Supporting Information:

A Facile Approach for In Situ Synthesis of Graphene-Branched Pt Hybrid nanostructures with Excellent Electrochemical Performance

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Figure S1: (a, b) FESEM, (c, d) TEM and (e-h) AFM measurements for as-synthesized GOs.
Figure S2: TEM images of as-synthesized graphene supported branched Pt nanostructures (GR-BPtNs).
Figure S3: EDAX pattern of GR-BPtNs
Figure S4: XPS spectra of graphene supported branched Pt nanostructures (GR-BPtNs)
Figure S5: UV-visible spectra of as-synthesized GO (a) and GR-BPtNs (b). Inset shows their optical images.
Figure S6: XPS Spectra of GO (A) and GR (B)

A

284.4 eV (C-C)
286.6 eV (C-O)
289 eV (C=O)

Intensity(a.u)

Binding energy(eV)

B

284.4 eV (C-C)
286.6 eV (C-O)
289 eV (C=O)

Intensity(a.u)

Binding energy(eV)
Figure S7: Characteristic Raman spectra of (a) GO and (b) GR-BPtNs.
Figure S8: TEM images of Pt Ns synthesized in absence (A) and presence (B) of graphene support under same conditions.
Figure S9: The proposed scheme showing the formation of Pt nanostructures in presence (A) and absence (B) of graphene support.
Figure S10: TEM images of graphene supported Pt nanostructures in absence of glucose under same conditions.
Figure S1: Cyclic Voltammetric profile of GR-BPtNs modified electrode in 0.5 M H₂SO₄. Scan rate: 10 mV/s

* The charge involved for the hydrogen adsorption (Qₕ) is estimated from the area under the potential window associated with oxidation curve. The electrochemically accessible surface area (ECSA) of GR-BPtNs was calculated to be 1.42 cm² with reference to the standard value of 210 µC/cm². ¹

Figure S12 (Table 1): Summarized the electrocatalytic activity of different electrodes towards oxidation of methanol (0.25M).

<table>
<thead>
<tr>
<th>Electrocatalyst</th>
<th>Oxidation Potential (V)</th>
<th>Forward Current density (µA/cm²)</th>
<th>I_f/I_b ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>GR-BPtNs</td>
<td>0.696±0.004</td>
<td>178.10±53.56</td>
<td>2.11±0.11</td>
</tr>
<tr>
<td>Pt/C</td>
<td>0.719±0.008</td>
<td>12.47±1.84</td>
<td>1.49±0.17</td>
</tr>
<tr>
<td>PtNs</td>
<td>0.679±0.011</td>
<td>3.56±2.42</td>
<td>1.24±0.44</td>
</tr>
</tbody>
</table>
Figure S13: Chronoamperometric data obtained for GR-BPtNs, Pt/C and PtNs modified electrodes towards oxidation of methanol (0.25M). Potentials are held at their oxidation potential.
Figure S14: Cyclic Voltammograms of different graphene supported Pt nanostructures synthesized at different pH conditions towards oxidation of methanol (0.25M) in 0.5M H₂SO₄. Scan rate: 10 mV/s.

<table>
<thead>
<tr>
<th>RG-Pt Nanostructures at different pH</th>
<th>Oxidation Potential (V)</th>
<th>Forward Current density (µA/cm²)</th>
<th>Iᵢ/Iₒ ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH 7.7 (a)</td>
<td>0.696±0.003</td>
<td>178.10±53.56</td>
<td>2.11±0.11</td>
</tr>
<tr>
<td>pH 10 (b)</td>
<td>0.68±0.05</td>
<td>81.541±11.81</td>
<td>1.7±0.37</td>
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<tr>
<td>pH 10 (c)</td>
<td>0.610±0.005</td>
<td>56.828±1.19</td>
<td>0.943±0.106</td>
</tr>
</tbody>
</table>
Figure S15: Cyclic Voltammograms of graphene supported Pt nanostructures synthesized in absence (a) and presence (b) of glucose with similar dimension towards oxidation of methanol (0.25M) in 0.5M H₂SO₄. Scan rate: 10 mV/s.
Figure S16. Cyclic Voltammograms of different loading of GR-BPtNs (different electrochemically accessible surface areas, ECSA) on GC electrode surface towards the oxidation of methanol (0.25M) in 0.5M H₂SO₄. a: 1.23, b: 1.42, c: 1.66 and d: 2.53 cm² Scan rate: 10 mV/s.
Figure S17 (Table 2): Summarized the electrocatalytic activity of different electrodes towards reduction of oxygen.

<table>
<thead>
<tr>
<th>Electro catalyst</th>
<th>Onset Potential (V)</th>
<th>Half Wave Potential, $E_{1/2}$ (V)</th>
<th>Reduction Current density (µA/cm$^2$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RG-BPtNs</td>
<td>0.674±0.003</td>
<td>0.489±0.005</td>
<td>421.584±15.484</td>
</tr>
<tr>
<td>Pt/C</td>
<td>0.596±0.004</td>
<td>0.377±0.026</td>
<td>16.773±2.193</td>
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<tr>
<td>PtNs</td>
<td>0.582±0.002</td>
<td>0.287±0.011</td>
<td>11.56±1.175</td>
</tr>
</tbody>
</table>
Figure S18: shows the typical RDE voltammograms for O₂ reduction on (a) graphene supported branched PtNs (GR-BPtNs, synthesized at pH 7.7), (b) graphene supported PtNs synthesized in absence of glucose residue (figure S10) (c) graphene supported PtNs synthesized at pH 10 (Figure 4 B), and (d) graphene supported PtNs synthesized at pH 3 (Figure 4 A) modified electrodes in 0.5M H₂SO₄ at 300 rpm. Scan rate: 5mV/s.