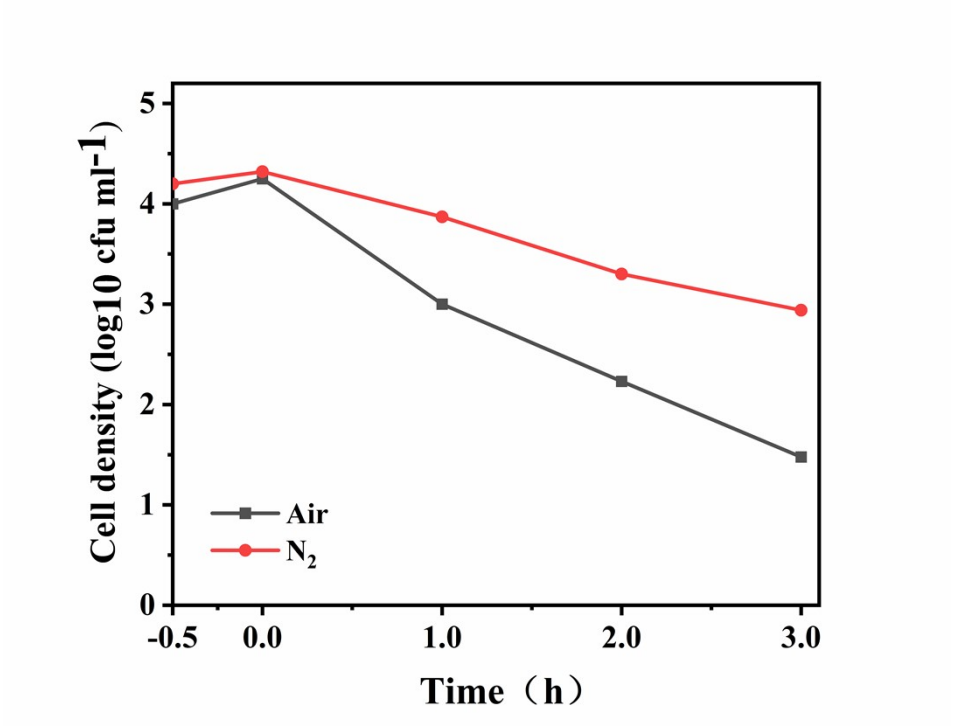

Fig. S6 Antibacterial effect of *E. coli K-12* on different materials in N_2 and air

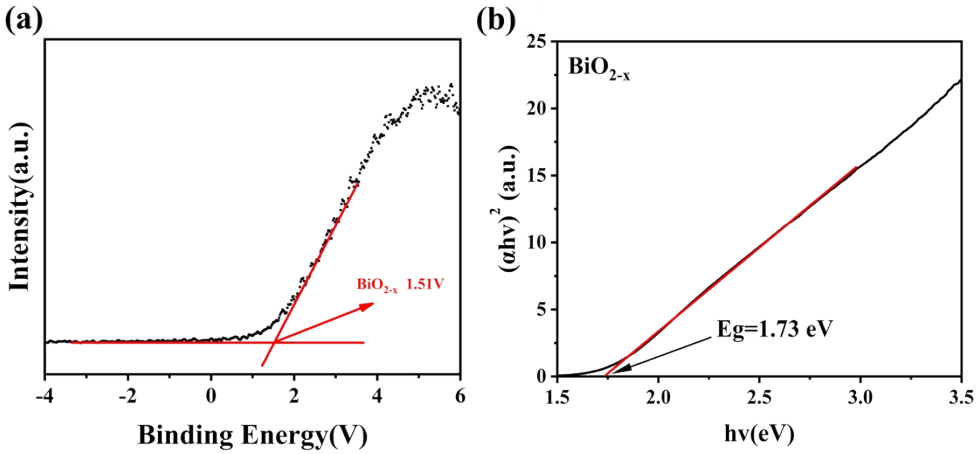

Fig.S7 (a) Valence band XPS spectra of BiO_{2-x}; (b) band gap of BiO_{2-x}