Supplementary Information

Amphiphilic Polyoxometalate-CNTs Nanohybrid as Highly Efficient Enzyme-free Electrocatalyst for H_2O_2 Sensing

Eman Gul[a], Gul Rahman[b], Yuefeng Wu[c], Tanveer Hussain Bokhari[d], Ata ur Rahman[b], Amina Zafar[e], Zohaib Rana[c], Attaullah Shah[f], Shafqat Hussain[a], Khan Maaz[a], Shafqat Karim[a], Saqib Javaid[g], Hongyu Sun[h], Mashkoor Ahmad[a,]*, Guolei Xiang[c,]*, Amjad Nisar[a]*

[a] Nanomaterials Research Group, PD, PINSTECH, Islamabad 44000, Pakistan

[b] Institute of Chemical Sciences, University of Peshawar, Peshawar 25000, Pakistan

[c] State Key Laboratory of Chemical Resource Engineering, Beijing University of Chemical Technology, Beijing 100029, PR China

[d] Department of Chemistry, GC University, Faisalabad 38000, Pakistan

[e] CAFD, PINSTECH, Islamabad 44000, Pakistan

[f] National Institute of Lasers and Optronics College, PIEAS, Islamabad 44000, Pakistan

[g]Theoretical Physics Division, PINSTECH, Islamabad 44000, Pakistan

[h] School of Resources and Materials, Northeastern University at Qinhuangdao, Qinhuangdao, 066004 PR China

Table S1. The assignment of FTIR spectra

$H_3PW_{12}O_{40}$ (cm^{-1})	HPW (cm^{-1})	CHPW (cm^{-1})	Assignment*
3503		3328	OH str.
	2923-2850	2926-2851	CH_2 asym. Str.
1630		1640	C=C str.
	1469	1468	C–H str.
1084	1084	1083	P-O asym. str.
987	987	976	$W=O_t$. Str
891	891	890	$W-O_b-W$ (corner sharing oxygen)
761	861	870	$W-O_c-W$ str. (edge sharing oxygen

* asym. str., asymmetric stretching; sym. str., symmetric stretching

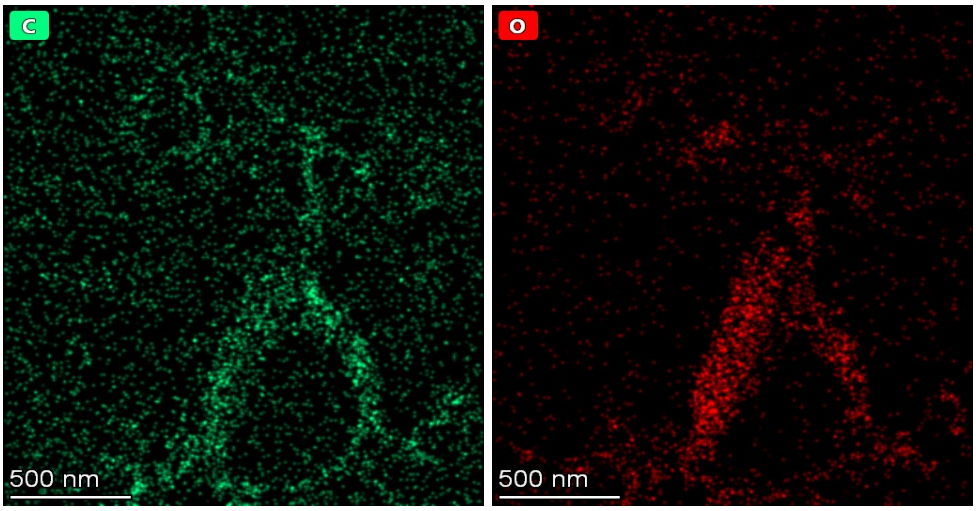

Fig. S1. C and O elements mapping in POM-CNTs amphiphilic nanostructures.

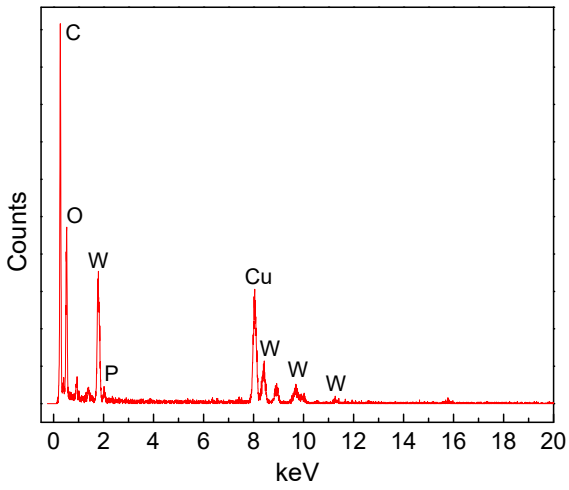

Figure S2. EDX spectra of POM-CNTs amphiphilic nanostructures.

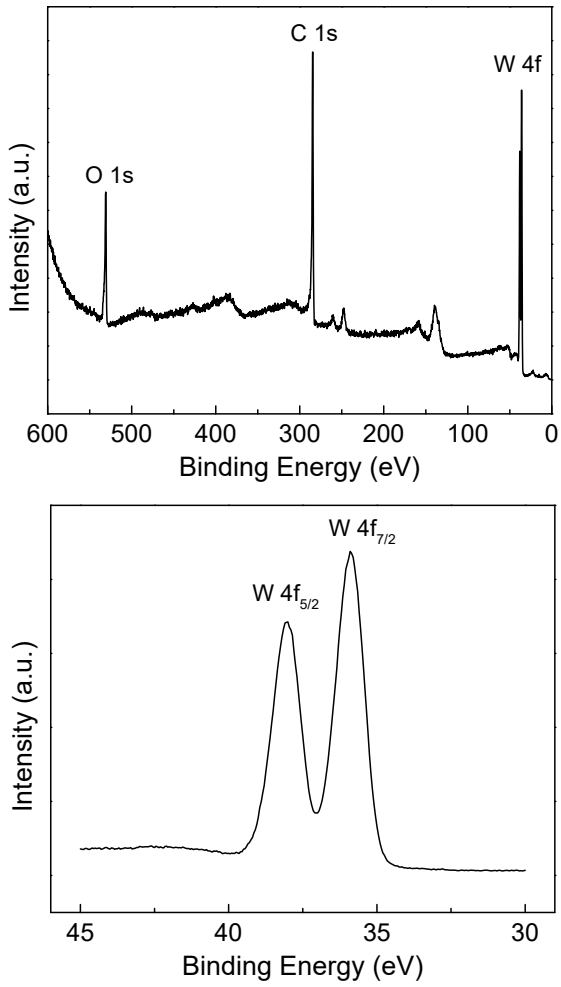

Figure S3. XPS analysis of representative POM-CNTs composite (CHPW): survey spectrum (upper) and narrow scan of W4f (lower).

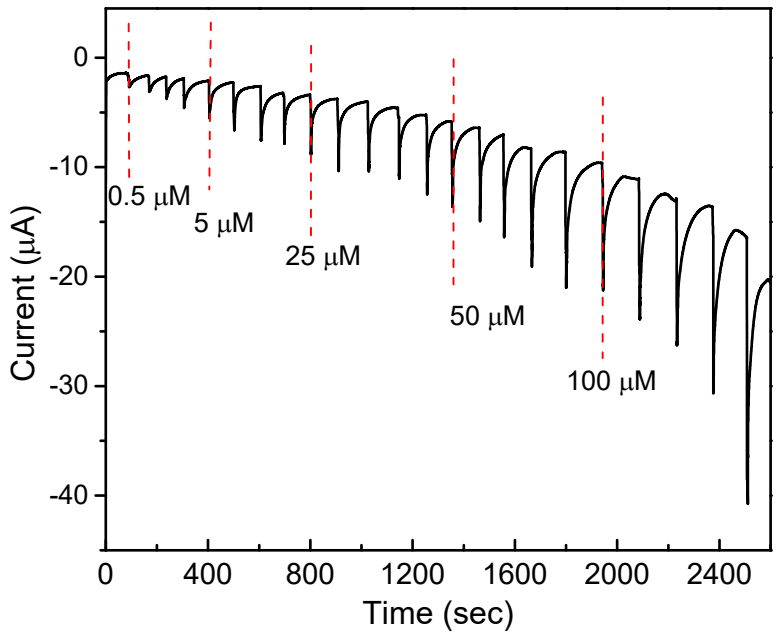

Fig. S4. Amperometry response of CHPW electrode at low concentrations of H_2O_2 at pH-5.

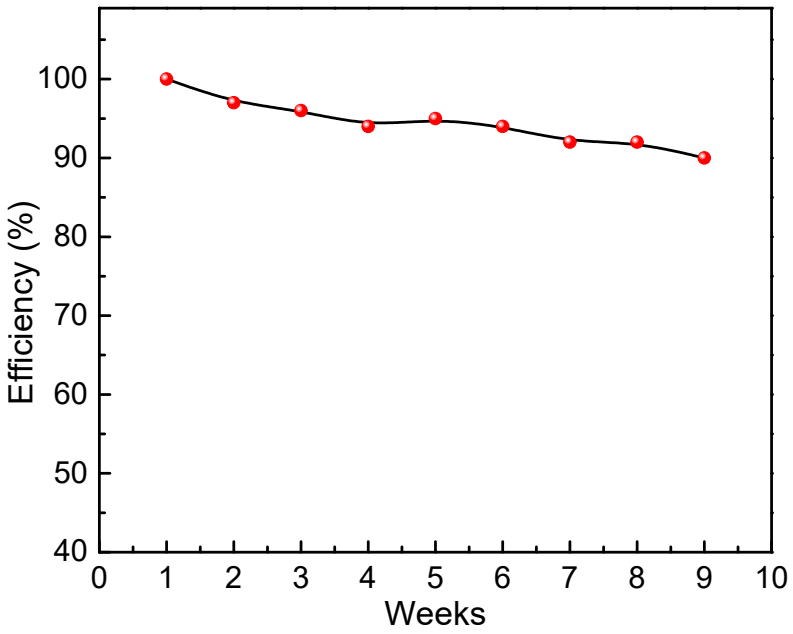

Fig. S5. The long-term stability of the CHPW modified electrode at pH-5.

Table S2. Comparison of various POMs-modified electrodes for H_2O_2 measurements.

Electrode	Electrolyte	Linear range (M)	Sensitivity ($\mu AmM^{-1}cm^{-2}$)	LOD (M)*	Reference
P2W18/CNTs/AuNPs	Na_2SO_4-H_2SO_4	1×10^{-6} to 98×10^{-6}	596.1	9×10^{-9}	[36]
PPy/PMo_{12}/Au	H_2SO_4	1×10^{-2} to 1×10^{-5}	-	-	[65]
Zr/POM	$HClO_4$	-	732	9×10^{-5}	[66]
PMo_{12}/PPy-bulk-modified CPE	Na_2SO_4 + H_2SO_4	2×10^{-4} to 3×10^{-2}	1.1	5×10^{-5}	[67]
PLL-GA-PW-modified GCE	H_2SO_4	2.5×10^{-6} to 6.85×10^{-3}	1.69	-	[61]
PEI/rGO}-Au@P_8W_{48}	PBS		74.56	3.1×10^{-7}	[68]
Fe^{3+} and Cu^{2+} POM doped polypyrrole films		3×10^{-4}	0.56	5.6×10^{-7}	[69]
ERGO/Au NPs/POM	-	-	740.8	5.6×10^{-7}	[70]
PEI/BSA-G/(BSA-G^+ /AuNPs)$_5$/FTO	-	-	72.9	1×10^{-6}	[71]
CHPW	PBS	3×10^{-4} to 1.35×10^{-3}	11450	5×10^{-7}	This work

* LOD (M), Limit of Detection (Molar)

Table S3. Real samples analysis for the measurement of H_2O_2 using CHPW.

Sample	Initially measured (μM)	Added (μM)	Expected (μM)	Finally measured (μM)	Recovery (%)	RSD (%)
Hand Sanitizer	324	350	674	638	94.6	±2.97
Surface cleaner	568	600	1168	1068	91.4	±2.05
Contact lens solution	480	500	980	965	98.4	±1.96
Processed Milk	254	300	554	536	96.7	±3.35