

Supporting Information

Tremella-Like ZnO@Col-I-Decorated Titanium Surfaces with Dual-Light-Defined Broad-Spectrum Antibacterial and Triple Osteogenic Properties

Siyu Zhao^{1, 2, 3}, Yingying Xu^{1, 3}, Wenying Xu⁴, Zhenzhen Weng⁵, Fei Cao², Xinyi Wan², Tongcan Cui², Yajun Yu², Lan Liao^{1, 3*}, Xiaolei Wang^{2, 5*}

¹Affiliated Stomatological Hospital, Nanchang University, Nanchang 330006, China

²National Engineering Research Center for Bioengineering Drugs and the Technologies, Institute of Translational Medicine, Nanchang University, Nanchang 330088, China

³Key Laboratory of Oral Biomedicine, Jiangxi Province, Nanchang 330006, China

⁴Wuhan Hospital of Traditional Chinese and Western Medicine, Wuhan, 430022, China

⁵College of Chemistry, Nanchang University, Nanchang 330088, China

*Corresponding authors.

E-mail: Liaolan5106@ncu.edu.cn

E-mail: wangxiaolei@ncu.edu.cn

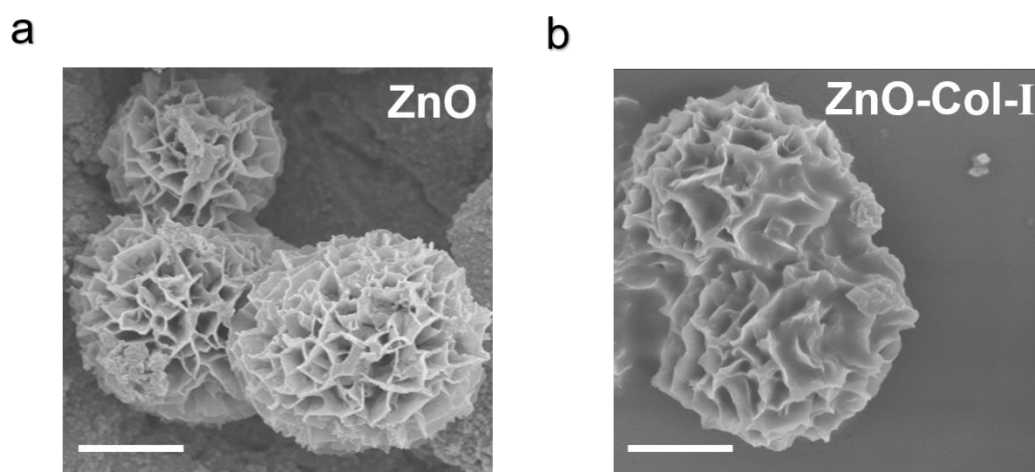


Figure S1. SEM images of ZnO before (a) and after (b) absorption of Col-I (scale bar = 1 μm).

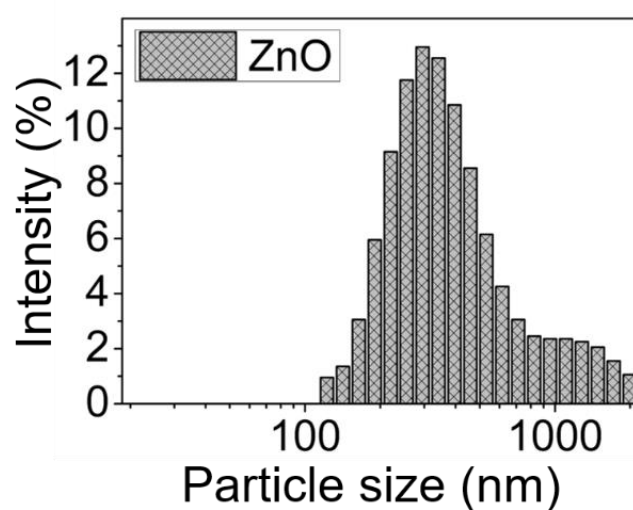


Figure S2. Particle size distribution of ZnO.

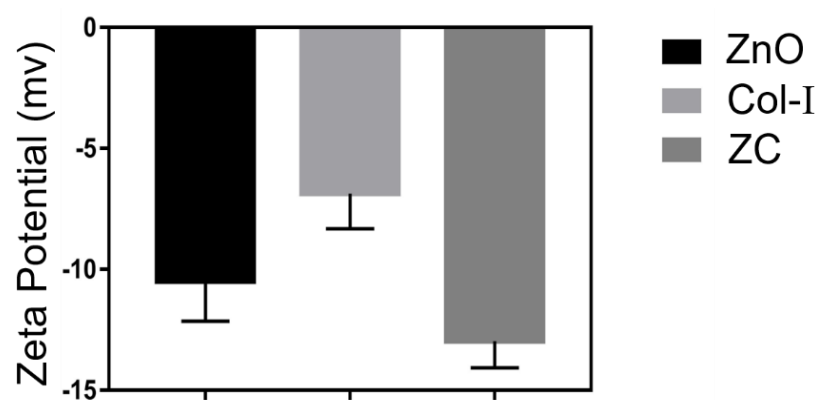


Figure S3. ζ -potential of ZnO, Col-I and ZC. Data are mean \pm SD ($n = 3$).

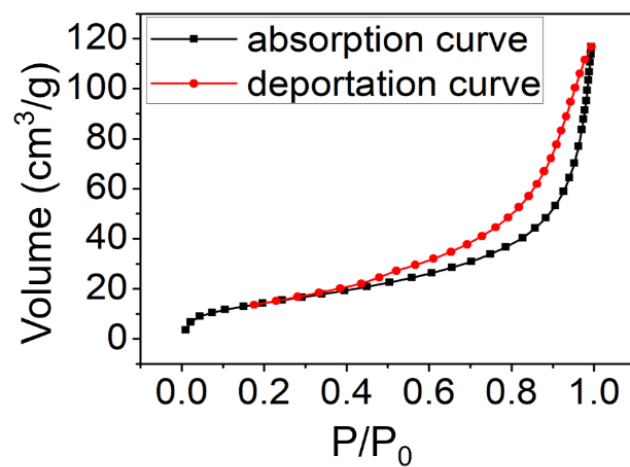


Figure S4. N₂-physical adsorption isotherm of ZnO.

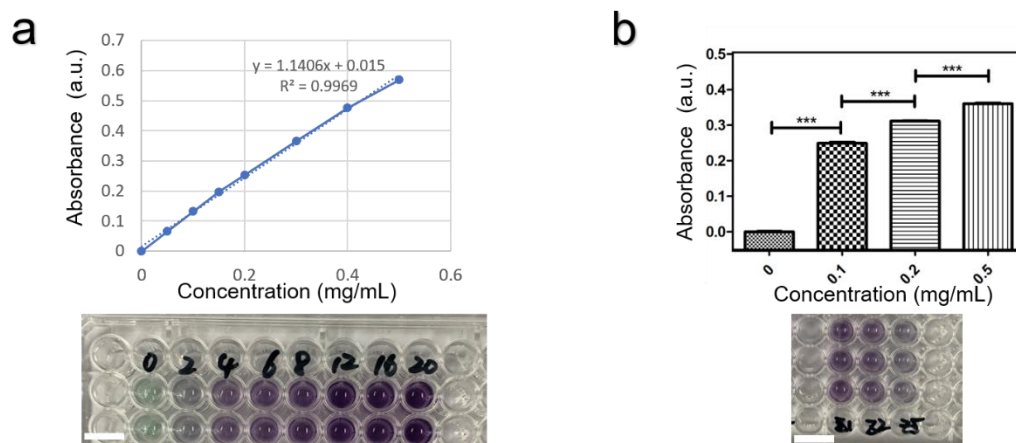


Figure S5. (a) Standard curve of BSA (scale bar = 1 cm). (b) Absorption of BSA by ZnO (scale bar = 1 cm). Data are mean \pm SD ($n = 3$). * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

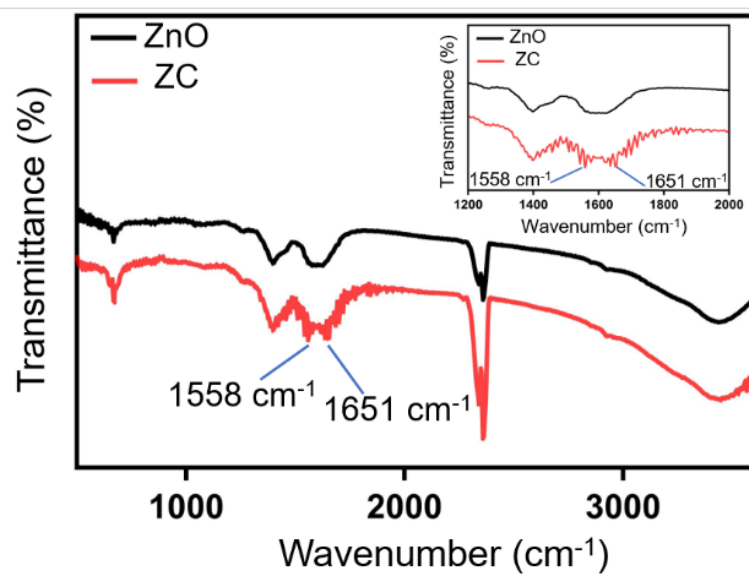


Figure S6. FTIR spectra of ZnO and ZC.

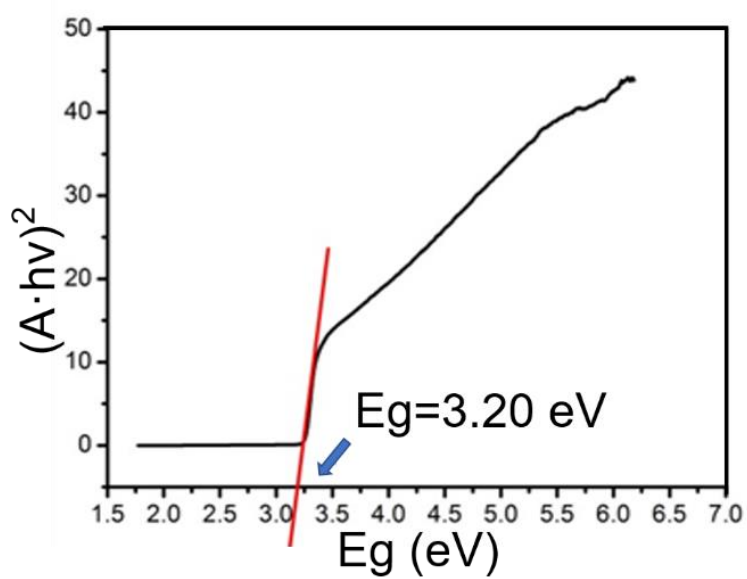


Figure S7. Band gap of conventional ZnO.

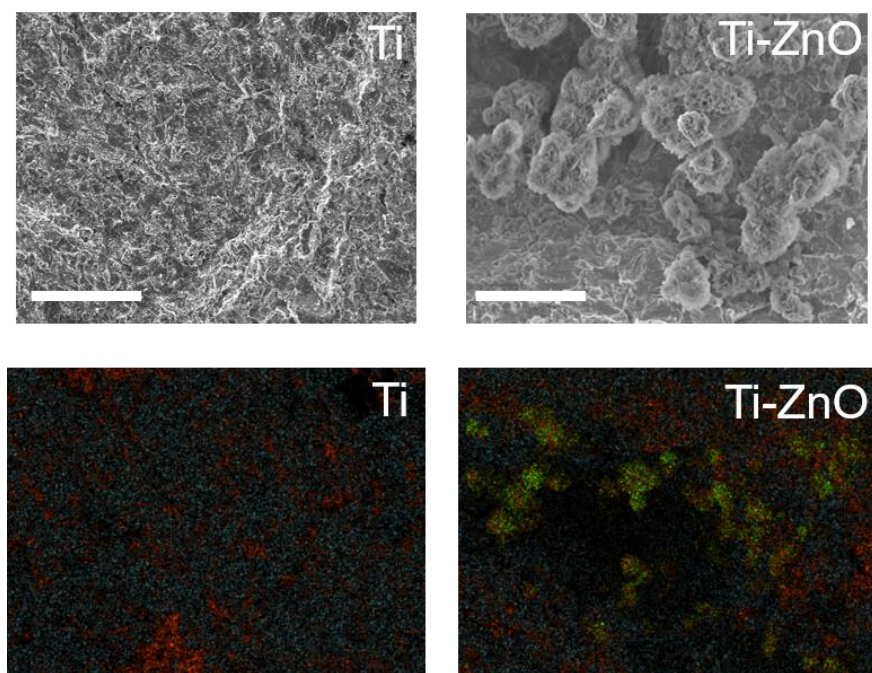


Figure S8. SEM and EDS images of Ti and Ti-ZnO. Blue color refers to Ti element. Red color refers to O element. Green color refers to Zn element (scale bar = 2 μm).

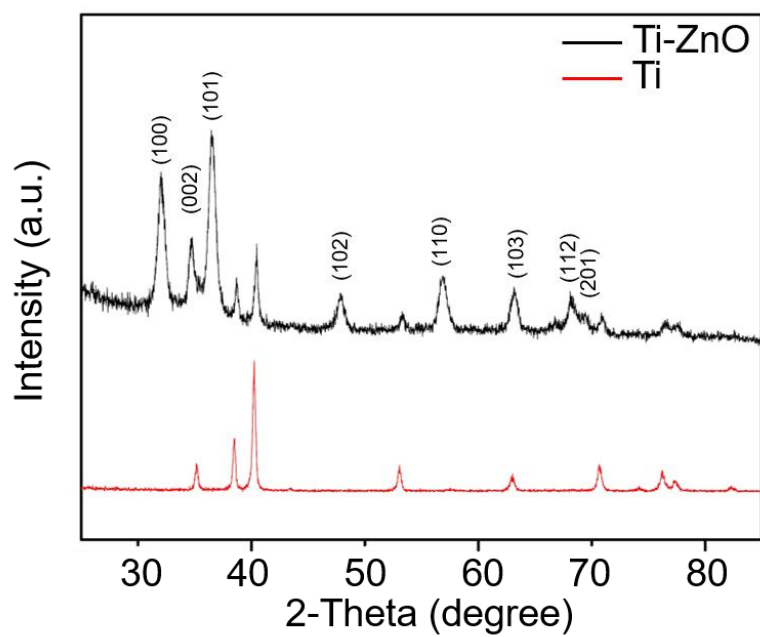


Figure S9. XRD spectra of Ti and Ti-ZnO.

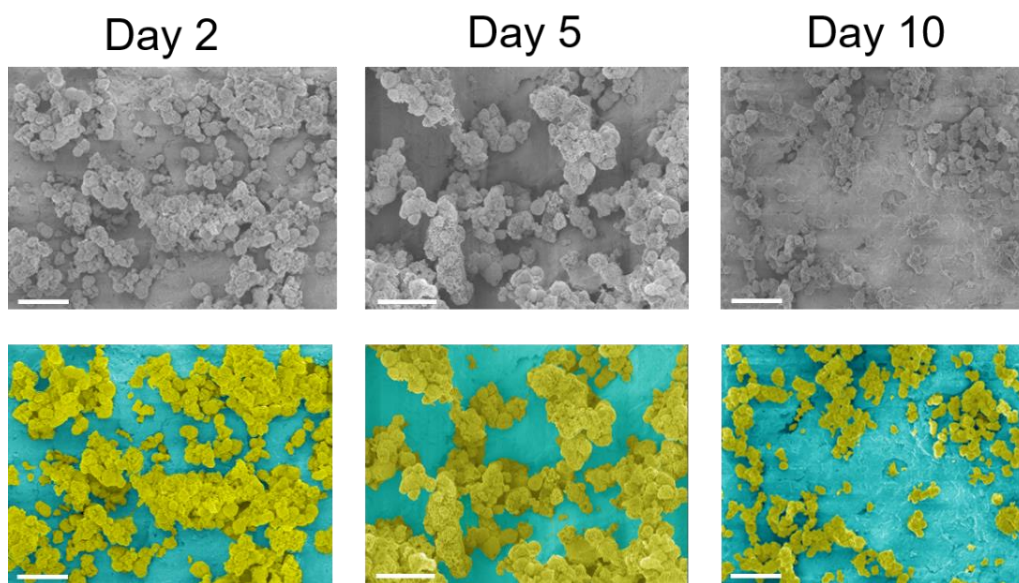


Figure S10. SEM images of Ti-ZC after immersion in PBS for different times. Yellow color represents ZC (scale bar = 10 μm).

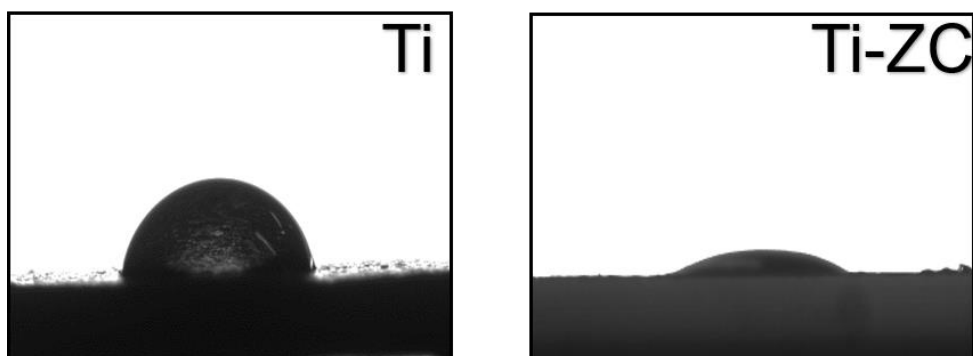


Figure S11. Water contact angles of different Ti samples.

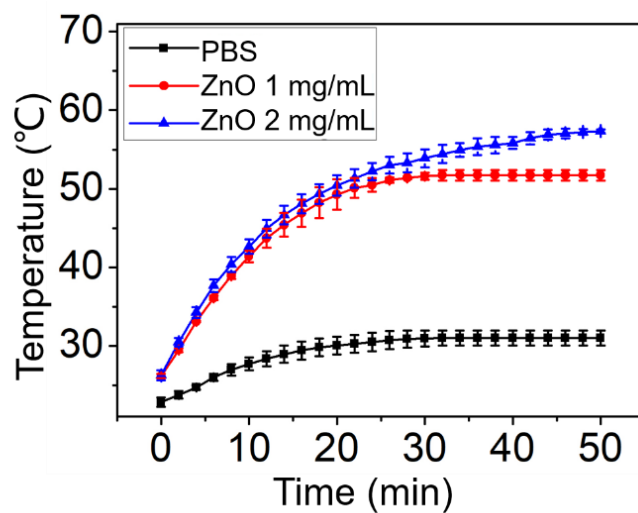


Figure S12. Temperature rising curves of ZnO with different concentrations. Data are mean \pm SD ($n = 3$).

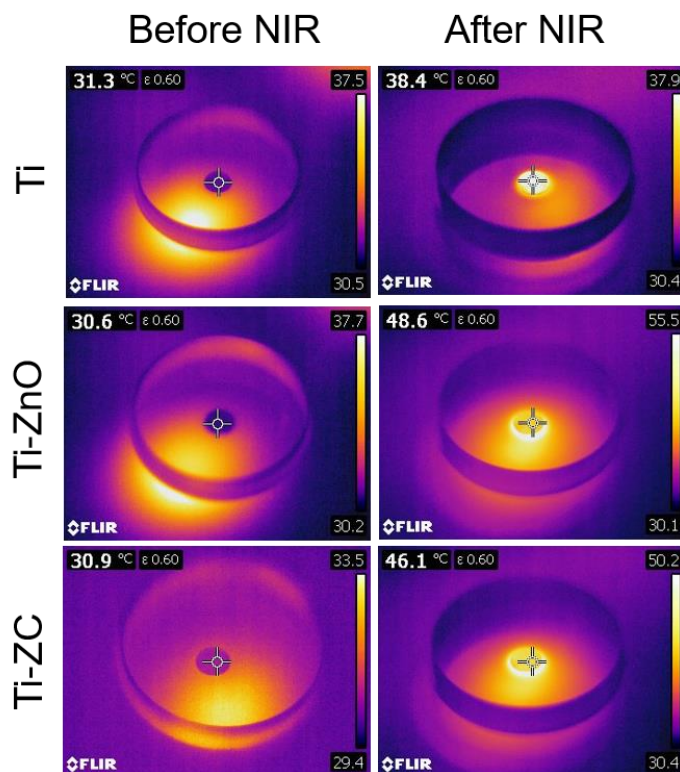


Figure S13. The IRT images of Ti, Ti-ZnO and Ti-ZC under NIR irradiation.

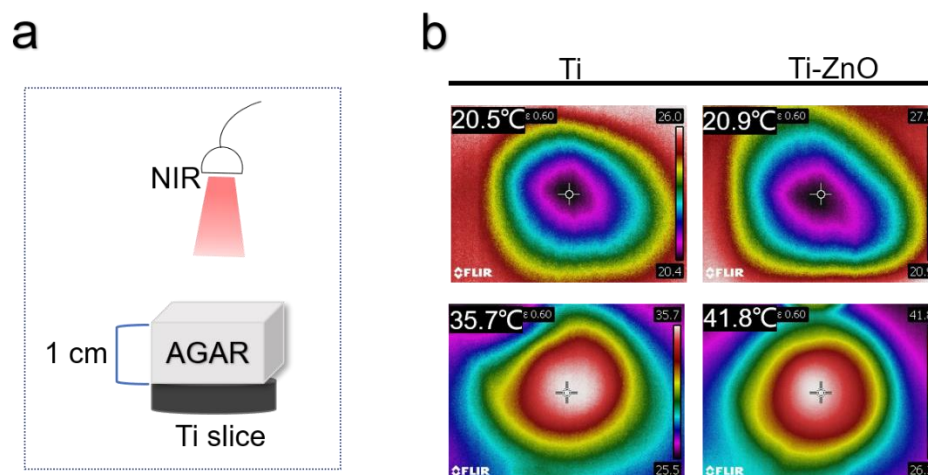


Figure S14. (a) Schematic diagram of experiment. (b) IRT images of Ti and Ti-ZC under NIR irradiation.

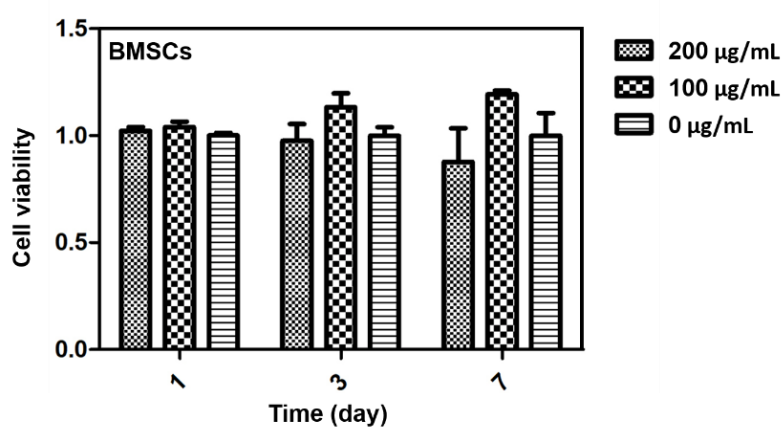


Figure S15. Cytocompatibility of ZnO to BMSCs. Data are mean \pm SD ($n = 3$).

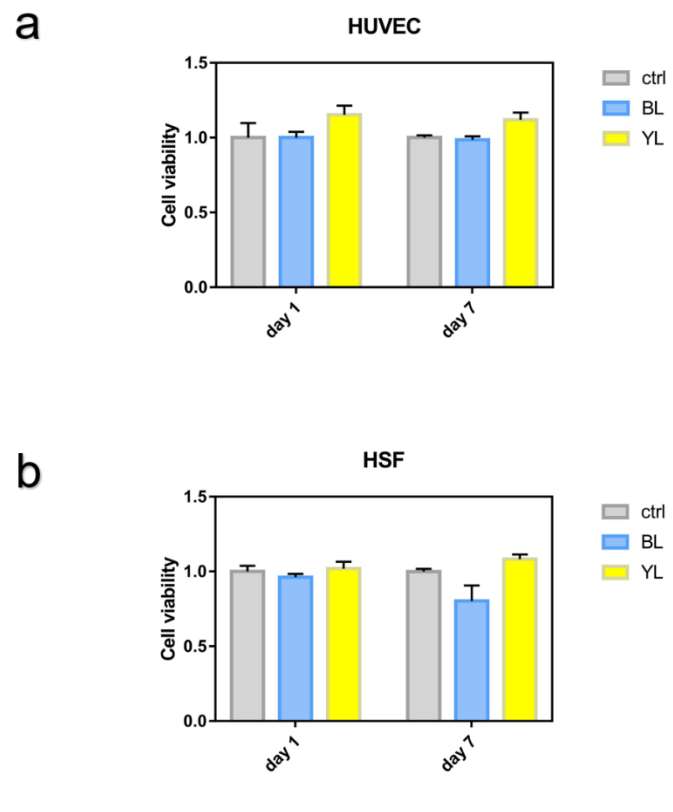


Figure S16. Cell viability of HUVECs (a) and HSF cells (b) under YL and BL irradiation for 1 day or 7 days. Data are mean \pm SD ($n = 3$).

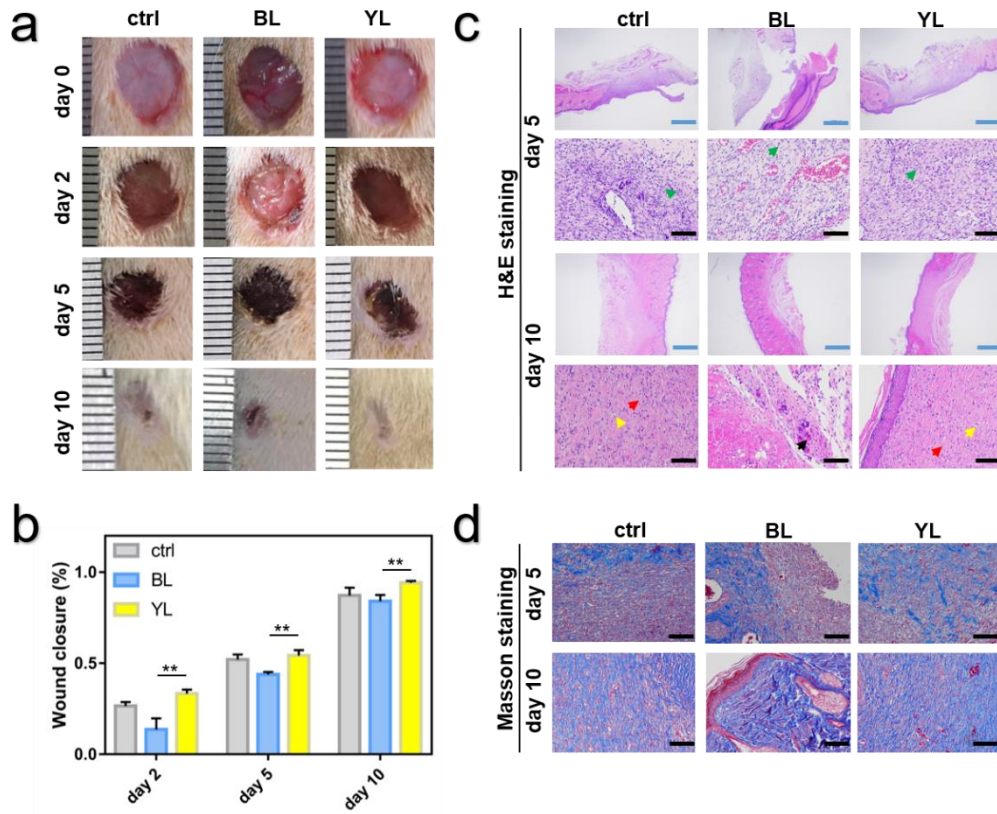


Figure S17. *In vivo* assessment of YL with wound healing capability. (a) Photographs of infected wound with different light irradiations at different time points. (b) Corresponding wound area reduction rate at the different time points. (c) H&E staining images of skin tissues in different groups showing the degree of infection after 5 days and 10 days (scale bar =100 μm (black bar), 1000 μm (blue bar)). (d) Masson staining images of different groups showing the degree of collagenation after 5 days and 10 days (scale bar =100 μm). Data are mean \pm SD ($n = 3$). $*p < 0.05$, $**p < 0.01$, $***p < 0.001$.

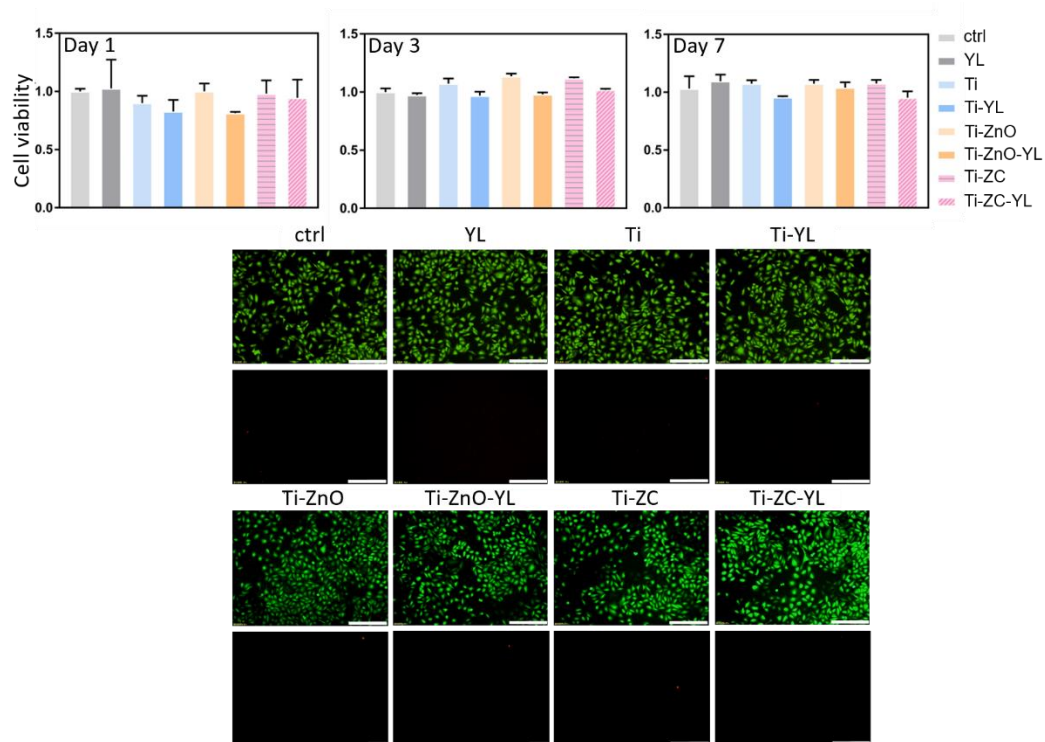


Figure S18. Cytocompatibility of different Ti samples to HUVECs. Live and dead cells were labeled by green and red fluorescent stains (scale bar = 200 μm). Data are mean \pm SD ($n = 3$).

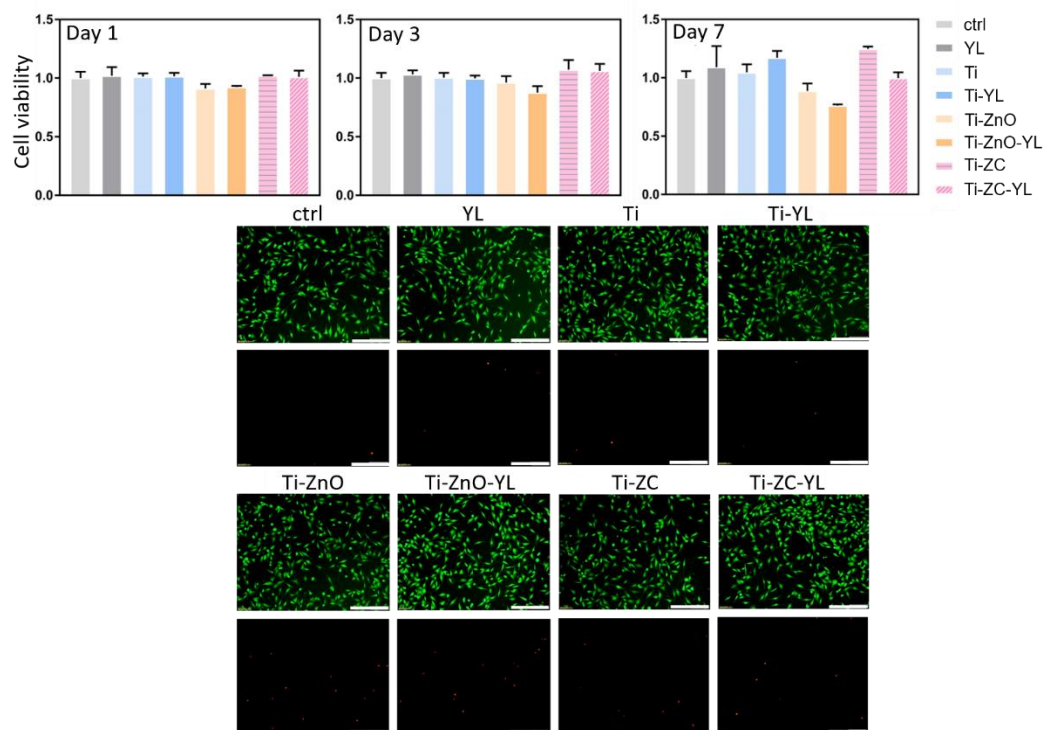


Figure S19. Cytocompatibility of different Ti samples to HSF cells. Live and dead cells were labeled by green and red fluorescent stains (scale bar = 200 μm). Data are mean \pm SD ($n = 3$).

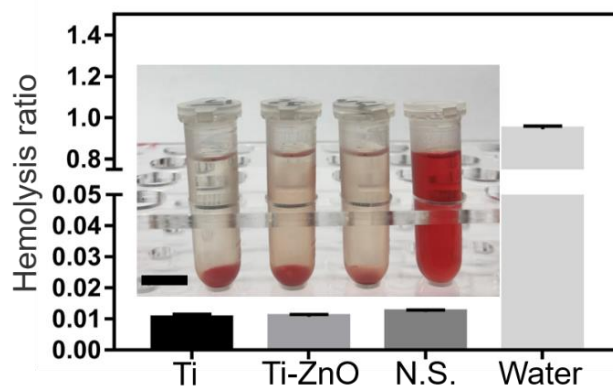


Figure S20. Hemolysis percentage of RBC with different Ti samples (scale bar = 1 cm). Data are mean \pm SD ($n = 3$).

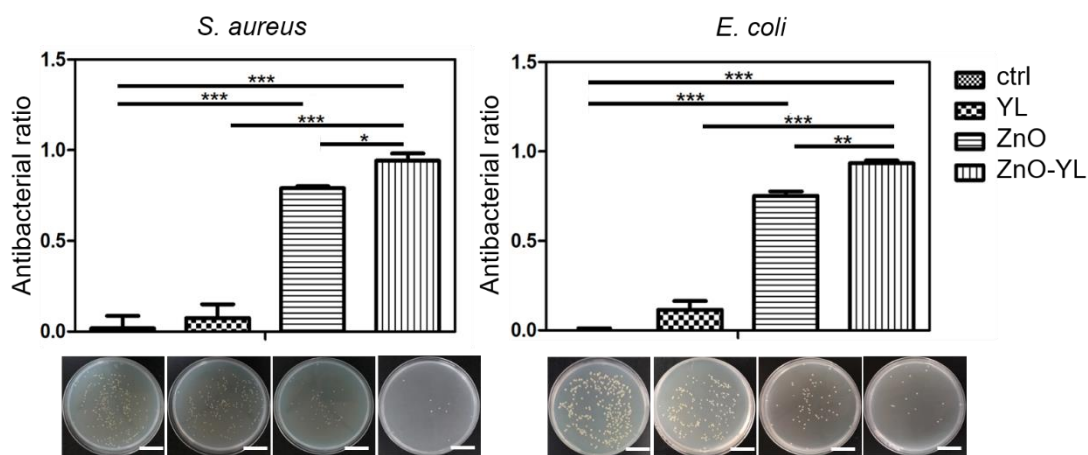


Figure S21. Antibacterial ratio of ZnO (200 $\mu\text{g mL}^{-1}$) against *S. aureus* and *E. coli* combined with or without YL irradiation via plate count method (scale bar = 2 cm). Data are mean \pm SD ($n = 3$). $*p < 0.05$, $**p < 0.01$, $***p < 0.001$.

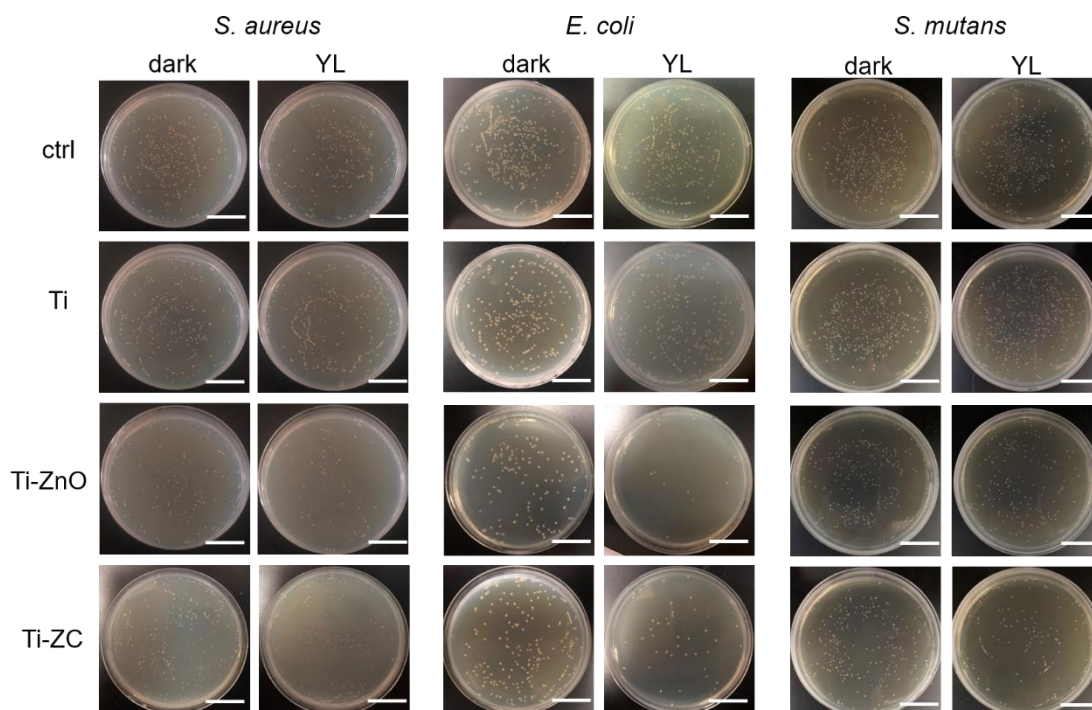


Figure S22. Representative images of viable *S. aureus*, *E. coli* and *S. mutans* grown on the plate after culturing with different Ti samples combined with or without YL irradiation as referred to Figure 3e-g (scale bar = 3 cm).

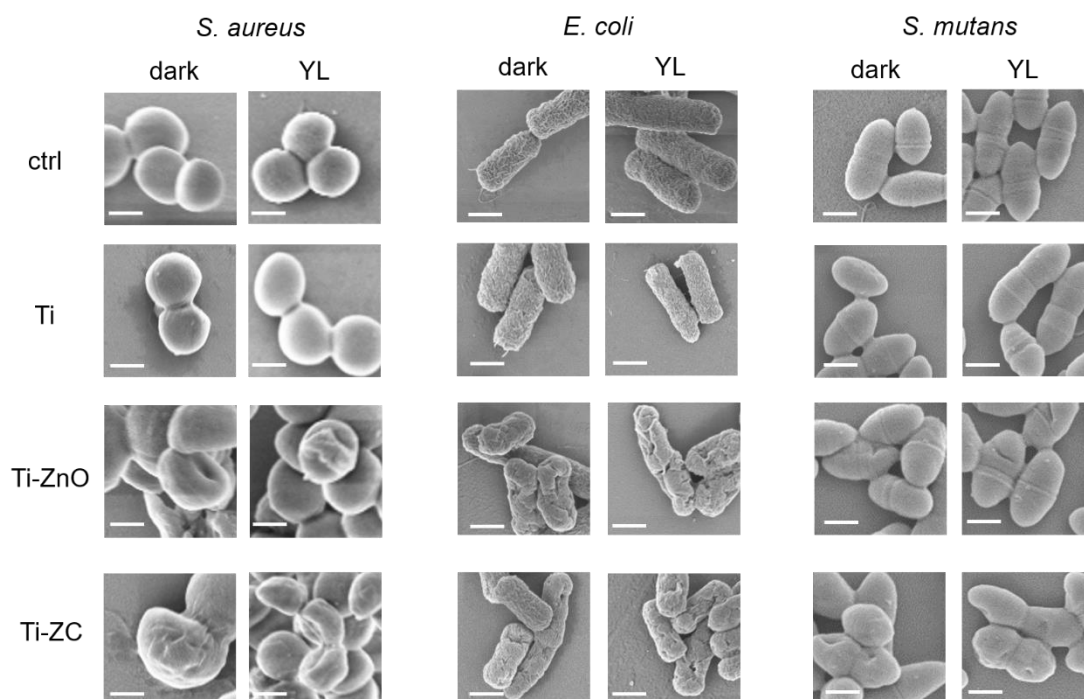


Figure S23. SEM images of bacteria after culturing with different Ti samples combined with or without YL irradiation as referred to Figure 3h-j (scale bar = 1 μ m).

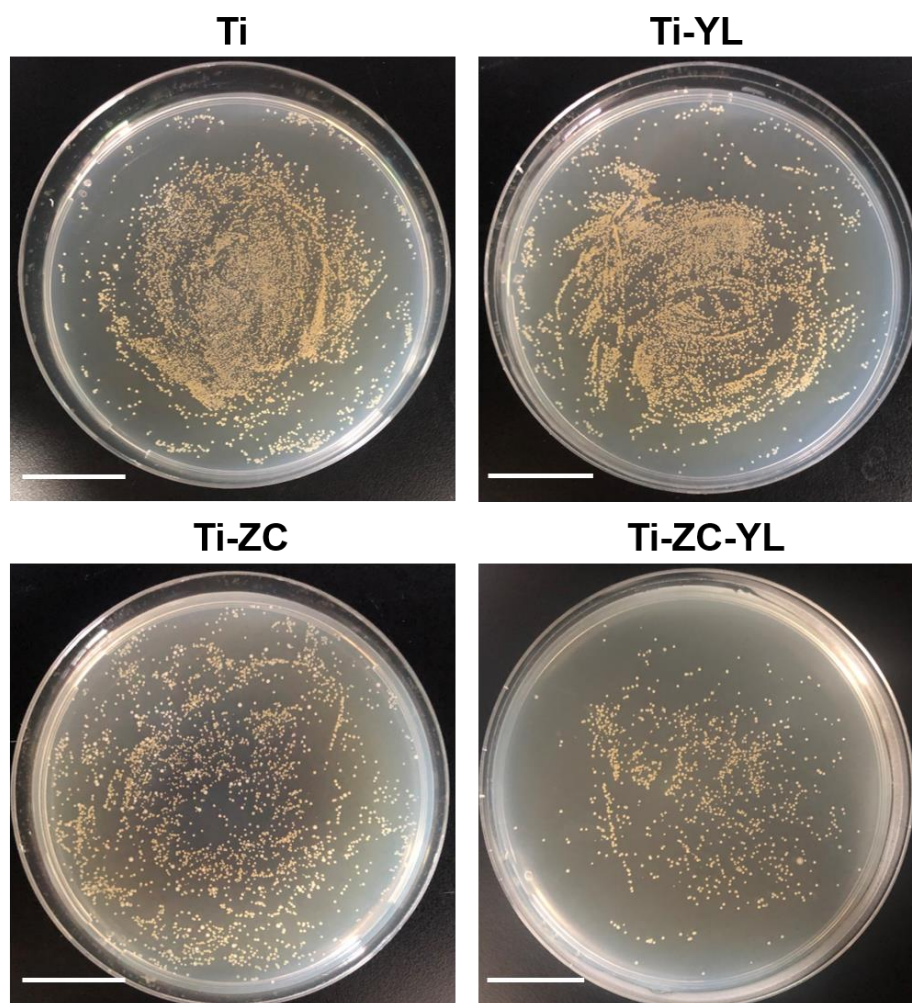


Figure S24. Representative images of viable *S. aureus* grown on the plate in different groups as referred to Figure 5b (scale bar = 2 cm).

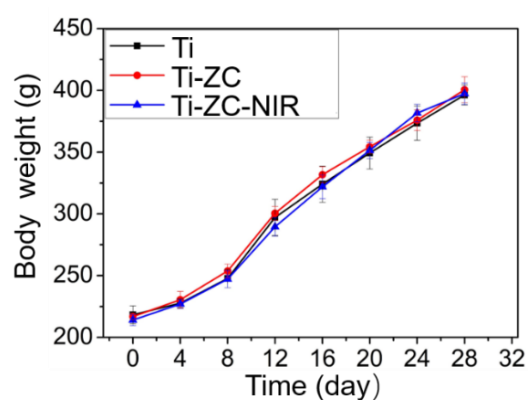


Figure S25. Body weight variation of rats in different groups during 28 days of treatment. Data are mean \pm SD ($n = 3$).

Abbreviation	Full name
ZnO	Zinc oxide
ZC	Zinc oxide combined with Col-I
BL	Blue light
YL	Yellow light
ZnO-YL	Zinc oxide combined with yellow light
Ti	Titanium
Ti-YL	Titanium combined with yellow light
Ti-ZnO	Zinc oxide coated titanium
Ti-ZnO-YL	Zinc oxide coated titanium combined with yellow light
Ti-ZC	ZC coated titanium
Ti-ZC-YL	ZC coated titanium combined with yellow light
Ti-ZC-NIR	ZC coated titanium combined with NIR

Table S1. The abbreviations and corresponding full names of different groups in our experiments.

Target mRNA	Primers (5'-3')	Size (bp)
R-GAPDH-S	CTGGAGAAACCTGCCAAGTATG	138
R-GAPDH-A	GGTGGAAGAATGGGAGTTGCT	
R-Runx2-S	CAGTATGAGAGTAGGTGTCCCGC	152
R-Runx2-A	AAGAGGGGTAAGACTGGTCATAGG	
R-OCN-S	CCCTGACTGCATTCTGCCTCT	136
R-OCN-A	CCAAGTCCATTGTTGAGGTAGCG	
R-TNF- α -S	CCAGGTTCTCTTCAAGGGACAA	80
R-TNF- α -A	GGTATGAAATGGCAAATCGGCT	

Table S2. Quantitative-polymerase chain reaction primers using in this paper.

	Normal Range	Ti	Ti-ZC	Ti-ZC-NIR
RBC	5.6-7.89 ($10^{12}/L$)	6.8	6.6	6.4
WBC	2.9-15.3 ($10^9/L$)	5.9	7.6	9.2
PLT	100-1610 ($10^9/L$)	653	652	611
HGB	120-150 (g/l)	127	124	121
HCT	36-46 (%)	39.7	38.5	36.8
MCH	16-23.1 (pg)	18.6	18.6	18.8
MCHC	300-341 (g/l)	321	321	329
MCV	53-68.8 (fl)	58.3	58.1	57.5
RDW	11-15.5 (%)	11.7	12.2	12

Table S3. Routine blood test of rats in different groups after treatment for 28 days.

Video S1. Hydrophilic property of Ti-ZC samples.