Supplemental Information

Oxidative Template for Conducting Polymer Nanoclips

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Synthesis of Conductive Polypyrrole Nanoclips

In a typical experiment, 0.01 M cetrimonium bromide ($(C_{16}H_{33})N(CH_3)_3Br$) (CTAB) is dispersed in 60 mL 1M HCl under ice bath. After being magnetically stirred 10 min, 0.03 M ammonium peroxydisulfate (APS) was added into the above solution and keep stirring for 10 min resulting in reactive template in the form of white precipitates. All solutions are cooled to 0-3ºC. Pyrrole (0.12 M) was added into the as-prepared reactive template solution, self-assembly was conducted at 0-3ºC for 24 hrs, the resulting black precipitate of polypyrrole was suction filtered, washed with copious amounts of aq. 1 M HCl (3 x 100 mL) and acetone (3 x 100 mL) and dried under freeze dry for 12 hrs. The yield of polypyrrole nanoclips powder was ~130 mg.

Synthesis of Conductive Polyaniline Nanoclips

In a typical experiment, 0.01 M cetrimonium bromide ($(C_{16}H_{33})N(CH_3)_3Br$) (CTAB) is dispersed in 60 mL 1M HCl under ice bath. After being magnetically stirred 10 min, 0.03 M ammonium peroxydisulfate (APS) was added into the above solution and keep stirring for 10 min resulting in reactive template in the form of white precipitates. All solutions are cooled to 0-3ºC. aniline (0.09 M) was added into the as-prepared reactive template solution, self-assembly was conducted at 0-3ºC for 24 hrs, the resulting dark green precipitate of polyaniline was suction filtered, washed with copious amounts of aq. 1 M HCl (3 x 100 mL) and acetone (3 x 100 mL) and dried under freeze dry for 12 hrs. The yield of polyaniline nanoclips powder was ~100 mg.

Synthesis of Conductive PEDOT Nanoclips

In a typical experiment, 0.01 M cetrimonium bromide ($(C_{16}H_{33})N(CH_3)_3Br$) (CTAB) is dispersed in 60 mL 1M HCl under ice bath. After being magnetically stirred 10 min, 0.03 M ammonium peroxydisulfate (APS) was added into the above solution and keep stirring for 10 min resulting in reactive template in the form of white precipitates. All solutions are cooled to 0-3ºC. EDOT (0.08 M) was added into the as-prepared reactive template solution, self-assembly was conducted at 0-3ºC for 100 hrs, the resulting naval blue precipitate of PEDOT was suction filtered, washed with copious amounts of aq. 1 M HCl (3 x 100 mL) and acetone (3 x 100 mL) and dried under freeze dry for 12 hrs. The yield of PEDOT nanoclips powder was ~80 mg.

Microwave synthesis of nanocarbons from conductive polymer nanoclips

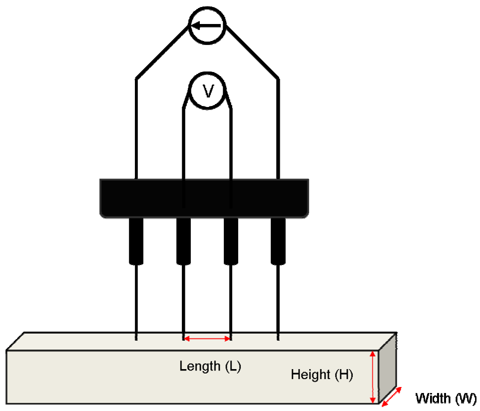
30 mg as-synthesized conductiong polymer nanoclips were placed in glass vials and then heated in a conventional microwave oven for 6 min, with 3min continuous heating and 1min interval. There was sharp sparking associated with light flame which appeared on conductive polymer nanoclips surface. Microwave heating is associated with 55-60% weight loss in polypyrrole, which is attributed to the loss of backbone nitrogen atoms and dopant ions (Cl^-). The elemental composition of carbon (by elemental analysis) has increased upon microwave heating.

Four probe conductivity measurements

The bulk electrical conductivity of the conducting polymer nanoclips was measured by a linear four probe measurement setup described elsewhere (Scheme S1).[1] The conducting polymer powder was pressed at 3500 psi in a mode to rectangular thin film, and the four probes were connected to Agilent Technologies 34980A multifunctional switch/measure unit. The conductivity σ (S/cm) is the reciprocal of electrical resistivity and can be expressed as:

$$\sigma = \frac{l}{R \times A}$$

R is the electrical resistance of a uniform specimen of the material (Ω), can be directly read from the Agilent system; l is the distance between the inner two probes (cm); A is the cross-sectional area of the specimen (cm^2). In our test, the parameters for the polypyrrole (PPy) nanoclips sample were: width: 0.2 cm, length: 0.52 cm, thickness: 0.06 cm, resistance from Agilent system: 15.0Ω. The calculated conductivity is 2.89 S/cm.



Scheme S1

Wan *et al.* has reported 30 S/cm of electrical conductivity for a single polyaniline nanotube.[2] However, we are measuring a pressed thin film, and do not expect to see anything different from granular powders. As shown in table S1, the conductivity of the conducting polymer nanoclips is very similar to conventional conducting polymer granular powders.

Table S1: Four probe conductivity (S/cm)

	Conventional samples	Nanoclips
PANI.HCl	2.50	2.15
PPy.Cl	3.28	2.89
PEDOT.Cl	4.23	4.35

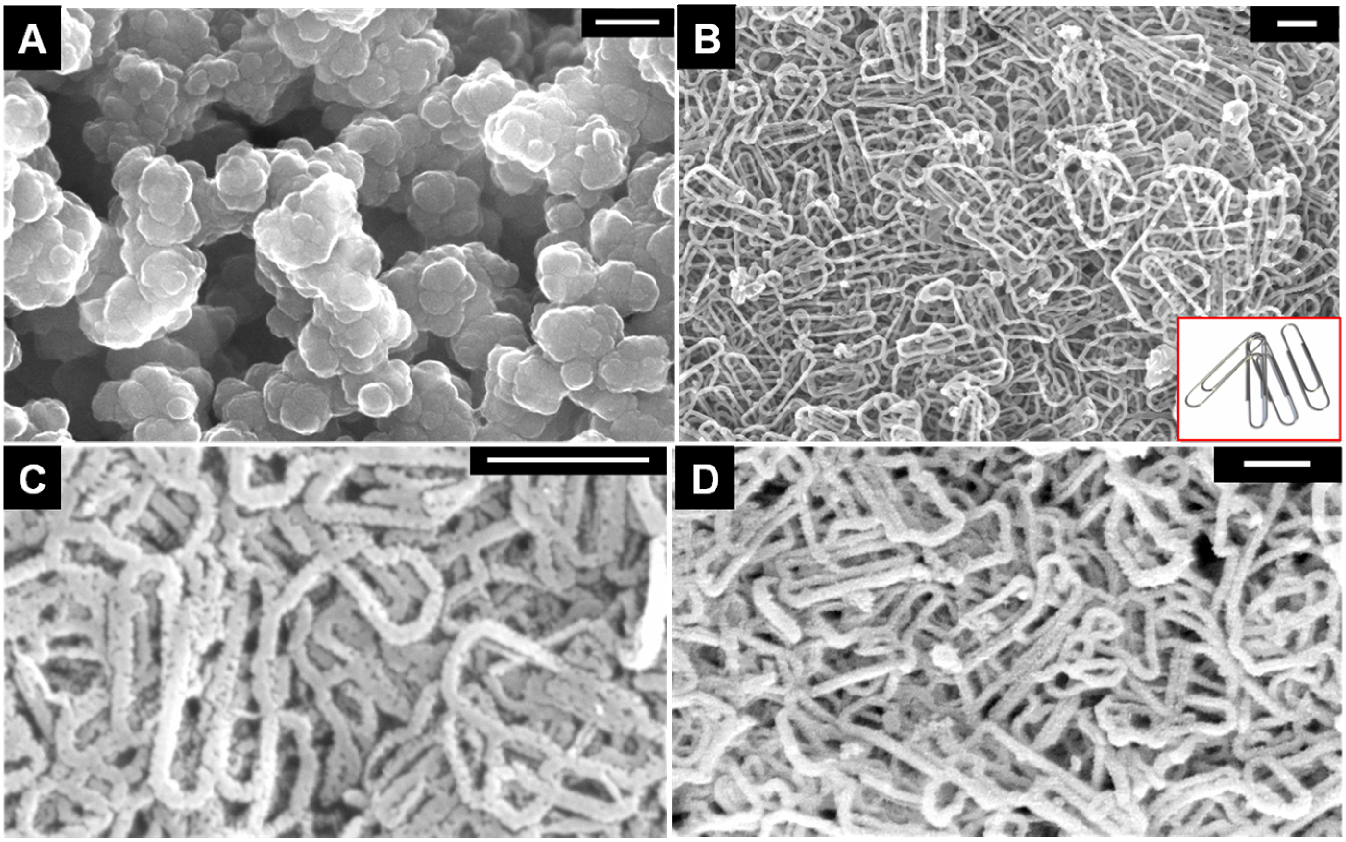


Figure S1. SEM images of (A) granular polypyrrole.Cl (scale bar: 200 nm); (B) polypyrrole.Cl nanoclips (scale bar 1 μm, Inset: digital picture of paper clips); (C) polyaniline.HCl nanoclips (scale bar: 1 μm); and (D) PEDOT.Cl nanoclips (scale bar: 1 μm).

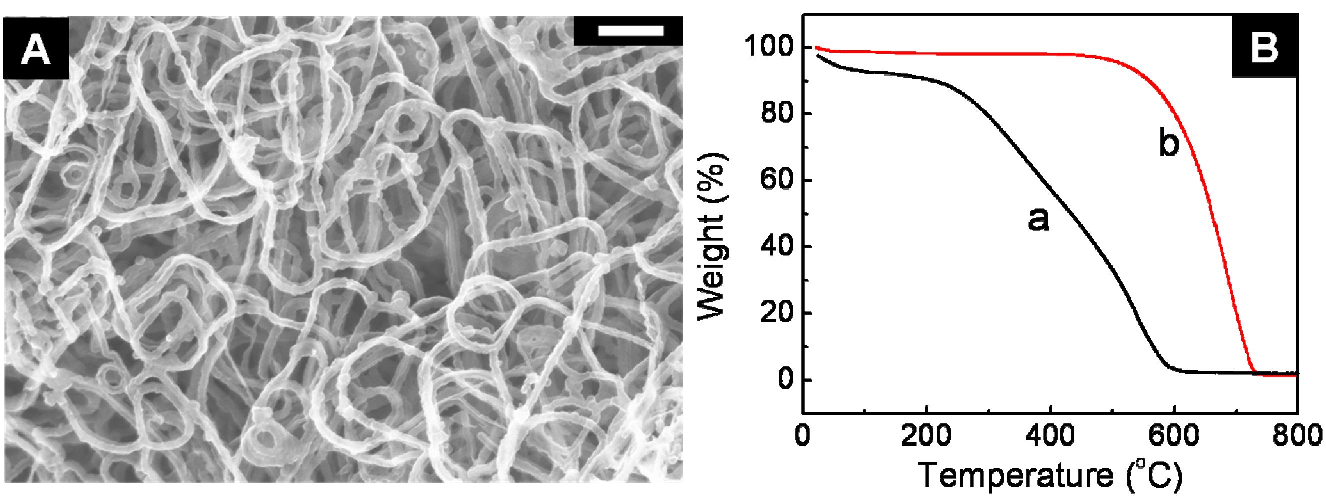


Figure S2. (A) SEM image of microwave heated polypyrrole.Cl (scale bar: 300 nm); and (B) TGA of polypyrrole.Cl nanoclips before (A) and after (B) microwave heating.

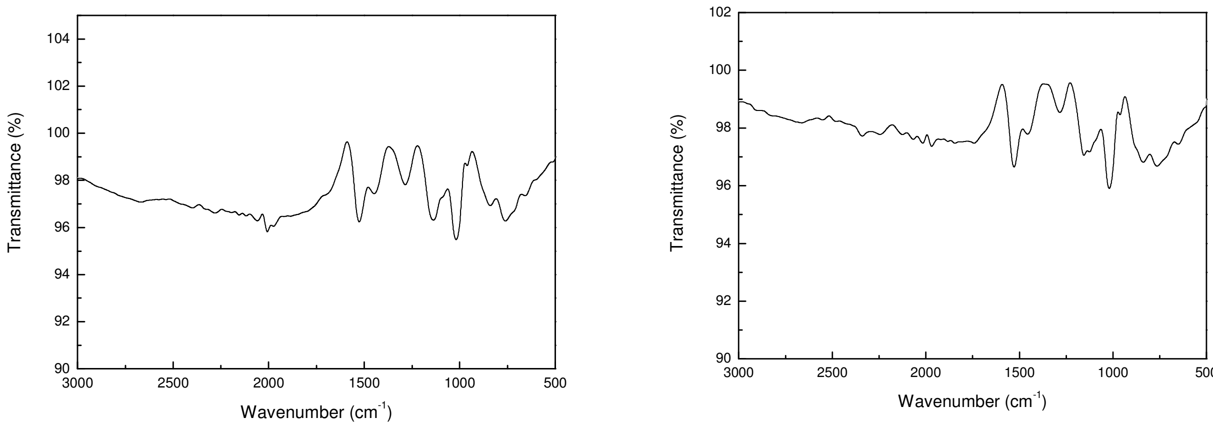


Figure S3. FTIR of conventional polypyrrole (left) and polypyrrole nanoclips (right).

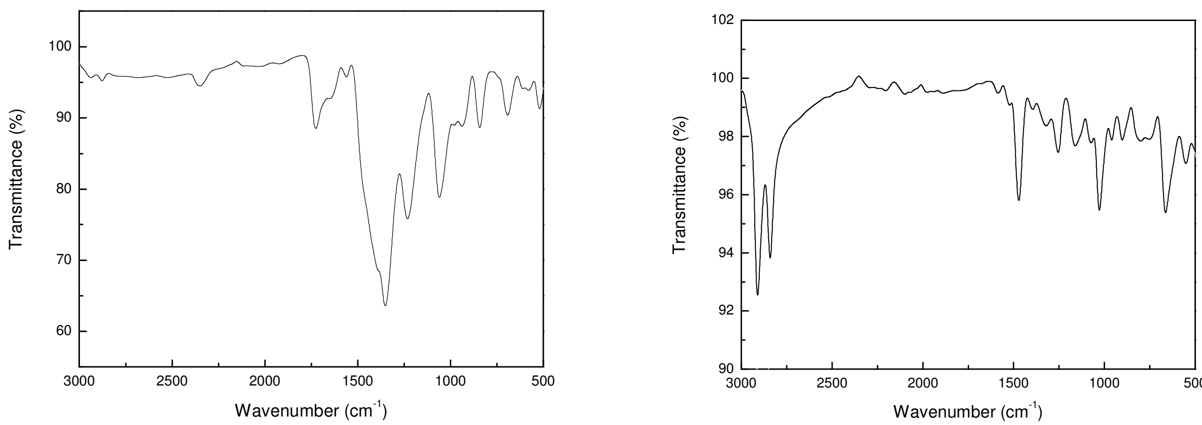


Figure S4. FTIR of conventional PEDOT (left) and PEDOT nanoclips (right)

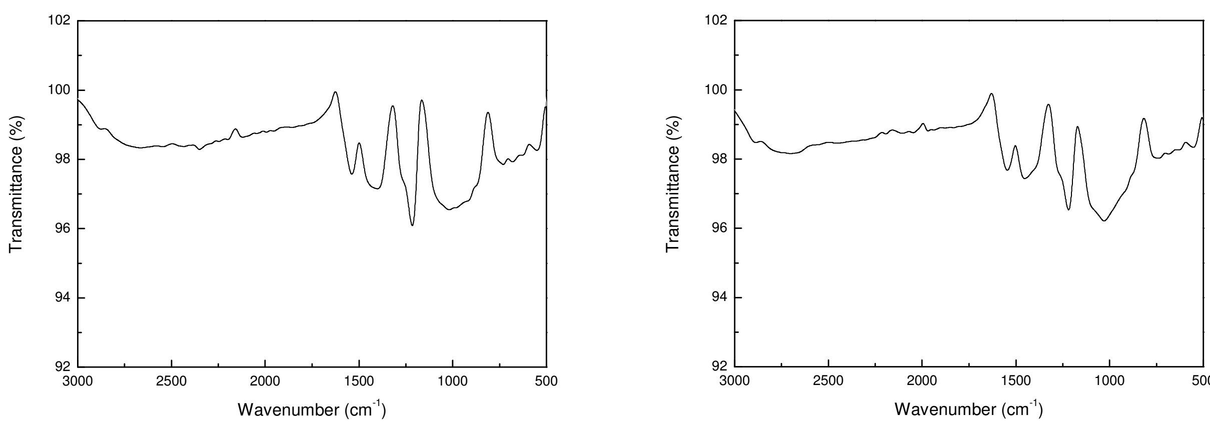


Figure S5. FTIR of conventional PANI (left) and PANI nanoclips (right).

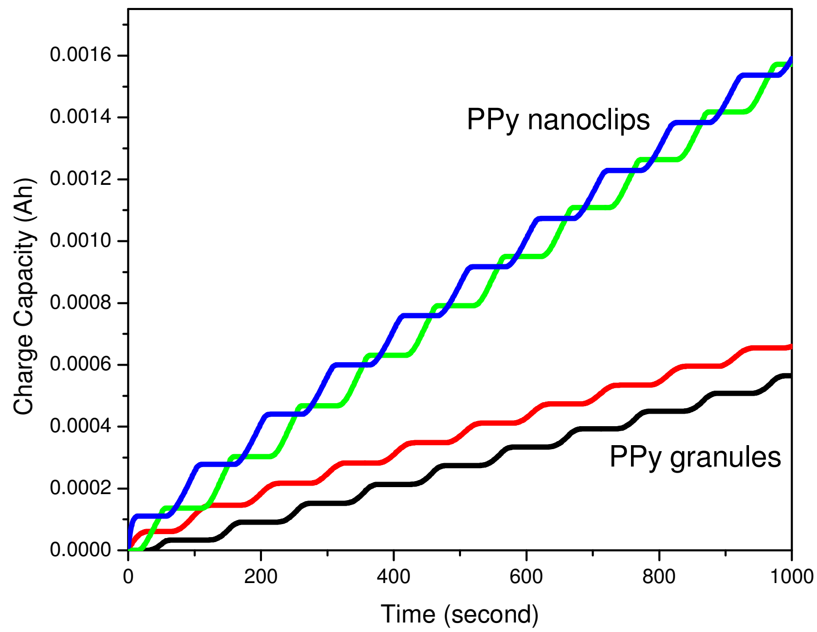


Figure S6. Charge/discharge capacity plot of PPy.Cl nanoclips and granules in the range of -0.5V~0.5V (vs. SCE) in aq. 1.0M NaCl electrolyte. Charge (green), discharge (blue) cycles for PPy nanoclips and charge (black), discharge (red) cycles for conventional (granular) PPy.Cl.

References:

1. Haupt, S. G.; Riley, D. R.; Zhao, J.; McDevitt, J. T., **1993** *J. Phys. Chem.* 97, 7796-7799.
2. Long, Y.; Chen, Z.; Wang, N.; Ma, Y.; Zhang, Z.; Zhang, L.; Wan, M., **2003** *Appl. Phys. Lett.* 83, 1863-1865.