Electronic Supporting Information

Functional holey graphene oxide: a new electrochemically transformed substrate material for dopamine sensing

A.B.M. Zakaria,^a Erick S. Vasquez,^b Keisha B. Walters^c and Danuta Leszczynska^{d*}



Fig. S1 Schematic illustration of the fabrication of GO film on GC electrodes (GCE) modified with a self-assembled monolayer of APTMS.



Fig. S2 Step-1: CV (reduction) of GO/APTMS/GC in the potential window from 0.0 to -1.2 V vs Ag/AgCl sat. KCl in 0.5 M H_2SO_4 at 50 mV/s scan rate [red line: first scan, black line: final scan, 30th cycle]. Vertical arrow (\uparrow) shows the reduction current increasing at the switching potential (-1.2 V) up to the 7th cycle



Fig. S3 SEM image of ERGO surface showing wrinkles, folds and rolled edges.





Fig. S4 AFM images of exfoliated GO (A), ERGO (B) and HGO (C). The lines in Fig. S4A, S4B, and S4C mark the location of cross section height profiles for individual sheets of exfoliated GO (D), ERGO (E), and HGO (F), respectively.





	Table 31	· Feak as	TOT Kalliali allu KPS Spectra			
Electrodes	Raman data			XPS data		
	D band (cm ⁻¹)	G band (cm ⁻¹)	I _D /I _G	C1s	O1s	C/O ratio
GO/APTMS/GCE	1365	1607	0.91	285.0→sp ² C 285.8→C-O 287.4→C=O 288.8 →HO-C=O	531.8→C-O 533.8→C=O 534.8→HO-C=O	2.09
ERGO/APTMS/GCE	1338	1620	1.23	285.0→sp ² C 286.0→C-O 288.2→C=O	531.8→C-O 533.8→C=O	4.14
HGO/APTMS/GCE	1352	1620	1.01	285.0→sp ² C 286.0→C-O 287.4→C=O 288.8→HO-C=O	532.6→C-O 533.8→C=O 534.8→HO-C=O	1.84

able S1:	Peak	assignr	nents	for	Raman	and	XPS	spectra
----------	------	---------	-------	-----	-------	-----	-----	---------

Nicholson method

According to Nicholson's working curve, ΔE_p values can be converted into a dimensionless kinetic parameter ψ that is inversely proportional to the square root of scan rate, $v^{1/2}$ (equation 1)¹. An empirical equation (2) developed by Irma *et.al.* also fits the Nicholson's data².

$$\psi = k^0 [\pi D n v F / (RT)]^{-1/2}$$
[1]

$$\psi = (-0.6288 + 0.021X)/(1 - 0.017X)$$
^[2]

In equation (1) ψ is a dimensionless kinetic parameter, k^0 is the rate constant, D is the diffusion constant of Fe(CN)₆^{3-/4-} (7.63×10–6 cm² s⁻¹,1.0 M KCl), n is the number of electrons transferred, F is the Faraday's constant, v is the scan rate (V/s), R is the universal gas constant, T is the temperature and α is the transfer coefficient (0.5). In equation (2), X= ΔE_p . The combination of equations (1) and (2) allowed us to determine the apparent heterogeneous rate constant, k^o .

Table S2: Cyclic voltammetric (CV) data (peak separation, ΔE ; current ratio, I_{pa}/I_{pc} ; effective surface area, cm²; apparent heterogeneous electron transfer rate constants, k^{0}_{app}) for $Fe(CN)_{6}^{3-/4-}$ redox systems using different electrodes.

Electrodes	ΔE(mV) at 0.1V	ESA (cm²)	<i>ا_{pa}/l_{pc}</i> scan range 0.01 to 0.6 V/s	k ^o _{app} (cm/s) scan range 0.01 to 0.6 V/s
Bare GC	80 ± 4	0.065 ± 0.005	1.15 ± .03	0.010 ± 0.002
GO/APTMS/GC	66 ± 5	0.012 ± 0.005	0.87 ± 0.12	0.045 ± 0.002
ERGO/APTMS/GC	61 ± 2	0.249 ± 0.076	1.04 ± 0.07	0.027 ± 0.012
HGO/APTMS/GC	61 ± 1	0.194 ± 0.035	0.95 ± 0.12	0.024 ± 0.009





Table S3: Average measured DA concentrations for five independently prepared β -CD-HGO/APTMS/GC electrodes using 0.1 mM DA solutions.Sample-to-sample variation indicatedby the percent relative standard deviation.

Electrode	Added DA (mM)	Avg DA Measured*	
1	0.1	0.110±0.06	
2	0.1	0.098±0.03	
3	0.1	0.097±0.08	
4	0.1	0.094±0.03	
5	0.1	0.104±0.02	
	R.S.D.	6.1%	

* Standard deviation of 3 measurements for each electrode

References

1. Nicholson, R. S., Theory and Application of Cyclic Voltammetry for Measurement of Electrode Reaction Kinetics. *Analytical Chemistry* **1965**, *37* (11), 1351-1355.

2. Lavagnini, I.; Antiochia, R.; Magno, F., An Extended Method for the Practical Evaluation of the Standard Rate Constant from Cyclic Voltammetric Data. *Electroanalysis* **2004**, *16* (6), 505-506.