Supporting Information

Exploring the Antibacterial Properties of ZnO Nanorods-CuO Nanoflowers: A Mode of Action Approach

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Experimental section

Synthesis of ZnO nanorods

ZnO NRs (zinc oxide nanorods) were prepared by using a simple sol-gel route. The stoichiometric amount of zinc (II) nitrate was mixed with double distilled water (DDW) and PEG as a capping agent under continuous stirring for 1 hr. Then, the pH of this mixture was adjusted to 9.00 ± 0.10 using diluted ammonia solution, with the formation of gel, and then converted to precipitate. Afterward, the gel solution was stirred at 70 ^{0}C for 2 hrs. and then cooled at room temperature. The obtained precipitate was centrifuged at 6000 RPM for 15 minutes, washed thrice with DDW, and twice in ethanol to remove formed impurities and by-products during the reaction process. After that, it was dried in an electric oven at 80 ^{0}C up to dryness. Finally, the dried crude product was calcined (annealed) at 400 ^{0}C for 4 hrs.

Reaction

$Zn^{2+} + 2OH^- \rightarrow Zn(OH)_2\downarrow$

$Zn(OH)_2 + 2OH^{-1} \rightarrow Zn(OH)^{2-}_4$

$Zn(OH)^{2-}_4 \rightarrow ZnO + 2H_2O + 2OH^-$

Synthesis of CuO nanoflowers

CuO NFs (copper oxide nanoflowers) were prepared by using a simple sol-gel route. The stoichiometric amount of copper (II) nitrate was mixed with DDW and PEG as a capping agent under continuous stirring for 1 hr. Then, the pH of this mixture was adjusted to 9.00 ± 0.10 using diluted ammonia solution, with the formation of gel, and then converted to precipitate. Afterward, the gel solution was stirred at 60 ^{0}C for 2 hrs. and then cooled at room temperature. The obtained precipitate was centrifuged at 6000 RPM for 10 minutes, washed thrice with DDW, and twice in ethanol to remove formed impurities and by-products during the reaction process. After that, it was dried in an electric oven at 80 ^{0}C up to dryness. Finally, the dried crude product was calcined (annealed) at 400 ^{0}C for 4 hrs.

Reaction

$$Cu(NO_3)_2 + 2H_2O \rightarrow Cu-(OH)_2 + 2HNO_3$$

$$Cu-(OH)_2 \xrightarrow{\Delta} CuO + H_2O$$

Table S1. Composition of ZC NC samples in their theoretical and experimental values.

Samples	ZnO	CuO
ZC 10	90%	10%
ZC 20	80%	20%
ZC 30	70%	30%
ZC 50	50%	50%

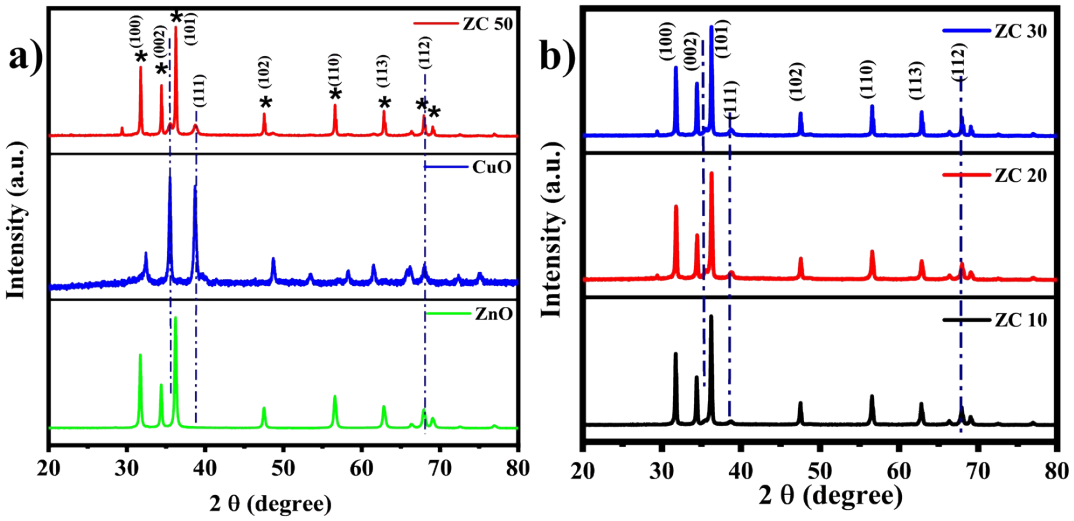

Figure S1. (a) XRD patterns of bare ZnO NRs, CuO NFs, and ZC-50 NCs. (b) XRD patterns of ZC 10, ZC 20, and ZC 30 NCs.

Table S2. Various Rietveld refinement structural parameters of all the ZC samples

Elements	x	y	z	Occupancy
ZnO				
Zn	0.3333	0.6667	0.00241	0.16667
O	0.3333	0.6667	0.38125	0.16667
CuO				
Cu	0.27376	0.21592	0.03351	1
O	-0.00598	0.44133	0.28621	1

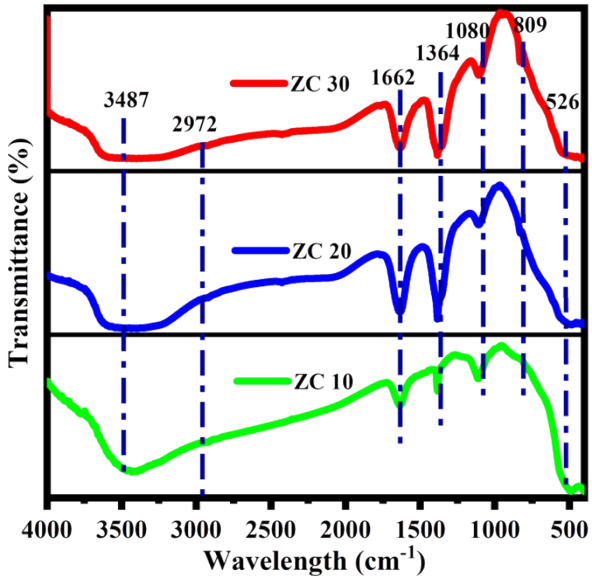

Figure S2. FT-IR spectra of ZC 10, ZC 20, and ZC 30 NCs.

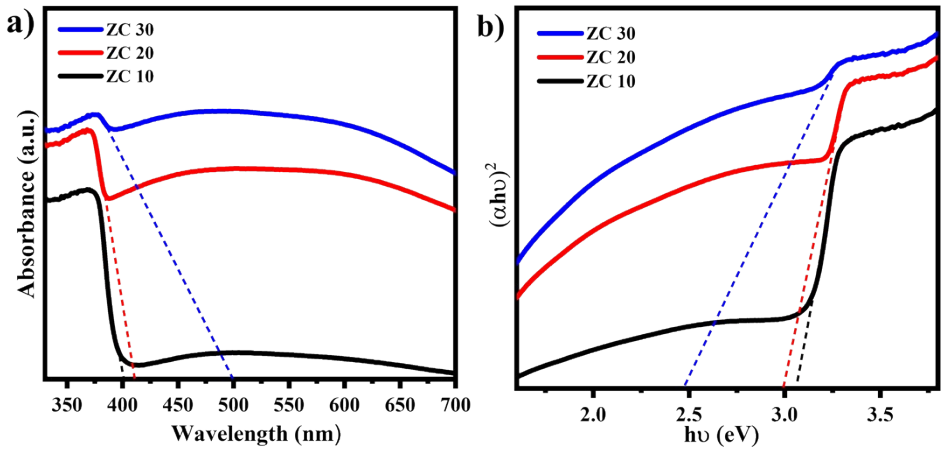

Figure S3. (a) UV-visible DRS, and (b) Tauc plots of ZC 10, ZC 20, and ZC 30 NCs.

Table S3. Absorbance and optical band gap values of bare ZnO NRs, CuO NFs, and ZC NCs

Sr. No.	Samples	Band edge (nm)	Optical band gap (eV)
1	ZnO NRs	397	3.12
	CuO NFs	433	2.86
2	ZC 10 NCs	406	3.05
3	ZC 20 NCs	412	3.00
4	ZC 30 NCs	499	2.48
5	ZC 50 NCs	523	2.37

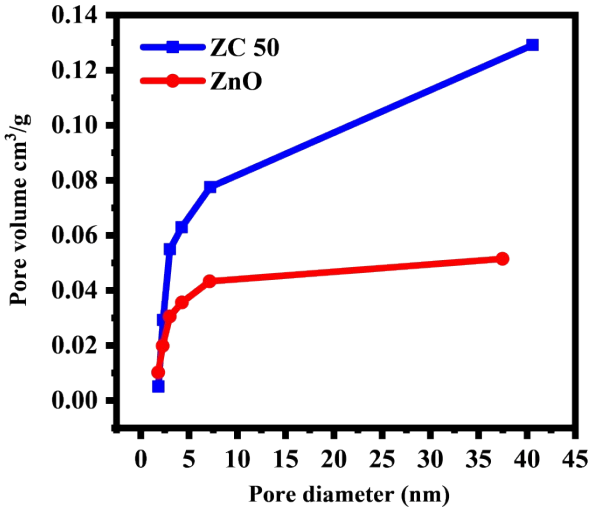

Figure S4. Barrett-Joyner-Halenda (BJH) analysis of bare ZnO NRs and ZC 50 NCs.

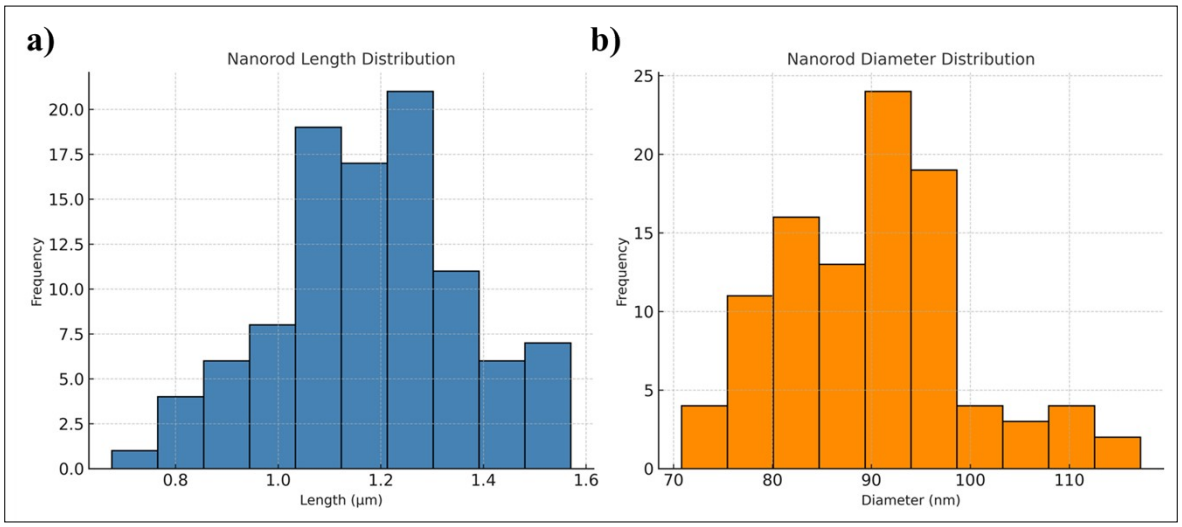

Figure S5. Histogram showing the size distribution of nanorods, (a) Length distribution and (b) diameter distribution were determined from SEM images.

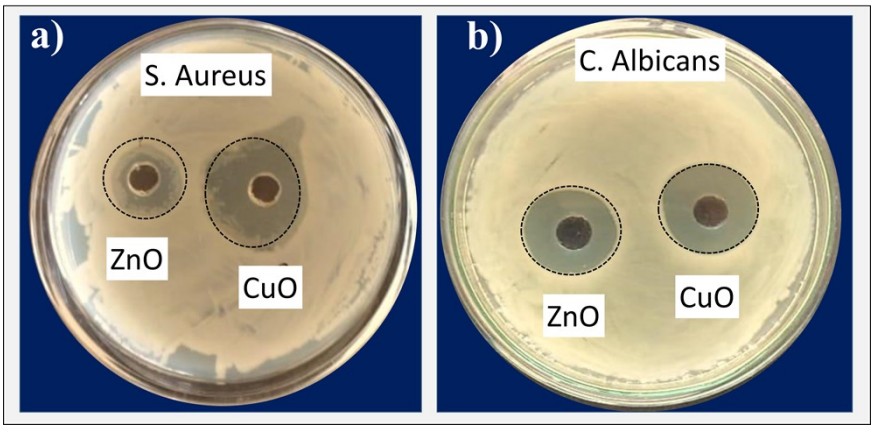

Figure S6. Zone of inhibition of ZnO NRs and CuO NFs against (a) B. cereus, (b) C. albicans.

Table S4. Zone of inhibition ZnO NRs and CuO NFs against various concentrations of respective test pathogens

Test Pathogens	**Nanocomposites Zone of inhibition in mm Concentration (100 µg/ml)**	
	ZnO NRs	**CuO NFs**
S. Aureus	00	22
C. Albicans	00	21