Electronic Supplementary Material (ESI) for New Journal of Chemistry.

Supporting Informations

A novel ternary CuO decorated Ag_3AsO_4/GO hybrid as a Z-scheme photocatalyst for enhanced degradation of phenol under visible light

Md.Rakibuddin, Subrata Mandal and Rajakumar Ananthakrishnan*

Department of Chemistry, Indian Institute of Technology, Kharagpur 721 302, India.

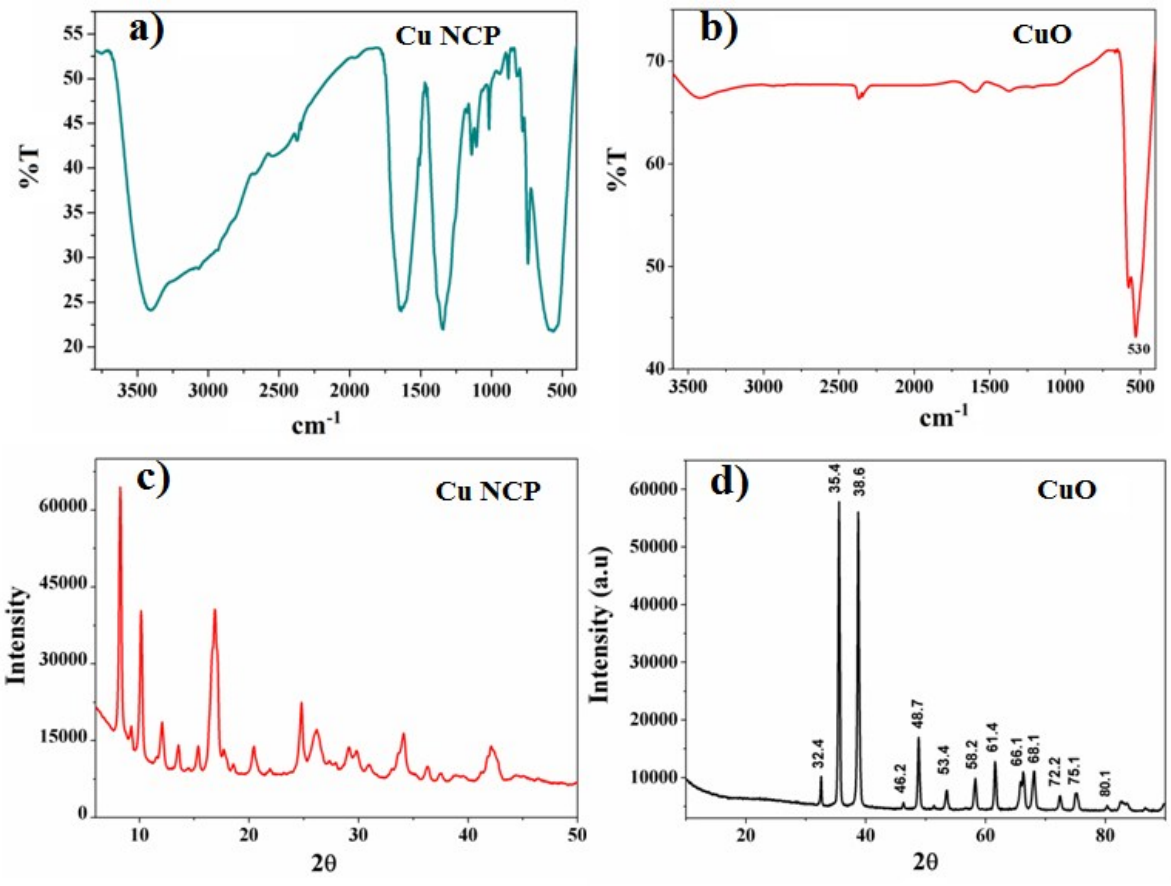


Figure S1. a) FT-IR spectra of the synthesized Cu NCP and b) corresponding CuO nanoparticles obtained from the Cu NCP after heating at 400 ºC; c) PXRD pattern of the synthesized Cu NCP and d) corresponding NCP derived CuO nanoparticles.

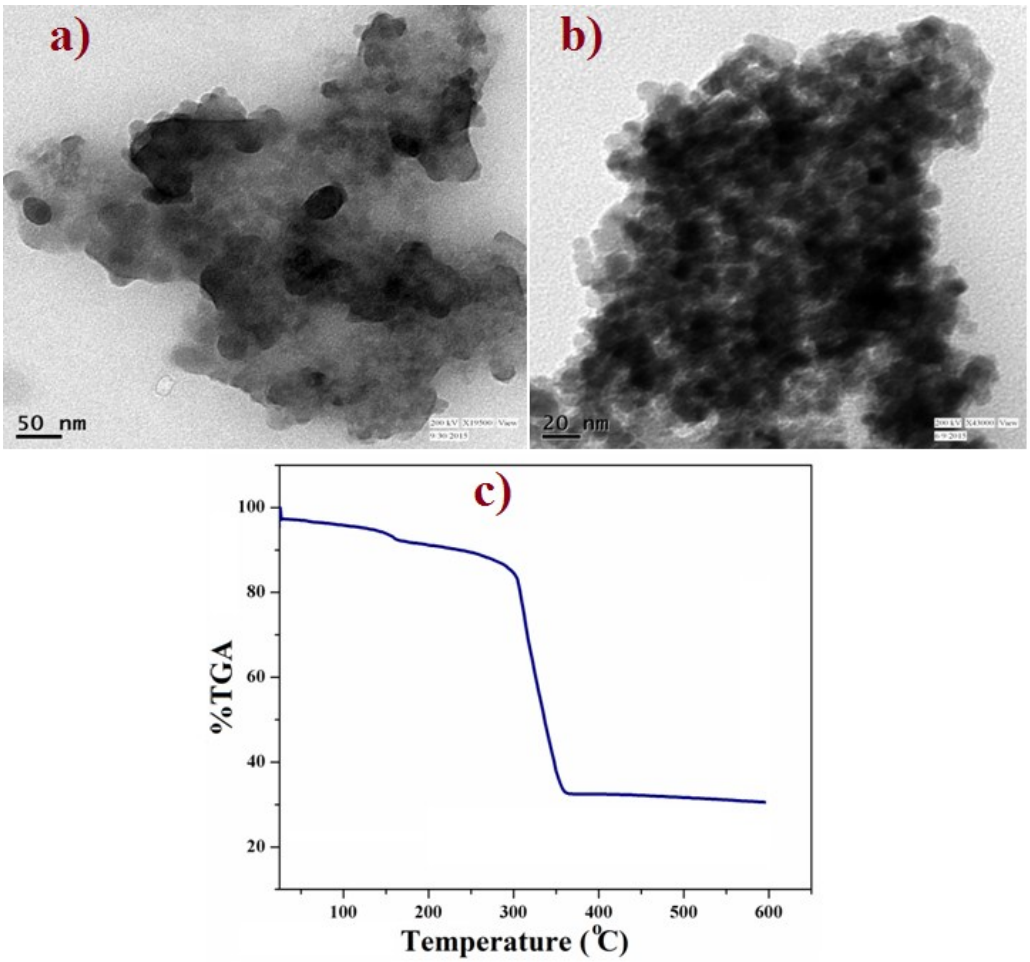


Figure S2. a) TEM image of the synthesized Cu NCP, b) corresponding NCP derived CuO nanoparticles and c) TGA analysis of the synthesized Cu NCP.

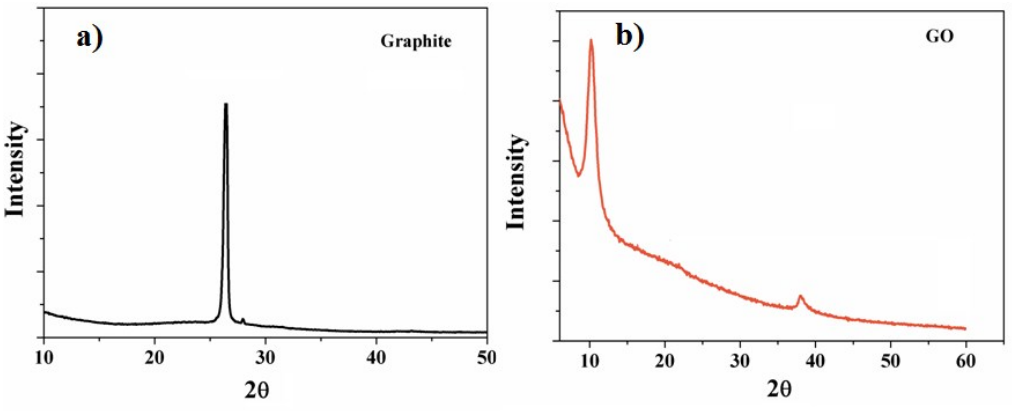


Figure S3. a) PXRD of the graphite and b) synthesized GO

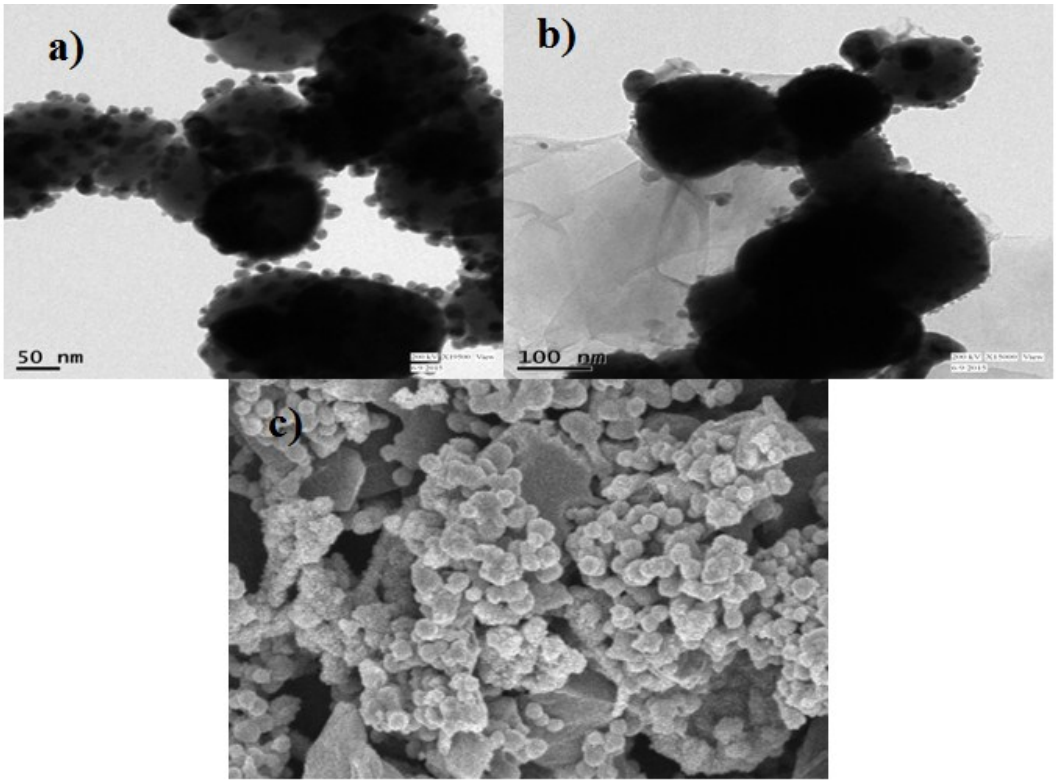


Figure S4. a) TEM image of the synthesized CuO/Ag_3AsO_4, b) CuO/Ag_3AsO_4/GO hybrid and c) FESEM image of the CuO/Ag_3AsO_4/GO hybrid.

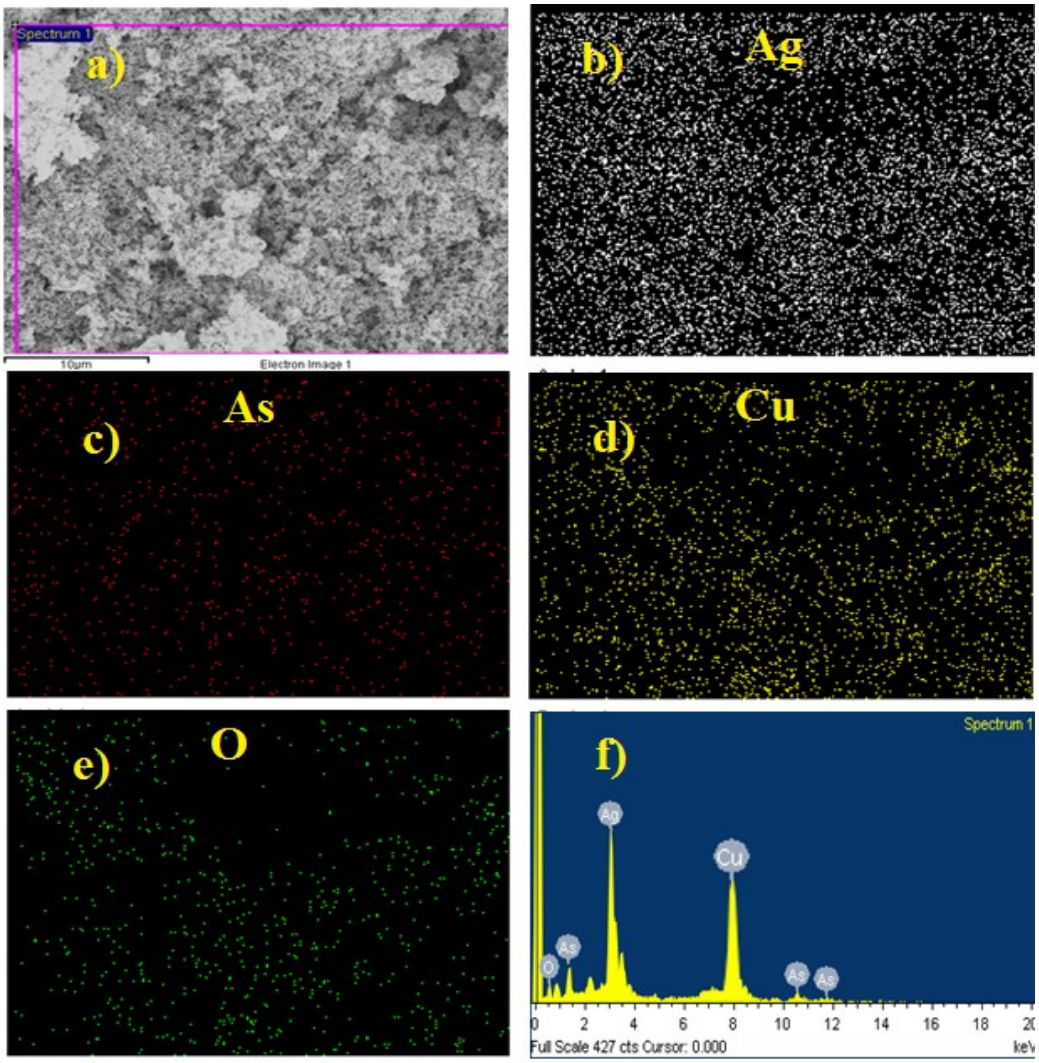


Figure S5. a) FESEM image of the CuO/Ag_3AsO_4 hybrid, b) corresponding elemental mapping of Ag, c) As, d) Cu, e) O and f) EDX analysis of the CuO/Ag_3AsO_4 hybrid.

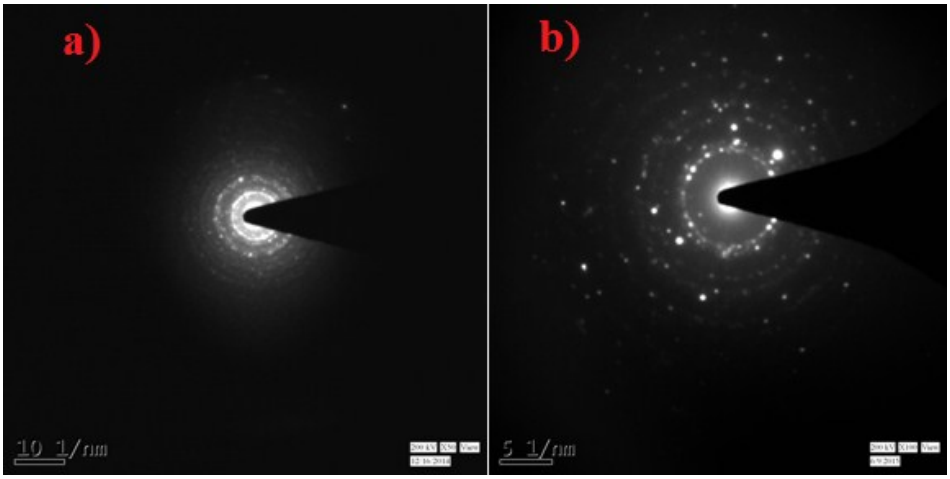


Figure S6. a) SAED pattern of the synthesized CuO and b) CuO/Ag_3AsO_4 hybrid.

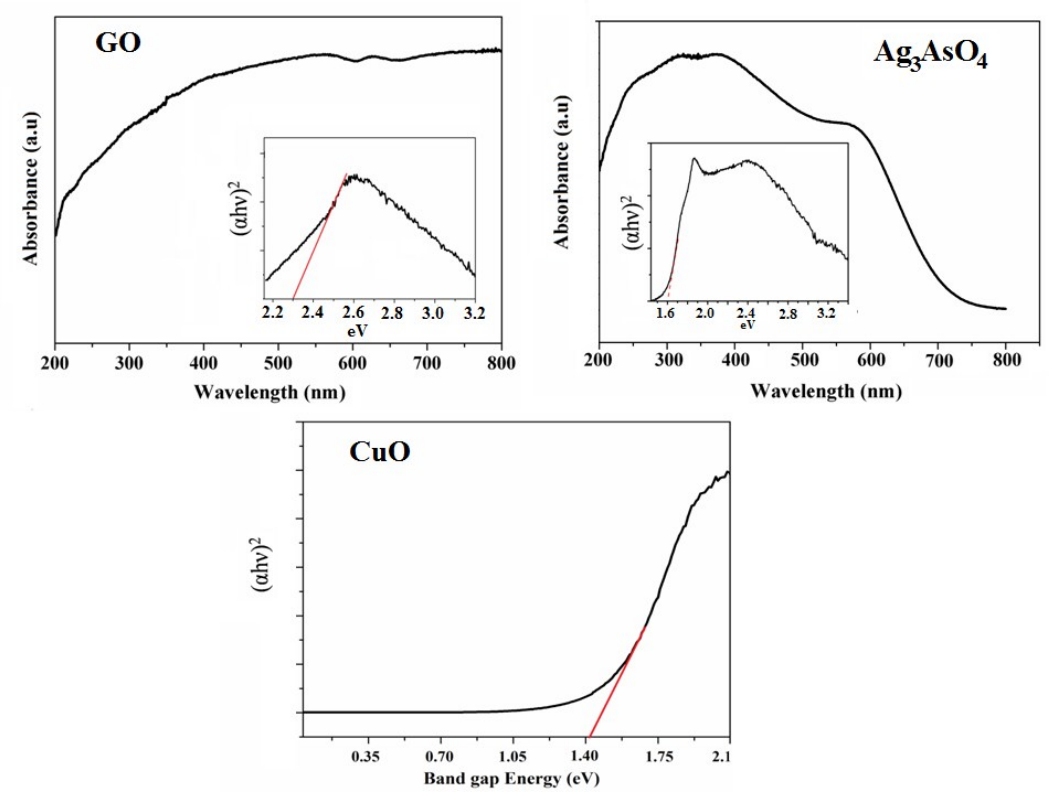


Figure S7. UV-Vis-DRS spectra and corresponding Tauc plot (inset) of the synthesized GO, Ag_3AsO_4 and CuO for determination of band gap of the materials.

The observed band gap for the GO, Ag_3AsO_4 and CuO are found to be 2.3 eV, 1.6 eV and 1.4 eV respectively.

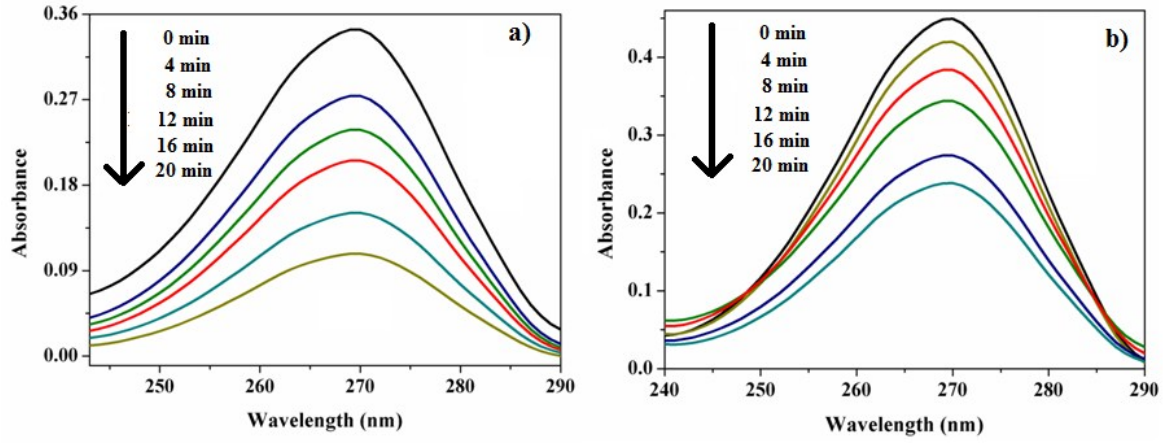
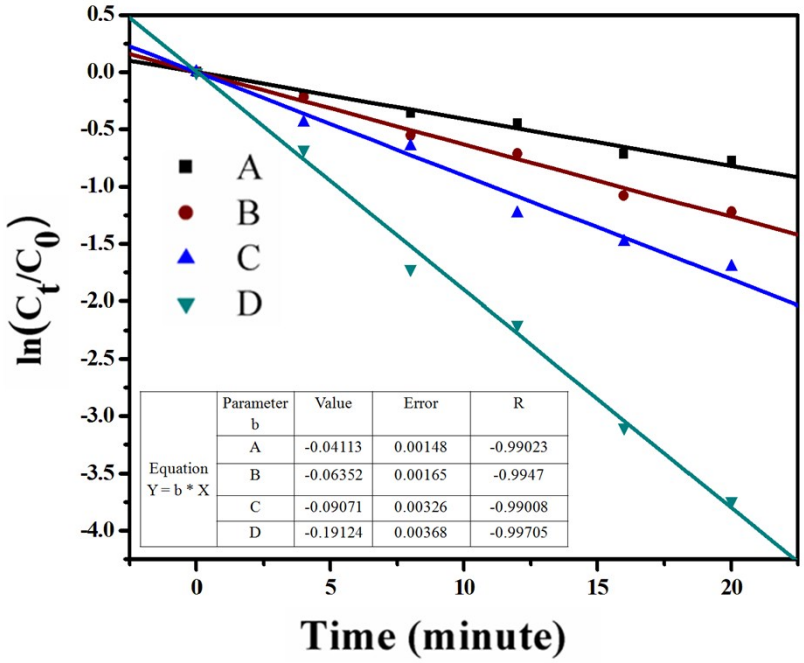


Figure S8. UV-Visible absorption spectra for the degradation of phenol by a) CuO/Ag_3AsO_4/GO-50 hybrid and b) CuO/Ag_3AsO_4 hybrid under visible light.



Equation Y = b * X	Parameter b	Value	Error	R
	A	-0.04113	0.00148	-0.99023
	B	-0.06352	0.00165	-0.9947
	C	-0.09071	0.00326	-0.99008
	D	-0.19124	0.00368	-0.99705

Figure S9. ln C_t/C_0 vs. Time plot for determination of rate constant of A) CuO/Ag_3AsO_4 , B) Ag_3AsO_4/GO, C) $CuO/Ag_3AsO_4/GO$-50 and D) $CuO/Ag_3AsO_4/GO$-25 catalyst.

Table S1. Comparative study for the photo-degradation of Phenol in presence of various semiconductor hybrids

Entry	Experimental Conditions	Performance (rate constant k, min^{-1})	References
1.	[Phenol]=7 ppm, [TiO_2/Fly ash] = 20 g L^{-1} UV Light intensity = 300 W Hg lamp	1.6×10^{-2}	50
2.	[Phenol]= 10 ppm [Ag/Ag_2CO_3-rGO]= 2 g L^{-1} Visible Light intensity = 350 W Xe lamp	1.5×10^{-1}	47
3.	[Phenol]= 40 ppm [ZnO-G/TiO_2-G]= 1 g L^{-1} Visible Light intensity = 1000 W Xe arc lamp	3.7×10^{-2}	48
4.	[Phenol]= 30 ppm [Au/TiO_2] thin film Sun light	1.1×10^{-2}	49
5.	[Phenol]= 15 ppm [Pt/I-TiO_2]= 1 g L^{-1} Visible Light intensity = 400 W dysprosium lamp	1.0×10^{-2}	45
6.	[Phenol]= 25 ppm [WO_3/H_2O_2]= 1.3 g L^{-1} Visible Light intensity = 150 W Xe lamp	1.7×10^{-2}	44
7.	[Phenol]= 10 ppm [g-C_3N_4]= 1.0 g L^{-1} Visible Light intensity = 300 W Xe lamp	9.5×10^{-3}	46
8.	[Phenol]= 20 ppm [CuO/Ag_3AsO_4/GO]= 0.2 g L^{-1} Visible Light intensity = 300 W halogen lamp	1.9×10^{-1}	This report

44. J. Sheng, X. Li and Y. Xu, *ACS Catal*., 2014, **4**, 732−73.

45. Z. He, L. Xie, J. Tu, S. Song, W. Liu, Z. Liu, J. Fan, Q. Liu and J. Chen, *J. Phys. Chem. C*, 2010, **114**, 526–532.

46. H. Zhang, L. H. Guo, L. Zhao, B. Wan and Y. Yang, *J. Phys. Chem. Lett.*, 2015, **6**, 958−963.

47. S. Song, B. Cheng, N. Wu, A. Meng, S. Cao and J. Yu, *Appl. Catal. B: Environ.*, 2016, **181**, 71–78.

48. G. Malekshoar, K. Pal, Q. He, A. Yu and A. K. Ray, *Ind. Eng. Chem. Res*., 2014, **53**, 18824−18832.

49. R.S. Sonawane and M.K. Dongare, *J. Molecular. Catal A: Chemical* , 2006, **243**, 68–76.

50. Z. Shi, S. Yao and C. Sui, *Catal. Sci. Technol*., 2011, **1**, 817–822.

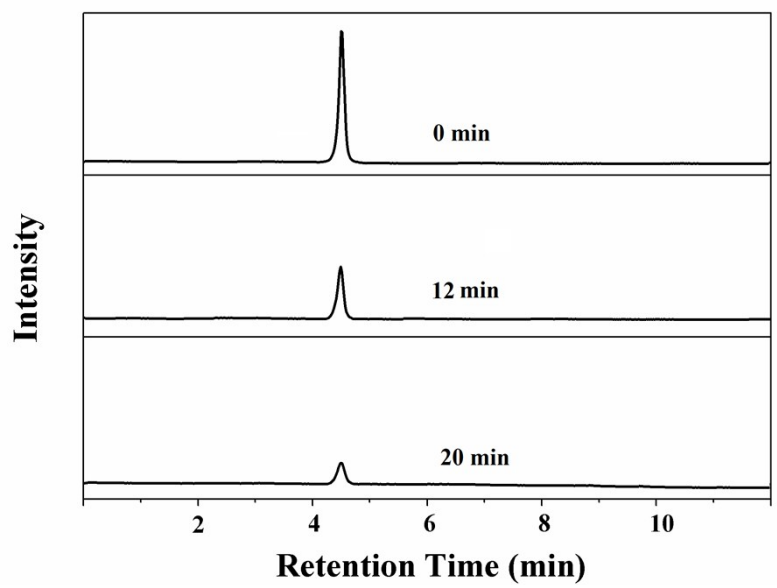


Figure S10. HPLC chromatographic peaks for the photodegradation of Phenol in presence of CuO/Ag_3AsO_4/GO-25 catalyst.

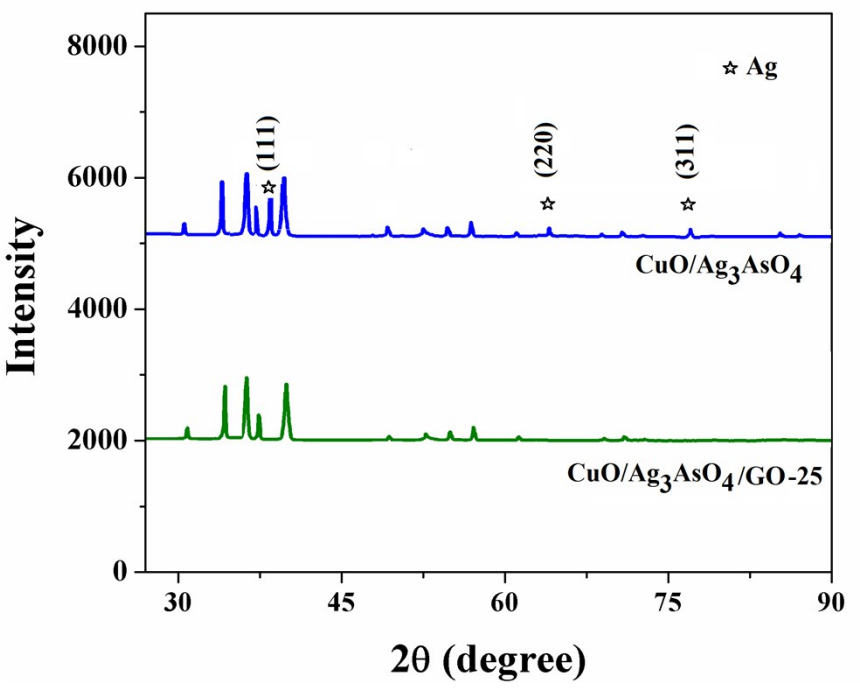


Figure S11. PXRD pattern of the $CuO/Ag_3AsO_4/GO$-25 and CuO/Ag_3AsO_4 catalyst after fourth cycle of photocatalytic operation.

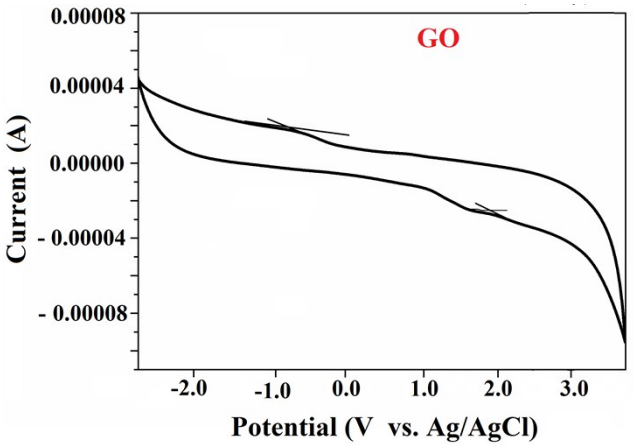


Figure S12. Cyclic voltammograms of Graphene oxide (GO) (0.1 M KCl , scan rate 50 mV s^{-1}, scan direction from -3.0 V to 4.0 V vs. Ag/AgCl).

HOMO= -e [4.65 V- E_{ox} (onset)] = -4.65 eV-1.9 eV = -6.55 eV (vs. Vacuum scale)

Using the equation ($E_{(NHE)} = -E_{(AVS)} - 4.50$), we get

HOMO= 2.05 eV [vs. NHE]

LUMO= -e [4.65 V- E_{red} (onset)] = -4.65 eV+0.9 eV = -3.75 eV (vs. Vacuum scale)

Using the equation ($E_{(NHE)} = -E_{(AVS)} - 4.50$), we get

LUMO = -0.75 eV [vs.NHE]

Band gap (E_g) = LUMO-HOMO = 6.55 eV- 3.75 eV = 2.8 eV (vs. NHE)

However the electrochemically obtained band gap of the GO (2.8 eV) is found to be somewhat higher than optical band gap of the GO (2.3 eV).

(J. Mater. Chem., 2012, **22**, 4299-4305; *Am. Mineral.*, 2000, **85**, 543–556.)

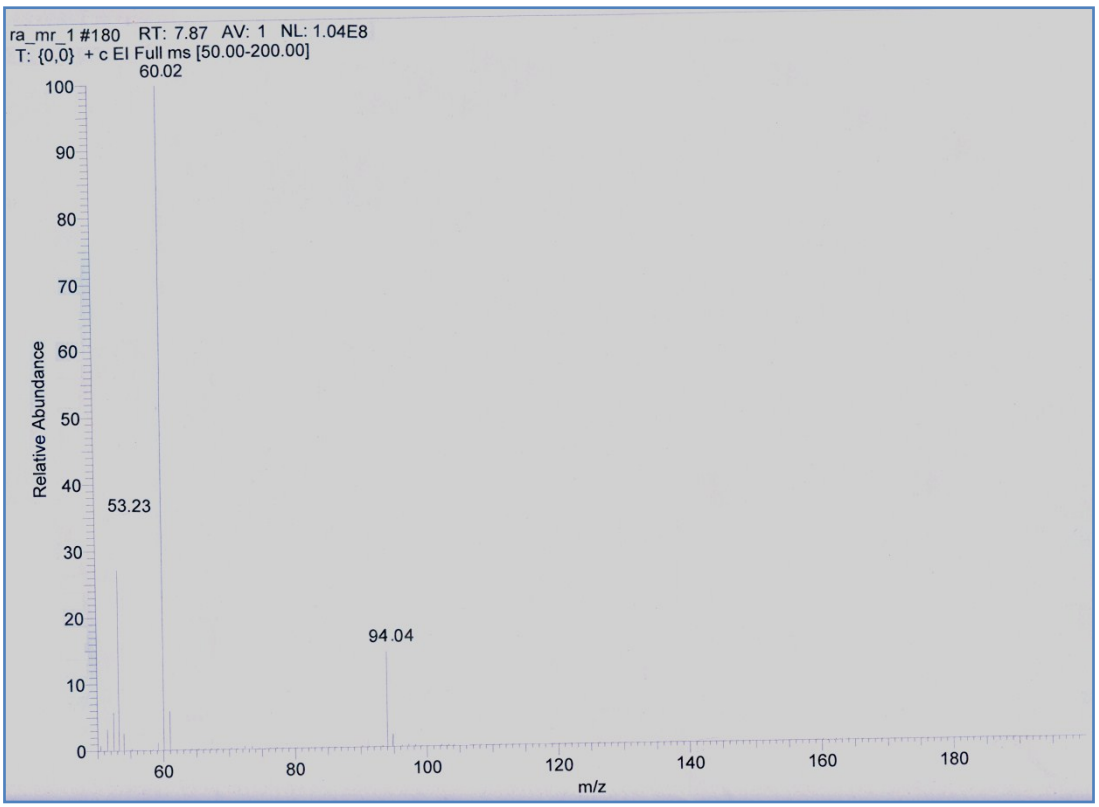


Figure S13. GC-MS spectrum of the photo-degraded products of Phenol after 20 min of the photocatalytic reaction.