Supporting Information

Under dark and visible light: fast degradation of methylene blue in presence of Ag-In-Ni-S nanocomposites

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General Experimental procedure:

All reagents were purchased either from Sigma or Alpha Aesar. Solvents were dried and purified using standard techniques. IR spectra were recorded in KBr on a Shimadzu IR Afinity I. SEM images were obtained from a Hitachi S-4800 microscope at an operating voltage of 15Kv. The sample was coated with platinum for effectual imaging before being charged. TEM images were obtained from JEOL instrument using Cu grid. UV-vis and fluorescence data was recorded in UV-vis spectrophotometers of Shimadzo UV-2550 using standard 1 cm quartz cuvette and Fluoromax-4 spectrofluorometer of Horiba Jobin YVON respectively. X-ray powder diffraction study was carried out on a Rigaku X-Ray diffractometer at a voltage of 10 Kv using Cu Kα radiations (λ=0.15418 nm) at scanning rate of 0.50°/minute in the 2θ range 10-80°. Surface Analysis by XPS is accomplished by irradiating a sample with monoenergetic soft X-ray, Mg Kα (1253.6 eV) was performed using the ESCAprobe TPD system in an ultra-high vacuum system. TGA experiment was carried out in SDT Q600. BET measurement was performed using Smart Instruments; Smart Sorb 92/93.

Table S1. Synthesis of Ag-In-Ni-S with variation of SDS

Sl No	Catalyst Code	Reaction Condition	Ratio (mmol)	
			Starting materials	Surfactant (SDS)
01	**N1**	80° C	1.0	**0.10**
02	**N2**	80° C	1.0	**0.20**
03	**N3**	80° C	1.0	**0.25**
04	**N4**	130° C, Hydrothermal	1.0	**0.25**
05	**N5**	80° C	1.0	**0.50**
06	**N6**	30° C, Room Temperature	1.0	**1.00**
07	**N7**	80° C	1.0	**1.00**
08	**N8**	80° C	1.0	**1.50**

Table S2, a: Phase name and JCPDS Data

Phase name	**Formula**	**DB card number**
Silver Indium	$Ag\ In\ S_2$	01-075-0117
Indium Sulfide	$In_2\ S_3$	00-025-0390
Acanthite, syn	$Ag_2\ S$	03-065-2356
Vaesite, syn	$Ni\ S_2$	03-065-3325
Indium Nickel	$In_2\ Ni\ S_4$	01-070-2900

Table S2, b: Quantitative analysis results (RIR) of Sample N8

2-θ (deg)	Phase name	DB card number
22.29	Indium Sulfide(0,0,8), Acanthite, syn(1,0,-1)	00-025-0390,03-065-2356
25.05	Indium Sulfide(2,0,4), Acanthite, syn(1,1,0), Indium Nickel Sulfide(2,2,0)	00-025-0390,03-065-2356, 01-070-2900
26.66	Silver Indium Sulfide(1,1,2), Acanthite, syn(0,1,2), Vaesite, syn(1,1,1)	01-075-0117,03-065-2356, 03-065-3325
28.43	Silver Indium Sulfide(1,0,3), Indium Sulfide(1,0,9), Acanthite, syn(0,2,1), Indium Nickel Sulfide(3,1,1)	01-075-0117,00-025-0390, 03-065-2356,01-070-2900
31.53	Silver Indium Sulfide(0,0,4), Acanthite, syn(1,1,-2),Vaesite, syn(2,0,0)	01-075-0117,03-065-2356, 03-065-3325
34.42	Indium Sulfide(0,0,12), Acanthite, syn(1,2,0), Indium Nickel Sulfide(4,0,0)	00-025-0390,03-065-2356, 01-070-2900
35.32	Silver Indium Sulfide(2,1,1), Indium Sulfide(2,2,4), Vaesite, syn(2,1,0)	01-075-0117,00-025-0390, 03-065-3325
36.71	Indium Sulfide(3,0,3), Acanthite, syn(1,1,2), Indium Nickel Sulfide(3,3,1)	00-025-0390,03-065-2356, 01-070-2900
38.75	Indium Sulfide(1,0,13), Acanthite, syn(1,2,-2),Vaesite, syn(2,1,1)	00-025-0390,03-065-2356, 03-065-3325
43.9	Silver Indium Sulfide(2,1,3), Indium Sulfide(3,2,1), Acanthite, syn(1,2,2), Indium Nickel Sulfide(4,2,2)	01-075-0117,00-025-0390, 03-065-2356,01-070-2900
44.65	Silver Indium Sulfide(2,0,4), Indium Sulfide(1,0,15), Acanthite, syn(1,3,0),Vaesite, syn(2,2,0)	01-075-0117,00-025-0390, 03-065-2356,03-065-3325
48.00	Silver Indium Sulfide(3,0,1), Indium Sulfide(2,2,12), Acanthite, syn(0,0,4), Vaesite, syn(2,2,1), Indium Nickel Sulfide(4,4,0)	01-075-0117,00-025-0390, 03-065-2356,03-065-3325, 01-070-2900
51.17	Indium Sulfide(4,1,5), Acanthite, syn(2,2,0)	00-025-0390,03-065-2356
53.44	Silver Indium Sulfide(3,1,2), Indium Sulfide(4,0,8), Acanthite, syn(1,2,3),Vaesite, syn(3,1,1), Indium Nickel Sulfide(5,3,1)	01-075-0117,00-025-0390, 03-065-2356,03-065-3325, 01-070-2900
56.52	Indium Sulfide(4,2,6)	00-025-0390
58.40	Acanthite, syn(1,4,-1),Vaesite, syn(3,0,2), Indium Nickel Sulfide(6,2,2)	03-065-2356,03-065-3325, 01-070-2900
60.90	Acanthite, syn(2,1,-4),Vaesite, syn(3,2,1), Indium Nickel Sulfide(4,4,4)	03-065-2356,03-065-3325, 01-070-2900

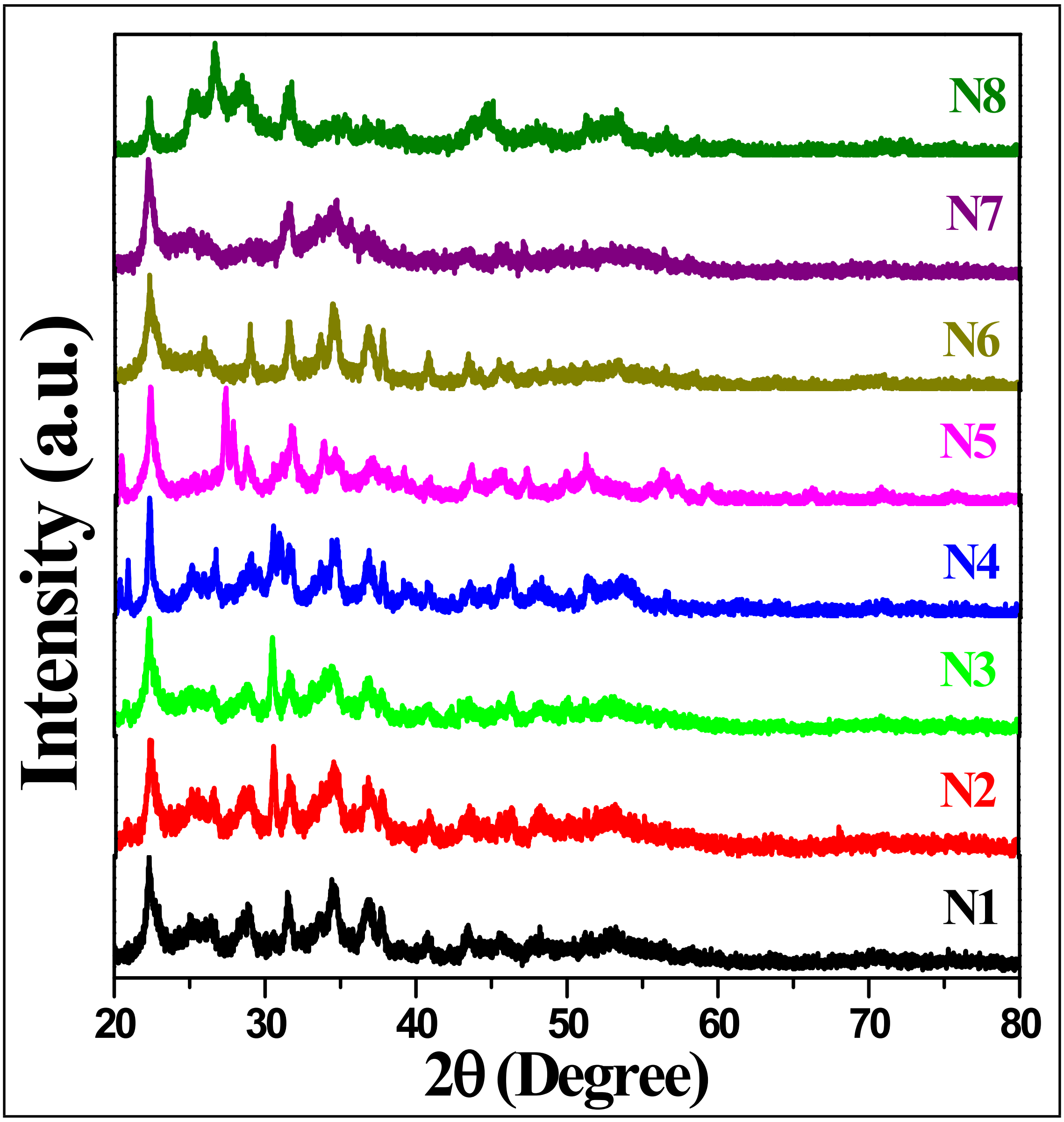

Fig. S1 PXRD plot of **N1**-**N8**.

The morphologies of the synthesized Ag-In-Ni-S: FE-SEM and TEM

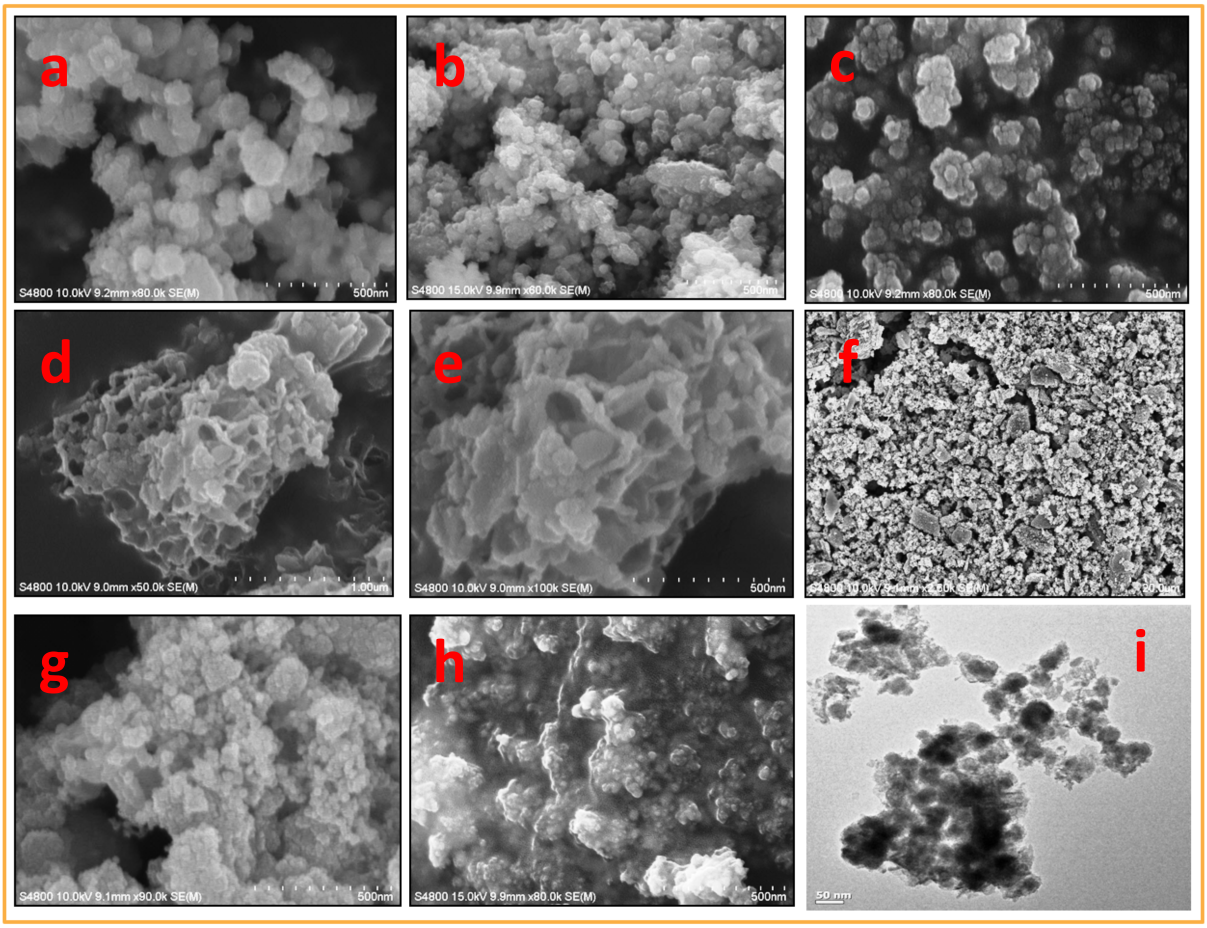

Fig. S2 a) FE-SEM image of sample **N1**, b) FE-SEM image of sample **N2**, c) FE-SEM image of sample **N3**, d) Low magnification FE-SEM image of sample **N4** , e) FE-SEM image of sample **N4** at 500nm, f) Low magnification FE-SEM image of sample **N6** , g) FE-SEM image of sample **N6** at 500nm, h) FE-SEM image of sample **N7**, i) TEM image of sample **N5** at 50nm.

Table S3 Distribution of Elements percentage from EDX analysis

Sl	Catalyst	Element Weight (%)			
		Silver	Indium	Nickel	Sulfide
01	**N1**	39.48	42.83	4.03	13.66
02	**N3**	44.98	39.33	1.41	14.28
03	**N4**	28.62	46.48	10.56	19.34
04	**N5**	31.21	34.97	9.07	24.75
05	**N6**	37.01	51.82	0.91	10.26
06	**N8**	32.96	32.92	9.34	24.79

EDX Line Spectra of Ag-In-Ni-S

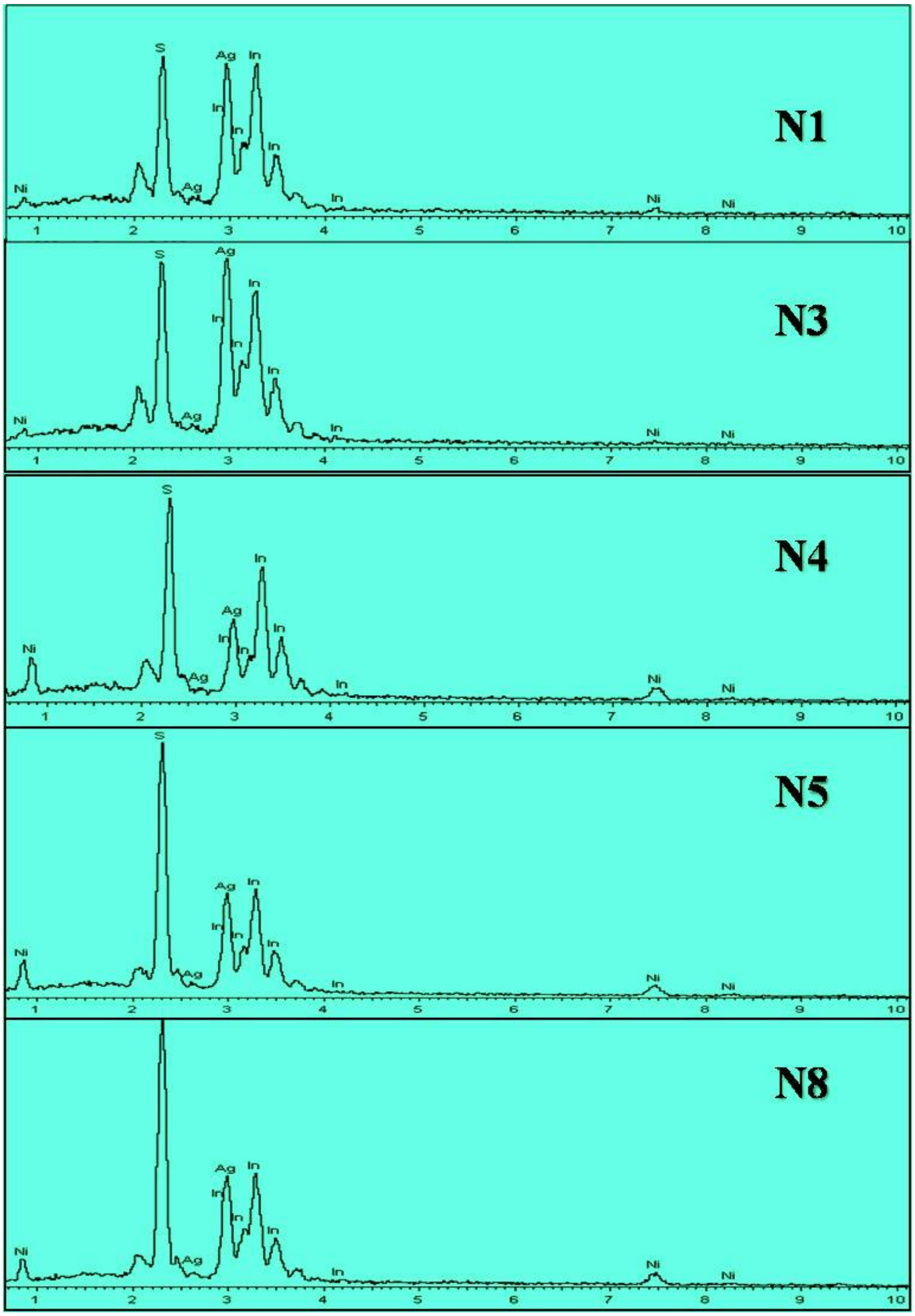

Fig. S3 EDX Line Spectra of Ag-In-Ni-S

Table S4 Degradation of MB in absence of light

Sl No	Sample	Reaction Condition	% MB	
			Consumed	**Remaining**
01	N1	**Dark 12 min (in absence of light) catalyst +MB Stirring condition**	60.04	39.96
02	N2		60.04	39.96
03	N3		92.10	7.90
04	N4		87.76	12.24
05	N5		92.29	7.71
06	N6		48.31	51.69
07	N7		94.46	5.54
08	N8		97.52	2.48
09	MB Blank		0.64	99.36
10	N5	100W (4min)	99.30	0.70
11	N8	100W (4min)	99.80	0.20
12	N5	Sunlight (2min)	100.00	00

Table S5 Comparison Table for Ag containing catalyst with Dye

Sl	Catalyst	Light Source	Dye	Time	Ref
01	Silver indium tungsten oxide $[AgIn(WO_4)_2]$ mesocrystals	UV and visible light (300 W Xe lamp)	Rhodamine B, Methyl Orange & Eosin Y	60 min	13a
02	Ag/TiO_2/graphene Nanocomposite	500W halogen lamp	Methylene blue	60 min	13b
03	Multi-walled carbon nanotubes loaded with Ag nanoparticles (Ag/MWNTs)	Visible light irradiation (λ> 420 nm)	Rhodamine B	8 hour	13c
04	Silver phosphate crystals	Ultraviolet light (8 W)	Rhodamine B (RhB)	4 hour	13d
05	Titania–silica photocatalysts: effect of carbon and silver doping	A xenon lamp (300 W) equipped with a UV-cutoff filter to remove the light below 400 nm wavelengths	Rhodamine B (RhB)	2.5hour	13e

06	$ZnSeIn_2Se_3Ag_2S$ solid solution coupled with $TiO_{2-x}S_x$ nanotubes film	500 W Xe lamp	photocatalytic hydrogen evolution	5 hour	13f
07	Ag_2S/MCM-41	UV lamp	Methylene blue	60 min	13g
08	Ag-entrapped hydrogel	Tested to catalyze the $NaBH_4$ reduction	Methylene blue & Congo Red	40 min	13h
09	Ag_2O–Bi_2O_3 composites	500 W Xe lamp	Methyl Orange (MO)	60 min	13i
10	AgBr/AgI@Ag composite	500W halogen tungsten lamp	Methyl orange (MO)	30 min	13j
11	TiO_2@Ag heterojunction	150 W GYZ220 high-pressure Xenon Lamp. average light intensity was 50 mW /cm^2.	Methylene blue (MB)	60 min	13k
12	Silver phosphate myriapods	Visible light irradiation ($\lambda > 420$ nm)	Rhodamine B (RhB)	15 min	13l
13	Silver(I) with a hybrid pyrazine–bipyridine ligand	UV light	Methylene Blue (MB)	400min	13m
14	Silver-nanoparticle-decorated $AgVO_3$ nanoribbons	Visible light irradiation	Crystal violet (CV)	90 min	13n
15	Ag/CN-TiO_2@g-C_3N_4	Visible light	Rhodamine B (RhB)	120min	13o
16	Ag@AgCl nanoframe	300 W Xe lamp	Methyl Orange (MO)	36 min	13p
17	**Ag-In-Ni-S nanocluster**	**No Light**	**Methylene Blue (MB)**	**12min**	**Present**
18	**Ag-In-Ni-S nanocluster**	**100W lamp**	**Methylene Blue (MB)**	**4min**	**Present**
19	**Ag-In-Ni-S nanocluster**	**Sunlight**	**Methylene Blue (MB)**	**2min**	**Present**

Catalytic degradations of MB under dark conditions

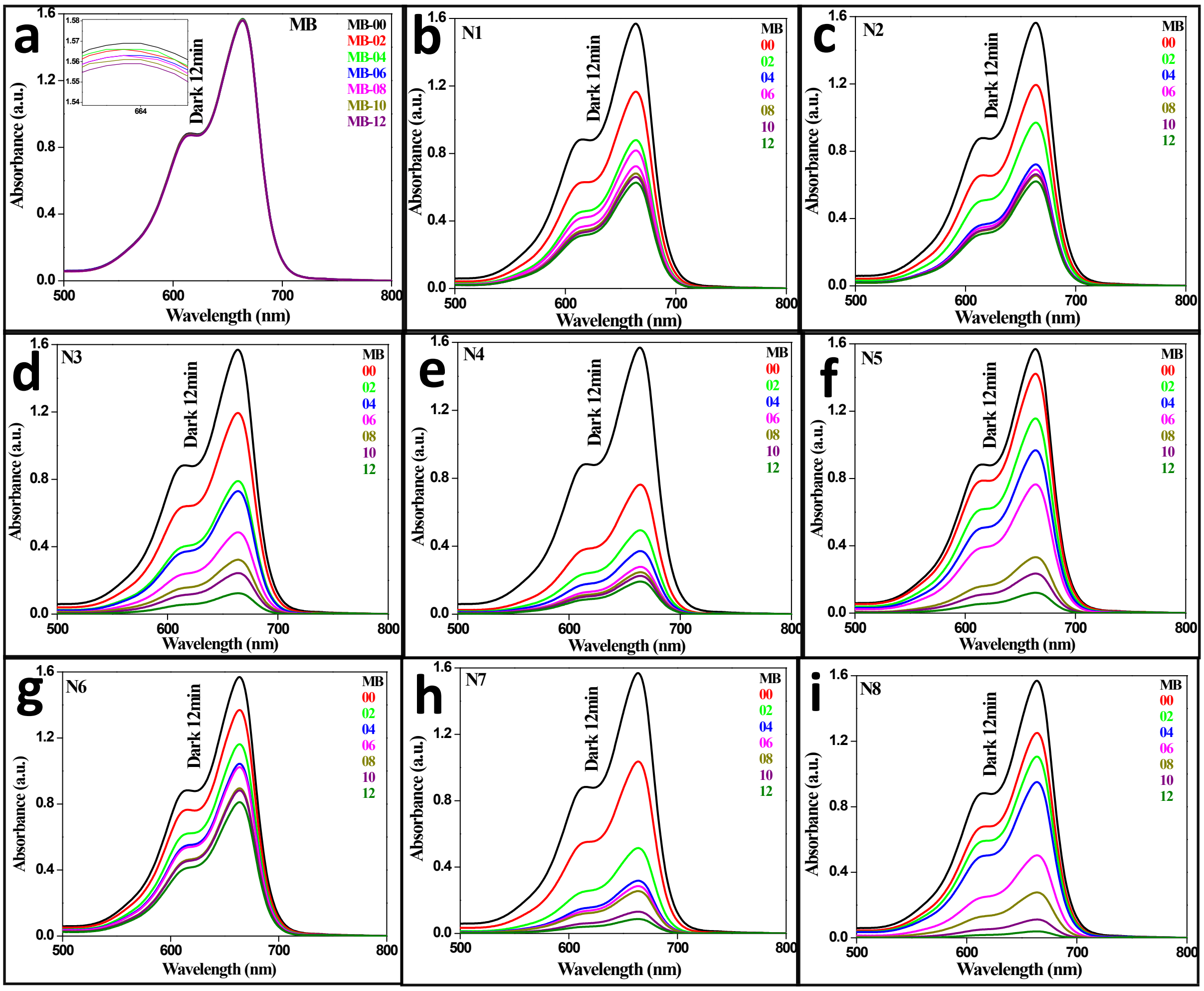

Fig. S4 Fate of MB in presence of a) without catalyst under dark, b)**N1**, c) **N2**, d) **N3**, e) **N4** , f) **N5**, g) **N6** , h) N7 and i) **N8.**

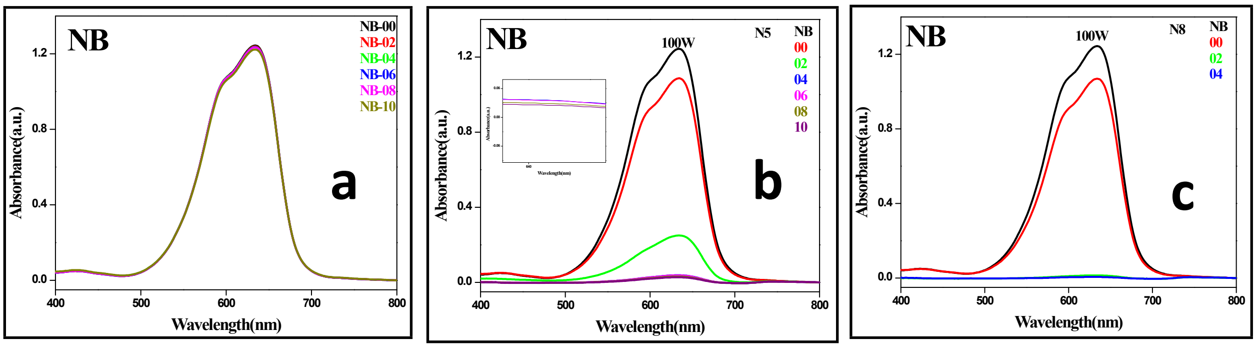

Fig. S5 Fate of NB under 100W lamp a) without catalyst, b)**N5**, c) **N8**

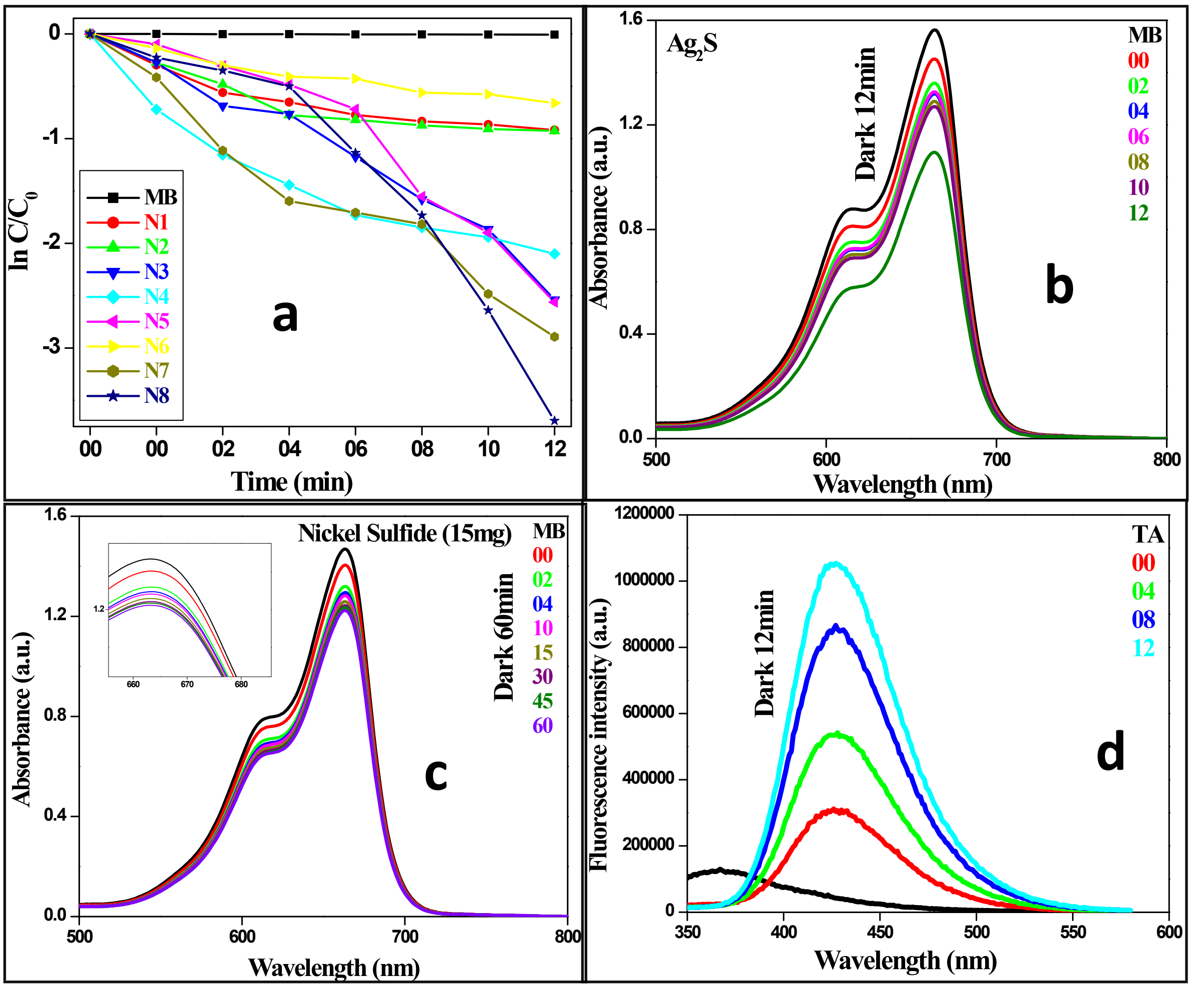

Fig. S6 a) Degradations of MB, ln(C/C_0) versus time in absence of light, b) Methylene Blue with Ag_2S, c) Methylene Blue with Nickel Sulphide, d) ROS generations with sample **N8.**

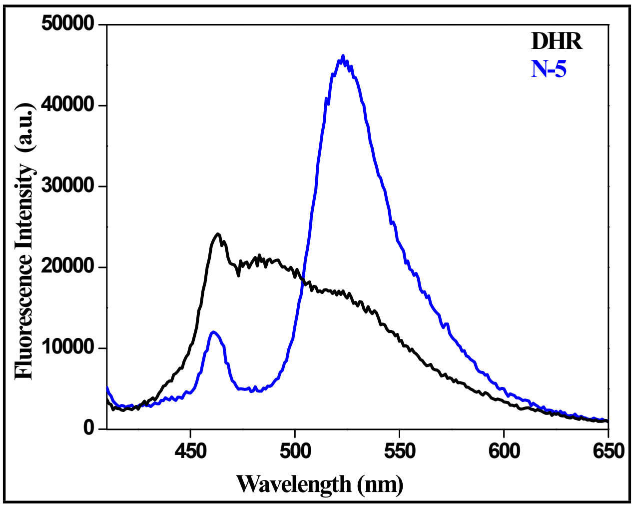

Fig. S7 ROS generations with sample **N5.**

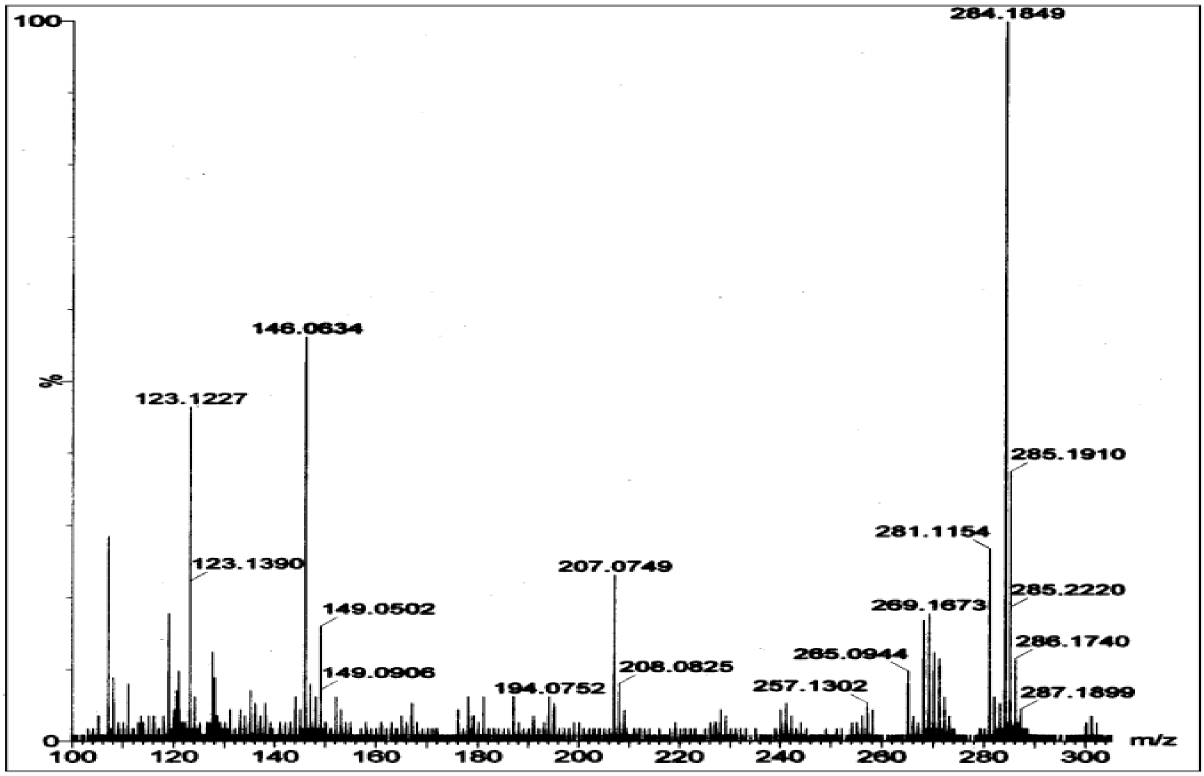

Fig. S8 ESI mass spectra of methylene blue (MB).

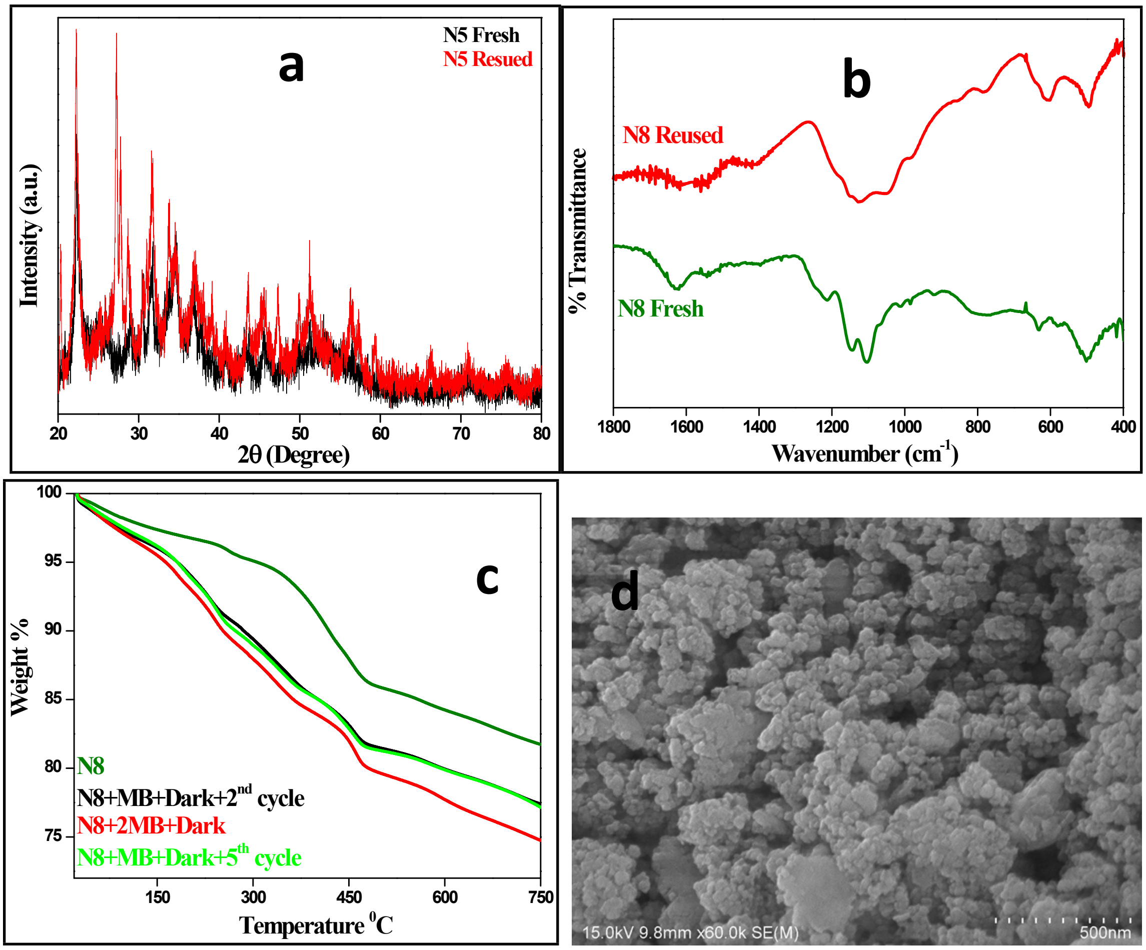

Fig. S9 Reusability of catalyst, a) PXRD of **N5** fresh and reused, b) IR of **N8** fresh and reused, c) TGA data of **N8** fresh and reused, d) SEM of **N8** reused.