

Thermo-responsive polymer-black phosphorus nanocomposites for NIR-triggered bacterial capture and elimination

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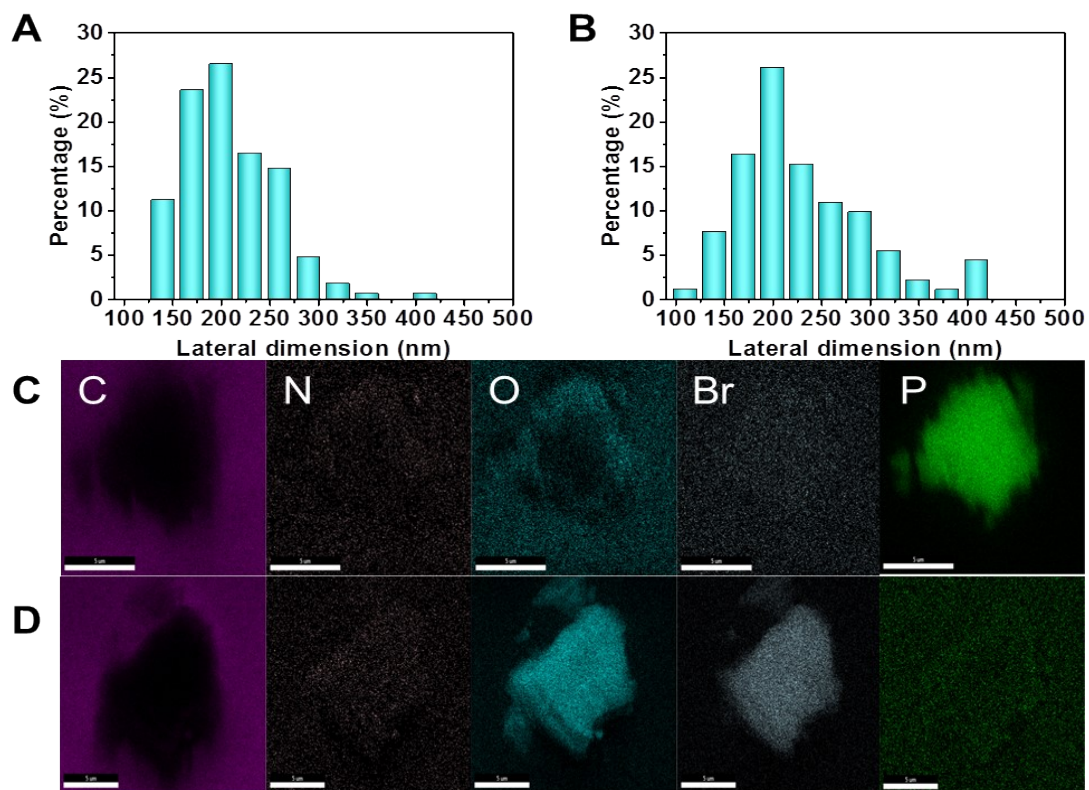


Fig. S1. Statistical analysis of lateral dimension from AFM images of BP nanosheets (A) and BP-PNIPAM (B); EDX images of BP nanosheets (C) and BP-PNIPAM (D).

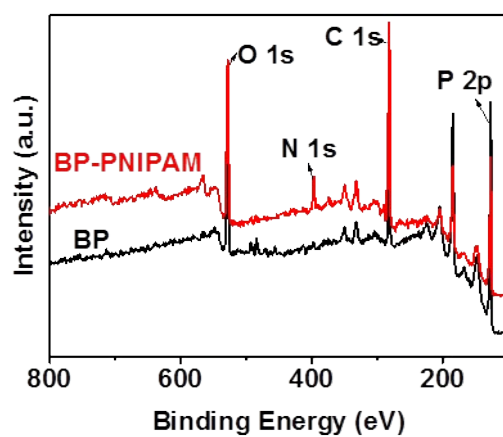


Fig. S2. XPS spectra of BP nanosheets and BP-PNIPAM.

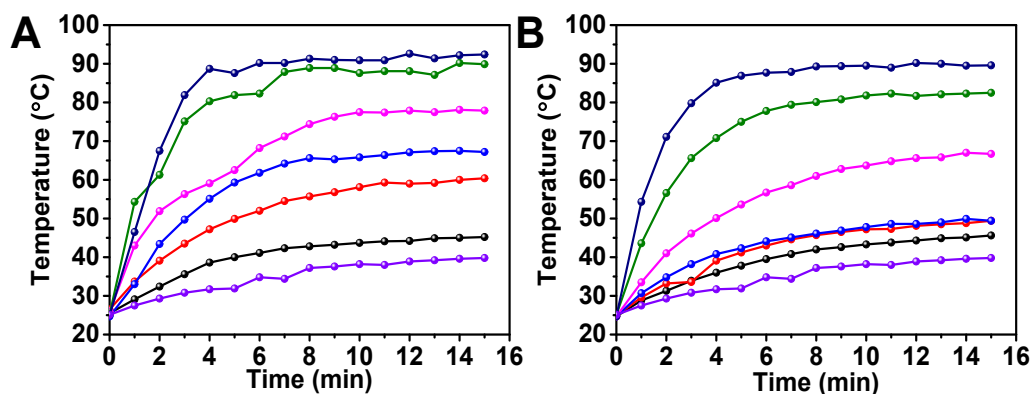


Fig. S3. Temperature curve of BP nanosheets (A) and BP-PNIPAM (B) at different concentration (Purple: water; Black: $10 \mu\text{g mL}^{-1}$; Red: $25 \mu\text{g mL}^{-1}$; Blue: $50 \mu\text{g mL}^{-1}$; Pink: $100 \mu\text{g mL}^{-1}$; Green: $250 \mu\text{g mL}^{-1}$; Indigo blue: $500 \mu\text{g mL}^{-1}$) under NIR light (808 nm , 2 W cm^{-2}) irradiation.

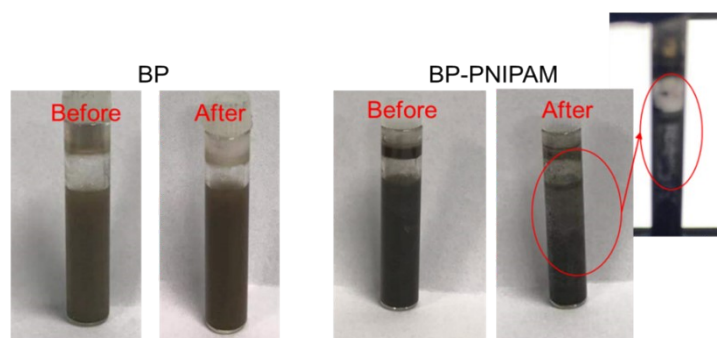


Fig. S4. Photographs of BP nanosheets and BP-PNIPAM before and after NIR light (808 nm , 2 W cm^{-1}) irradiation.

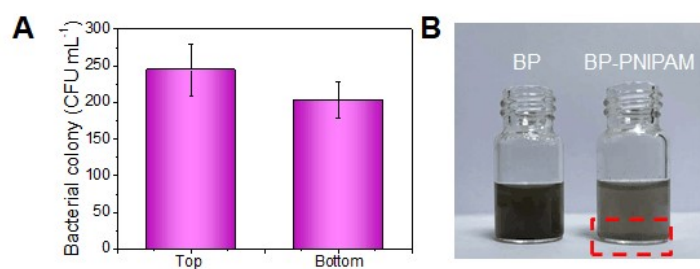


Fig. S5. (A) The colony number of *E. coli* in the top and bottom of the culture flask after 5-min standing; (B) Photographs of *E. coli* suspension in the presence of BP nanosheets or BP-PNIPAM ($200 \mu\text{g mL}^{-1}$) after 5-min NIR light (808 nm , 2 W cm^{-2}) irradiation.

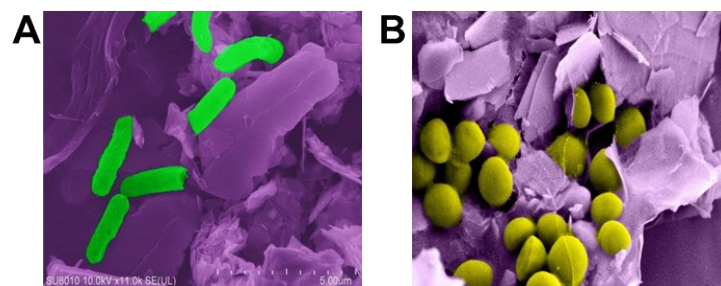


Fig. S6. SEM images of *E. coli* (A) and *S. aureus* (B) captured by 200 $\mu\text{g mL}^{-1}$ of BP-PNIPAM under 5-min NIR irradiation (808 nm, 2 W cm^{-2}).

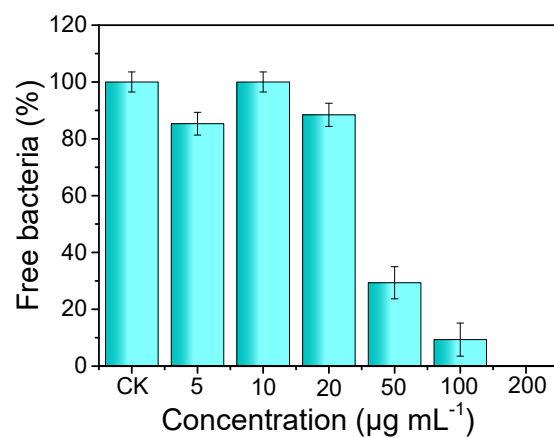
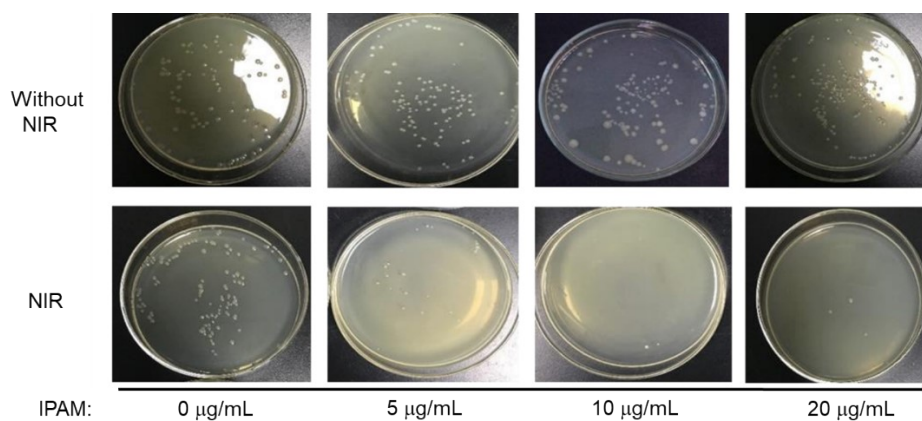


Figure S7 The capacity of BP-PNIPAM for capturing ampicillin-resistant *E. coli*.



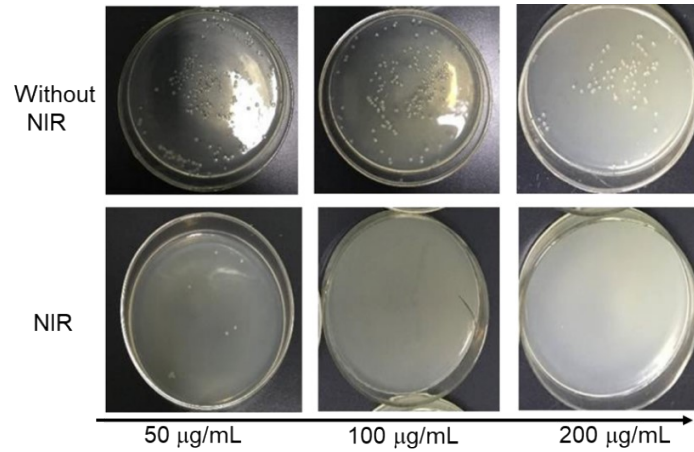


Fig. S8. Digital photographs of agar plate of *E. coli* treated with different concentrations of BP-PNIPAM with or without NIR light irradiation.

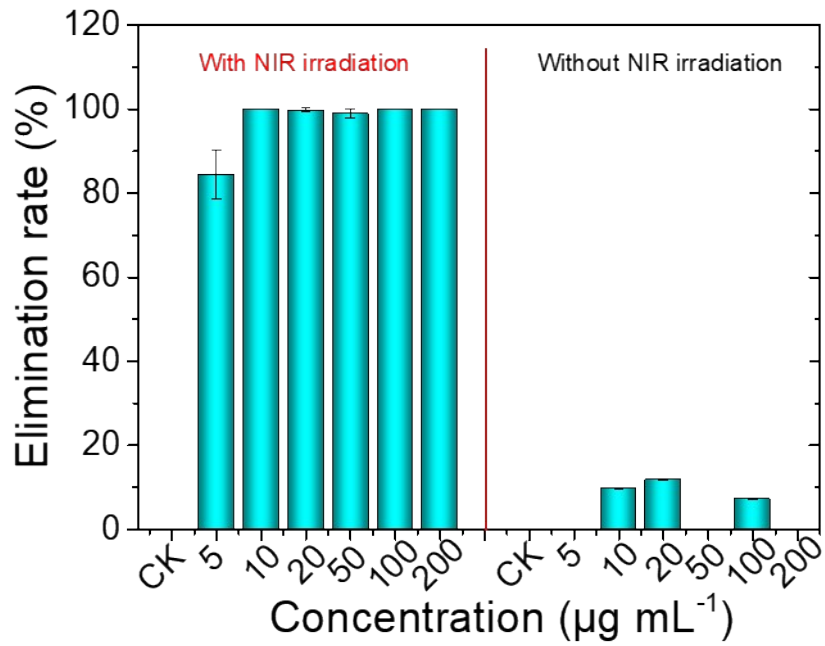


Figure S9. Elimination rate of *E. coli* treated with BP-PNIPAM at different concentrations with/without NIR irradiation.

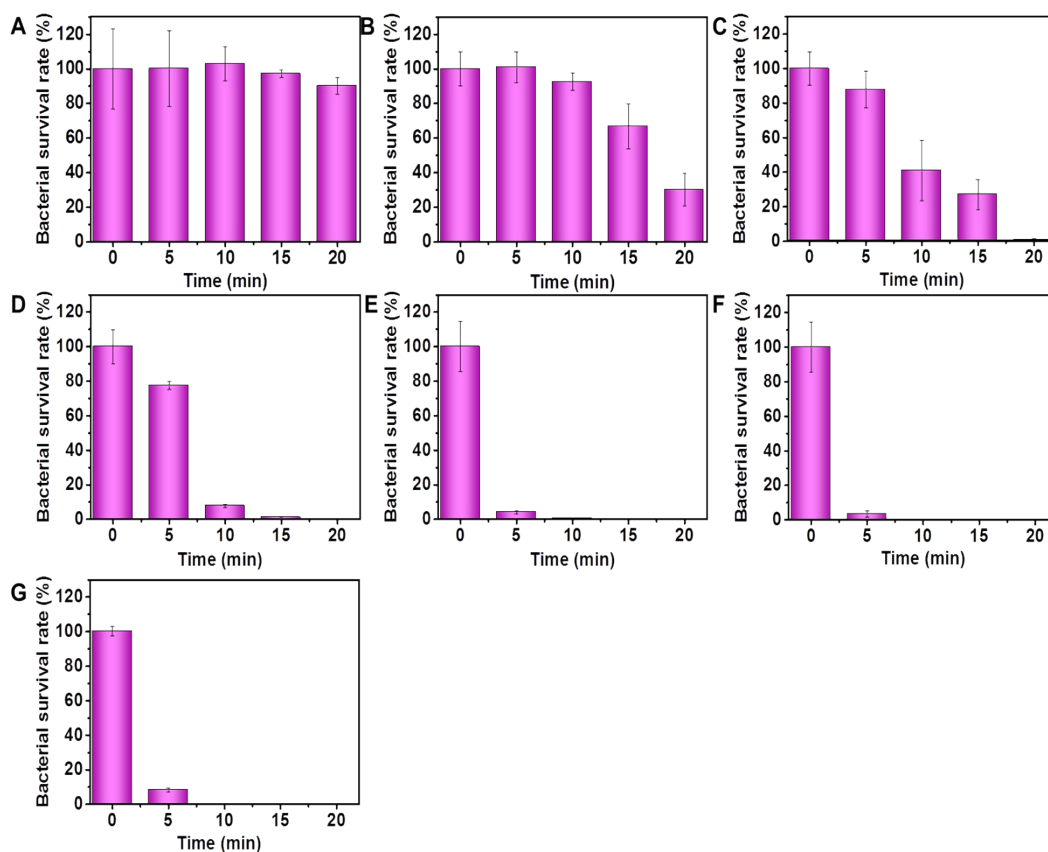


Fig. S10. Survival rate of *E. coli* treated with BP-PNIPAM at different concentrations (A: 0; B: 5 µg mL⁻¹; C: 10 µg mL⁻¹; D: 20 µg mL⁻¹; E: 50 µg mL⁻¹; F: 100 µg mL⁻¹; G: 200 µg mL⁻¹) under NIR light irradiation (0-20 min).

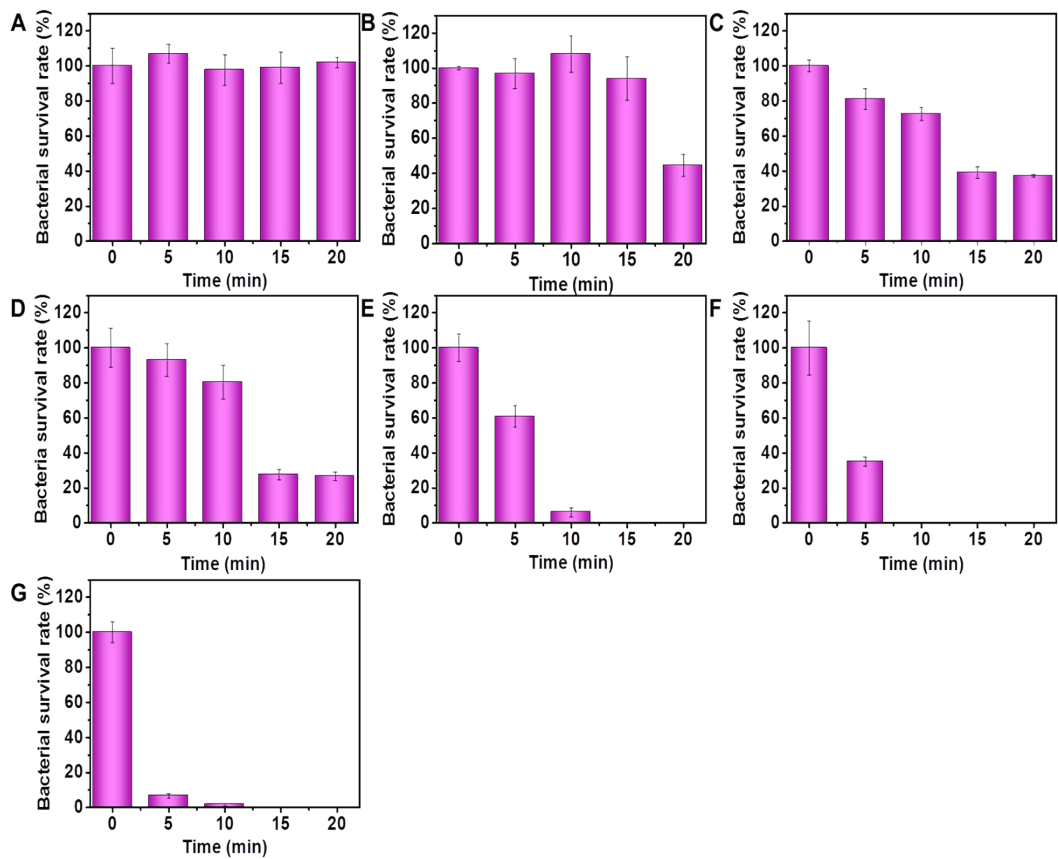


Fig. S11. Survival rate of *S. aureus* treated with BP-PNIPAM at different concentrations (A: 0; B: 5 $\mu\text{g mL}^{-1}$; C: 10 $\mu\text{g mL}^{-1}$; D: 20 $\mu\text{g mL}^{-1}$; E: 50 $\mu\text{g mL}^{-1}$; F: 100 $\mu\text{g mL}^{-1}$; G: 200 $\mu\text{g mL}^{-1}$) under NIR light irradiation (0-20 min).

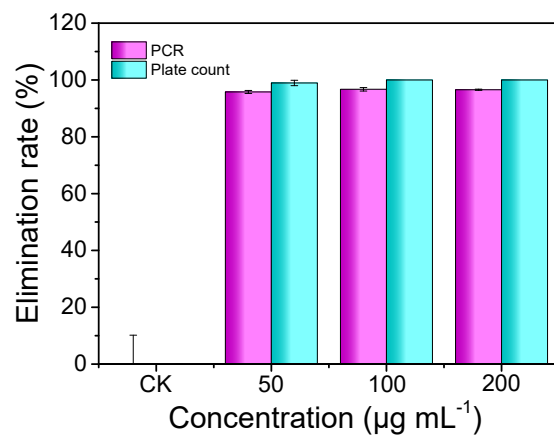


Fig. S12. Bacterial elimination by different concentrations of BP-PNIPAM determined by qPCR and colony-counting method.

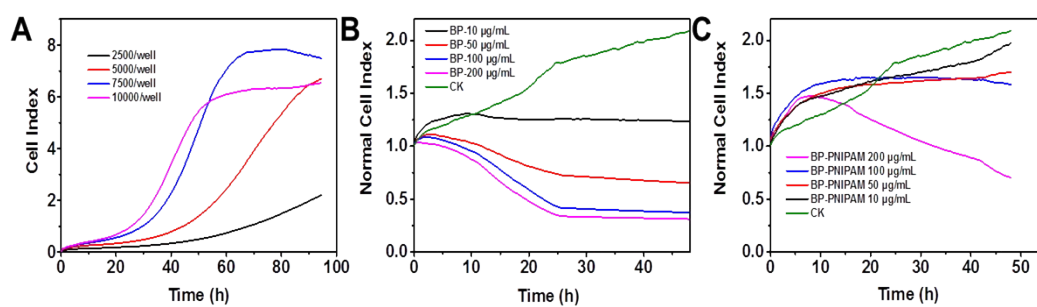


Fig. S13. (A) The proliferation profiles of Caco-2 at different culture densities; The proliferation profiles of Caco-2 treated with different concentration of BP nanosheets (B) and BP-PNIPAM (C) monitored by the RTCA device.

Table S1. Contents of P, N, O, and C in BP nanosheets and BP-PNIPAM determined by XPS.

Element	BP nanosheets (At%)	BP-PNIPAM (At%)
P	41.25	25.19
N	1.41	4.63
O	13.64	17.23
C	43.70	52.95

Table S2. The performance of bacterial capture and elimination for the materials reported in the literature. “C” refers to the materials with bacterial activity; “E” refers to materials with elimination activity; “CE” refers to materials with both bacterial capture and elimination activities; “+” refers to Gram-positive bacteria; “-” refers to Gram-negative bacteria.

	Materials	Particle Size	Capture dosage	Capture time	Capture efficiency	Driving force	Elimination dosage	Elimination time	Elimination efficiency	Cytotoxicity	Nanomaterials (YES/NO)	Ref
C1	Fe ₃ O ₄ @AA	10 nm	0.8 mg mL ⁻¹	20 min	(-) > 97%, 10 ⁷ CFU mL ⁻¹						YES	1
C2	AMP-MNPs	280 nm	0.5 mg mL ⁻¹	5 s	(+), (-) > 97%, 10 ⁷ CFU mL ⁻¹	-----	-----	-----	-----	-----	YES	2
C3	AF-CoFe ₂ O ₄	-----	2 mg mL ⁻¹	60 min	(+) 100%, 10 ⁷ CFU mL ⁻¹ ; (-) 65%, 10 ⁷ CFU mL ⁻¹	-----	-----	-----	-----	> 85%, 1 mg mL ⁻¹ , 24 h	YES	3
C4	Fe ₃ O ₄ @Al ₂ O ₃ MNPs	14.5 ± 1.6 nm.	500 µg mL ⁻¹	60 s	(+)	-----	-----	-----	-----	-----	YES	4
C5	Fe ₃ O ₄ @CTAB	10 nm	0.5 g L ⁻¹	60 min	(+), (-) 99%, 10 ⁷ CFU mL ⁻¹	-----	-----	-----	-----	-----	YES	5
E1	CS/ AM NSs hydrogel	Thickness: 0.85–1.78 nm	-----	-----	-----	Light irradiation	-----	10 min	(-) 97.1%, 10 ⁶ CFU mL ⁻¹ (+) 100%, 10 ⁶ CFU mL ⁻¹	89%, 4 h	NO	6
E2	KGM/Gelatin@Au NPs/ GS	-----	-----	-----	-----	-----	(-) 2 µg mL ⁻¹ (+) 4 µg mL ⁻¹	480 min	(+),(-)100%,10 ⁸ CFU mL ⁻¹	89.04%, 0.01 g, 24 h	NO	7
E3	RBC@Fe ₃ O ₄	110 nm	-----	-----	-----	Light irradiation	100 µg mL ⁻¹ of Fe	5min	(+) 100%, 10 ⁸ CFU mL ⁻¹	-----	YES	8

E4	Ag-PPAni-II	-----	-----	-----	-----	Ag ⁺	-----	6 days	(+), (-) 100%, 10 ⁹ CFU mL ⁻¹	-----	NO	9
E5	Melanin powder	200 ± 18 nm	-----	-----	-----	Chemical action	25 mg mL ⁻¹	62 min	(-) 88%, 10 ⁶ CFU mL ⁻¹ ; (+) 100%, 10 ⁶ CFU mL ⁻¹	50%, 55.6 μg mL ⁻¹ , 48 h	YES	10
CE1	Fe ₃ O ₄ @SiO ₂ -NH ₂	10 – 53 nm	6 mg mL ⁻¹	10 min	(+) 96%, 10 ⁹ CFU mL ⁻¹ ; (-) 96%, 10 ⁸ CFU mL ⁻¹	radiofrequency current	1 mg mL ⁻¹	30 min	100%, 10 ⁸ CFU mL ⁻¹	-----	YES	11
CE2	MoS ₂ -Hydrogel	-----	-----	30 min	(+) 37.3%, 10 ⁶ CFU mL ⁻¹ ; (-) 27.3%, 10 ⁶ CFU mL ⁻¹	Light irradiation	-----	300 min	(+), 10 ⁶ CFU mL ⁻¹ (-), 10 ⁶ CFU mL ⁻¹	90%, 24 h	NO	12
CE3	Ag@Fe ₂ O ₃ yolk-shell	-----	128 μg mL ⁻¹	30 min	(-) 99%, 10 ⁷ CFU mL ⁻¹	-----	128 μg mL ⁻¹	30 min	(-), 100% 10 ⁷ CFU mL ⁻¹	-----	YES	13
@	BP-PNIPAM	-----	50-100 μg mL ⁻¹	5 min	(+) >90%, 10 ⁷ CFU mL ⁻¹ ; (-) >80%, 10 ⁷ CFU mL ⁻¹	Light irradiation	20 μg mL ⁻¹	20 min	(+) 100%, 10 ⁷ CFU mL ⁻¹ ; (-) 100%, 10 ⁷ CFU mL ⁻¹	> 90%, 50 μg mL ⁻¹ , 48 h	-----	This work

Notice: Fe₃O₄@AA represents amino acids functionalized Fe₃O₄; AMP-MNPs represent antimicrobial peptide functionalized Fe₃O₄; AF-CoFe₂O₄ represents amine-functionalized cobalt ferrite; Fe₃O₄@Al₂O₃ MNPs represent aluminum oxide-coated iron oxide (Fe₃O₄@Al₂O₃) MNPs with the peptide HHHHHHDEEGLFVD; Fe₃O₄@CTAB represents Fe₃O₄ nanoparticles modified with cetyltrimethylammonium bromide (CTAB); CS/AM NSs hydrogel represents chitosan hydrogel with antimonene nanosheets; KGM/Gelatin@Au NPs/GS represents mixture of konjac glucomannan (KGM) and gelatin enveloping Au NPs mixed with gentamicin sulfate (GS); RBC@Fe₃O₄ represents red blood cell membrane-coated Fe₃O₄ nanoparticles; Ag-PPAni-II represents silver (Ag) and plasma polymerized aniline (PPAni) composite.

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