Supporting Information

Unique BiFeO₃/g-C₃N₄ mushroom heterojunction with photocatalytic antibacterial and wound therapeutic activity

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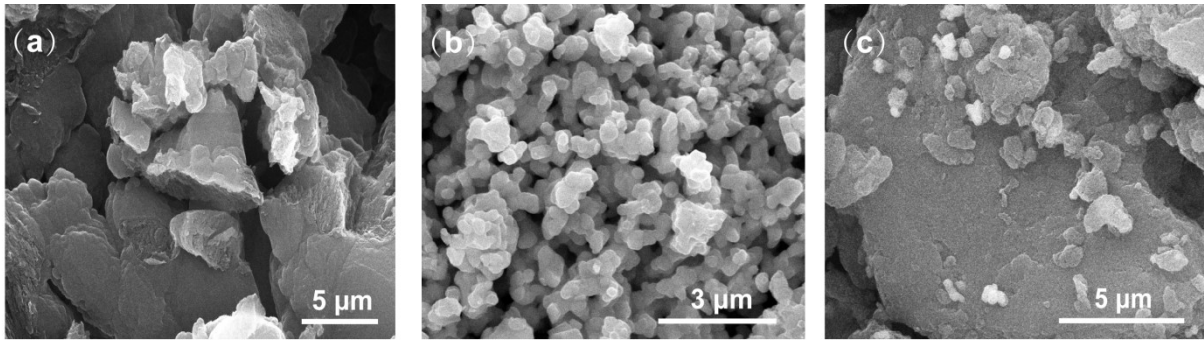*1 Equal contribution*

Fig. S1. SEM images of g-C$_3$N$_4$, BiFeO$_3$ and 10%BFO/CN composite.

Fig. S2. Photos of color changes of different samples.

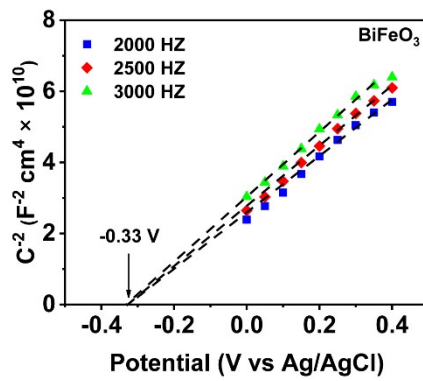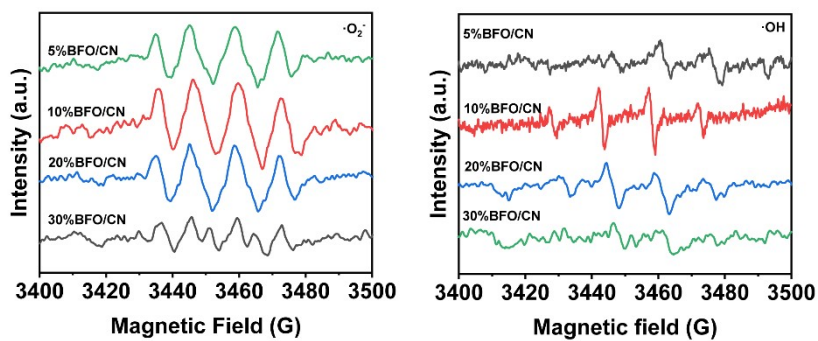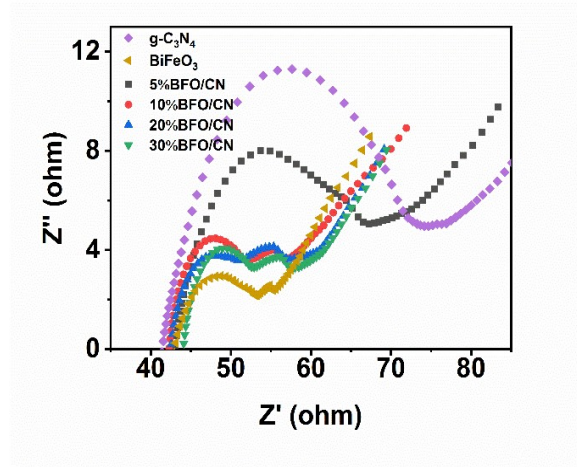**Fig. S3.** Mott-Schottky plots of BiFeO$_3$.

Fig. S4. ESR-DMPO-$\cdot O_2^-$ spectrum and ESR-DMPO-$\cdot OH$ spectrum of different materials.

Fig. S5. EIS of different materials.

Photocatalytic degradation performance measurement

Under the same light conditions, the photocatalytic performance of BFO/CN (concentration 1mg/ml) was further verified by degrading RhB solution (10 mg L^{-1}, 100 ml). In order to achieve adsorption-desorption equilibrium, before irradiation, the solution and materials were mixed and stirred for 30 min in dark conditions. Determine the concentration by UV-vis using the peak absorbance of RhB at 554 nm. Calculate the degradation rate (E) of RhB from the following formula:

$$E = (1-C/C_0) \times 100\% = (1-A/A_0) \times 100\%$$

Where C (mg L^{-1}) and C_0 (mg L^{-1}) are the concentration of the solution at reaction t (min) and t_0 (min), A and A_0 are the corresponding absorbance values.

The degradation kinetics of the catalyst is obtained by the first-order kinetic equation:

$$\ln(C_0/C) = k\, t$$

Where C_0 and C are as described above, and k (min^{-1}) is the rate constant.

The performance of the photocatalyst was evaluated by degrading RhB under visible light (λ>420 nm). As shown in **Fig. S6a**. After 140 min of illumination, the degradation of RhB can be neglected. The degradation rates of pure g-C_3N_4 and $BiFeO_3$ to RhB are 63.44% and 11.07%, respectively. For BFO/CN composites with different $BiFeO_3$ loadings amounts (5%, 10%, 20%, 30%), the degradation rates are 67.32%, 92.38%, 74.79% and 53.74%, respectively, which are better than that of pure g-C_3N_4 and $BiFeO_3$. Thus, the photocatalytic performance of BFO/CN composites is greatly enhanced due to the synergy effect of g-C_3N_4 and $BiFeO_3$. The photodegradation efficiency of RhB by BFO/CN with different $BiFeO_3$ loadings amounts are investigated in detail as shown in **Fig. S6b**, which follow a pseudo-first-order correlation. The value of rate constants (k) corresponding to the photo degradation of RhB under different $BiFeO_3$ content is shown in **Fig. S6c**. As the loading rate of $BiFeO_3$ increases to 10%, the degradation rate increases. The 10%BFO/CN composite material has the highest degradation rate (k=0.01839min^{-1}), which is not only 2.6 times that of g-C_3N_4 (k=0.0072min^{-1}), but also 1.23 times that of previous related reports[1]. However, when the $BiFeO_3$ loading rate further increases to 20% and 30%, the photocatalytic performance decreases, which can be attributed to the fact that although the increasing loading amount of $BiFeO_3$ might promote the utilization of photoelectrons, but it also inhibits the absorption of light by the g-C_3N_4 semiconductor, thereby limiting the photocatalytic performance of the materials. The stability of the catalytic performance of the photocatalyst is very important for practical applications. Here, we conducted a cycle stability test of 10%BFO/CN under the same conditions. In **Fig. S6d**, after four experiments of photodegradation of RhB, the photocatalytic degradation efficiency still reached more than 81% indicating that 10%BFO/CN is photo-stable.
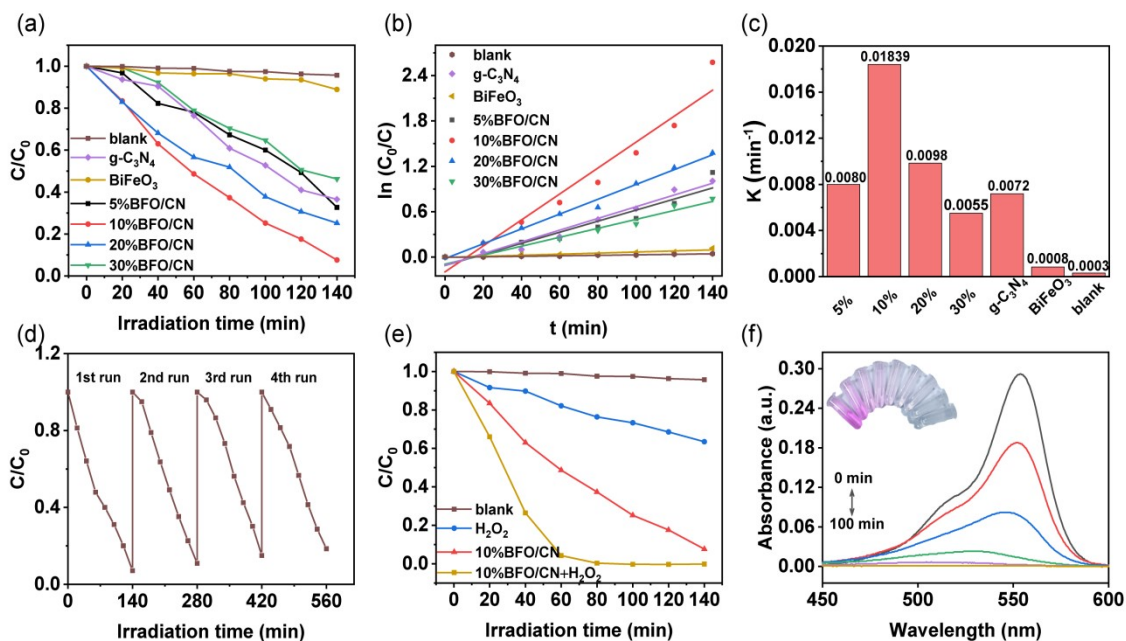
Fig. S6. (a) Different samples degrade RhB under visible light. (b) Corresponding RhB degradation kinetics fitting and (c) degradation rate constant. (d) Stability test of 10%BFO/CN photocatalytic degradation RhB solution. (e) Photocatalytic degradation of different samples under visible light irradiation; (f) Changes of RhB absorption spectrum and the color of the solution with time in the presence of 10%BFO/CN and 2 mM H_2O_2 under illumination.

Fig. S6e shows the photocatalytic performance of photodegradation of RhB in the presence of H_2O_2. The degradation rate of RhB in 140 min under the effect of H_2O_2 is 36.52%. But the co-reaction of 10%BFO/CN and H_2O_2 significantly boost the degradation of RhB with a photoreaction efficiency as 100%. This phenomenon can be attributed to the combination of photo-Fenton and the photocatalytic reaction on the surface of the catalyst, so that more active free radicals are generated. **Fig. S6f** shows the UV absorption peak and color change of RhB solution under the co-reaction of 10%BFO/CN and 2 mM H_2O_2. As time increases, the maximum absorption peak of RhB near 554 nm decreases significantly. After 100 min of illuminate, the visible light absorption value is close to 0 and the color of the solution is transparent, indicating that the RhB molecule is almost completely degraded.
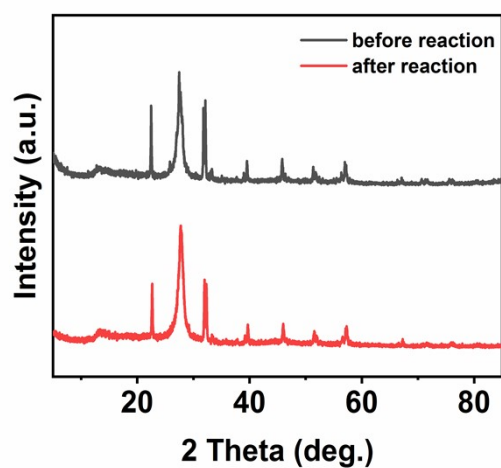
Fig. S7. Comparison of XRD patterns of 10%BFO/CN before and after the photocatalytic reaction .
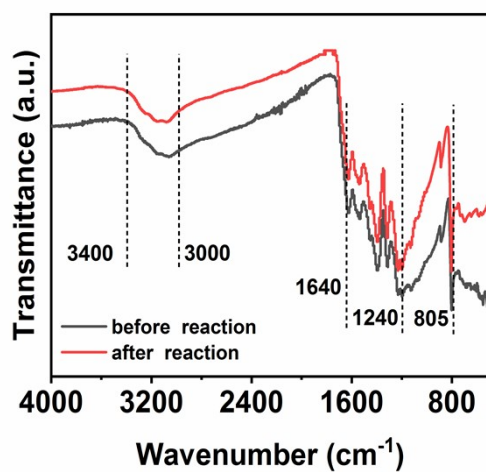
Fig. S8. Comparison of FTIR spectra of 10%BFO/CN before and after photocatalytic reaction
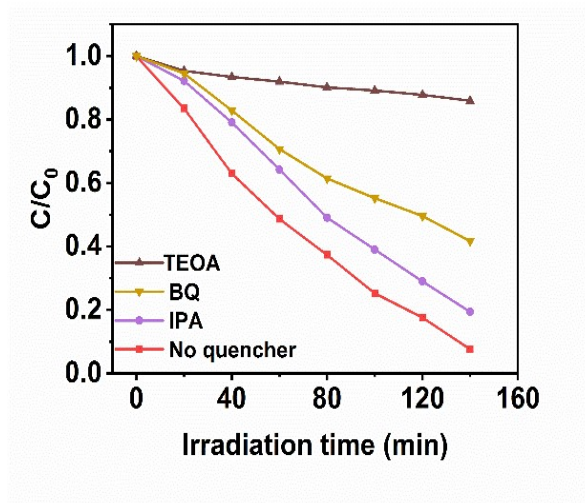
Fig. S9. Experiment of capturing active substances produced during photocatalytic degradation of RhB with 10%BFO/CN composites.

The ROS capture experiment was used to further verify the active substances produced by BFO/CN composites in photocatalytic process. Isopropanol (IPA), p-benzoquinone (BQ) and triethanolamine (TEOA) were added as scavengers of $\cdot OH$, $\cdot O_2^-$ and h^+ in the photocatalytic degradation of RhB by BFO/CN. As shown in **Fig. S9**. When IPA is added to eliminate $\cdot OH$, the degradation rate of RhB approached the photocatalytic reaction without quencher. Therefore, $\cdot OH$ is not the main active substance for degrading RhB. When BQ is added, the degradation of RhB is inhibited, which indicated that $\cdot O_2^-$ promoted the degradation of RhB. When TEOA exists in the reaction system, the degradation reaction is inhibited and the degradation rate is extremely low, which means that h^+ is of great significance in the photocatalytic process. The results show that the active substances that play a major role in the photocatalytic degradation of RhB by BFO/CN are h^+ and $\cdot O_2^-$.
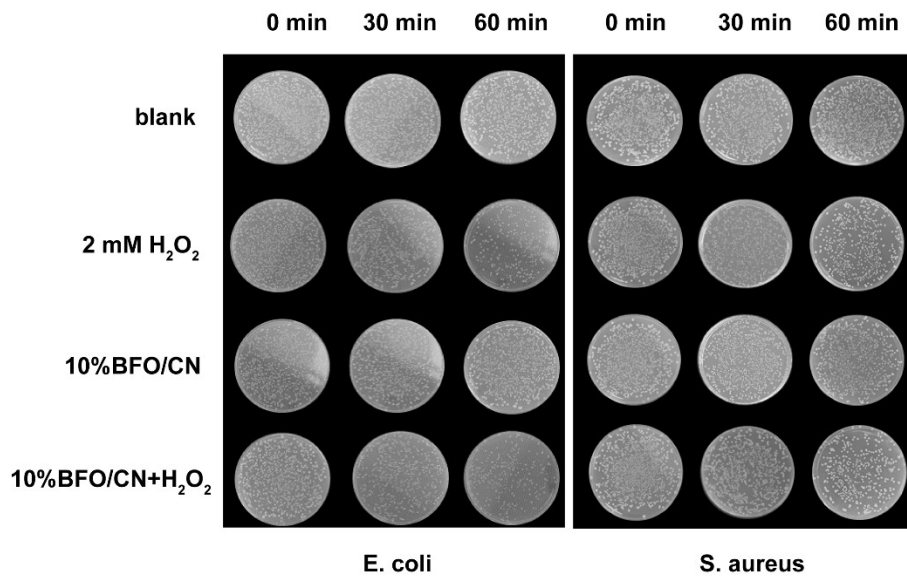
Fig. S10. Antibacterial effect of different materials in 0, 30 and 60 min under dark station.
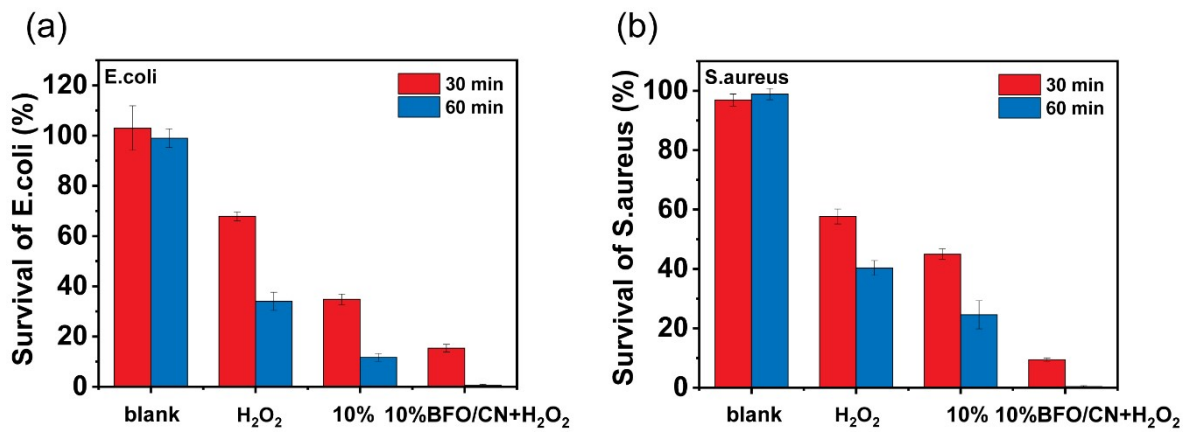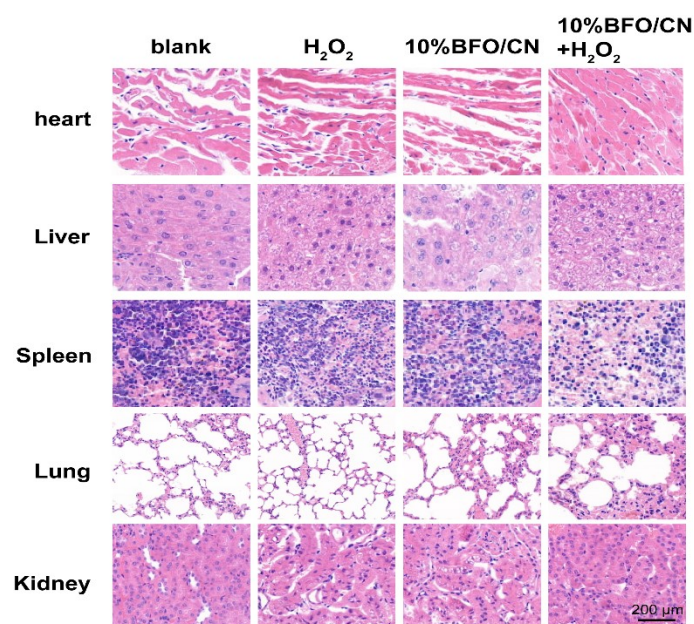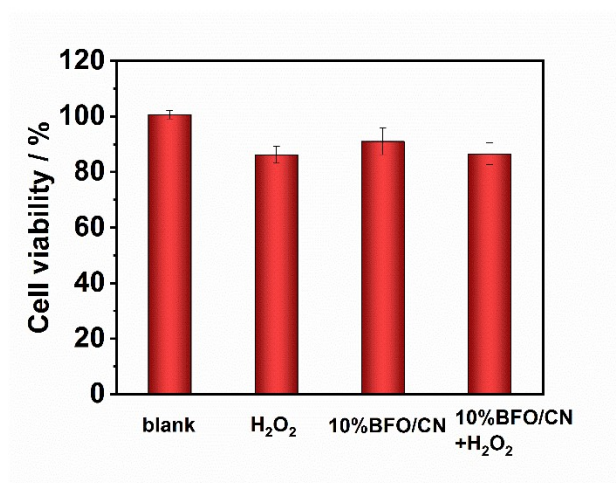

Fig. S11. Survival rate of bacteria under different conditions.

Fig. S12. H&E staining images of the heart, liver, spleen, lung and kidney of mice treated with different conditions.

Fig. S13. Cytotoxicity test of different materials.

1. R. You, H. L. Dou, L. Chen, S. H. Zheng and Y. P. Zhang, *Rsc Adv*, 2017, **7**, 15842-15850.