Supplementary Information

Porous carbon modified electrodes for highly selective and sensitive detection of dopamine

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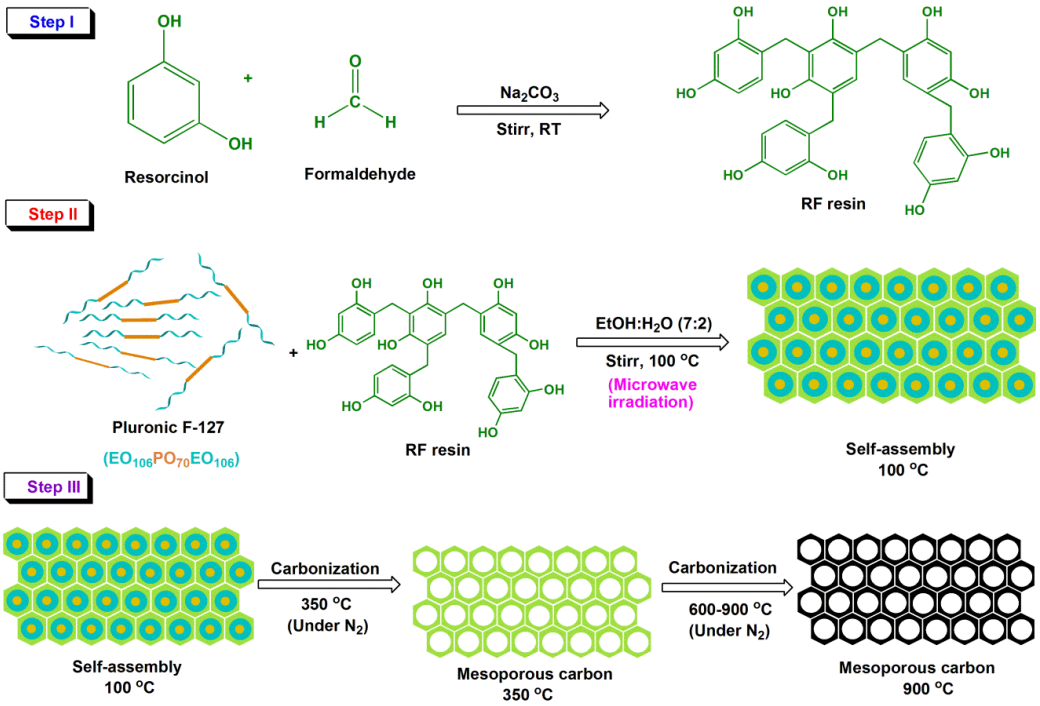
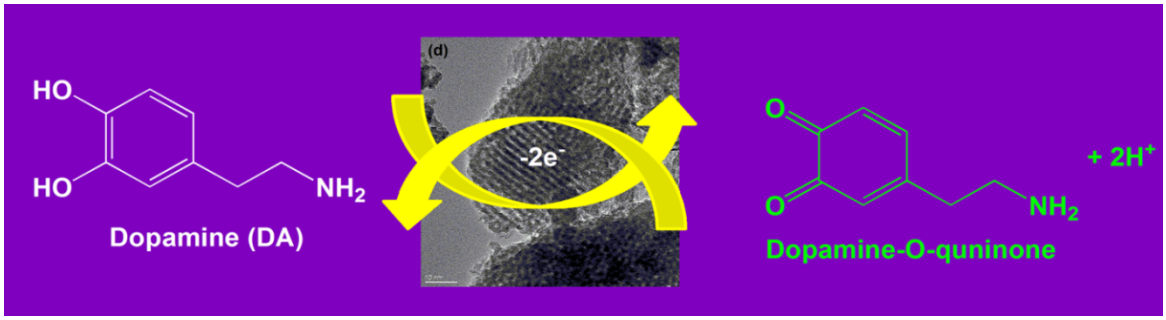
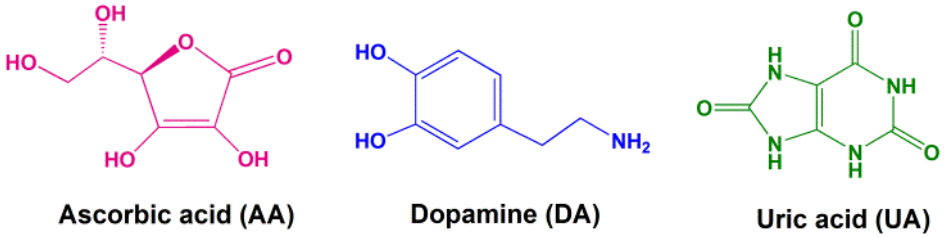


Scheme S1 Schematic illustration of the microwave-assisted synthesis of CPMs. [Ref.: J. Xu, A. Wang and T. Zhang, Carbon 50 (2012) 1807–1816.]



Scheme S2 Illustration of electrochemical oxidation mechanism of DA over CPM-modified GCE.



Scheme S3 Structural illustrations of AA, DA, and UA.

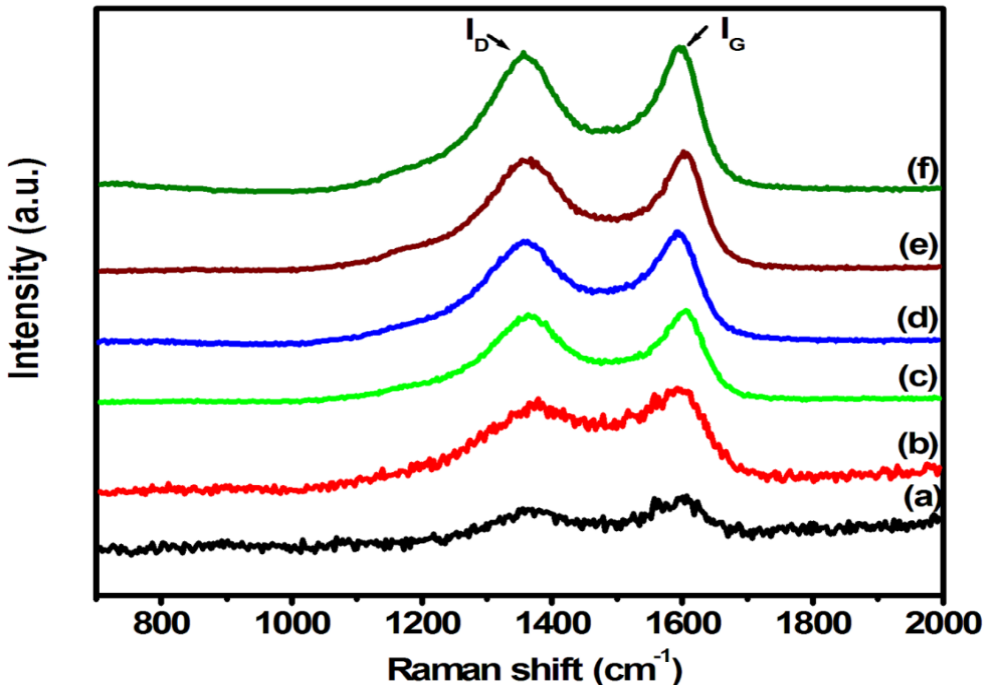


Fig. S1 Raman spectra of (a) CPM-350, (b) CPM-600, (c) CPM-900, (d) CPM-900-A1, (e) CPM-900-A2, and (f) CPM-900-A3 materials.

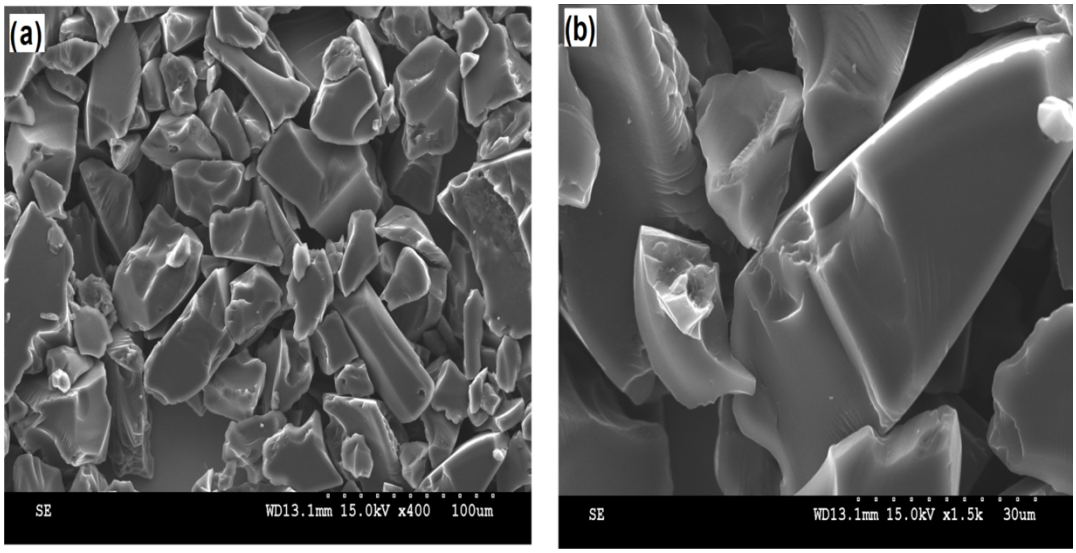


Fig. S2 SEM images of CPM-900 in different magnified scales.

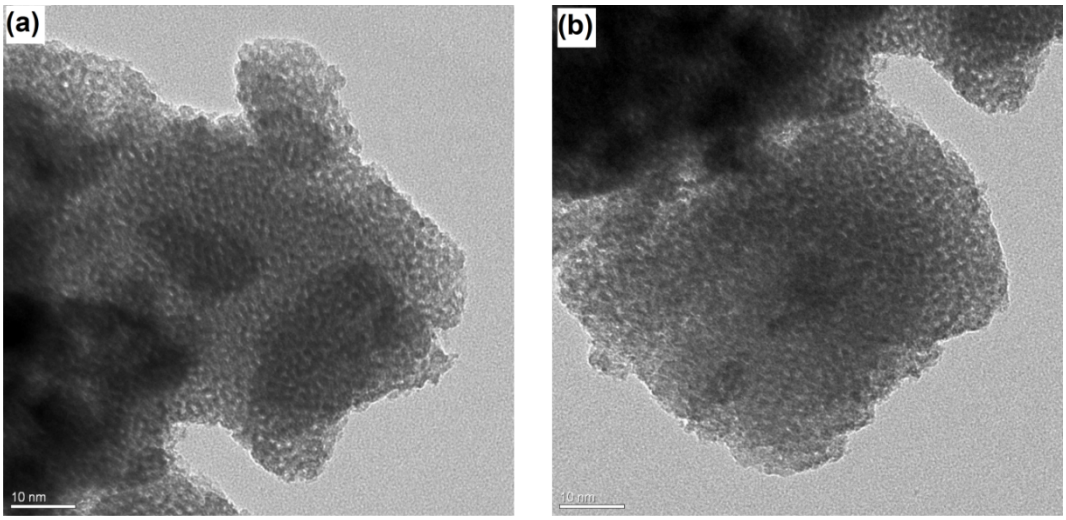


Fig. S3 TEM images of the as-synthesized (a) CPM-350 and (b) CPM-600 samples.

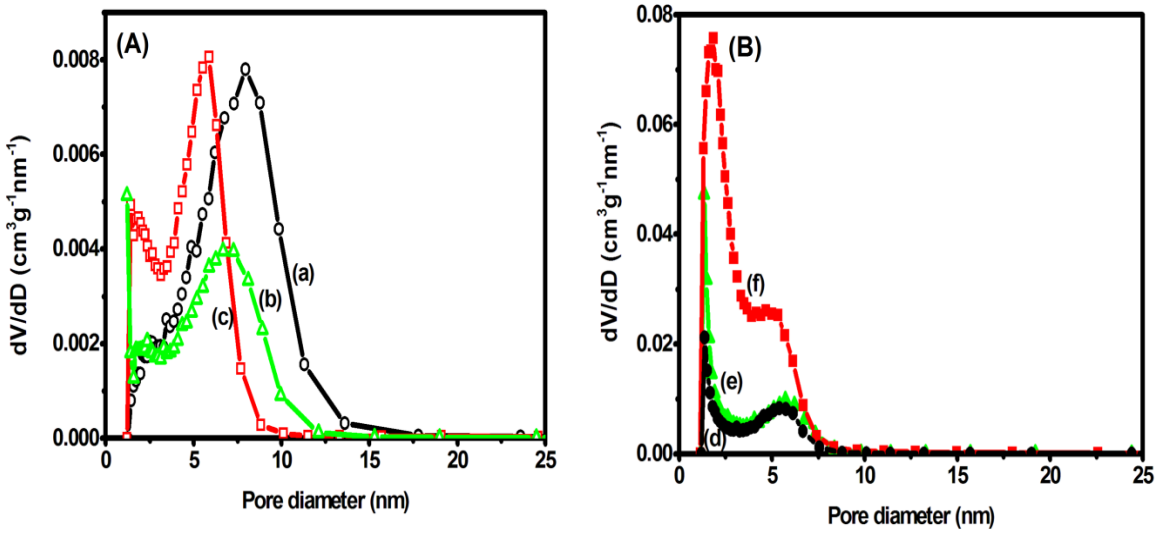


Fig. S4 Pore size distributions of various CPMs (A) before and (B) after CO_2-activation treatment. Sample legends: (a) CPM-350, (b) CPM-600, (c) CPM-900, (d) CPM-900-A1, (e) CPM-900-A2, and (f) CPM-900-A3.

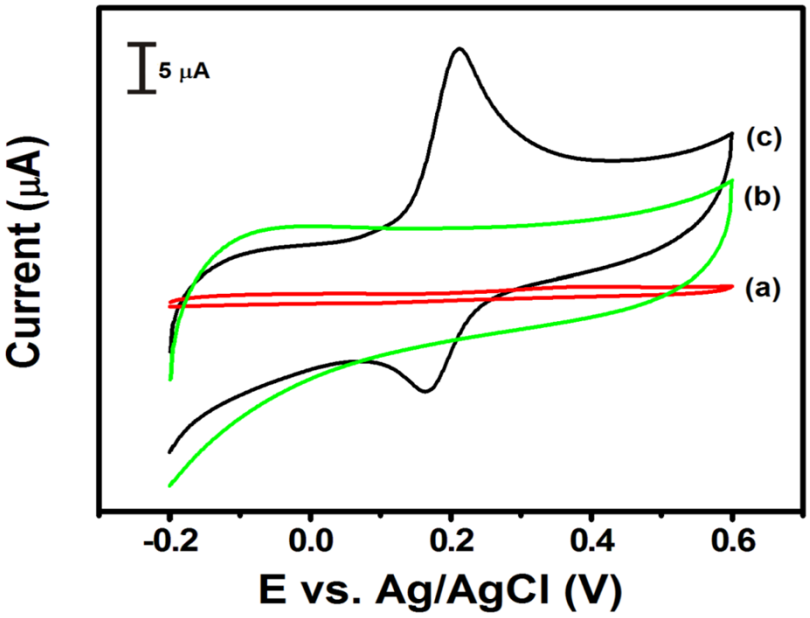


Fig. S5 CV curves of (a) bare GCE, and CPM-900-A3 modified GCE (b) without, and (c) with 2.0 μM DA in N_2 saturated PBS recorded at a scan rate of 50 mV s^{-1}.

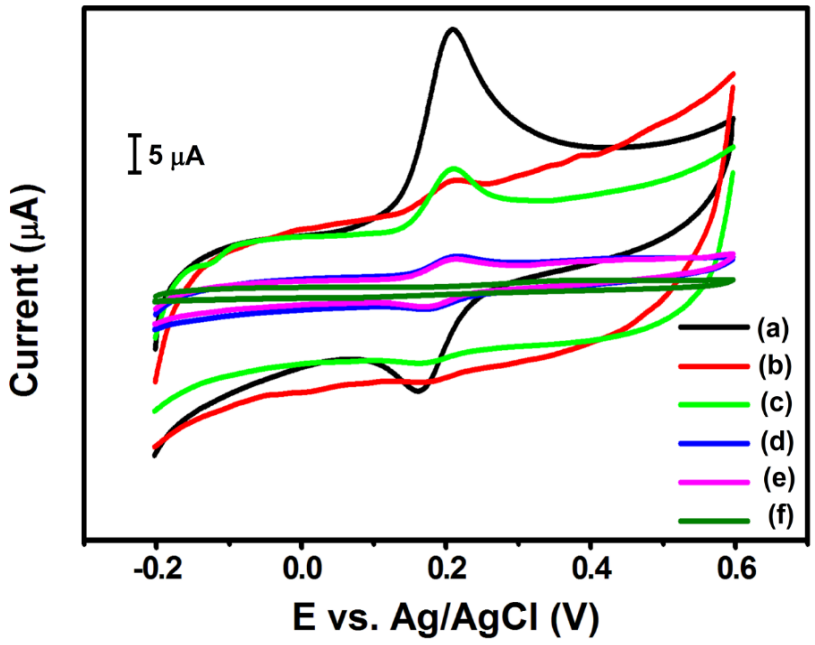


Fig. S6 CV curves of (a) CPM-900-A3, (b) CPM-600, (c) CPM-900, (d) CPM-900-A1, (e) CPM-900-A2, and (f) CPM-350 modified GCE with 2.0 μM DA in N_2 saturated PBS recorded at a scan rate of 50 mV s^{-1}.

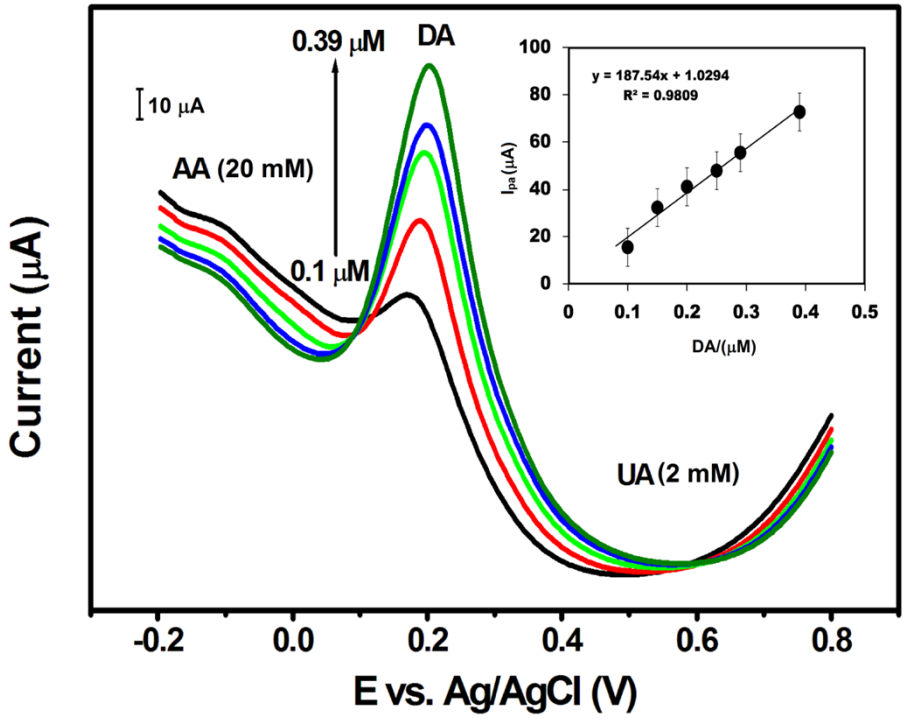


Fig. S7 (a) DPV curves of CPM-900-A3 modified GCE in N_2 saturated PBS with varied concentrations of DA (0.10–0.39 μM) in presence of 20 mM ascorbic acid (AA), and 2mM uric acid (UA). Inset (b): correlation of peak current with DA concentration.

Derivations of diffusion coefficient (*D*) and electron transfer rate constant (K_a) for various CPM-modified glossy carbon electrode (GCE)

Regarding to the kinetics related to the textural properties of various CPM-modified GCE during detection of dopamine (DA), their diffusion coefficients (*D*) were calculated by means of Randles- Sevcik equation (Eq. 1) using a charge transfer coefficient (α = 0. 5) deduced based on Laviron theory. Accordingly, the corresponding apparent rate constants (K_a) for heterogeneous electron transfer of DA were derived by the Laviron equation for surface-controlled transfer model (Eq. 2):[1-3]

$$I_p = 0.4463\, nFAC\, (nF\upsilon D/RT)^{1/2} \qquad \text{(Eq. 1)}$$

$$\log K_a = \alpha \log(1-\alpha) + (1-\alpha) \log \alpha - \log(RT/nF\upsilon) - \alpha(1-\alpha)\, nF\Delta E_p/2.3RT \qquad \text{(Eq. 2)}$$

The following parameters and values during detection of DA over various CCPM-modified GCE were adopted for the calculations of corresponding *D* and K_a values (*cf.*

Table 1 of the main text):

I_p denotes the observed anodic peak current (in A),

$n = 2$ is the number of electrons,

$F = 96{,}485$ C mol^{-1} is the Faradeic constant,

$A = 0.079$ cm^2 is the electrode area,

$C = 0.002$ mol cm^{-3} is the concentration,

$\upsilon = 50$ mV s^{-1} is the scan rate,

D represents diffusion coefficient (in cm^2 s^{-1}),

$R = 8.314$ J K^{-1} mol^{-1} is the gas constant,

T = 25 ^oC is the temperature,

K_a is the apparent electron transfer rate constant (in cm s^{-1}),

$\alpha = 0.5$ is the charge transfer coefficient, and

$\Delta E_p = 41$ mV is the peak potential separation of the redox pair,

It is found that the CPM-900-A3 modified GCE, which exhbited a two-electron transfer process indeed shows the higherest diffusion coefficient (D), hence, the highest electron transfer rate (K_a) compared to the other substrates. On the basis of the observed K_a value, it is indicative that the electrochemical reaction should follow a quasi-reversible or irreversible kinetics.[4,5]

References

1. E. Laviron *J. Electroanal. Chem. Interfacial Electrochem*., 1979, **101**, 19.
2. H. Lindstro1m, S. So1dergren, A. Solbrand, H. Rensmo, J. Hjelm, A. Hagfeldt and S.E. Lindquist. *J. Phys. Chem. B*, 1997, **101**,7717.
3. Y. Zhang, J. Zhou, L. Lin and Z. Lin, *Electroanalysis*, 2008, **20**,1490.
4. Y. Zhu and C. Wang, *J. Phys. Chem. C*, 2011, **115**, 823.
5. A. Shanmugavani and R. Kalai Selvan, *RSC Adv.*, 2014, **4**, 27022.