Electronic Supplementary Material (ESI) for Physical Chemistry Chemical Physics.

Supporting Information

Redox-Exchange Induced Heterogeneous RuO_2-Conductive Polymer Nanowires

Zhe Gui, Jonathon Duay, Junkai Hu and Sang Bok Lee*

Department of Chemistry and Biochemistry, University of Maryland, College Park, MD 20740, USA.

* Address correspondence to: slee@umd.edu

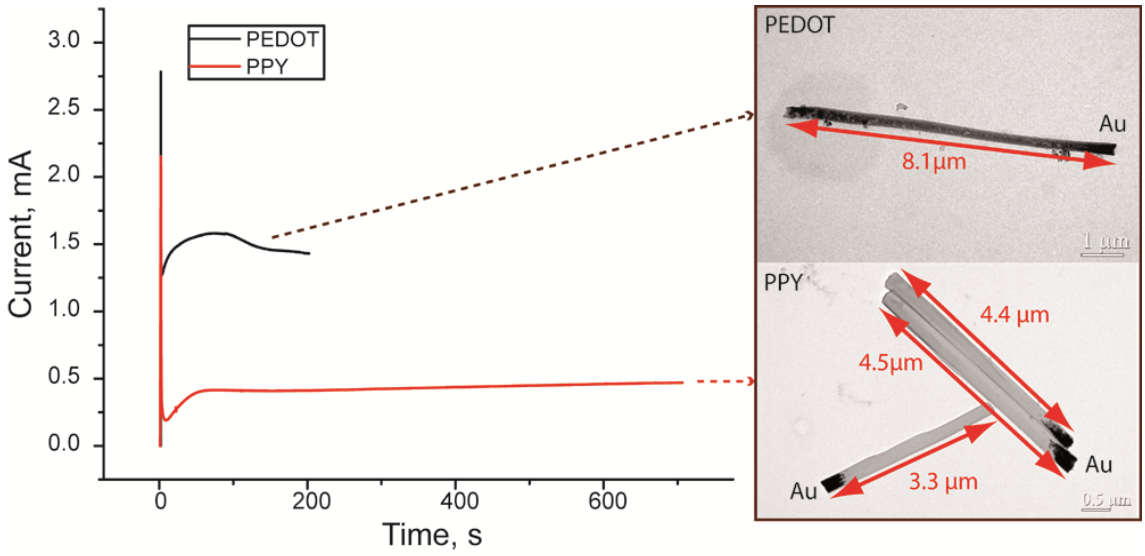

Figure S1. Potentiostatic transients for the electrodepositions of PPY (red curve) and PEDOT (red curve) nanowires with charge of 300 mC. The corresponding TEM image of intact individual polymer nanowires are shown on the right with Au bottom indicated. The lengths of the individual nanowires are marked. Based on a large amount of sample length measurements, the average length of 300 mC PEDOT is around 8 µm, and the length for 300 mC PPY is around 3-4 µm.

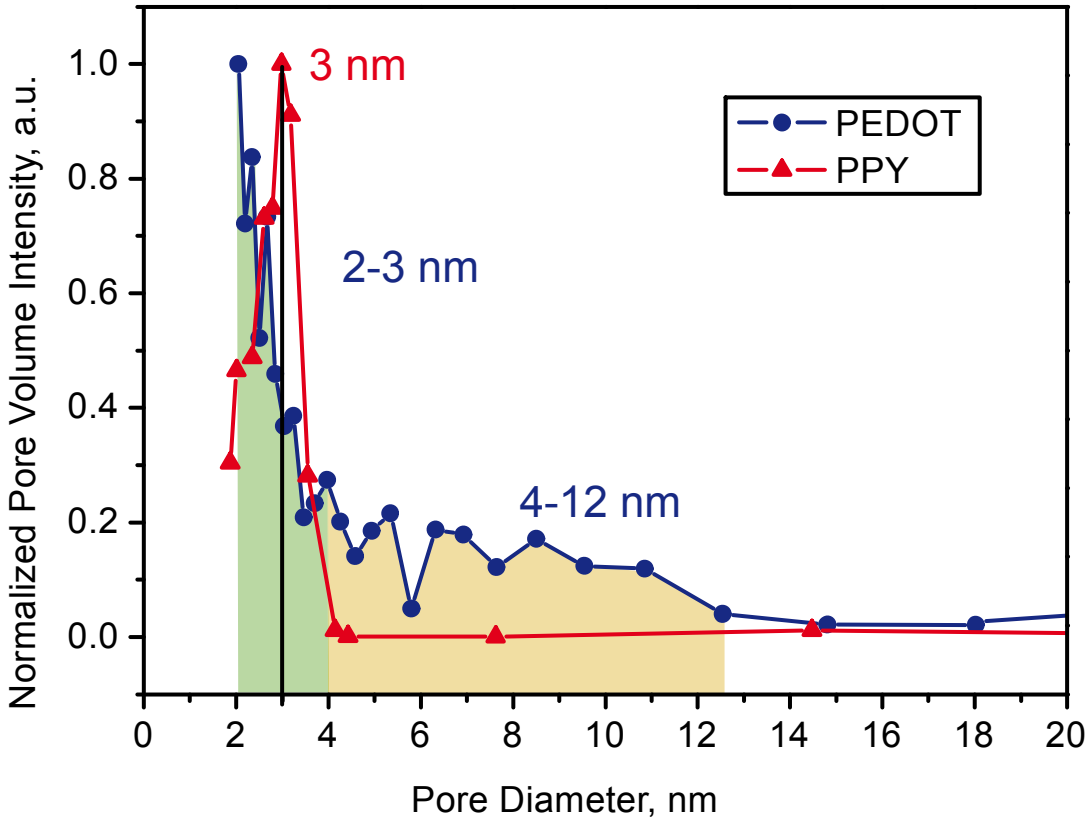

Figure S2. Barrett-Joyner-Halenda pore-size distribution curves from N_2 adsorption branches of PEDOT and PPY films**.**

To prepare an efficient amount of polymer samples for the BET measurement, we used electrodeposited polymers films. Both PEDOT and PPY were grown on to Au-sputtered glass slide. After air-drying at room temperature, the polymer film was peeled off from the glass slide. Electrodeposited PPY formed a continuous film and can be easily peeled off from the glass-Au substrate. While for the PEDOT film, there was a strong adhesion between the polymer film and the Au layer. As we peeled the film, PEDOT came off together with the Au layer from the glass slide. There were also some

black powders loosely deposited at the film surface as well. For comparing purpose, a charge of 30 C was applied for both polymer depositions onto Au-sputtered glass slide substrates with an active deposition area of 8.75 cm^2 using the same conditions as applied for the nanowire growth. The nitrogen adsorption isotherms were measured at 77K, and the polymer samples were degassed at 343.15 K for 4 hours before the measurement**.**

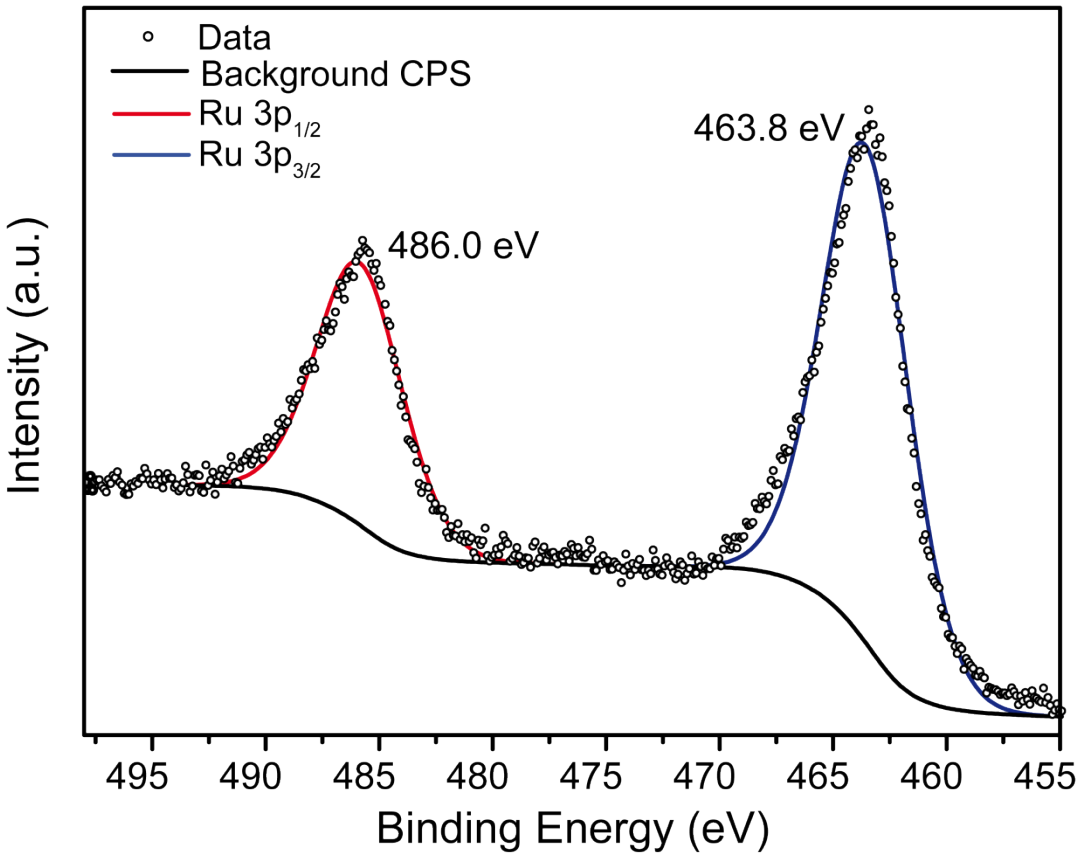

Figure S3. XPS Ru 3p spectra of composite PEDOT-RuO_2. The Ru 3p peaks at 486.0 and 463.8 eV agree with the reported value for hydrous RuO_2.[1-2] Similar Ru 3p spectra was also found for PPY- RuO_2 sample.

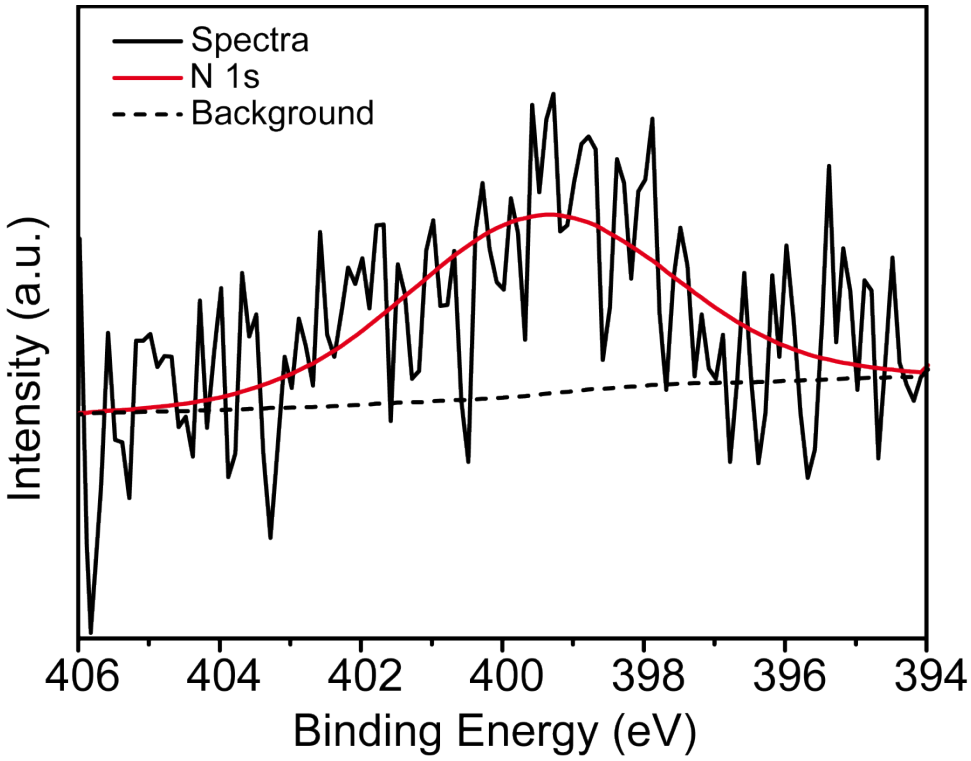

Figure S4. XPS spectra of N 1s of of PPY-RuO_2.

S5 Calculation:

The pristine specific capacitances of RuO_2 in PEDOT and PPY nanowires can be estimated by using the following equation:

$$C_{spec}^{composite} \times m_{composite} = C_{spec}^{RuO_2} \times m_{RuO_2} + C_{spec}^{polymer} \times m_{polymer} \quad (2)$$

The C_{spec} values of composite and polymer were calculated based on the cyclic voltammetry charge/discharge measurements at 20 mV/s on the hybrid nanowires and pristine polymer nanowires samples. The mass "m" of the polymer is calculated based on charge applied for electrodeposition. While the mass of RuO_2 is determined by ICP-AES characterization. The mass for composite nanowires is the sum of both polymer (PEDOT or PPY) mass and RuO_2 mass. By using the equation 2, we can derive the specific capacitance of RuO_2 as 829 F/g in PPY-based nanowires, and 1191 F/g in PEDOT-based nanowires at 20 mV/s.

Reference:

[1] J. Wen, X. Ruan, and Z. Zhou, *J. Phys. Chem. Solids*, 2009, 70, 816–820.

[2] M. Sathiya, K. Ramesha, G. Rousse, D. Foix, D. Gonbeau, A. S. Prakash, M. L. Doublet, K. Hemalatha, and J. M. Tarascon, *Chem. Mater.*, 2013, 1121–1131.