Supplementary Information

One-pot Formation of Multifunctional Pt-Conducting Polymer Intercalated Nanostructures

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Experimental Section

Materials: The materials used included pyrrole (C_4H_5N, 98%, Alfa Aesar), platinum chloride ($PtCl_2$, 98%, Alfa Aesar), polyvinylpyrrolidone (PVP, Mw=58000, Alfa Aesar), sodium borohydride ($NaBH_4$, 97%, Alfa Aesar), graphite paste (colloidal, isopropanol base, Electron Microscopy Sciences), glucose (D-glucose, J.T. Baker), uric acid (99%, Alfa Aesar), 4-acetamidophenol (98%, Sigma-Aldrich), ascorbic acid (UPS grade, AMRESCO). The V_2O_5 nanofiber sol-gel was prepared based on the reported method (Bailey, J. K.; Pozarnsky, G. A.; Mecartney, M. L. J. Mater. Res. 1992, 7, 2530).

Synthesis of Pt NP intercalated PPy NF network (Pt NP@PPy NF): In a typical synthesis of Pt NP@PPy NF, 0.1 mL pyrrole was firstly dispersed in 40 mL D. I. water under magnetic stirring. Then 1 mL vanadium pentoxide (V_2O_5) nanofiber sol-gel was added in the solution and allowed to react with pyrrole for 20 min. Afterwards, 20 mL platinum chloride ($PtCl_2$) aqueous dispersion (0.015M) with 3.08 mmol polyvinylpyrrolidone (PVP Mw=58000, Pt:PVP=1:10, in terms of repeating unit) was added and the reaction was proceeded for another 24 hrs. Eventually 3 mmol $NaBH_4$ was added into the solution and reacted for 1 hr in order to completely reduce the Pt ions into the metallic state.

Synthesis of Pt NP decorated PPy NF network (Pt NP/PPy NF): Pt NP/PPy NF was also synthesized using the same procedures above without the presence of PVP.

Material Characterization: Scanning electron microscope (SEM) and energy dispersive X-ray (EDX) characterization of the sample were performed on a JEOL JSM-7000F equipped with an EDX detector. High resolution transmission electron microscope (HRTEM) and selected area electron diffraction (SAED) characterization were performed on a JEOL 2100F TEM operated at 200 kV. UV-vis of the sample was obtained from a SHIMADZU UV-2450 spectrophotometer. Fourier transform infrared (FTIR) and Raman data were acquired from a Thermo Nicolet 6700 FTIR and a Renishaw invia Raman microscope, respectively. Thermal gravimetric analysis (TGA) of the sample was performed on a TA Q2000 system.

Electrochemical measurement: The electrochemical tests of the sample were performed on a CHI 601D electrochemical workstation equipped with a three-electrode cell system. The working electrode was prepared by casting 0.5 mg of the electrocatalyst onto the graphite electrode through graphite paste and dried for 15 minutes at room temperature prior to use. All the graphite electrodes were mirror polished before used. A Pt wire was used as the counter electrode and Ag/AgCl was used as the reference. For the glucose sensing test, cyclic voltammetry (CV) was performed from -0.8 to 0.6 V at a scan rate of 20 mV/s in 0.1 M NaOH solution. The amperometric test was performed at an applied potential of -0.3 V in 0.1 M NaOH solution, to which 1 mM glucose (1-45 mM) was successively injected at an interval of 60 s. The amperometric tests were conducted after the electrode reached its steady-state in the solution and the electrode response was taken as the difference between the steady-state and background current. For the methanol oxidation reaction (MOR), the CV was recorded from 0-1.0 V at a scan rate of 50 mV/s in a nitrogen saturated solution containing 0.5 M methanol and 0.5 M H_2SO_4. The chronoamperometric tests were performed in nitrogen saturated 0.5 M methanol/0.5 M H_2SO_4 solution at an applied potential of 0.7 V. For the oxygen reduction reaction (ORR), CV was performed from -0.2-1.0 V at a scan rate of 10 mV/s in either a nitrogen saturated or oxygen saturated 0.5 M H_2SO_4 solution, respectively.

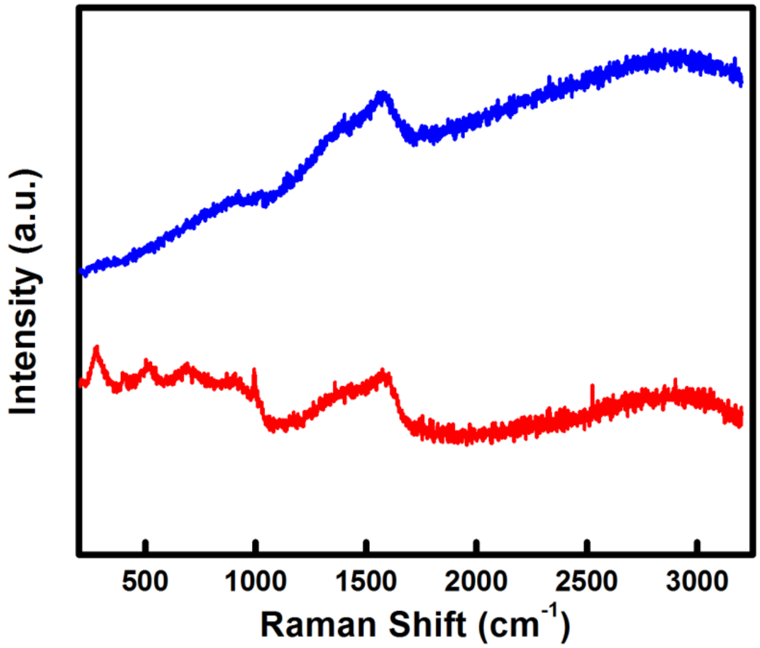

Figure 1. Raman spectra of Pt NP/PPy NF (blue) and Pt NP@PPy NF (red). Characteristic Raman scattering modes of polypyrrole can be observed as the broad band between 1250 and 1750 cm^{-1}.[1] The Raman spectrum of the Pt NP@PPy NF also shows typical Raman peaks of polyvinylpyrrolidone (PVP) in the region below 1000 cm^{-1}, indicating the existence of PVP within the ordered structure.[2]

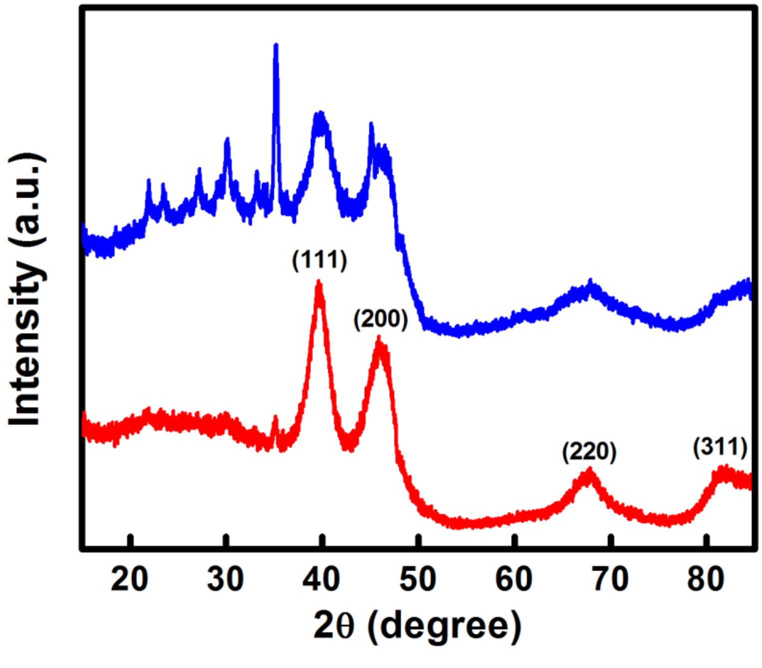

Figure 2. XRD spectra of Pt NP/PPy NF (blue) and Pt NP@PPy NF (red). Typical XRD diffraction peaks correspond to the {111}, {200}, {220} and {311} facets of the face-centered cubic (*fcc*) Pt were observed for the Pt NP@PPy NF;[3] while characteristic XRD peaks for polypyrrole were observed for the Pt NP/PPy NF below 40°.[4]

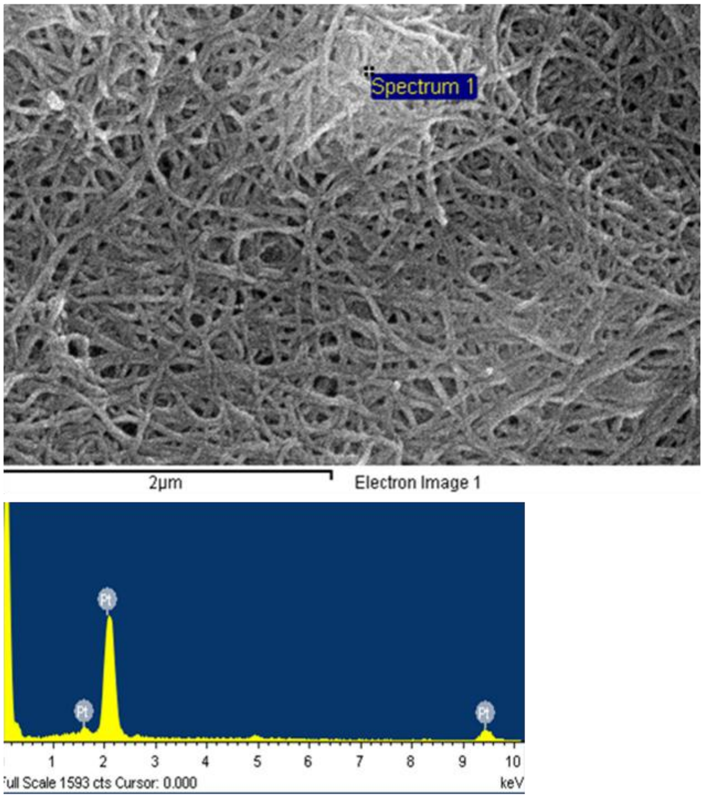

Figure 3. EDX spectrum of the selected area of the Pt NP@PPy NF under SEM. It indicates the bright prominent spot showing in the Pt NP@PPy NF structure was composed of the elemental platinum.

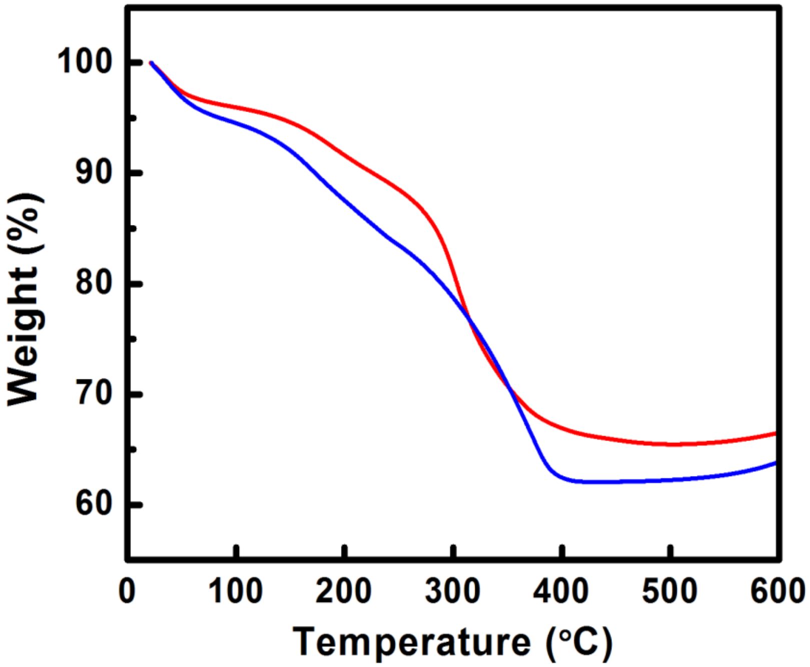

Figure 4. TGA graphs of Pt NP@PPy NF (red) and Pt NP/PPy NF (blue).

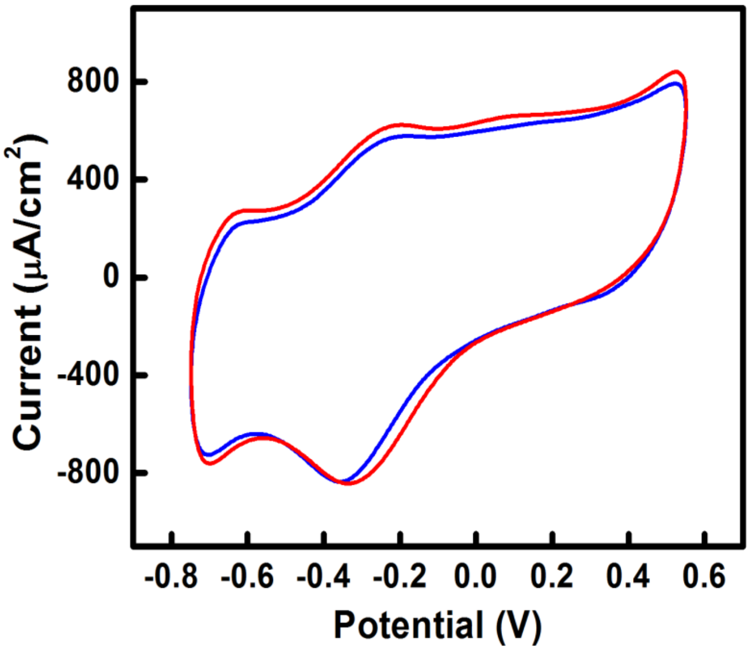

Figure 5. Cyclic voltammograms (CVs) of the Pt NP@NF/G electrode in 0.1 M NaOH solution containing 5 mM glucose before (blue) and after (red) the addition of 0.15 M KCl.

Reference

[1] Liu, Y. C.; Hwang, B. J. *Synth. Met.* 2000, 113, 203-207.

[2] Borodko, Y.; Habas, S. E.; Koebel, M.; Yang, P.; Frei, H.; Somorjai, G. A. *J. Phys. Chem. B* 2006, 110, 23052-23059.

[3] Mizukoshi, Y.; Oshima, R.; Maeda, Y.; Nagata, Y. *Langmuir* 1999, 15, 2733-2737.

[4] Mavinakuli, P.; Wei, S.; Wang, Q.; Karki, A. B.; Dhage, S.; Wang, Z.; Young, D. P.; Guo, Z. *J. Phys. Chem. C* 2010, 114, 3874-3882.