Electronic Supplementary Information

Porous ZnO microtubes with excellent cholesterol sensing and catalytic properties

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Table S1 Detailed synthetic condition for hydrozincite intermediate and their morphology.

Sl. No	ZnO (B) (g)	AMC (g)	EG (mL)	H_2O (mL)	Temp. (°C)	Time (h)	Shape	Sample name
1	0.5	2.5	0	60	27	24	Random flakes	-
2	0.5	2.5	10	50	27	24	Flakes with long range assembly	-
3	0.5	2.5	20	40	27	24	Mixed tube and flower	-
4	0.5	2.5	30	30	27	24	Tube	ZnO(T)
5	0.5	2.5	40	20	27	24	Tube assembly of individual flakes	-
6	0.5	2.5	50	10	27	24	Random flakes	-
7	0.5	2.5	60	0	27	24	No shape	-
8	1.5	7.5	90	90	120(R)	24	Nest like structure	ZnO(NS)
9	1.5	7.5	0	180	120(R)	24	Arranged flakes towards big flowers	ZnO(FFR)
10	1.5	4.5	90	90	130(HT)	24	Spindle shape flakes	ZnO(SSF)
11	1.5	4.5	0	180	130(HT)	24	Arranged flowers from flakes	ZnO(FFH)
12	4	10	0	160	27	0.5	Flakes like woolen thread [1]	ZnO(FWT)

B= Bulk; AMC= Ammonium carbonate; EG= Ethylene glycol; R= Reflux; HT= Hydrothermal

Table S2. Comparison of the performances of various types of cholesterol biosensors.

Electrode materials	Sensitivity ($mA.M^{-1}\ cm^{-2}$)	Linear range (mM)	LOD (mM)	Referance
Pt–Au@ZnONRs	26.8	0.0001–0.759	30	2
MWCNTs/SiO_2-CS	3.8	0.25–125	0.016	3
MWNTs-Au/PPD	0.559	0.5–6	0.200	4
DTSP-Au	0.054	0.2–2.1	0.022	5
ZnO	3.01	1.1-4.83	0.0220	6
polypyrrole	0.044	0.025-0.30	-	7
PANI-MWCNTs	6.8	1.29–2.93	-	8
Au Nanowire	0.85	0.01–0.06	-	9
ZnO(NT)/CT	**54.5**	**0.4–4**	**0.200**	**This work**

Table S3. Comparison of the catalytic activity of different heterogeneous catalyst system reported in literature with the present ZnO microtube for the synthesis of 5-benzyl-1-H tetrazole form benzonitrile and NaN_3.

Entry	Catalyst	NaN_3[a] (mmol)	Temp. (°C)	Time (h)	Yield (%)	Ref.
1.	3D Porous ZnO (FWT)	1.1	125	14	87	1
2.	Bulk ZnO	1.1	125	14	51	-------
3.	ZnO nanoparticles	1.1	125	14	68	-------
4.	ZnO nanoparticles	1.1	120	14	72	10
	Mesoporous ZnS			36	84	
5.	HNO_3 activated Mesoporous	2	120	12	60	11
	ZnS			36	96	
6.	CoY Zeolite	2	120	14	90	12
7.	Zn/Al hydrotalcite	1.5	120	12	84	13
8.	Zinc Hydroxyapatite	2	120	12	78	14
9.	$FeCl_3$–SiO_2	1.5	120	12	79	15
10.	**ZnO microtubes**	**1.1**	**125**	**14**	**92**	**Present work**

[a.] with respect to 1 mmol benzonitrile

Entry 1 The 3D Porous ZnO (FWT) synthesized as reported earlier

Entry 2 The Bulk ZnO (commercial) which we have used as zinc source for 3D Porous ZnO structure.

Entry 3 The ZnO nanoparticles were synthesized in our laboratory through precipitation method starting from zinc nitrate.

Entry 4 Nano ZnO was employed for the reaction 72 % yield of 5-benzyl-1-H tetrazole was obtained which less than the present work.

Entry 5 84 % yield was observed in 36h of reaction time over mesoporous ZnS. Whereas 96% yield was observed in same tine over HNO_3 mesoporous ZnS, but only 60 yield was observed in 12 h of reaction time with the HNO_3 mesoporous ZnS.

However, in all the cases they used excess amount of NaN_3.

Entry 6 90% yield was obtain, but excess amount of NaN_3 was used.

Entry7 Comparable yield was observed with higher amount of NaN_3.

Entry 8 Lower yield was observed with higher amount of NaN_3.

Entry 9 Lower yield was observed with higher amount of NaN_3 and catalyst.

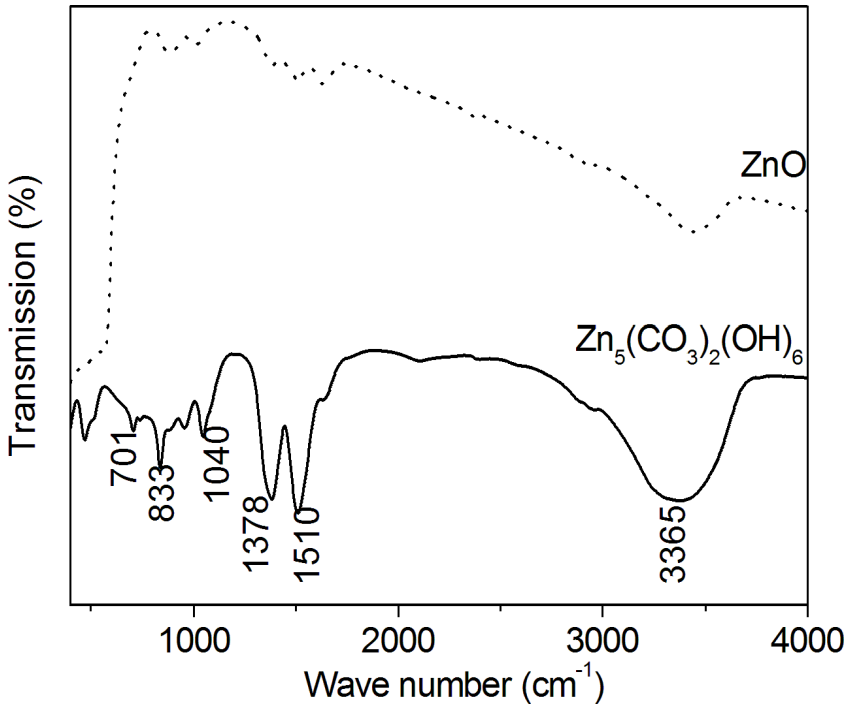

Fig. S1 FT-IR spectra of hydrozincite microtube intermediate and the corresponding porous ZnO obtained after calcination (500°C /2 h).

To confirm the formation of intermediate hydrozincite and the corresponding calcined product ZnO, the FT-IR experiment was performed in the detection range of 400-4000 cm^{-1}. The FTIR spectrum of the synthesized hydrozincite intermediate and product ZnO (Fig. S1) is very similar to that of the reported results.[16-17] The characteristic sharp bands of hydrozincite at 701,

833, 1378, 1510 cm^{-1} can be attributed to the C-O bending vibration of CO_3^{2-}. The broad band at 3365 cm^{-1} is due to the hydroxyl group of hydrozincite and adsorbed water molecule. On calcination, the bands correspond to C-O bending vibration of CO_3^{2-} and hydroxyl or water molecules substantially weakened and confirm the decomposition of hydrozincite precursor to ZnO. However, the existence of the respective bands C-O vibration and water molecule with low intensity in the calcined ZnO can be attributed to the surface adsorbed CO_2 and water. In the previous reports the similar observation was reported [17] except the report of Wang *et al.*[16], where they have not identified any band for corresponding adsorbed water molecule.

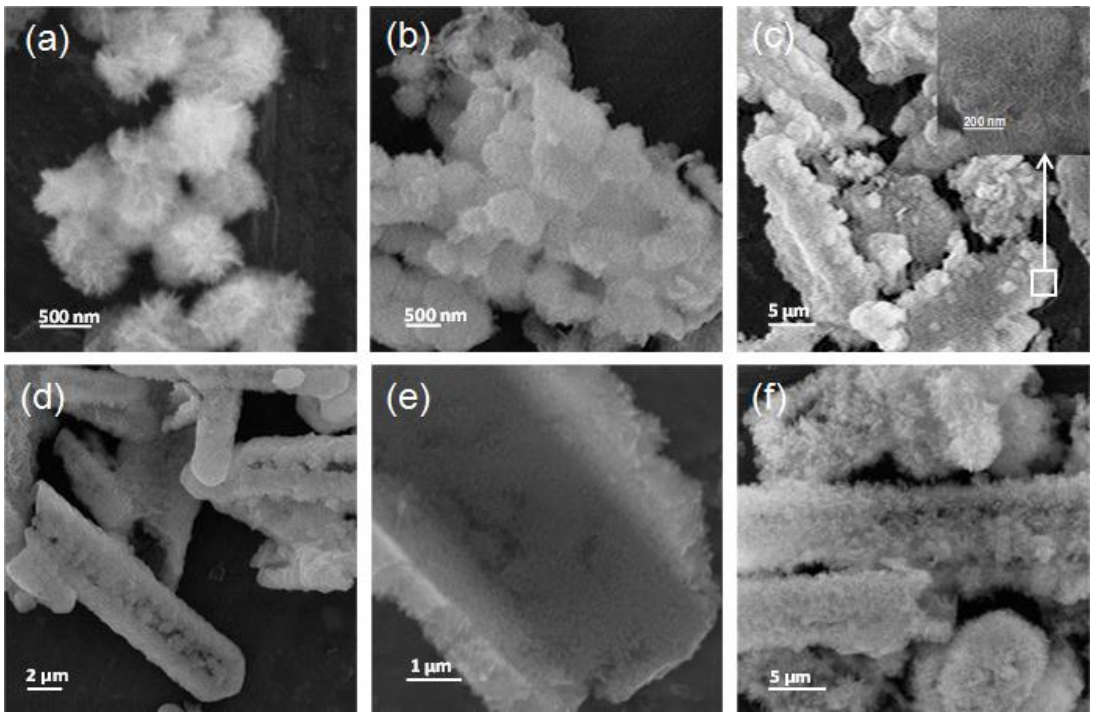

Fig. S2 SEM images of the hydrozincite intermediates formed during the formation of microtubes with 50% of EG in water at room temperature, after (a) 4 h, (b) 8 h, (c) 12 h, (d &e) 18 h and (f) 30 h.

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