$Nd{:}ZnS@GO$ Nanotubes: Novel Adsorbent cum photocatalyst for Efficient Removal of Antibiotics and dyes from Wastewater

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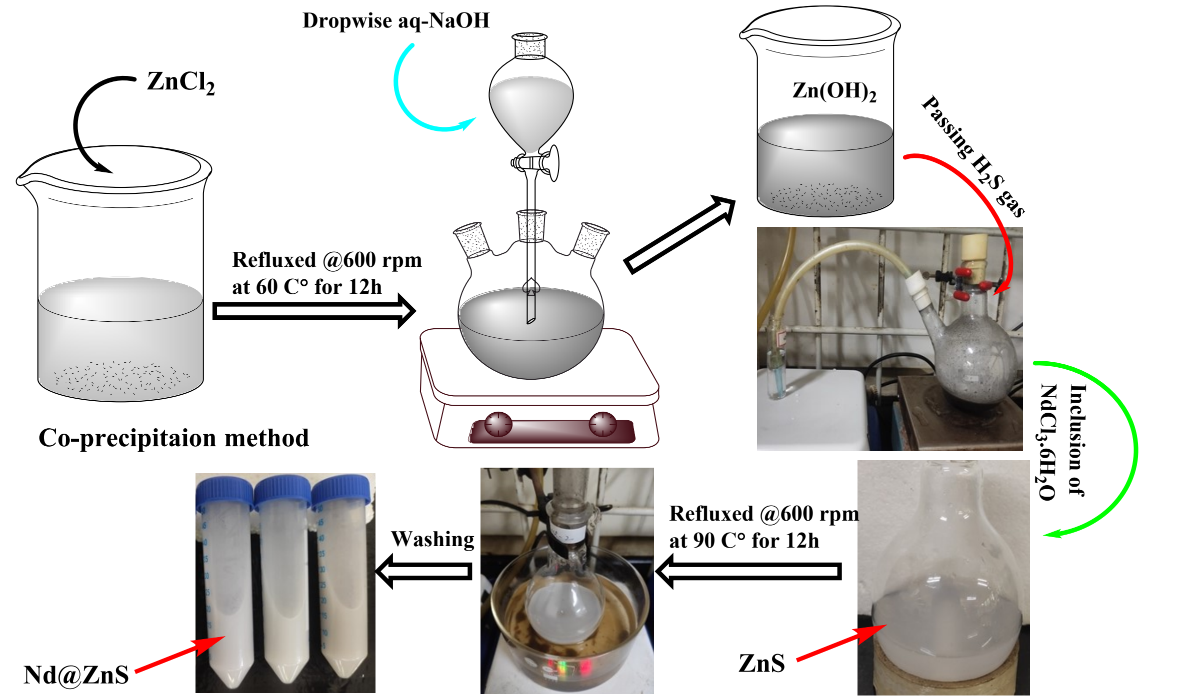
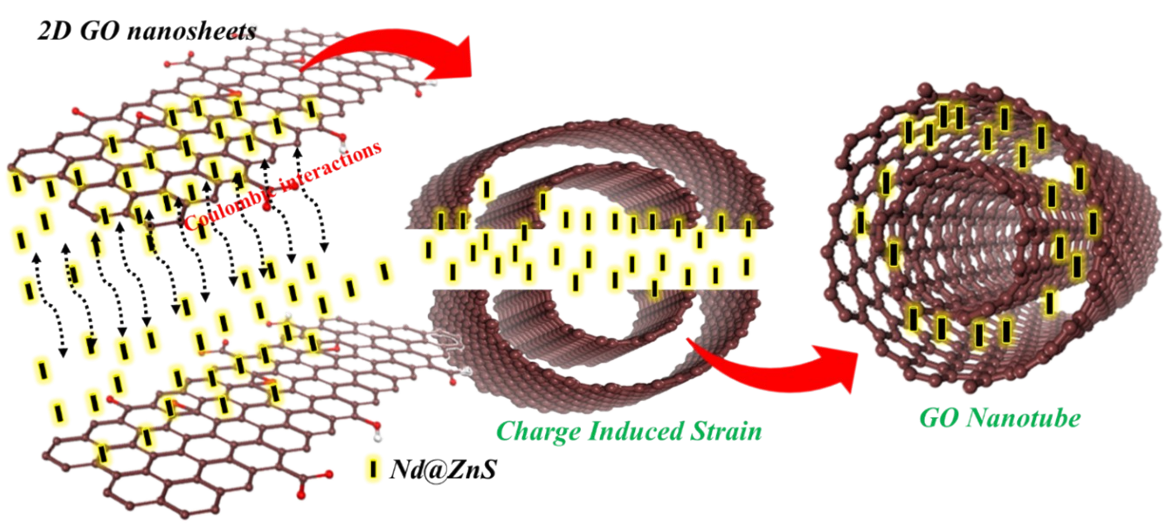


Scheme S1. Synthesis of ZnS and Nd@ZnS via co-precipitation method.



Scheme S2. Charge induced strained wrapping of GO nanosheets into GO nanotubes.

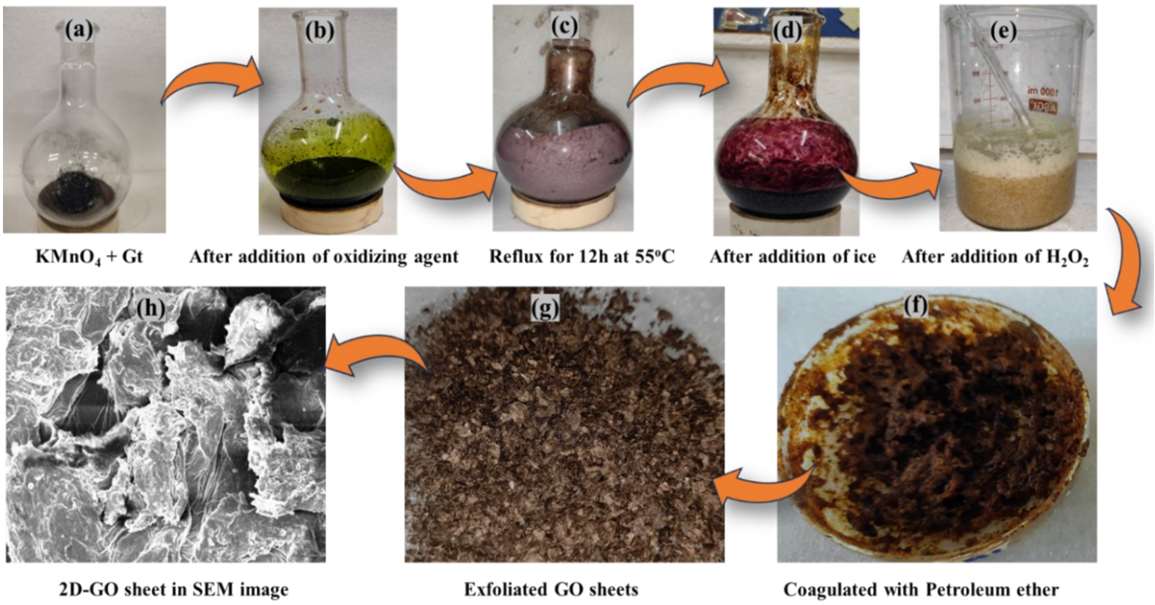
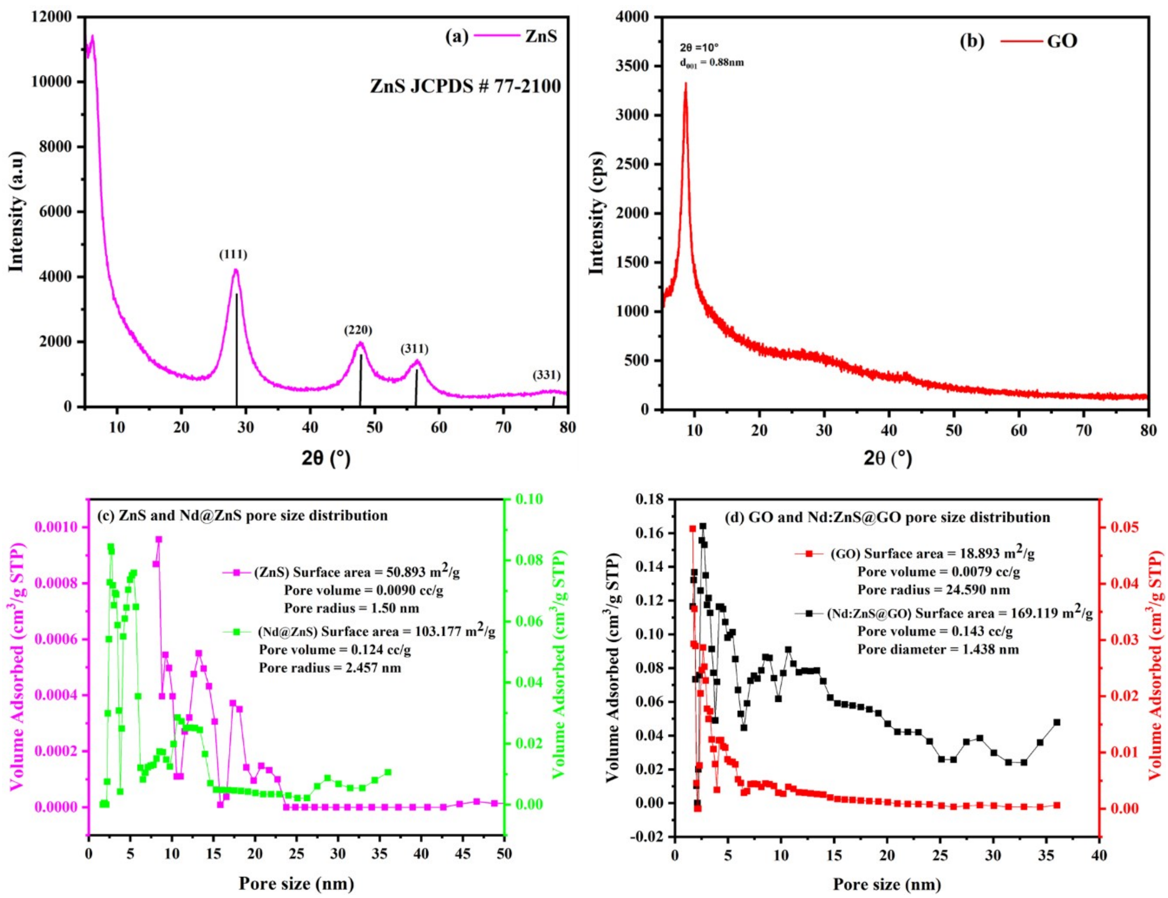


Fig. S1. Synthesis of graphene oxide (GO) via modified Hammer method[1].



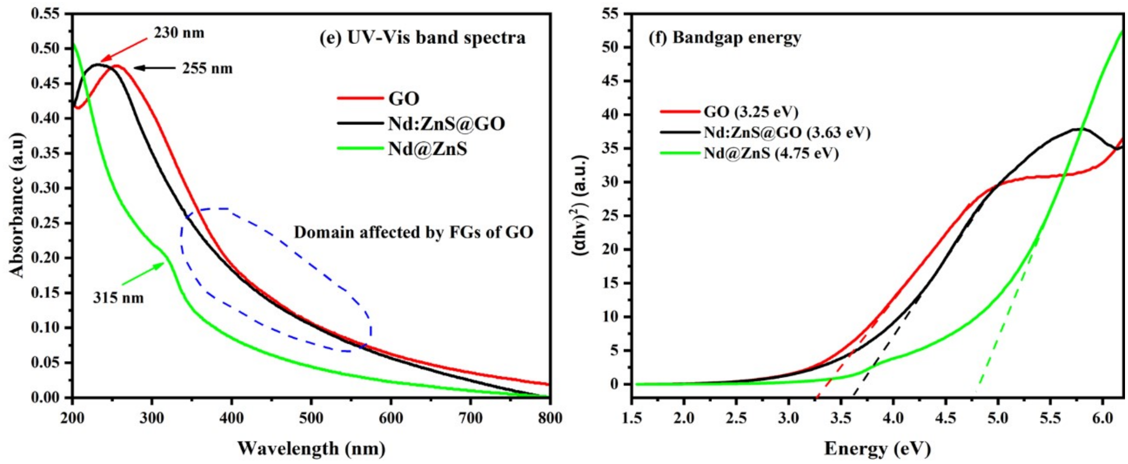


Fig. S2 XRD analysis (a) ZnS (b) Gt and GO and (c-d) BET (e-f) UV-Vis and bandgap energy.

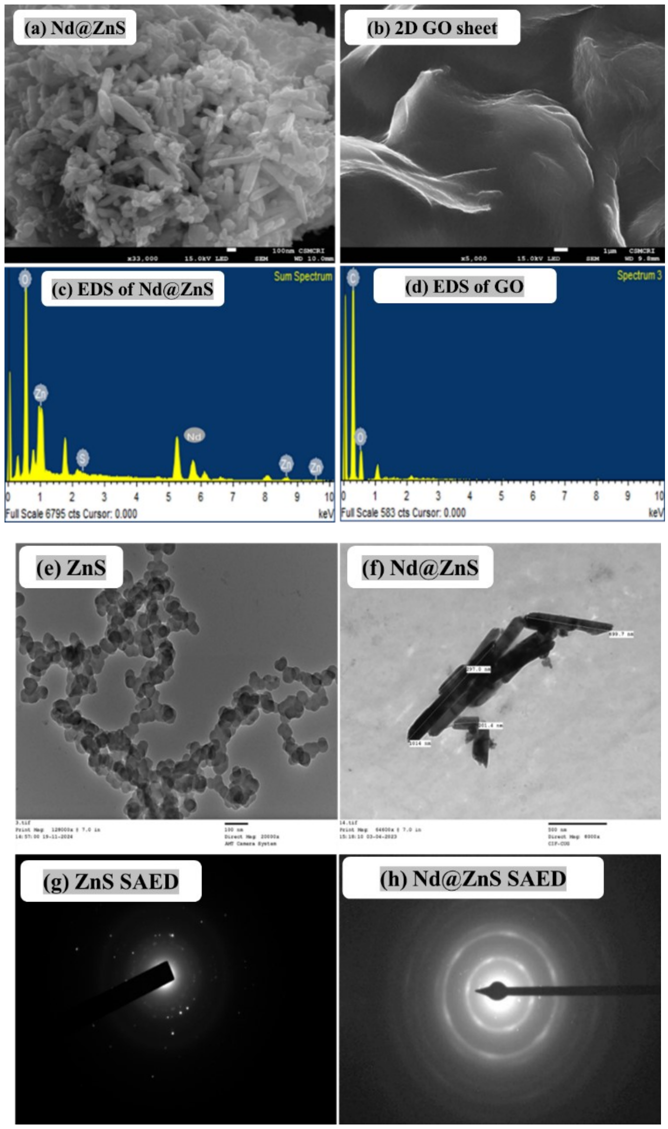


Fig. S3. FE-SEM images for (a) Nd@ZnS (b) GO (c-d) and EDS spectra and (e-f) HR-TEM Images and (g-h) SAED pattern for ZnS.

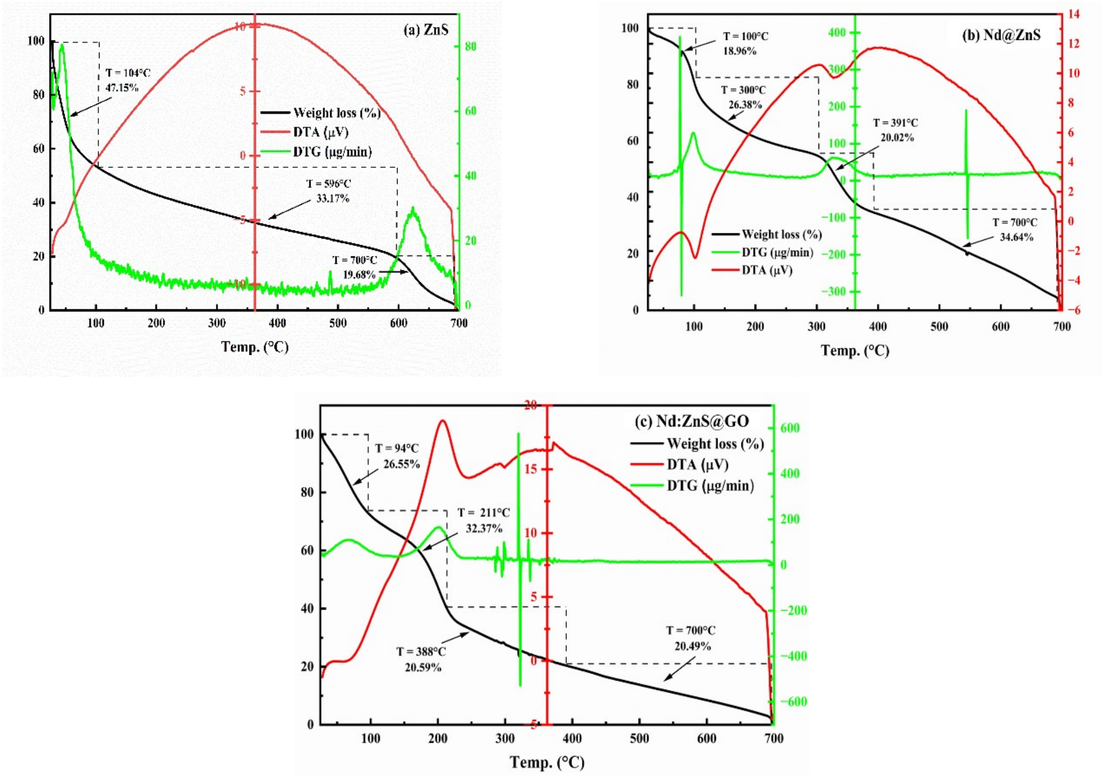
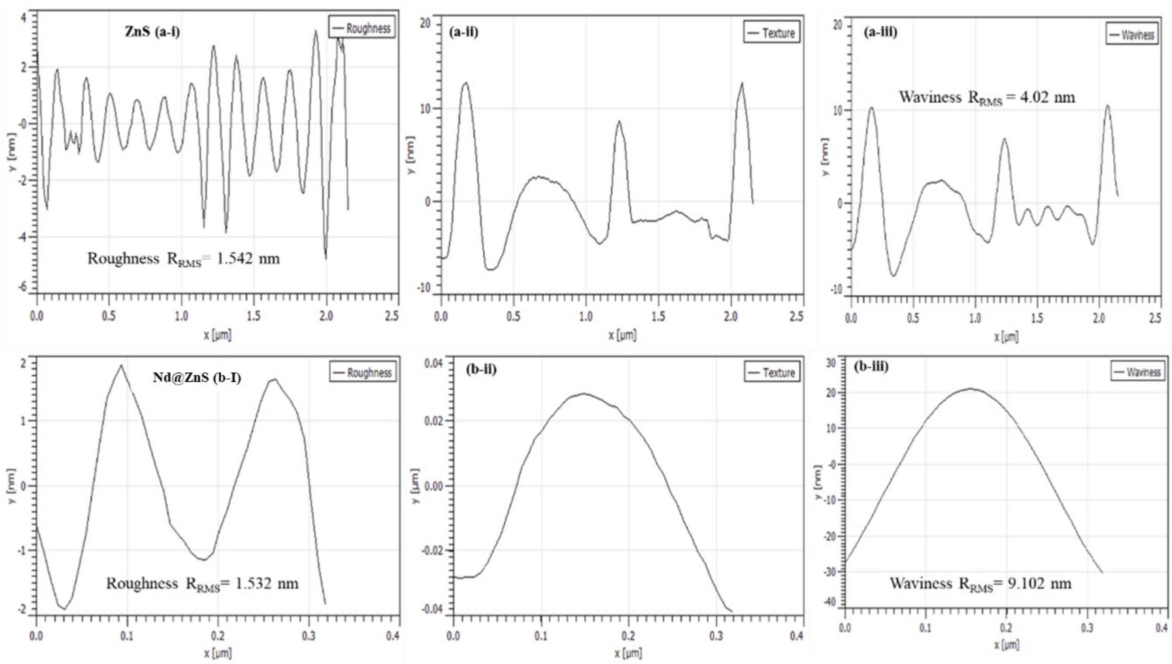


Fig. S4. Thermal analysis for (a) ZnS (b) Nd@ZnS (c) Nd:ZnS@GO.



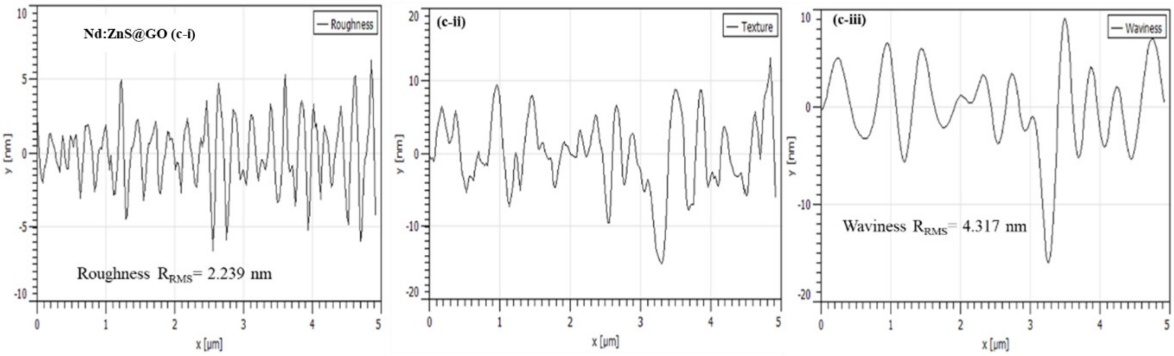
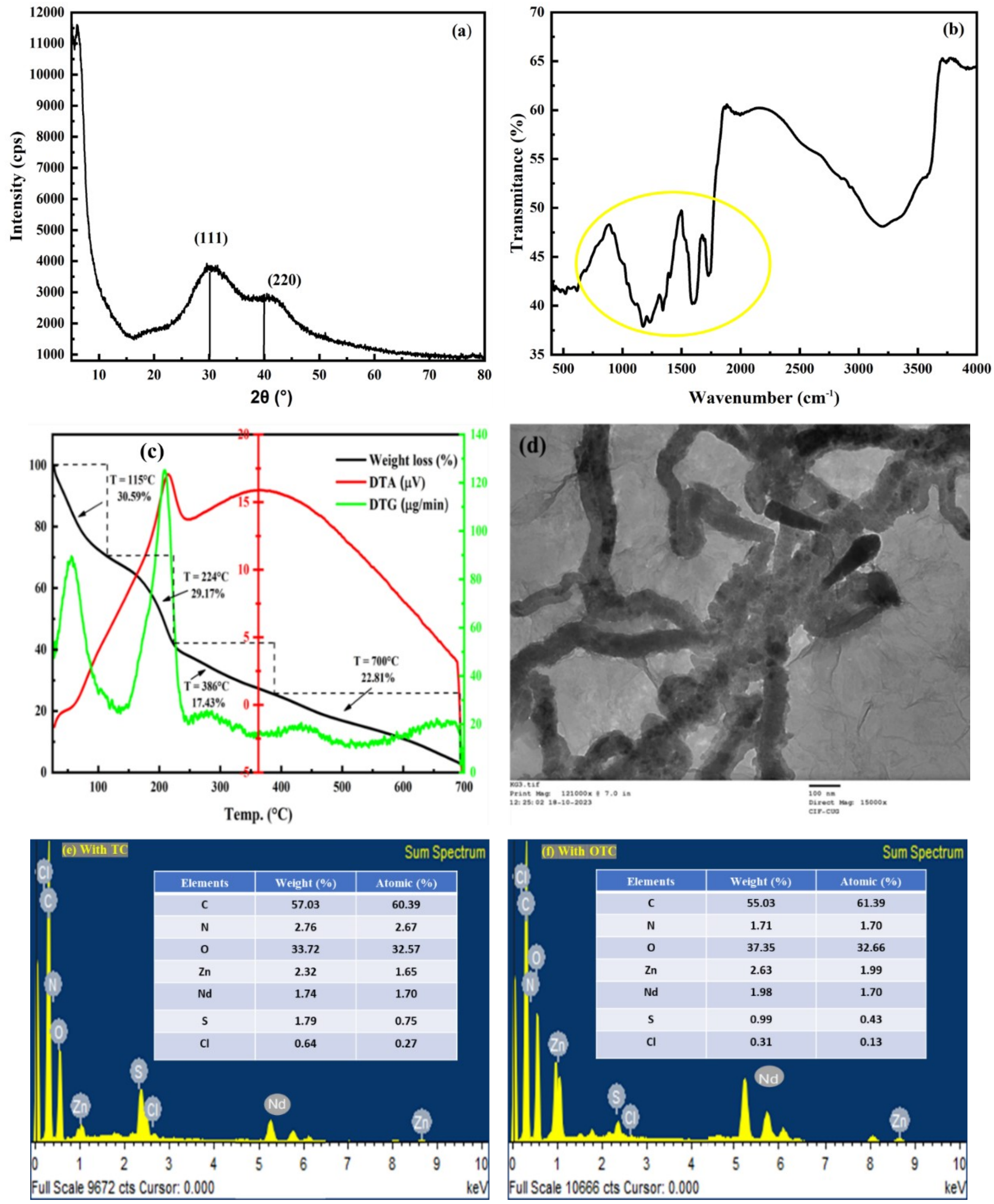
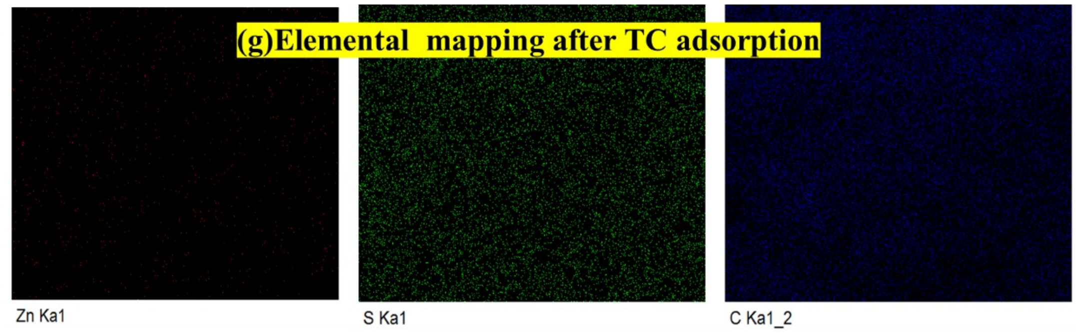


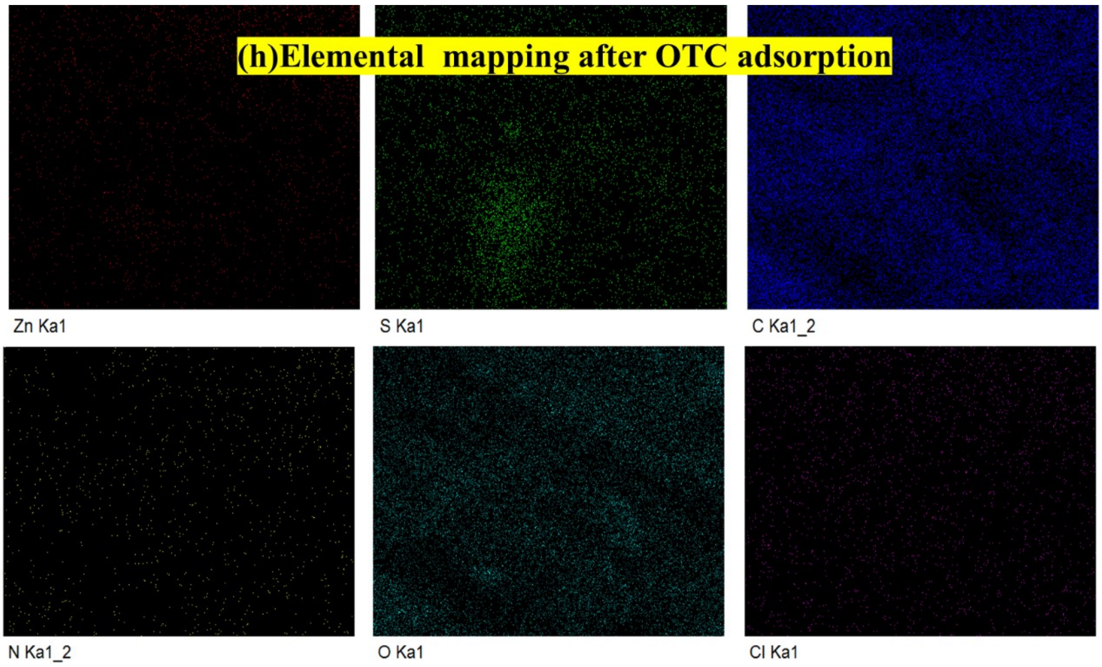
Fig. S5. AFM roughness, texture, and waviness for (a) ZnS (b) Nd@ZnS (c) Nd:ZnS@GO.



Elements	Weight (%)	Atomic (%)
C	57.03	60.39
N	2.76	2.67
O	33.72	32.57
Zn	2.32	1.65
Nd	1.74	1.70
S	1.79	0.75
Cl	0.64	0.27

Elements	Weight (%)	Atomic (%)
C	55.03	61.39
N	1.71	1.70
O	37.35	32.66
Zn	2.63	1.99
Nd	1.98	1.70
S	0.99	0.43
Cl	0.31	0.13


(g)Elemental mapping after TC adsorption
Zn Ka1
S Ka1
C Ka1_2
N Ka1_2
O Ka1
Cl Ka1


(h)Elemental mapping after OTC adsorption
Zn Ka1
S Ka1
C Ka1_2
N Ka1_2
O Ka1
Cl Ka1

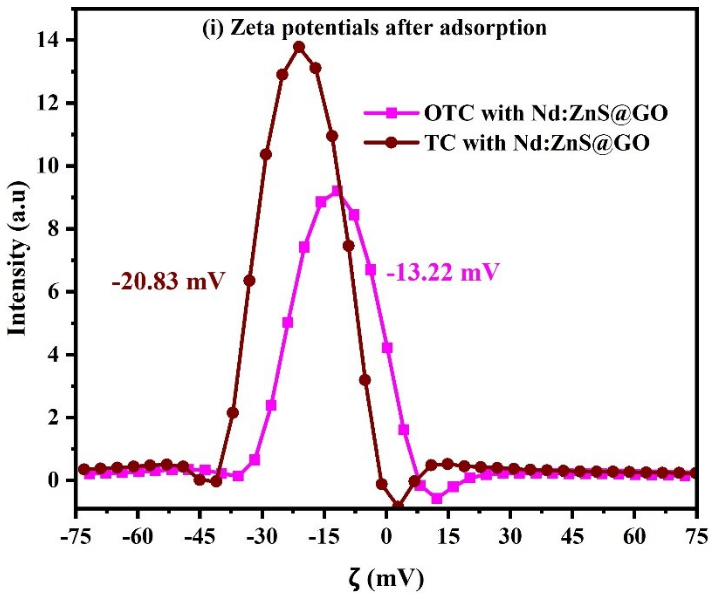


Fig. S6. Post-characterization after adsorption (a) P-XRD (b) FT-IR (C) TGA/DTG (d) HR-TEM (e-h) EDS with elemental mapping (i) zeta potentials after adsorption of TC and OTC with Nd:ZnS@GO respectively.

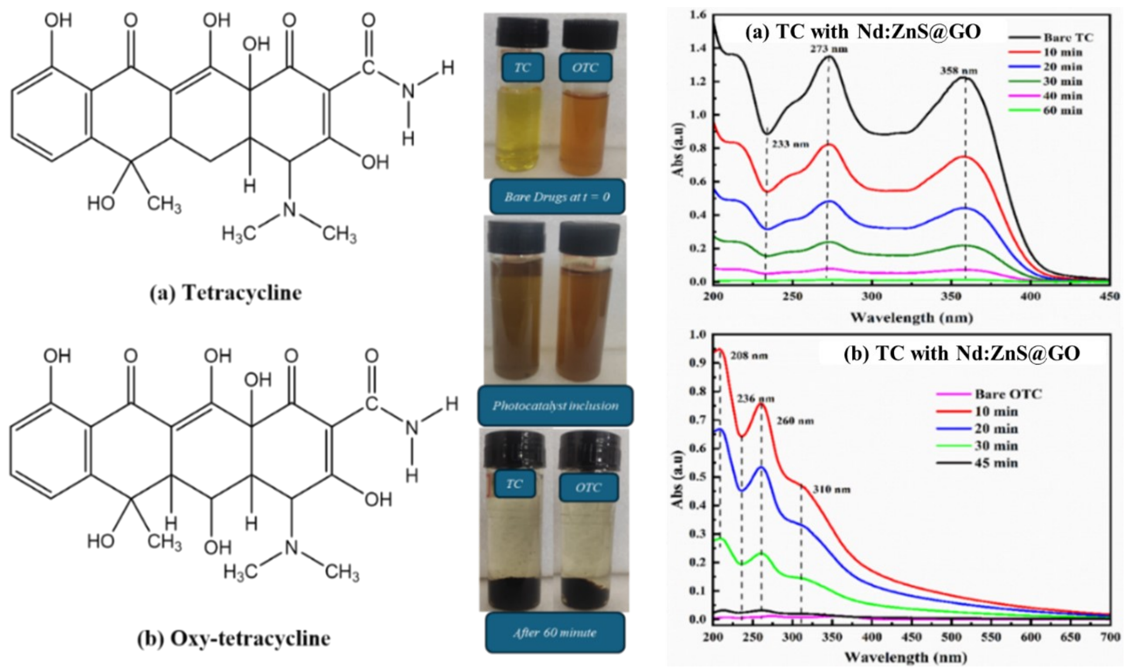


Fig. S7. PCD of TC and OTC in visible light.

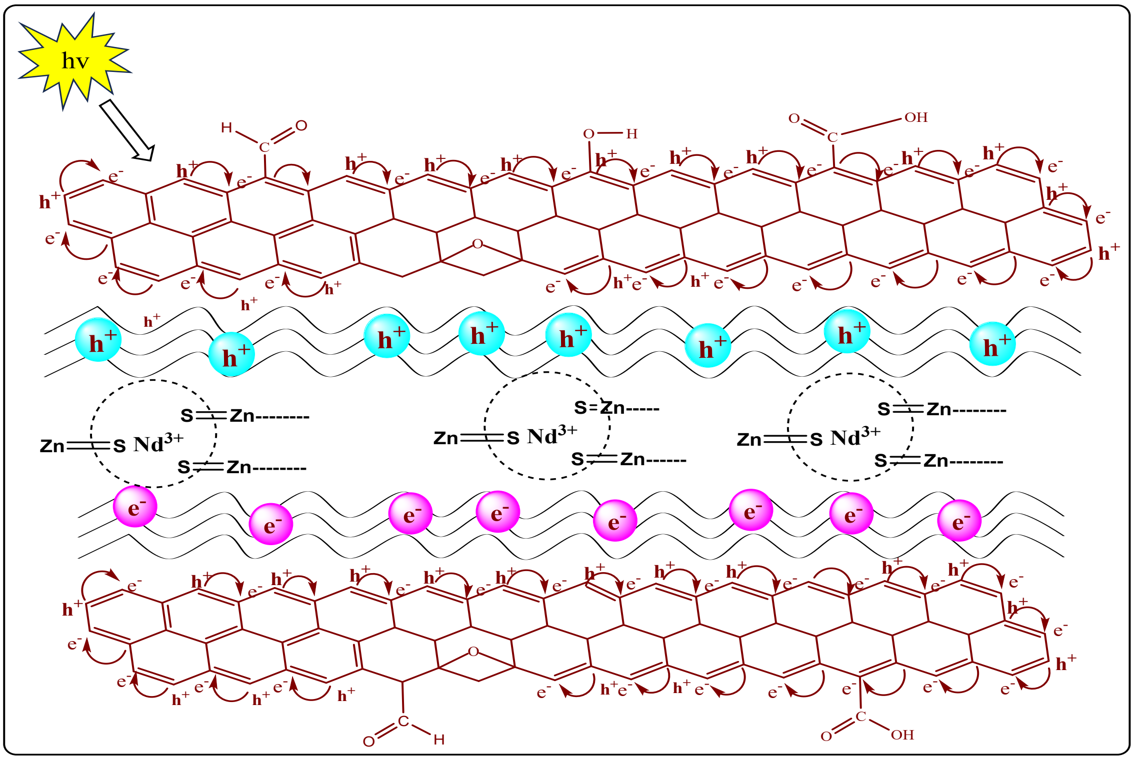
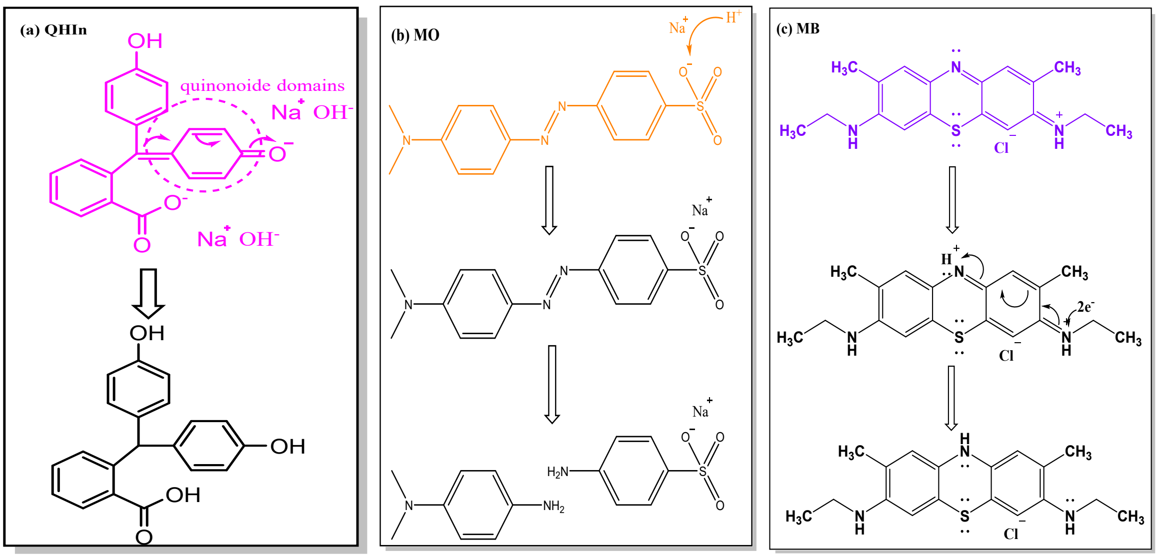


Fig. S8. Hole generation from Nd:ZnS@GO on exposing sunlight.



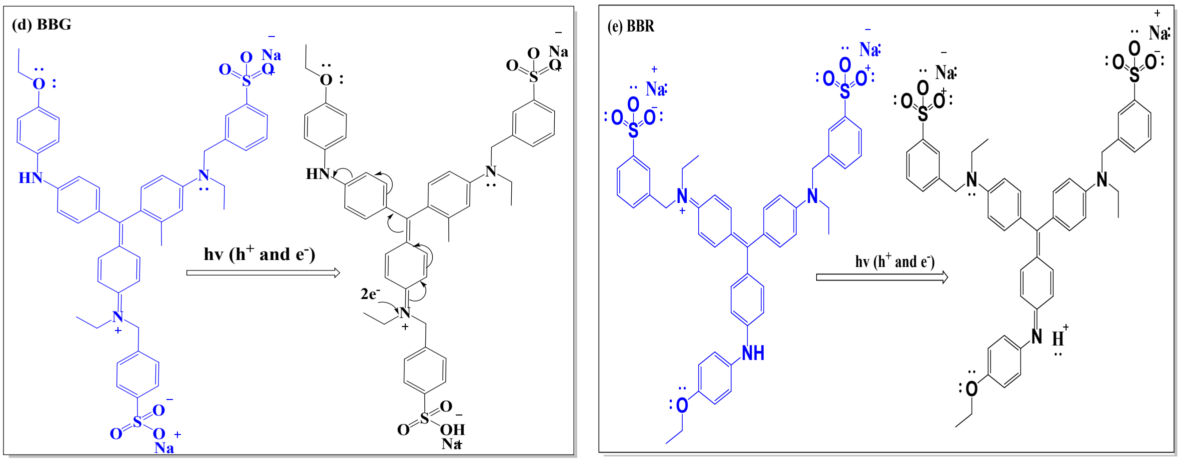
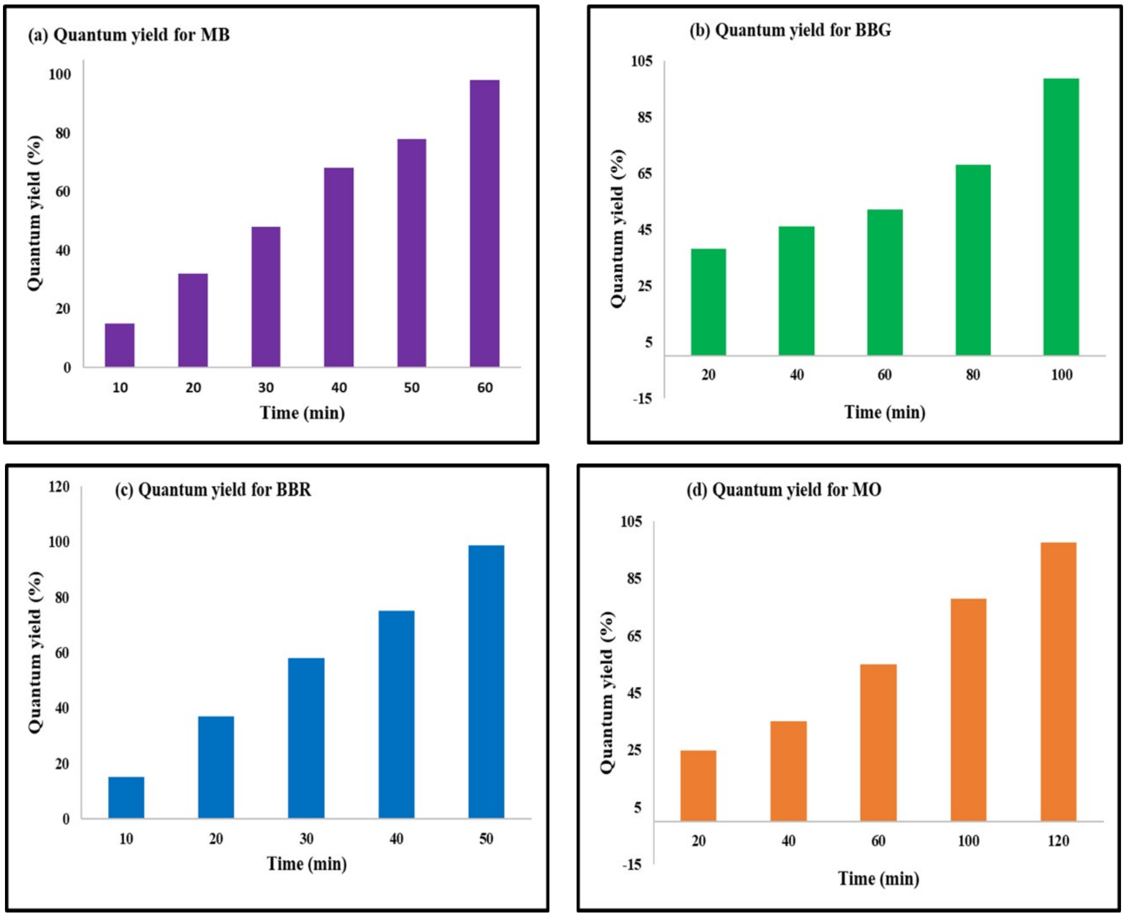


Fig. S9. Holes activation under visible light and transferred to a deficient site for PCD.



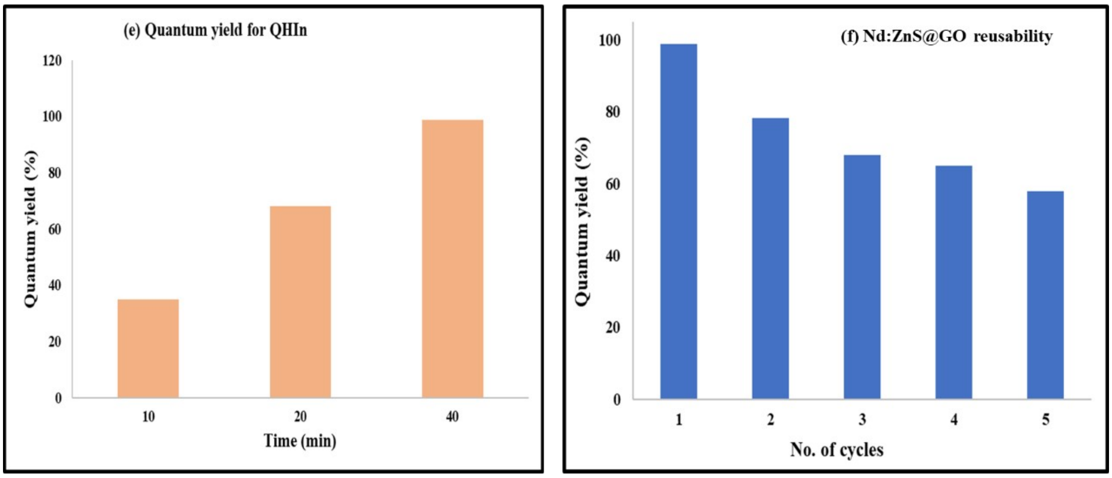


Fig. S10. Quantum yield for (a) MB (b) BBG (c) BBR (d) MO (e) QHIn with Nd:ZnS@GO and (f) reusability.

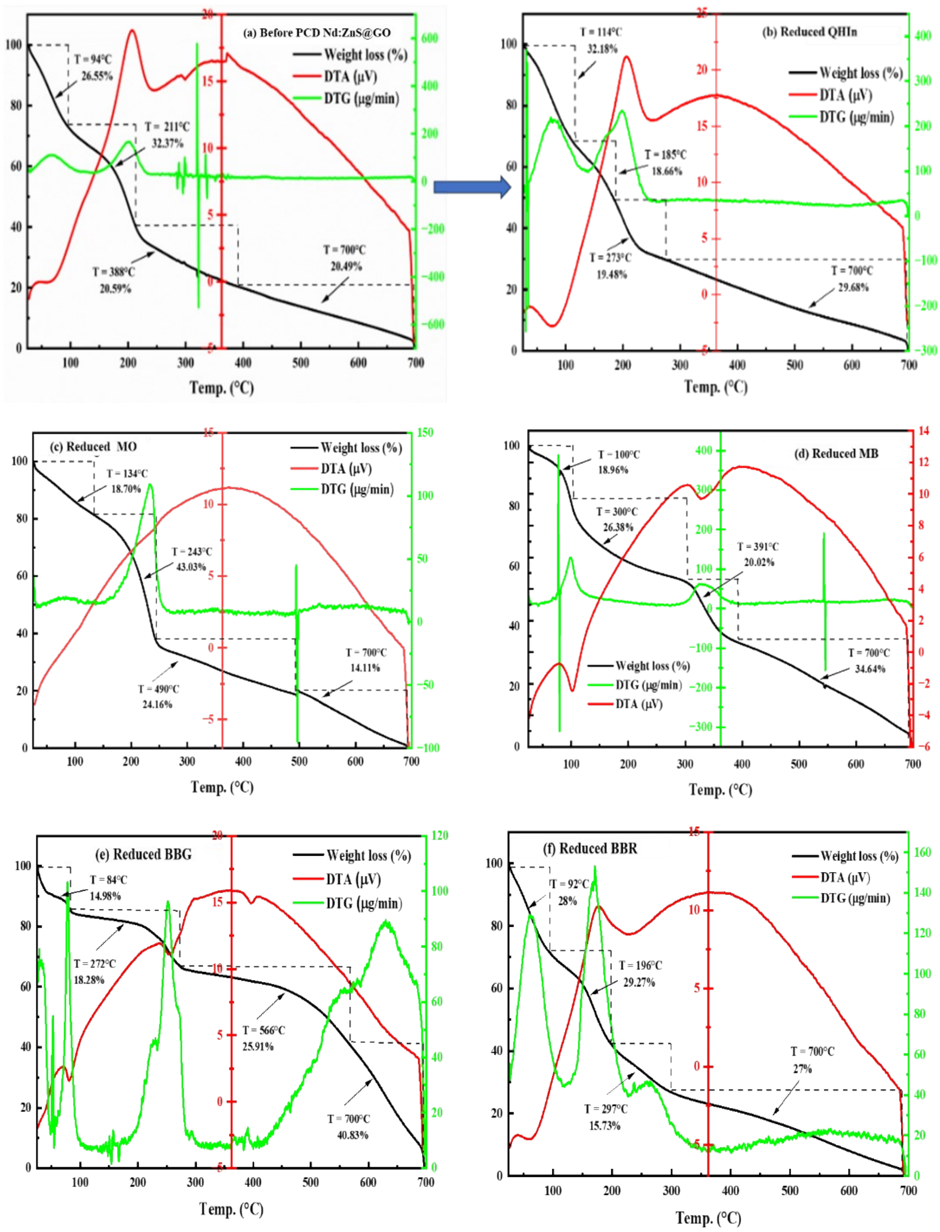


Fig. S11. Thermal stability of Nd:ZnS@GO before and after PCD of OFDs.

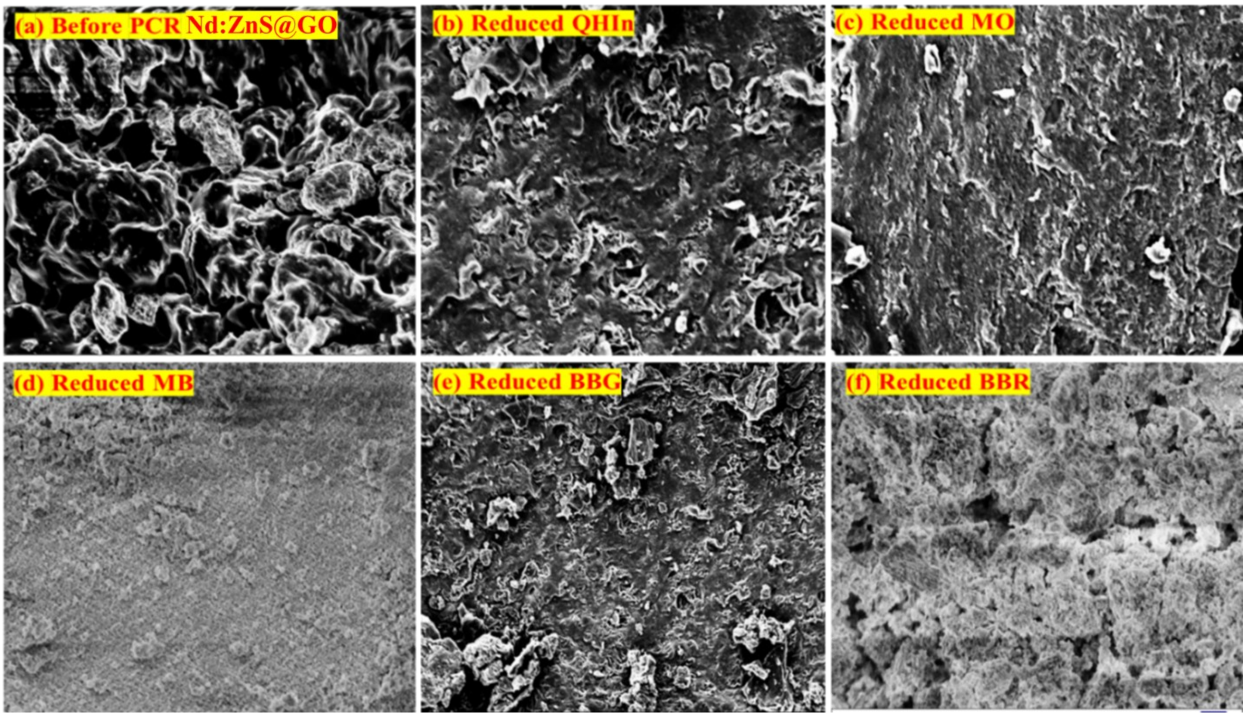
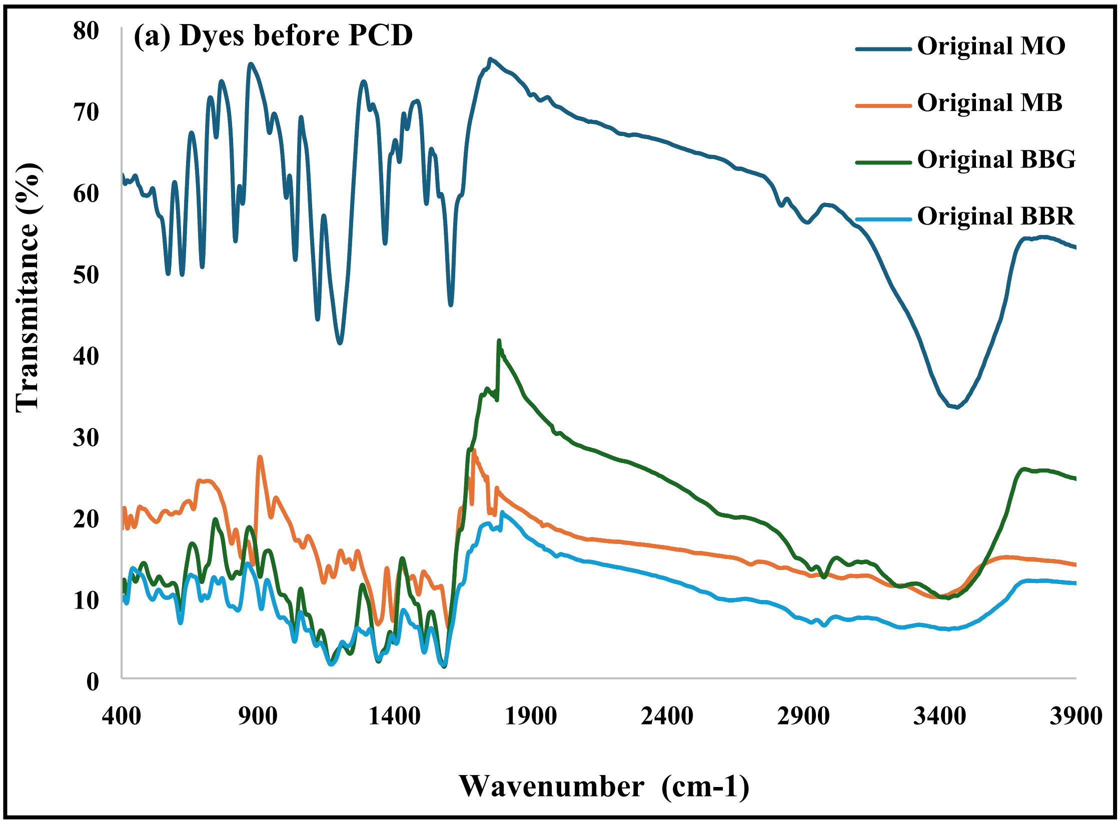


Fig. S12. SEM images (a) before PCD (b-f) and after PCD reduced OFDs.



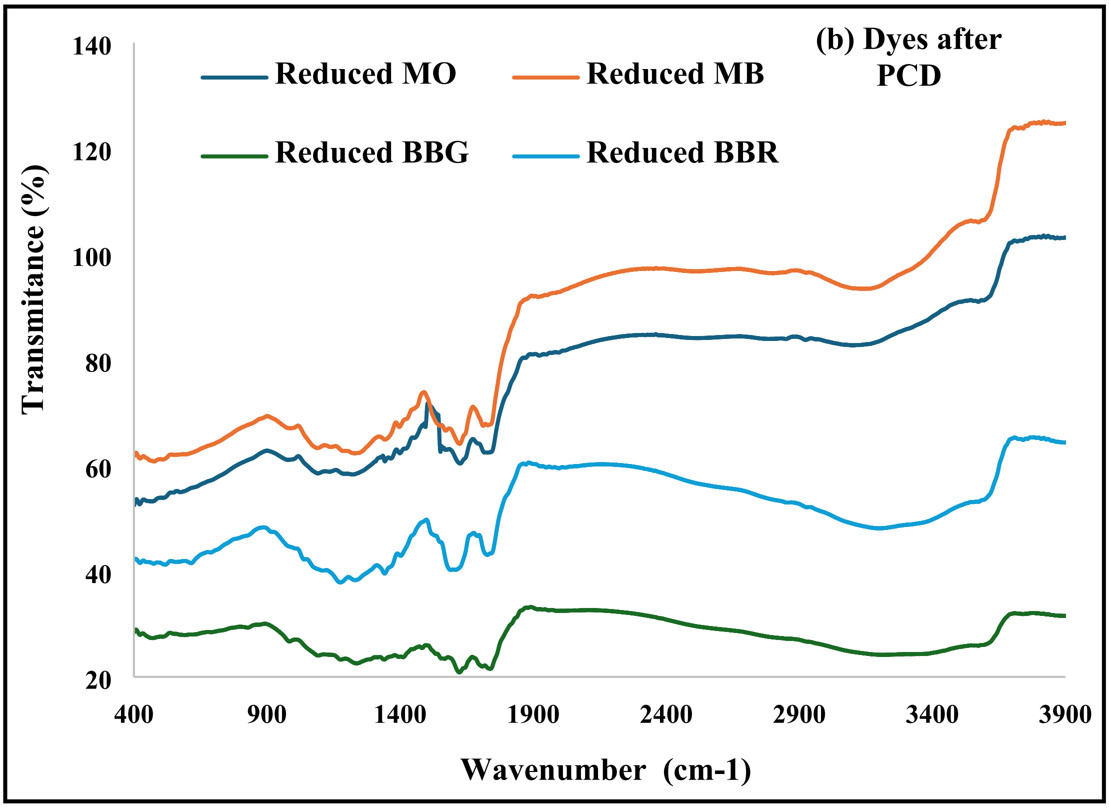


Fig. S13. FT-IR analysis before and after PCD (a) original OFDs dyes (b) reduced OFDs.

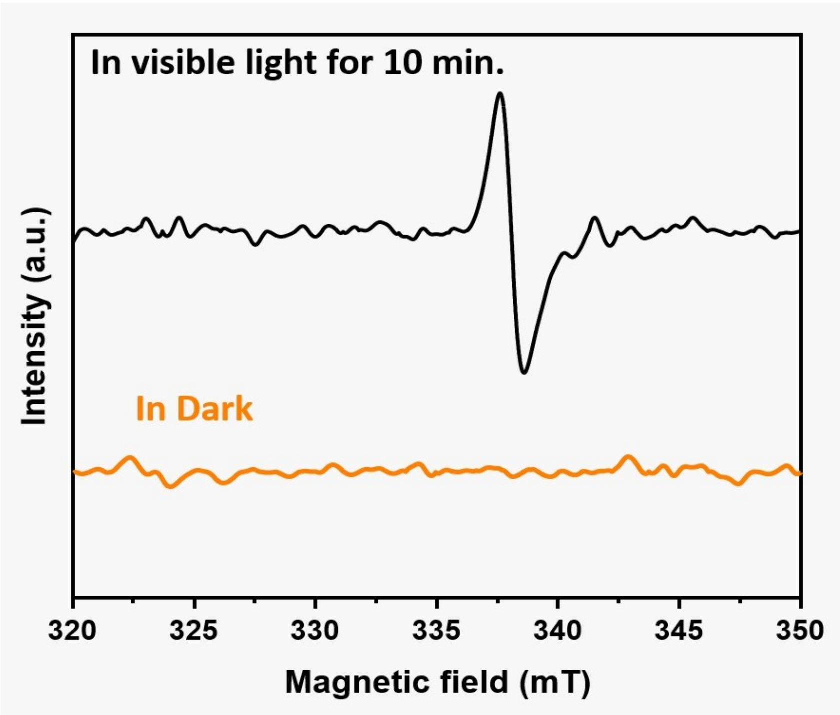


Fig. S14. EPR analysis of regenerated Nd:ZnS@GO nanotubes.

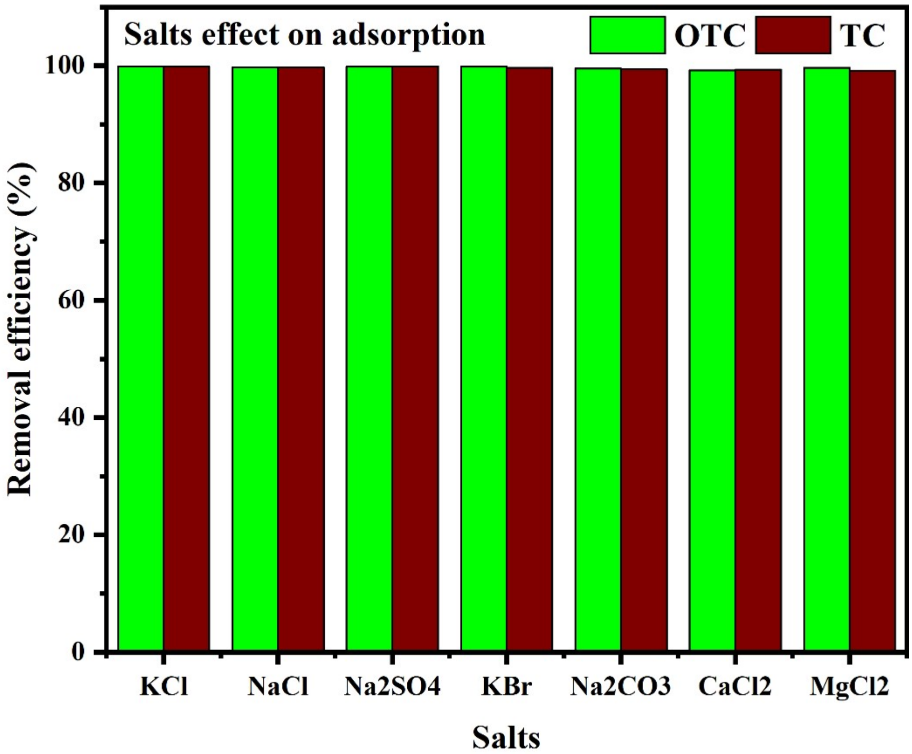


Fig. S15. Salt effect on adsorption of antibiotics using Nd:ZnS@GO nanotubes.

Tables:

Table S1. ICP-OES analysis for ZnS, Nd@ZnS, and Nd:ZnS@GO.

Systems	Analyte quantity	Corresponding Intensity (g)	Prep. Vol.: Conc. (Calib) (mg/L)	Conc. (Sample) (mg/L)
ZnS	Zn (206.200)	164539.7	3.66	3.66
Nd@ZnS	Zn (206.200)	186663.1	2.595	2.595
	Nd (406.109)	3358.5	1.268	1.268
Nd:ZnS@GO	Zn (206.200)	193241.5	2.506	2.506
	Nd (406.109)	1648.2	1.260	1.260

Table. S2. Comparative adsorption for TC and OTC capacity (mg/g) with reported studies.

Adsorbents	Adsorption capacity (TC: mg/g)	Adsorption capacity (OTC: mg/g)	Mechanism type	Ref.
Monoclinic-ZrO_2@rGO, Fe_3O_4@MWCNT-CdS	116.27	198.4	π-π interaction and cation-π bonding	[2]
α-Fe_2O_3 @RGO	180.8	98.4,	π-π interaction and cation-π bonding	[3]
La_2S_3 and MgO (La/Mg-biochar	120.8	---	---	[4]
RS-FeS and RSBC-FeS	--	635.66 and 827.80	π-π interaction and cation-π bonding	[5]
Graphene oxide (GO)	313	--	π-π interaction and cation-π bonding	[6]
$CoFe_2O_4$/h-BN/MIL-53(Al) nanocomposite	625	--	---	[7]
magnetic Fe/porous carbon hybrid (MagFePC)	130.24	>800	---	[8]
MGO@CdS	4.5 μg L^{-1}	--	---	[9]
Nd:ZnS@GO nanotubes at NTP	960	1117.76	Hydrogen bonding , π-π interaction and cation-π bonding	This work

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