

Supporting Information on:

**Photocatalytic antibacterial application of zinc oxide nanoparticles  
and self-assembled networks under dual UV irradiation for enhanced  
disinfection**

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*Field emission-scanning electron microscopy (FE-SEM) of conventional ZnO particles*

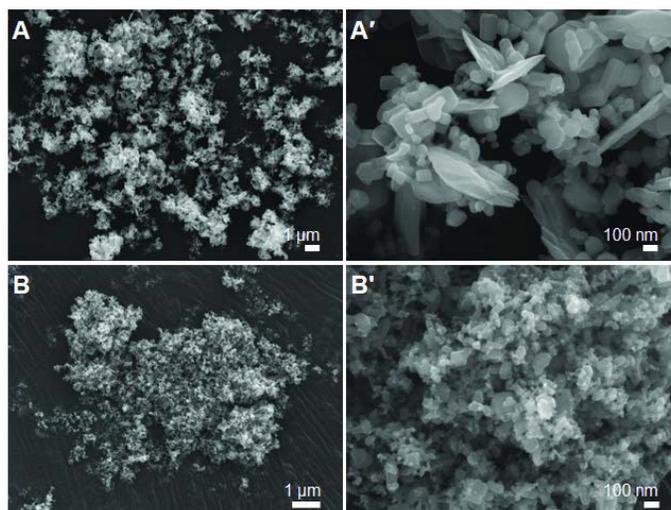


Figure S1 FE-SEM images of conventional ZnO particles: (A, A') nano- to micro-ZnO (hybrid-ZnO) and (B, B') nano-ZnO.

*X-ray photoelectron spectroscopy (XPS) of ZnO particles*

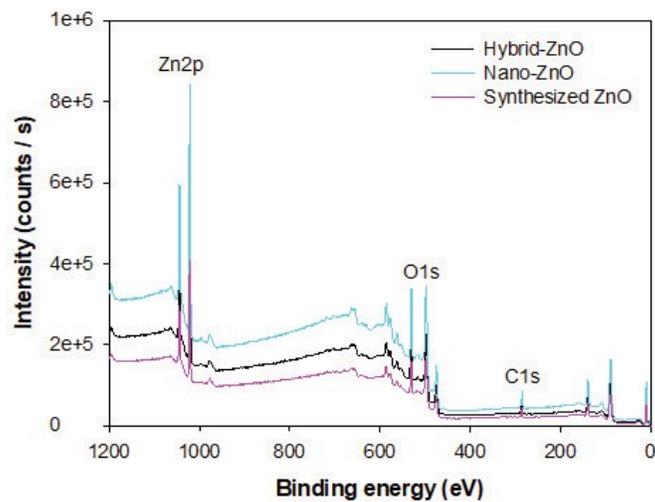


Figure S2 XPS spectra of ZnO particles. Binding energy peaks of ZnO particles were respectively detected at 1,021 eV and 1,044 eV for Zn2p, 530 eV for O1s and 285 eV for C1s.

*FE-SEM of conventional ZnO particles immobilized on Si wafers*

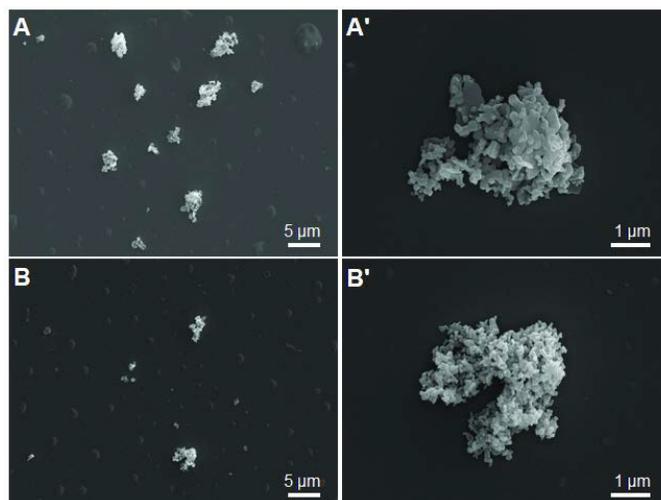


Figure S3 FE-SEM images of (A, A') hybrid-ZnO and (B, B') nano-ZnO on Si wafers. Their concentrations were fixed at 0.5 mg/wafer.

*Inductively coupled plasma-mass spectrometry (ICP-MS)*

The concentrations of Zn ion released from ZnO particles immobilized on Si wafers were monitored using an ICP-MS (ELAN6100, PerkinElmer, USA). Water samples were collected after 24-h incubation and directly injected into the equipment without further treatment at the flow rate of 0.5 mL/min. Operation conditions were 1,500 W, 18 L/min, 1.25 L/min, and 1.02 L/min of RF power, plasma gas flow, auxiliary gas flow, and nebulizer gas flow, respectively.

Table S1 Zn ion release from ZnO particles immobilized on Si wafer (n=3).

Immobilized particles (concentration)	Hybrid-ZnO	Nano-ZnO	Synthesized ZnO
	(0.05 mg/Si wafer)		
Zn ion detection	N.D.	N.D.	N.D.

N.D.: not detected

## Gene ontology (GO) analysis

Table S2 Gene ontology (GO) of oxidative stress in *E. coli* (EcoCyc).

GO-terms	Parents of GO class	Children of GO class	GO term members
GO:0006979 - response to oxidative stress	GO:0006950 - response to stress	GO:0071450 - cellular response to oxygen radical GO:0071451 - cellular response to superoxide GO:0000303 - response to superoxide GO:0071731 - response to nitric oxide GO:1901530 - response to hypochlorite GO:0034599 - cellular response to oxidative stress GO:0000305 - response to oxygen radical GO:0033194 - response to hydroperoxide GO:0070301 - cellular response to hydrogen peroxide GO:0071732 - cellular response to nitric oxide GO:0033195 - response to alkyl hydroperoxide GO:0000302 - response to reactive oxygen species GO:0042542 - response to hydrogen peroxide GO:0034614 - cellular response to reactive oxygen species	DUF1107 domain-containing protein YtfK fused DNA-binding transcriptional repressor / proline dehydrogenase / 1-pyrroline-5-carboxylate dehydrogenase PutA 3-mercaptopyruvate sulfurtransferase molecular chaperone Hsp33 cell division protein required during stress conditions ferrous iron transport system protein EfeO periplasmic protein-L-methionine sulfoxide reductase catalytic subunit 2,3-bisphosphoglycerate-independent phosphoglycerate mutase ATP-dependent Clp protease ATP-binding subunit ClpA putative hydratase YbhJ flavin reductase lipoamide dehydrogenase Fe-S cluster scaffold complex subunit SufD isocitrate dehydrogenase sulfate adenyltransferase subunit 2 conserved inner membrane protein YidH protein RseC ferredoxin-type protein putative transporter YaaU Sel1 repeat-containing protein YbeQ ferritin iron storage protein sulfur acceptor for SufS cysteine desulfurase alkyl hydroperoxide reductase, AhpC component thioredoxin/glutathione peroxidase catalase II redox-responsive ATPase YchF hydroperoxidase I nucleotide binding filament protein small regulatory RNA MicF fumarase C peptidyl-lysine acetyltransferase FMN dependent NADH:quinone oxidoreductase osmotically inducible peroxiredoxin CPS-53 (KpLE1) prophage; protein YfdS CPS-53 (KpLE1) prophage; putative defective phage replication protein O

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			CPS-53 (KpLE1) prophage; putative tail fiber assembly protein YfdK putative pyruvate-flavodoxin oxidoreductase superoxide dismutase (Mn) 2-octaprenyl-6-methoxyphenol hydroxylase iron-sulfur cluster insertion protein SufA thiol peroxidase iron-sulfur cluster carrier protein NfuA protein/nucleic acid deglycase 2 NAD(P)H:quinone oxidoreductase small regulatory RNA OxyS DNA-binding transcriptional dual regulator SoxR DNA-binding transcriptional dual regulator OxyR disulfide reductase methionine sulfoxide reductase B methionine sulfoxide reductase A periplasmic serine endoprotease DegP aconitate hydratase 1
GO:0034599 - cellular response to oxidative stress	GO:0006979 - response to oxidative stress GO:0033554 - cellular response to stress GO:0070887 - cellular response to chemical stimulus	GO:0071450 - cellular response to oxygen radical GO:0071451 - cellular response to superoxide GO:0070301 - cellular response to hydrogen peroxide GO:0071732 - cellular response to nitric oxide GO:0034614 - cellular response to reactive oxygen species	frataxin CyaY putative quinone oxidoreductase 1 reduced thioredoxin 2 thioredoxin 1 membrane-bound lytic murein transglycosylase C putative Fe <sup>2+</sup> -trafficking protein glucose-6-phosphate isomerase protein/nucleic acid deglycase 3 Mn <sup>2+</sup> /Fe <sup>2+</sup> : H <sup>+</sup> symporter MntH lipid hydroperoxide peroxidase

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*Microscopic analysis of HaCaT cells after ZnO nanoparticle treatment*

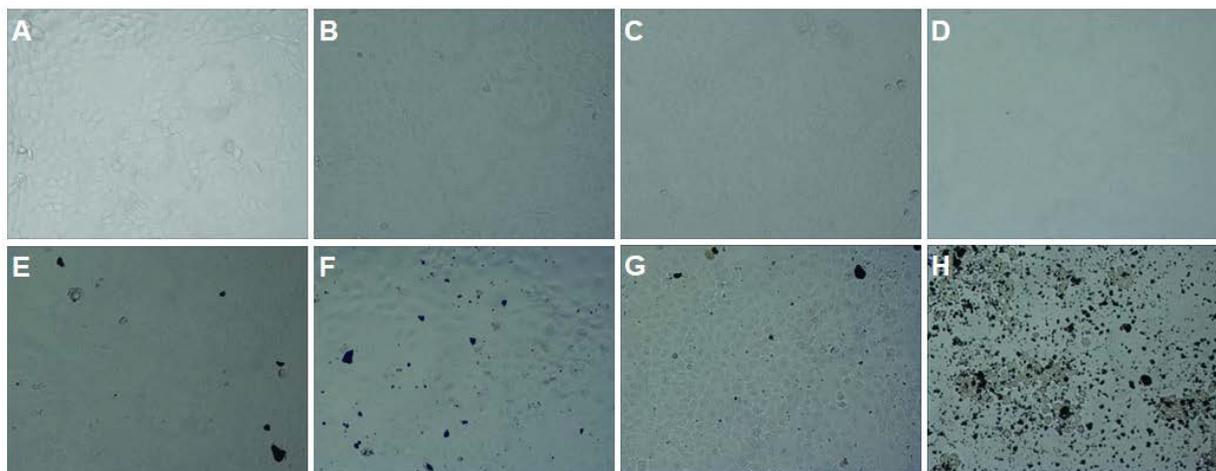


Figure S4 Representative HaCaT images after 48-h treatment of synthesized ZnO nanoparticles. Concentrations were used at (A) 0, (B) 0.01, (C) 0.1, (D) 1.0, (E) 2.0, (F-G) 5.0, and (H) 10.0 mg/mL.

## Phototoxicity of conventional ZnO particles

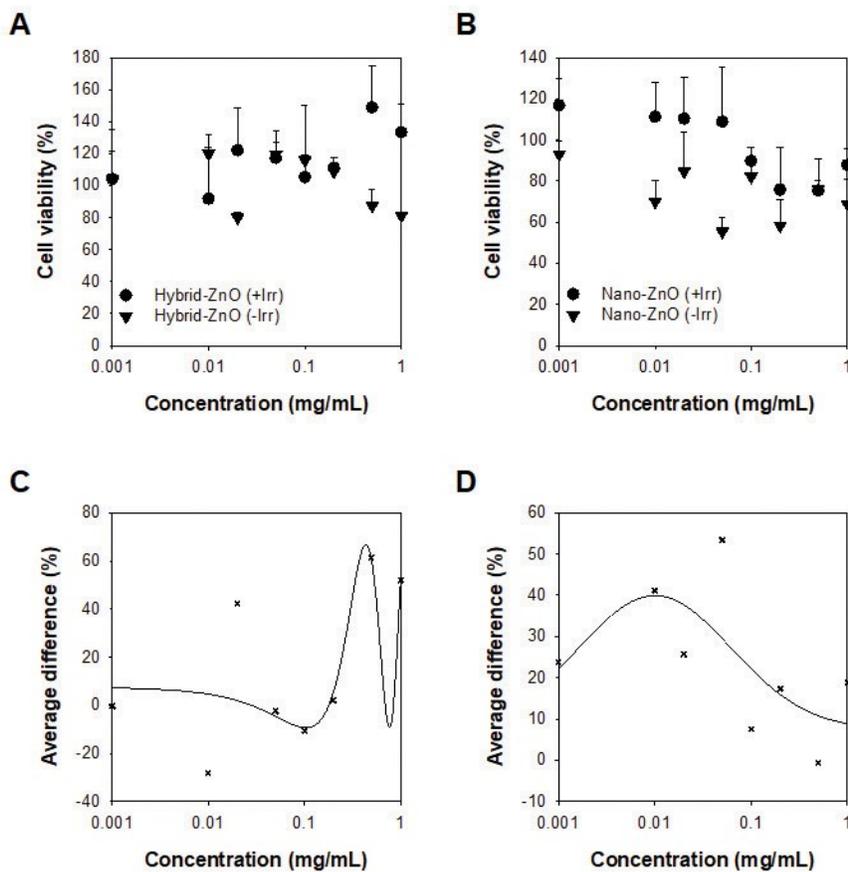


Figure S5 Phototoxicity of ZnO particles, (A, C) hybrid-ZnO and (B, D) nano-ZnO: (A, B) cell viability in Balb/c 3T3 cells and (C, D) average difference of cell viability levels with and without UV irradiation (+Irr, with UV irradiation; -Irr, without UV irradiation).