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Electronic Supplementary Information

Morphology engineering of ZnO nanorod arrays to hierarchical nanoflowers for enhanced photocatalytic activity and antibacterial action against *Escherichia coli*

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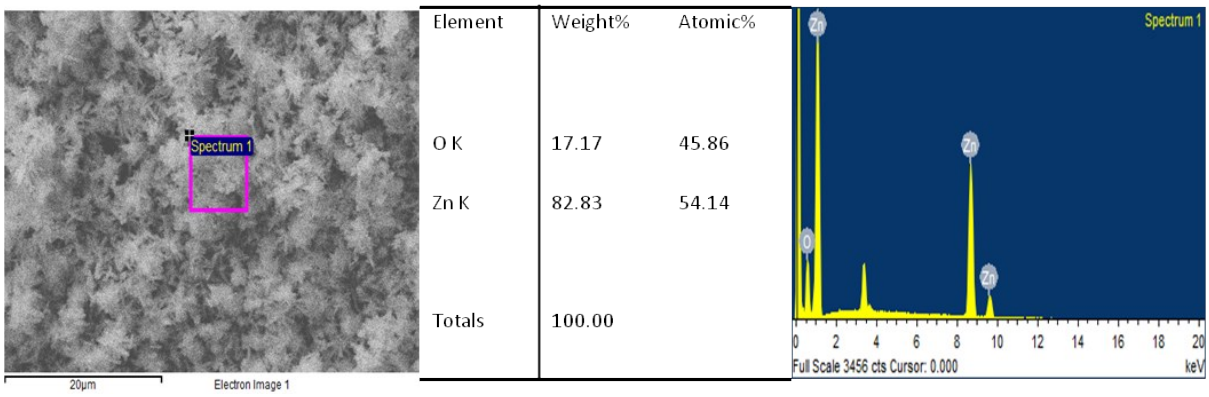


Fig. S1 EDX spectrum of **ZnO-1**.

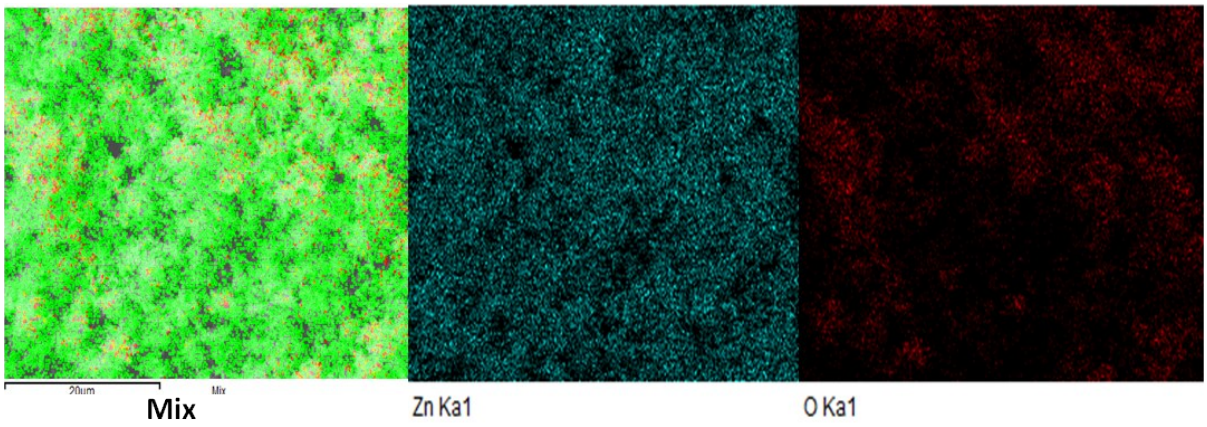


Fig. S2 Elemental mapping of **ZnO-1**.

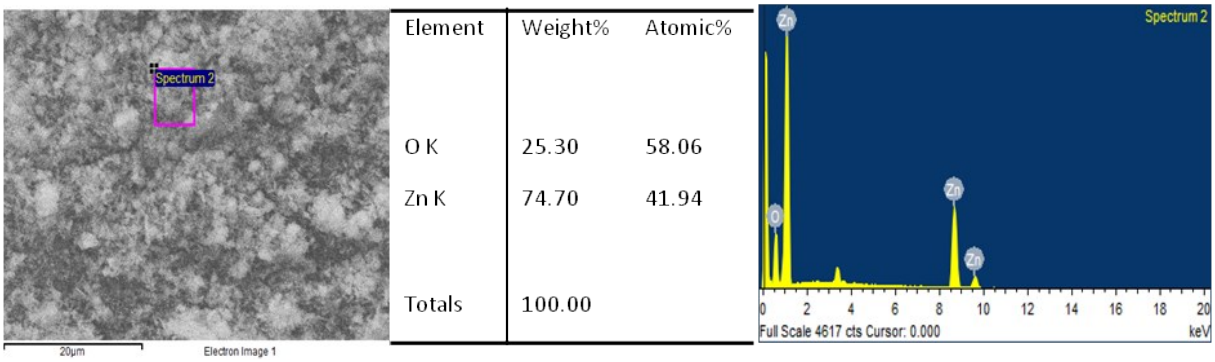
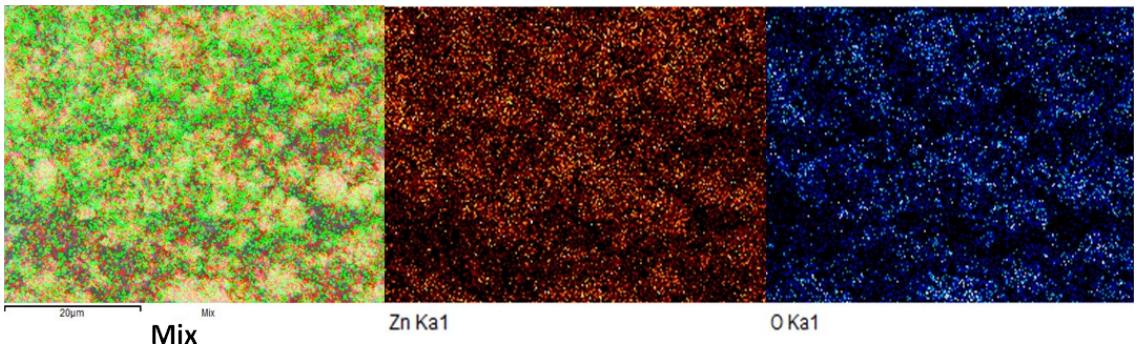


Fig. S3 EDX spectrum of **ZnO-2**.



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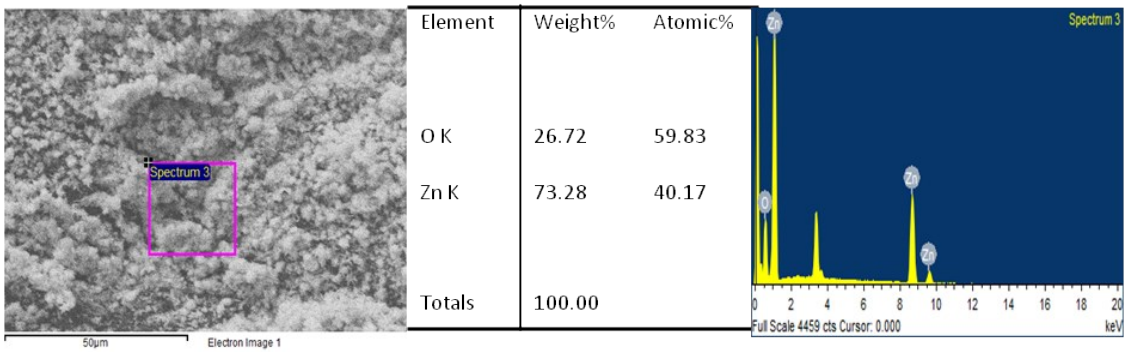


Fig. S5 EDX spectrum of **ZnO-3**.

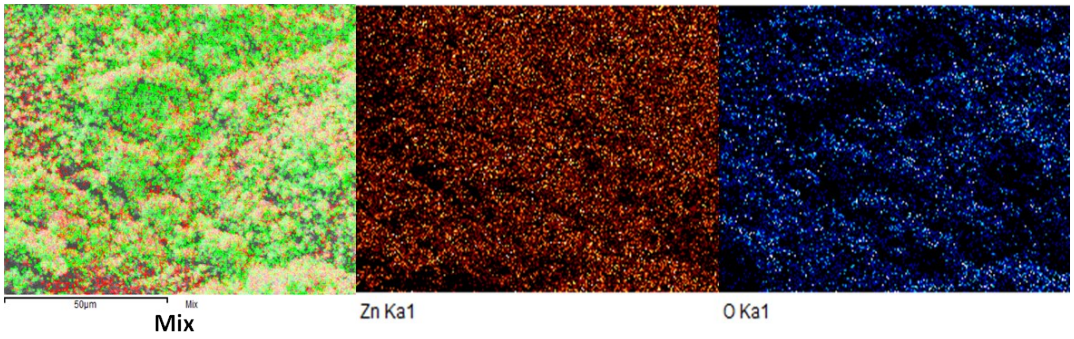


Fig. S6 Elemental mapping of **ZnO-3**.

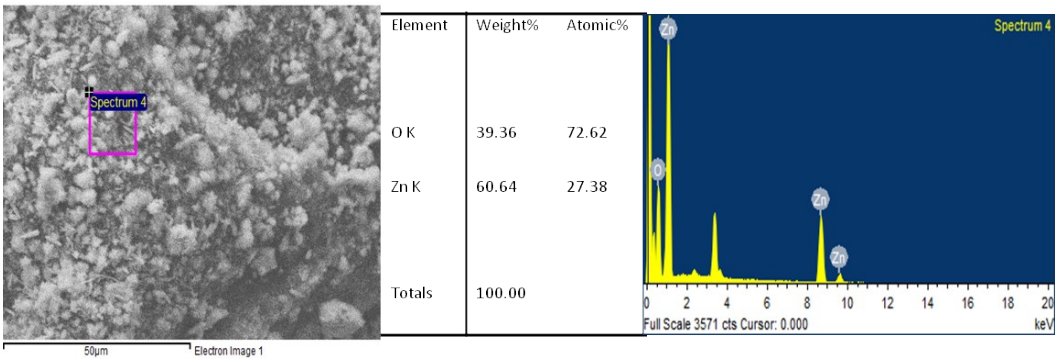


Fig. S7 EDX spectrum of **ZnO-4**.

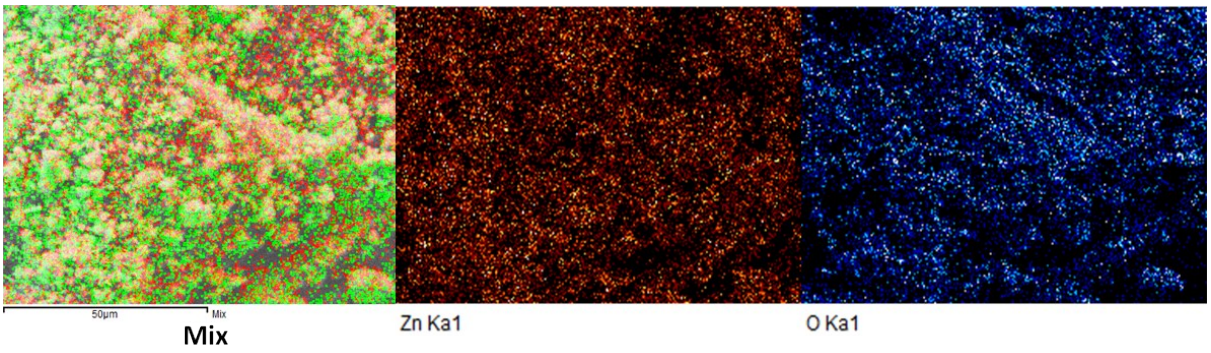
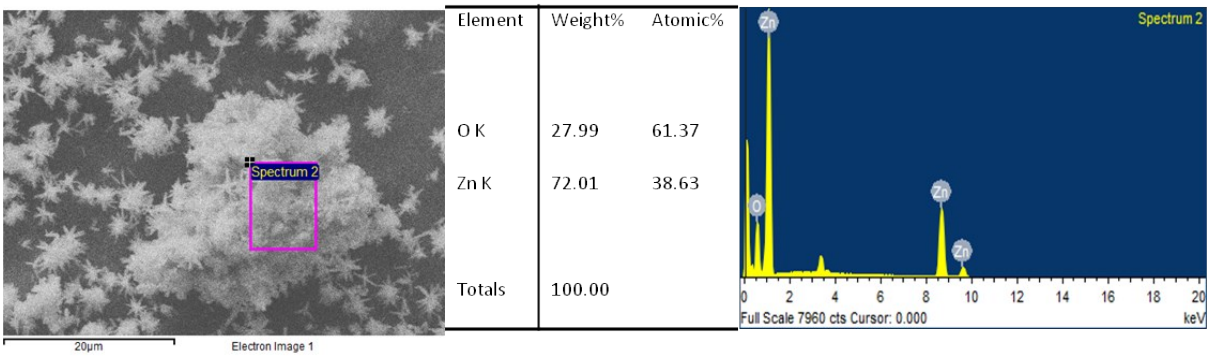


Fig. S8 Elemental mapping of **ZnO-4**.



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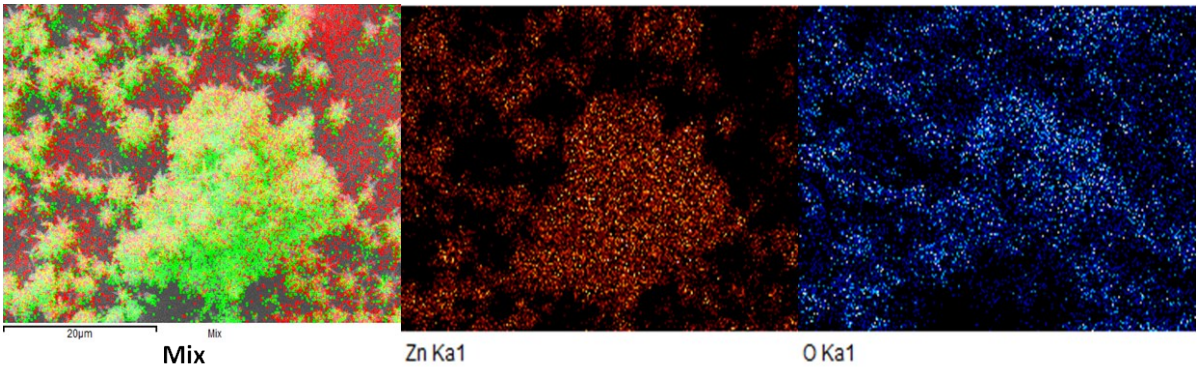


Fig. S10 Elemental mapping of **ZnO-1a**.

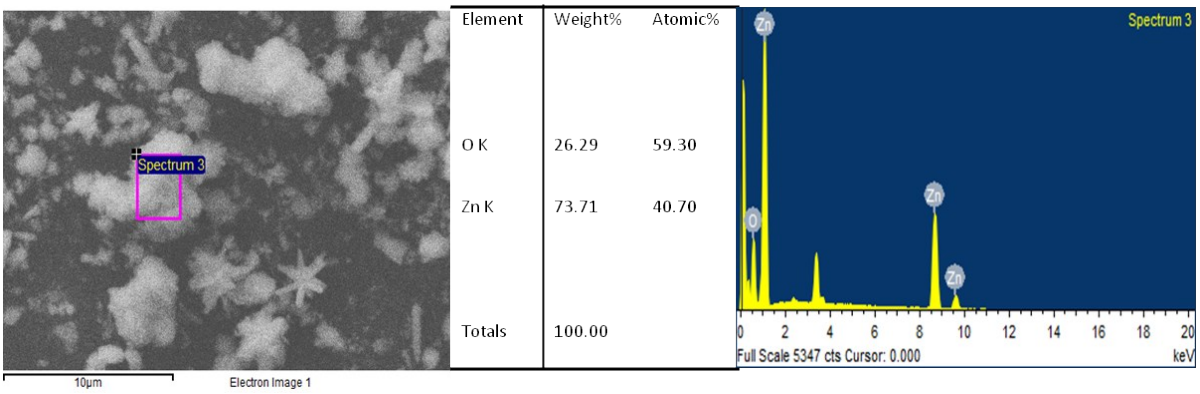


Fig. S11 EDX spectrum of **ZnO-2a**.

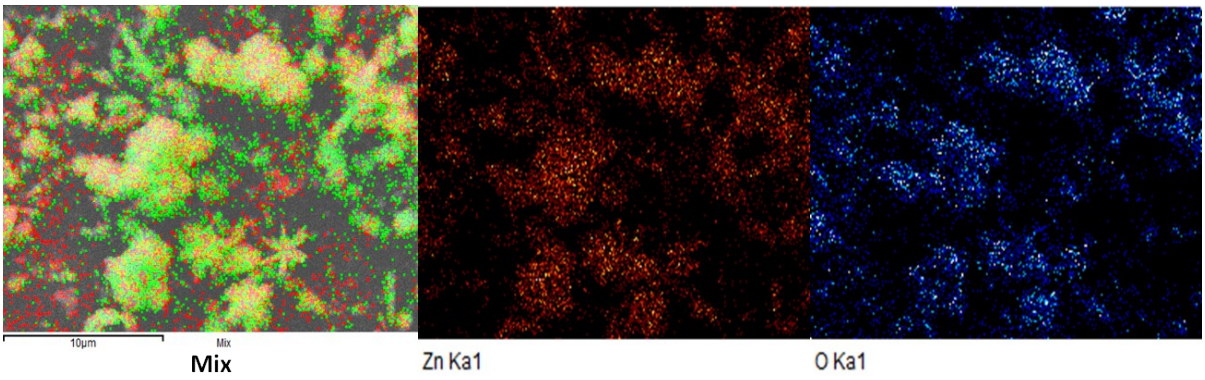


Fig. S12 Elemental mapping of **ZnO-2a**.

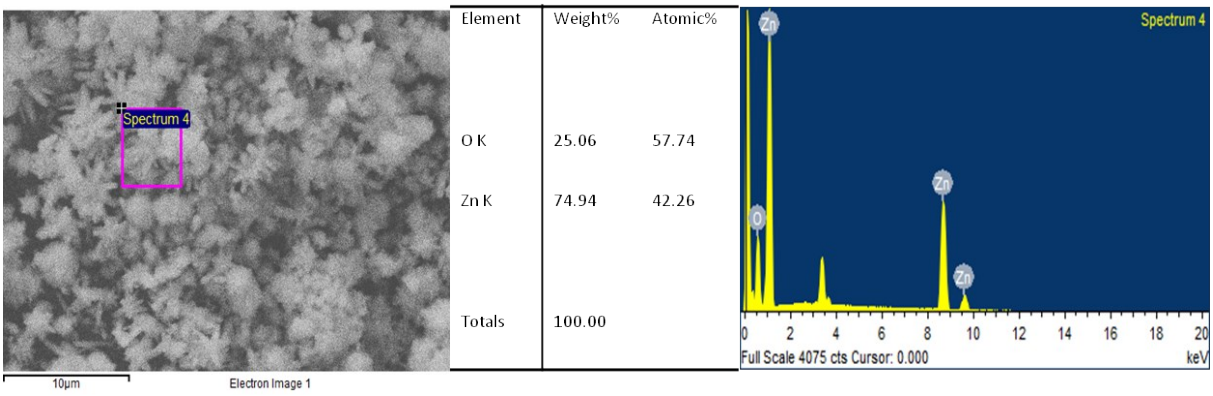


Fig. S13 EDX spectrum of **ZnO-3a**.

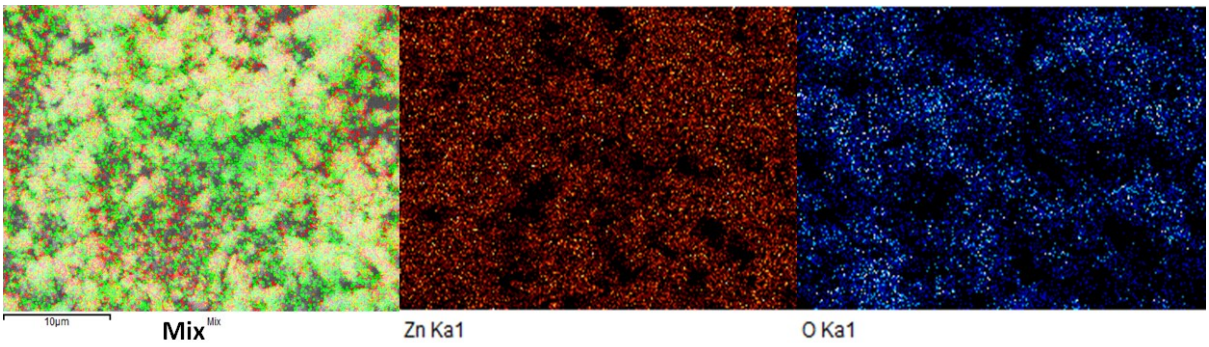


Fig. S14 Elemental mapping of **ZnO-3a**.

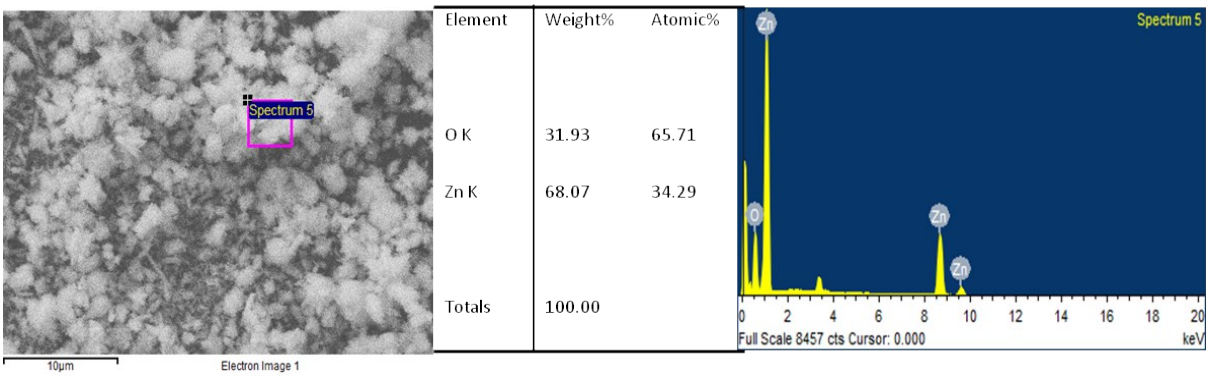


Fig. S15 EDX spectrum of **ZnO-4a**.

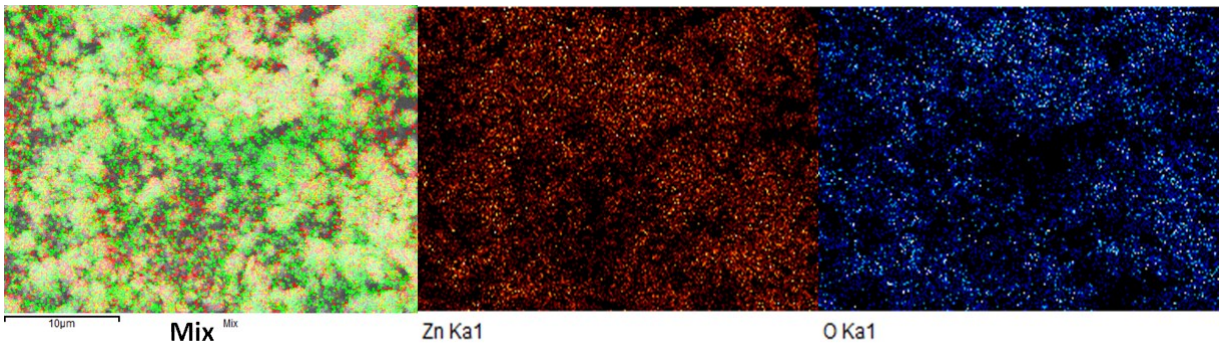


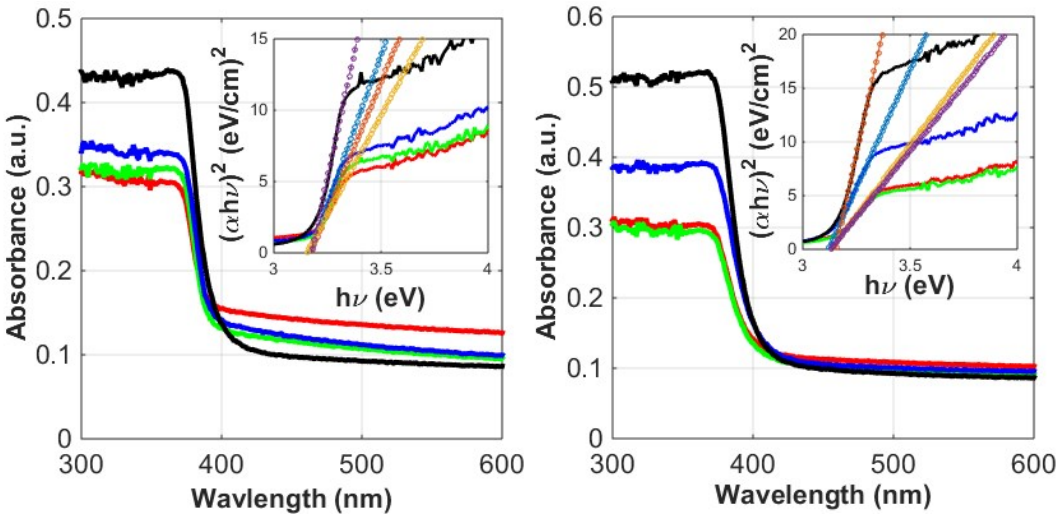
Fig. S16 Elemental mapping of **ZnO-4a**.

Section S-2: Lattice parameters of ZnO nanostructures

Table S1. Lattice parameters for ZnO nanoflowers (**ZnO-1** to **ZnO-4a**)

Sample	h k l	2θ values (degrees)	Lattice constants a, b, c (Å)	Volume of unit cell (Å^3)	Atomic packing fraction	d spacing (Å)	FWHM	Crystallite size (nm)
ZnO-1	(100) (002) (101)	31.4586 34.1174 35.9500	a = b = 3.28, c = 5.26	49.34	0.755	2.84 2.63 2.50	0.306	40.5
ZnO-2	(100) (002) (101)	31.4674 34.1204 35.9504	a = b = 3.28, c = 5.26	49.31	0.755	2.84 2.63 2.50	0.294	42.2
ZnO-3	(100) (002) (101)	31.4726 34.1403 35.9714	a = b = 3.28, c = 5.26	49.26	0.755	2.84 2.63 2.50	0.306	40.1
ZnO-4	(100) (002) (101)	31.4844 34.1479 35.9682	a = b = 3.28, c = 5.26	49.22	0.755	2.84 2.63 2.50	0.321	38.4
ZnO-1a	(100) (002) (101)	31.4559 34.1170 35.9535	a = b = 3.28, c = 5.26	49.35	0.755	2.84 2.63 2.50	0.300	41.23
ZnO-2a	(100) (002) (101)	31.4662 34.1267 35.9514	a = b = 3.28, c = 5.26	49.30	0.755	2.84 2.63 2.50	0.286	43.2
ZnO-3a	(100) (002) (101)	31.4737 34.1399 35.9644	a = b = 3.28, c = 5.26	49.26	0.755	2.84 2.63 2.50	0.299	41.1
ZnO-4a	(100) (002) (101)	31.4881 34.1459 35.9778	a = b = 3.28, c = 5.26	49.21	0.755	2.84 2.63 2.50	0.312	39.1

Section S-3: Tauc plots of as-synthesised ZnO nanostructures



(a) **(b)**

Fig. S17 Solid state absorption spectra of (a) **ZnO-1** to **ZnO-4** where red is for **ZnO-1**, green colour is for **ZnO-2**, blue colour represents **ZnO-3** and black colour represents **ZnO-4** where (inset) plot is between $(\alpha h\nu)^2$ versus $(h\nu)$, (b) **ZnO-1a** to **ZnO-4a** where red is for **ZnO-1a**, green colour is for **ZnO-2a**, blue colour represents **ZnO-3a** and black colour represents **ZnO-4a** where (inset) plot is between $(\alpha h\nu)^2$ versus $(h\nu)$.

Section S-4: Band Gap values of ZnO nanostructures

Table S2. Band gap values of as-grown ZnO nanostructures (**ZnO-1a** to **ZnO-4a**)

Sample	Band Gap (E_g, eV)
ZnO-1	3.19
ZnO-2	3.18
ZnO-3	3.20
ZnO-4	3.19
ZnO-1a	3.13
ZnO-2a	3.14
ZnO-3a	3.11
ZnO-4a	3.15

Section S-5: Photoluminescence spectra of as-synthesised ZnO nanostructures

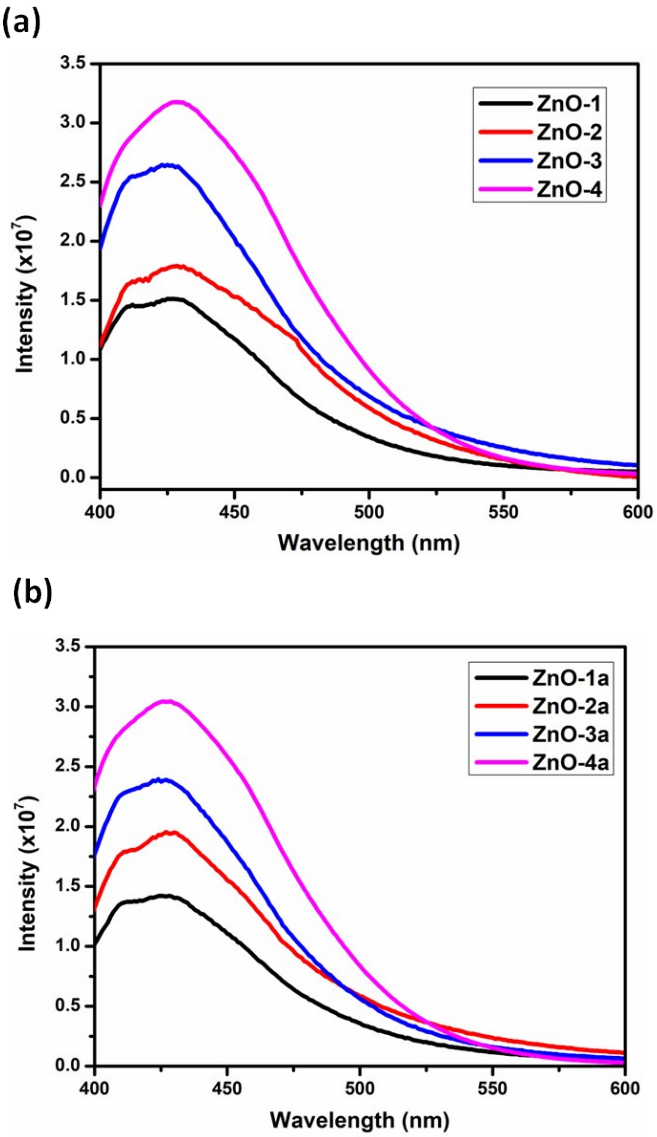
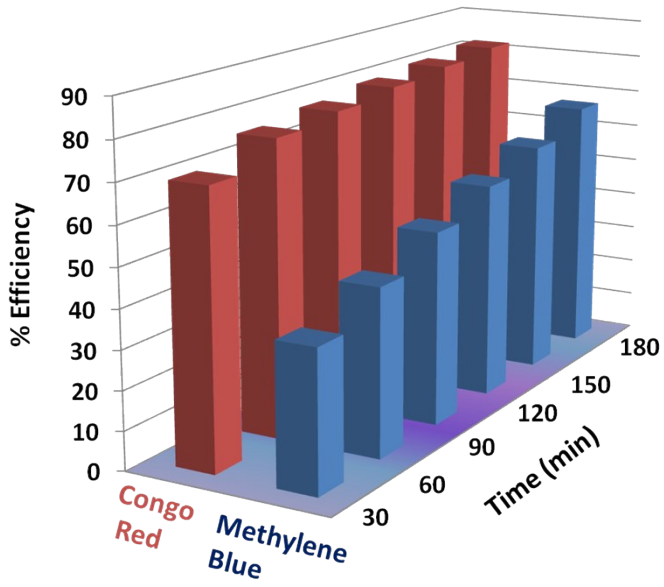


Fig. S18 Photoluminescence spectra of (a) **ZnO-1** to **ZnO-4**, (b) **ZnO-1a** to **ZnO-4a**.

Section S-6: Comparison of percent efficiencies and rate constants of ZnO nanostructures for the degradation of Congo red and Methylene blue

(a)



(b)

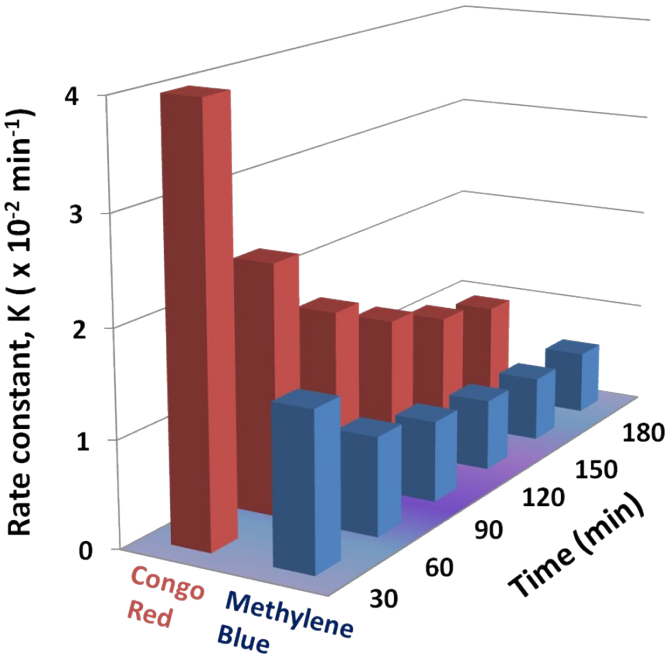


Fig. S19 (a) Comparison of percentage efficiencies of Methylene blue and Congo red by **ZnO-1** and (b) Comparison of rate constants of degradation of Methylene blue and Congo red by **ZnO-1**.

Section S-7: Photocatalytic degradation of ZnO-1 at different pH conditions

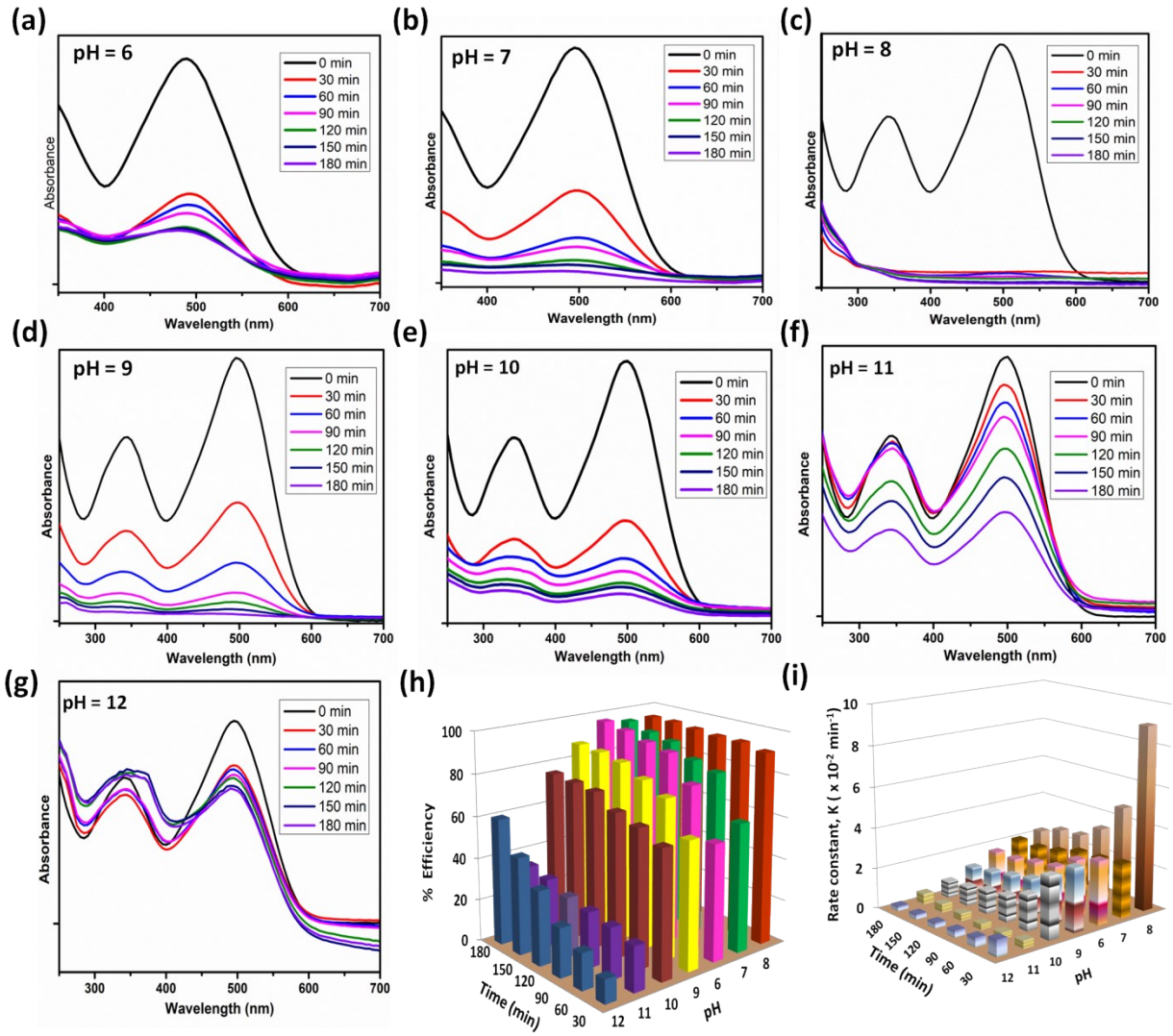


Fig. S20 (a-g) Comparison of photodegradation of Congo Red by **ZnO-1** at different pH conditions, (h) Comparison of percentage efficiencies of Congo Red by **ZnO-1** at different pH and (i) Comparison of rate constants of degradation of Congo Red by **ZnO-1** at different pH.

Section S-8: Comparsion of photocatalytic degradation of Congo red by different photocatalysts

Table S3. Comparison of percentage degradation efficiency of Congo red with other photocatalysts and with ZnO nanostructures under similar conditions

Time	pH	Photocatalyst	% degradation efficiency	Reference
180 min	6	PVA nanocomposite film	84	84
180 min	6	Chitosan nanocomposite film	88	84
180 min	6	$PbTiO_3$ nanorods	92	85
180 min	6	Pure TiO_2	80	86
180 min	6	Nd^{3+} doped TiO_2	97	86
180 min	6	Er^{3+} doped TiO_2	90	86
70 min	8	Ni-Co-ZnO nanocomposites	99	87
180 min	6	ZnO under UV-A irradiation	70	88
180 min	7	ZnO under UV-A irradiation	76	88
180 min	8	ZnO under UV-A irradiation	95	88
180 min	9	ZnO under UV-A irradiation	89	88
180 min	10	ZnO under UV-A irradiation	86	88
180 min	6	ZnO under UV-A irradiation	95	This work
180 min	7	ZnO under UV-A irradiation	76	This work
60 min	8	ZnO under UV-A irradiation	95	This work
180 min	8	ZnO under UV-A irradiation	98	This work
180 min	9	ZnO under UV-A irradiation	97	This work
180 min	10	ZnO under UV-A irradiation	89	This work
180 min	11	ZnO under UV-A irradiation	61	This work
180 min	12	ZnO under UV-A irradiation	34	This work

Section S-9: Comparison of percent bacterial inhibition of ZnO-1 at different dosages

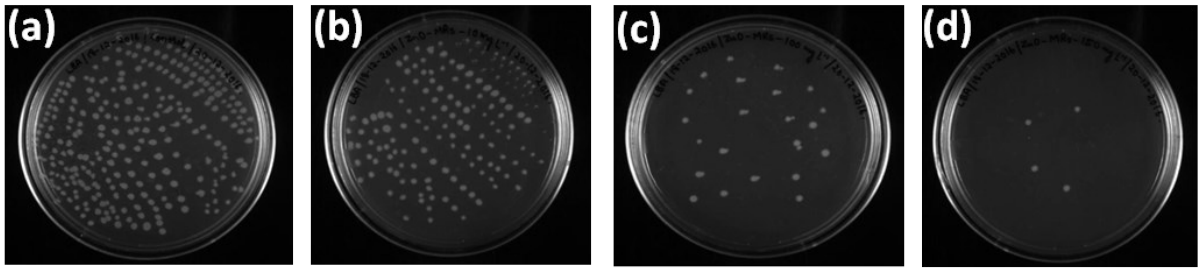


Fig. S21 *E. coli* culture plates: (a) control, (b) with 10 mg/L, (c) with 100 mg/L and (d) with 150 mg/L of **ZnO-1**.

Table S4. Bacterial growth inhibition results of **ZnO-1**

Sample	**No. of colonies observed**	**Percentage bacterial inhibition**
Control	252	0
ZnO-1 with 10 mg/L	154	38.90
ZnO-1 with 100 mg/L	28	88.89
ZnO-1 with 150 mg/L	4	98.41