Electronic Supplementary Material (ESI) for Nanoscale.

Supporting Information

Radially-controlled ZnS interlayer on ultra-long ZnO–Gd_2S_3 core–shell nanorod arrays for promoting the visible photocatalytic degradation of antibiotics

Kugalur Shanmugam Ranjith[a], D. Ranjith Kumar[b], Seyed Majid Ghoreishian[c], Yun Suk Huh*[,c]

Young Kyu Han*[,a], R. T. Rajendra Kumar*[,b]

[a]*Department of Energy and Material Engineering, Dongguk University, Seoul 04620, Republic of Korea.*

[b]*Advanced Materials and Devices Laboratory (AMDL), Department of Nanoscience and Technology, Bharathiar University, Coimbatore-641 046, India.*

[c]*Department of Biological Engineering, Inha University, Incheon 22122, Republic of Korea*

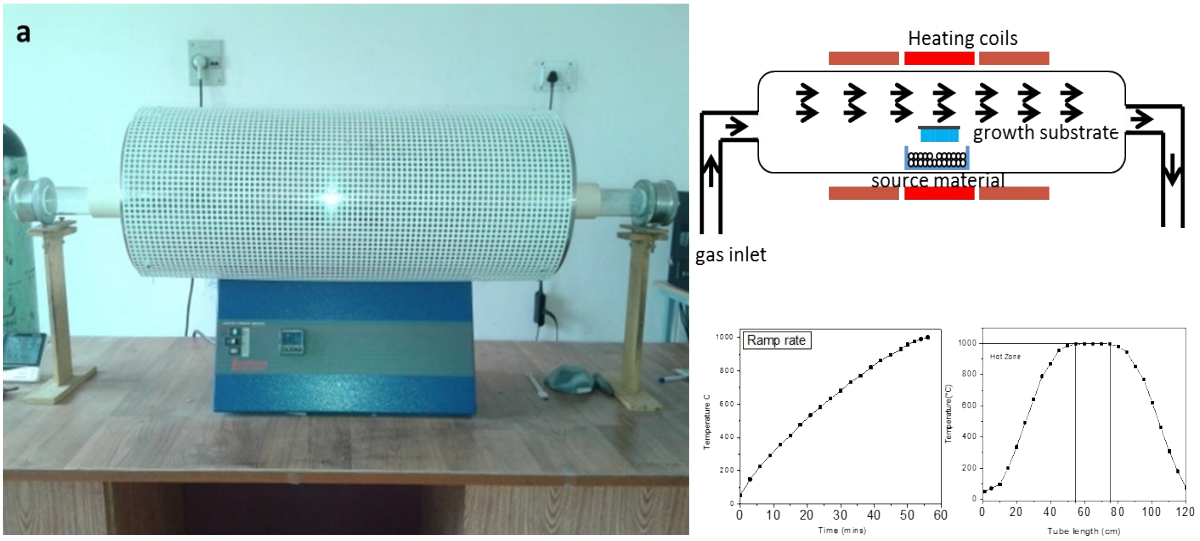

Fig. S1 (a) Photograph and Schematic representation of the growth setup and (b) temperature ramp profile of the tubular furnace.

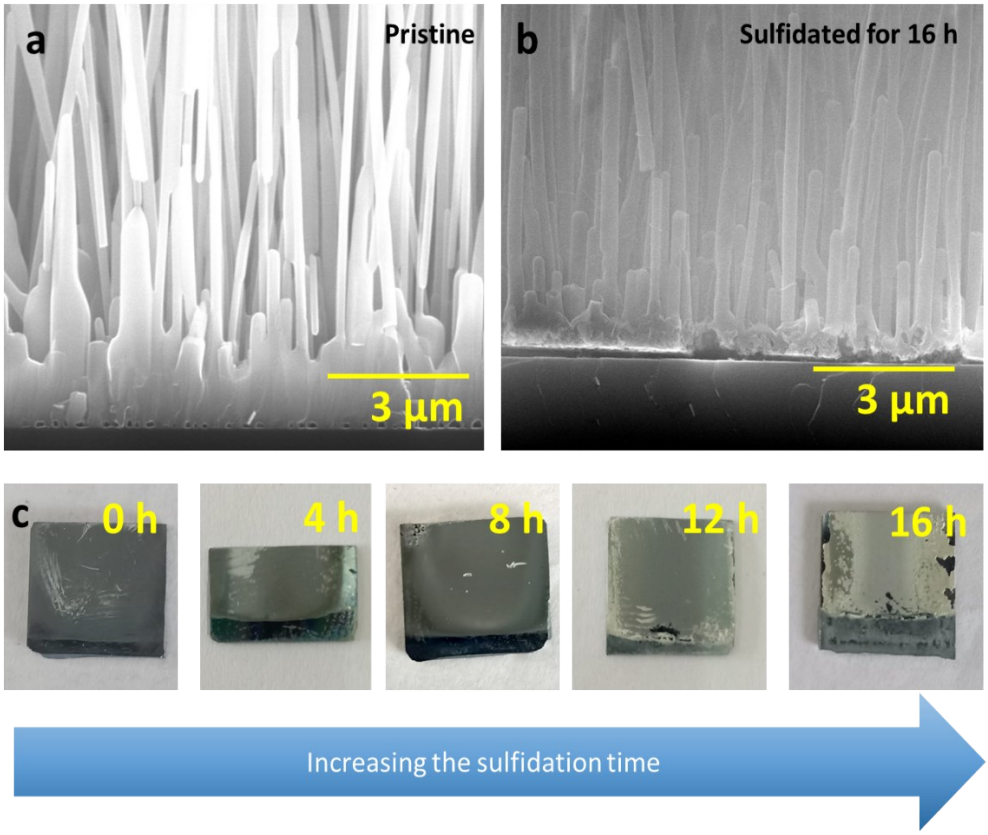

Fig. S2 (a-b) ZnO NR arrays stability before and after the sulfidation time of 16 h, (c) optical images of ZnO-ZnS-Gd_2S_3 NR grown Si substrate with respective to sulfidation time.

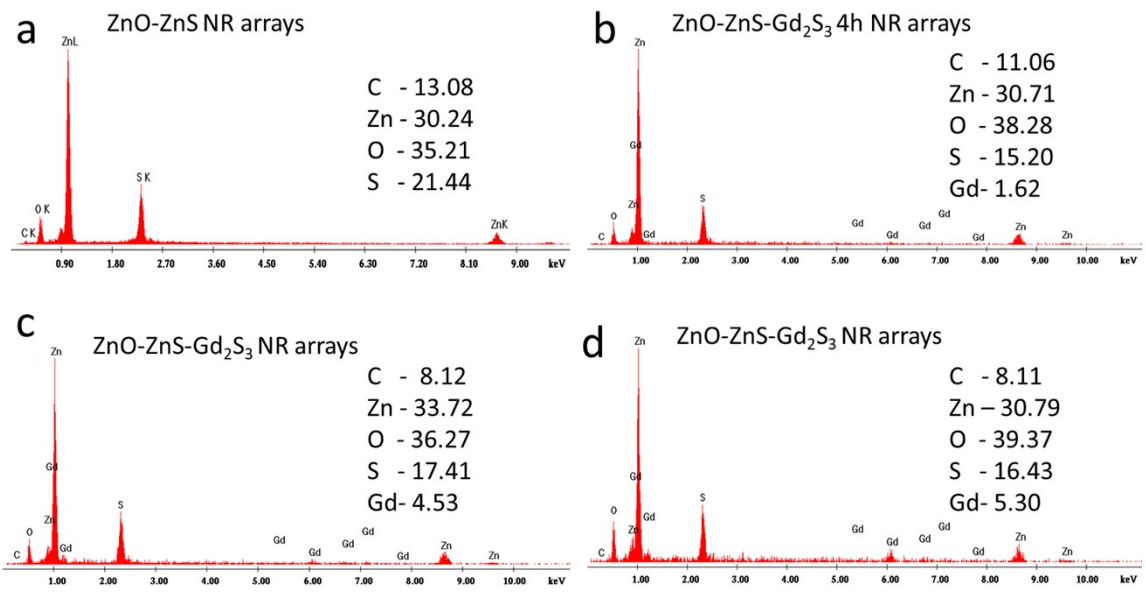

Fig. S3 EDAX spectra of the vertically aligned sulfidated ZnO-ZnS-Gd_2S_3 NR arrays under different reaction time (a) ZnO-ZnS in 8h, (b) ZnO-ZnS-Gd_2S_3 in 4h, (c) ZnO-ZnS-Gd_2S_3 in 8h and (d) ZnO-ZnS-Gd_2S_3 in 12h.

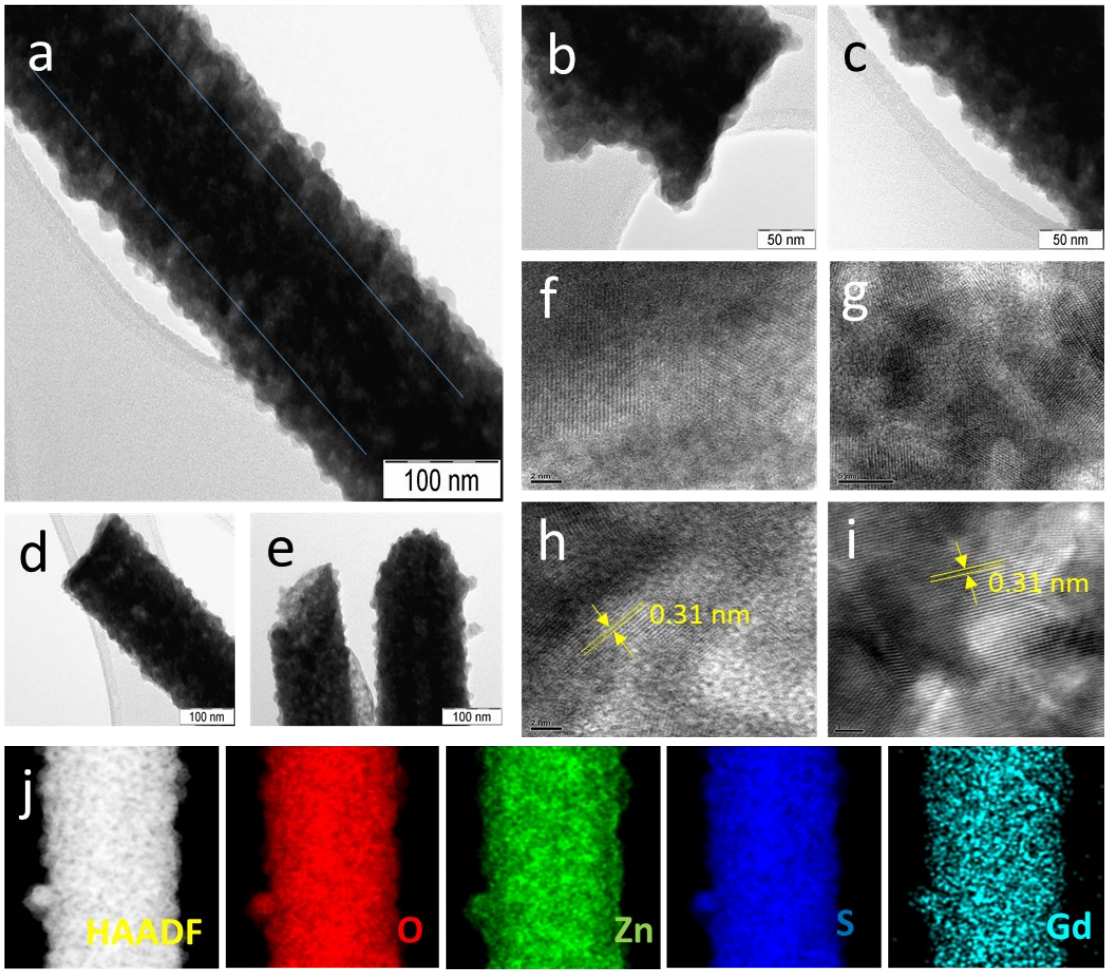

Fig. S4 (a-e) TEM, (f-i) HETEM and (j) elemental mapping results of images of the ZnO-ZnS-Gd_2S_3 (12h) core-shell NR arrays.

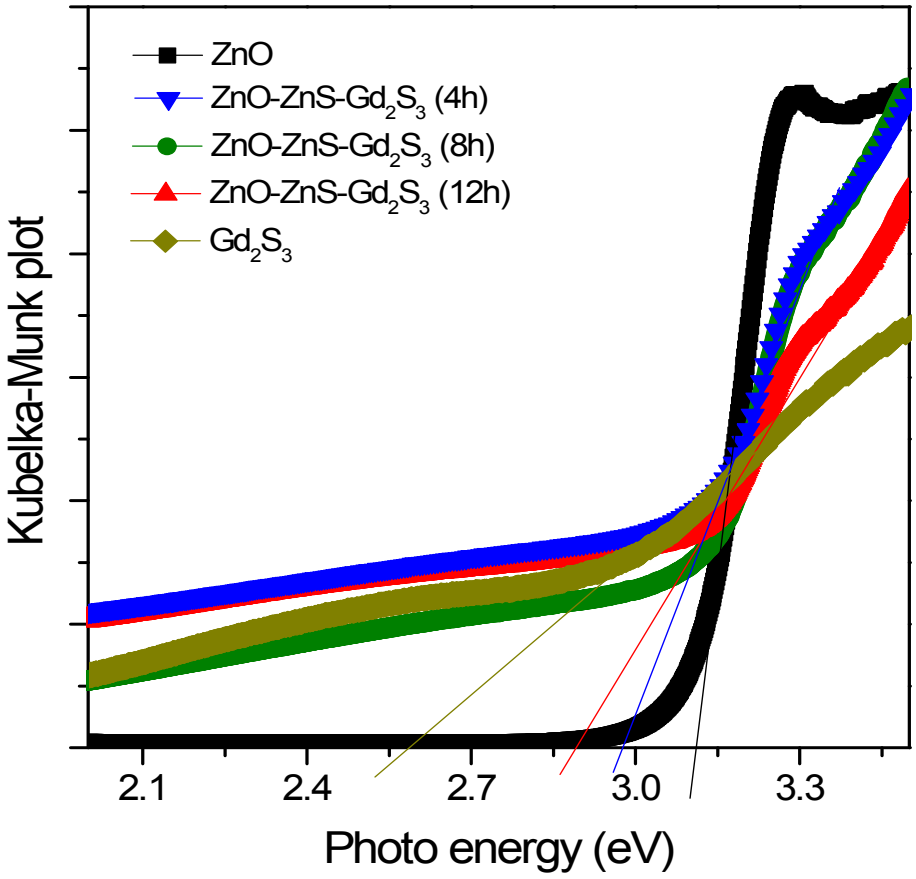

Fig. S5 K-M plot of the different hour sulfidated ZnO-ZnS-Gd_2S_3 hybrid NR arrays.

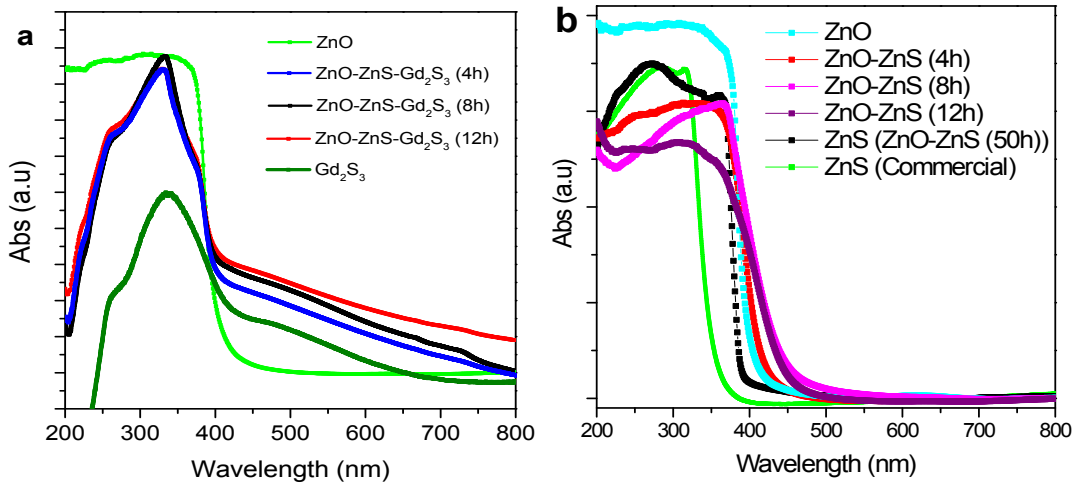

Fig. S6 UV DRS spectra of the (a) shell wall controlled ZnO-ZnS-Gd_2S_3 and (b) ZnO-ZnS core-shell NR arrays.

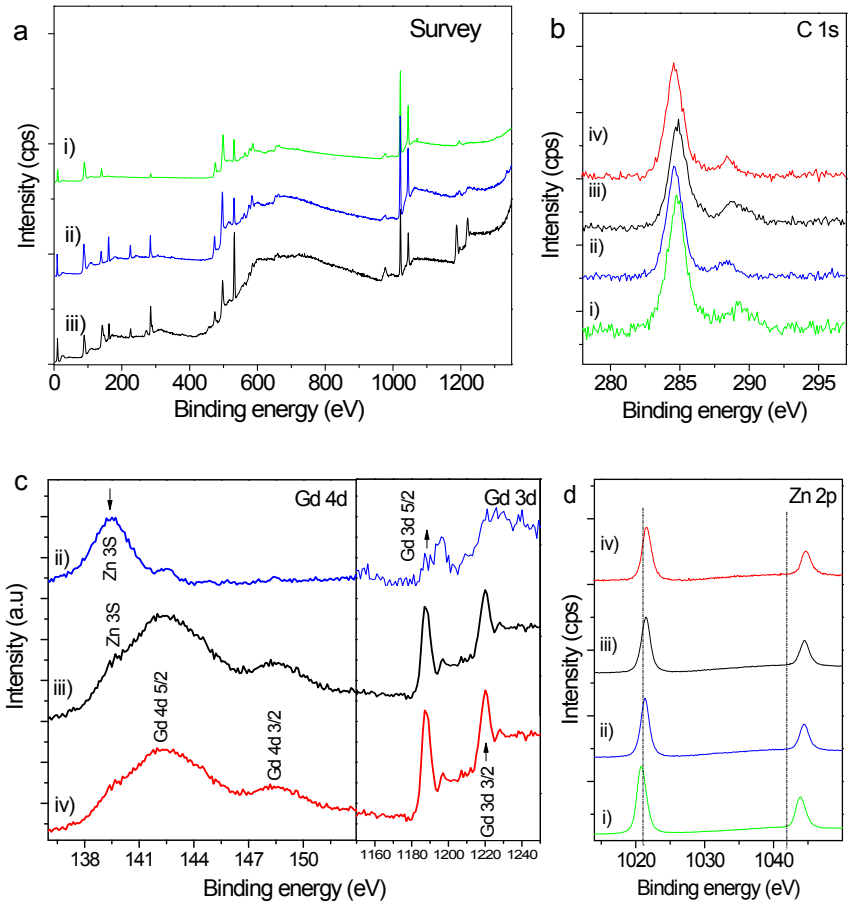

Fig. S7 XPS survey spectra of sulfidated ZnO–ZnS–Gd_2S_3 core–shell NR arrays. (a), high-resolution XPS spectra of the C1s region (b), Gd 4d and 3d region (c), Zn 2p region (d) of pristine (i), 4h (ii), 8h (iii) and 12h (iv) sulfidated ZnO–ZnS–Gd_2S_3 core–shell NR arrays.

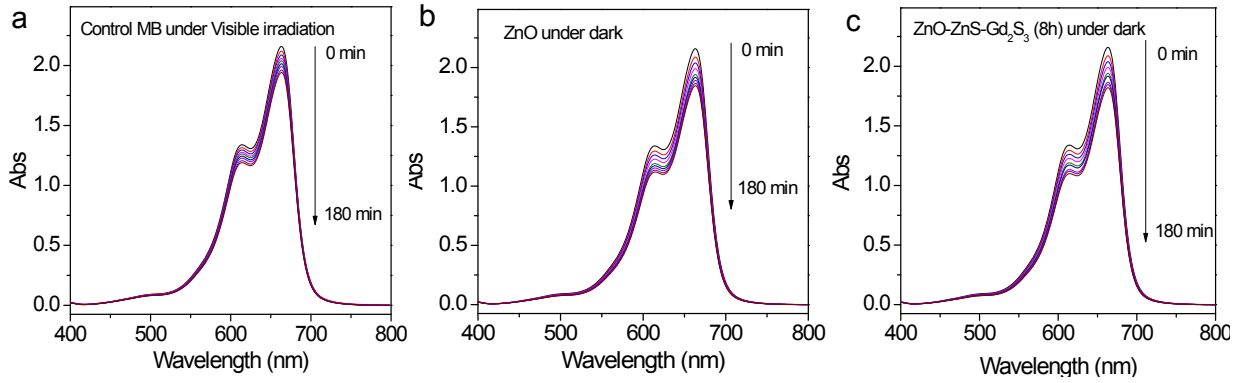

Fig. S8 Photocatalytic activity in absence of (a) catalyst under visible irradiation and activity in dark with the presence of (b) ZnO NR arrays and (c) ZnO-ZnS-Gd_2S_3 (8h) catalyst respectively.

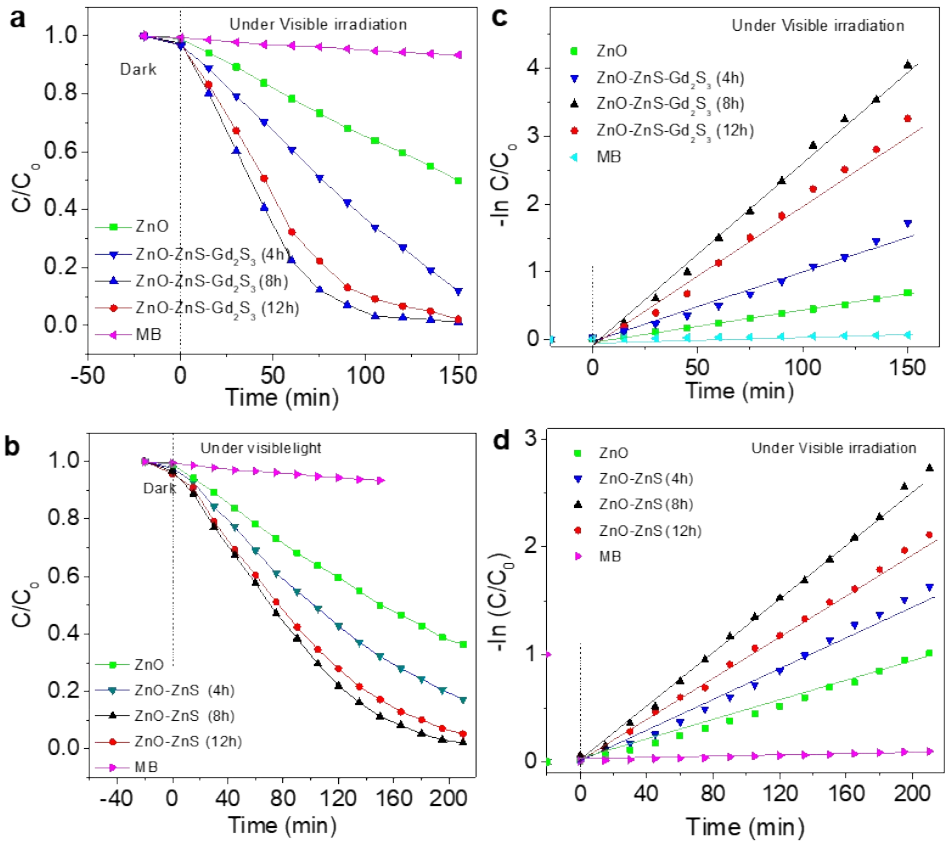

Fig. S9 (a-b) degradation rate (c-d) the plot of ln (C_0/C) with irradiation time of visible light, (C_0 is the initial concentration of MB after absorption; C is the concentration of MB after photoirradiation) for sulfidated ZnO NR arrays. (a, c) shell wall controlled ZnO-ZnS-Gd_2S_3 NR arrays and (b, d) shell wall controlled ZnO-ZnS NR arrays.

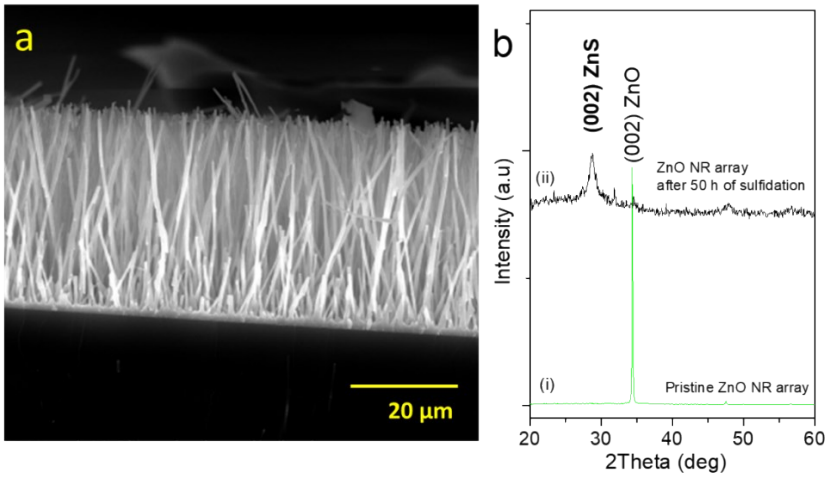

Fig. S10 (a) SEM and (b) XRD results of the 50 h sulfidated ZnO (ZnS NRs) NR arrays images.

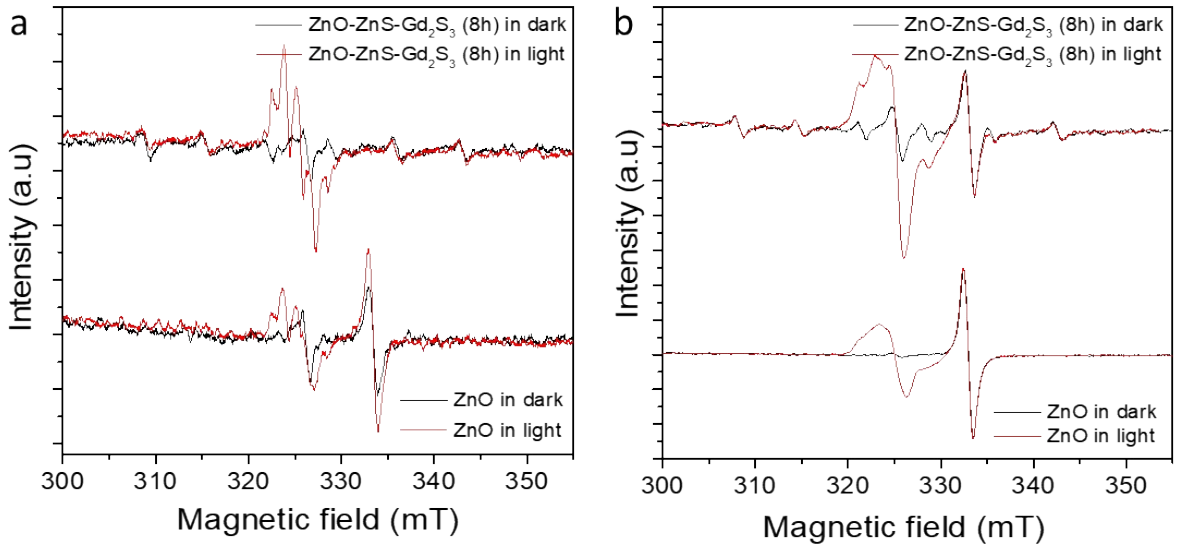

Fig. S11 ESR spectra of the radical adducts trapped by DMPO: (a) DMPO-$O_2^{\cdot-}$ radical species detected from the sample dispersion in methanol, (b) DMPO-•OH radical species detected for the sample dispersion in water.

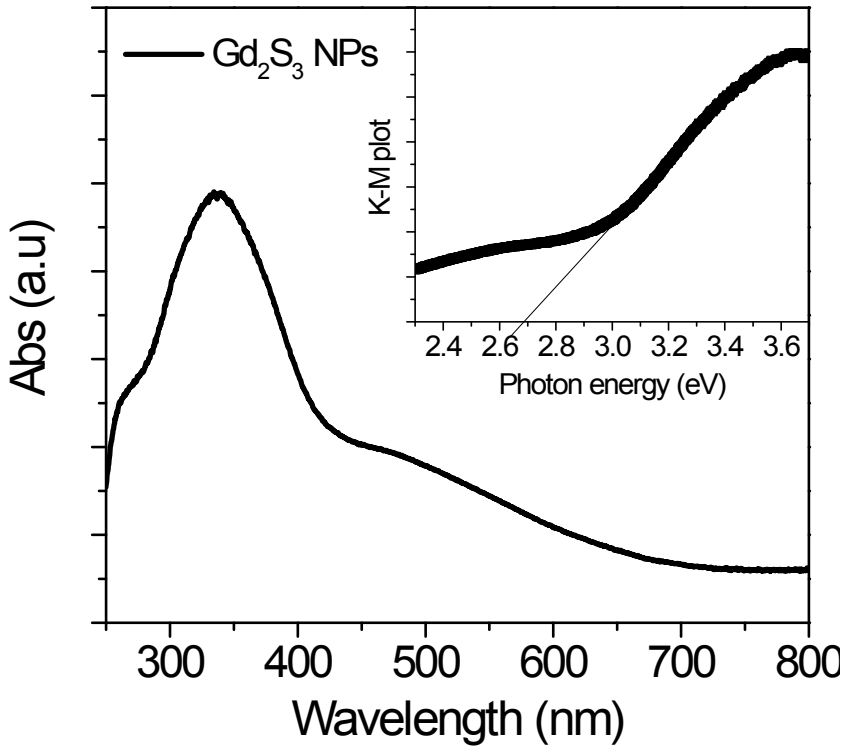

Fig. S12 UV DRS- absorbance spectra of the Gd_2S_3 nanoparticles and inset shows K-M plot of Gd_2S_3 nanoparticles.

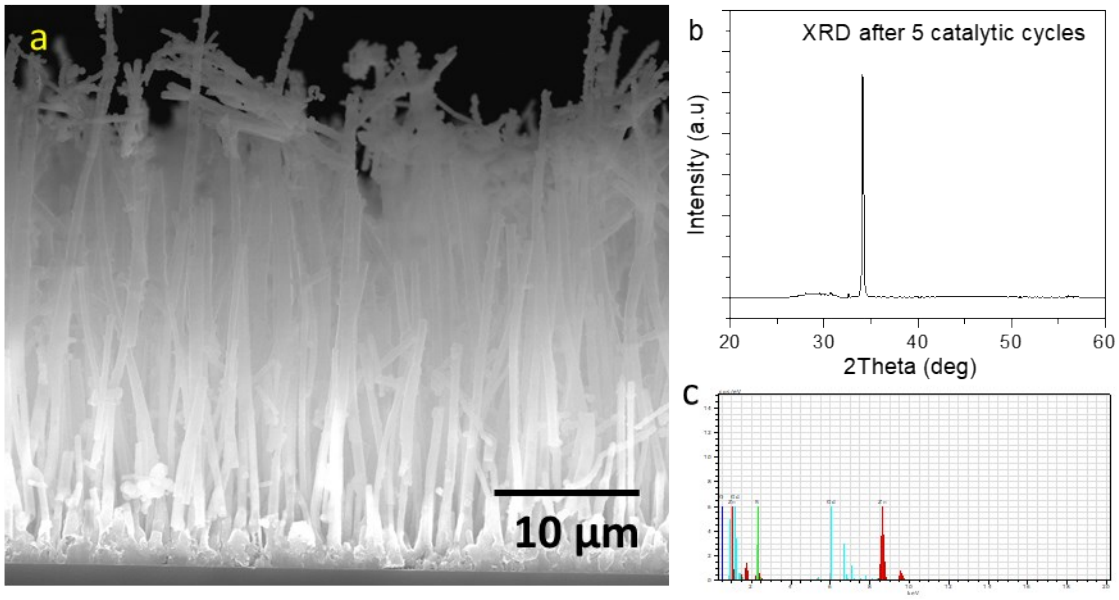

Fig. S13 (a) FESEM, (b) XRD and (c) EDX spectra of the ZnO-ZnS-Gd_2S_3 core-shell nanorod arrays after 5 reusable cycles.

Table S1. Chemical composition of the ZnO-ZnS-Gd_2S_3 NR array, which are calculated using ICP-MS results.

Sample	ICP-MS (wt %)
ZnO	Zn: 72.3
ZnO-ZnS	Zn:54.5
ZnO-ZnS-Gd_2S_3 (4h)	Zn: 61.8 Gd: 2.4
ZnO-ZnS-Gd_2S_3 (8h)	Zn: 51.8 Gd: 7.3
ZnO-ZnS-Gd_2S_3 (12h)	Zn: 48.4 Gd: 9.1