**Supporting information**

# High performance carbon nanotube based fiber-shaped supercapacitors using redox additives of polypyrrole and hydroquinone

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## Calculation method for the supercapacitor performance values

Capacitance (*C*/F), energy storied (*E*/Wh) and power (*P*/W) of FSSCs were evaluated from GCD curves at various discharging current (I/A) following the equations[1]:$C = I \times \Delta t/\Delta U$, $E = 0.5 \times C \times \Delta U^2/3600$,$P = E/\Delta t \times 3600$, where Δ*U* (V) is width of voltage window and Δ*t* (s) is discharging time. Specific performance values have much more importance, such as specific capacitance ($C_s$), energy density ($E_{ds}$) and power density ($P_{ds}$). These values in terms of weight (m/g), length (L/cm), area (*S*/cm$^2$) or volume (*V*/cm$^3$) were calculated by dividing *C*, *E* or *P* with *m*, *L*, *S* or *V*. In this paper, m is the total weight of two fiber electrodes measured by an analysis balance, and L is the length of a fiber-shaped supercapacitor measured by a microcalliper. *S* ($= \pi \times D \times L$) is the surface area of a single fiber electrode, and *V* ($= 2 \times \pi \times (D/2)^2 \times L$) is the total volume of two fiber electrodes. *D* (cm) represents diameter of a cylinder-shape fiber electrode measured by an optical microscope.

## Figures

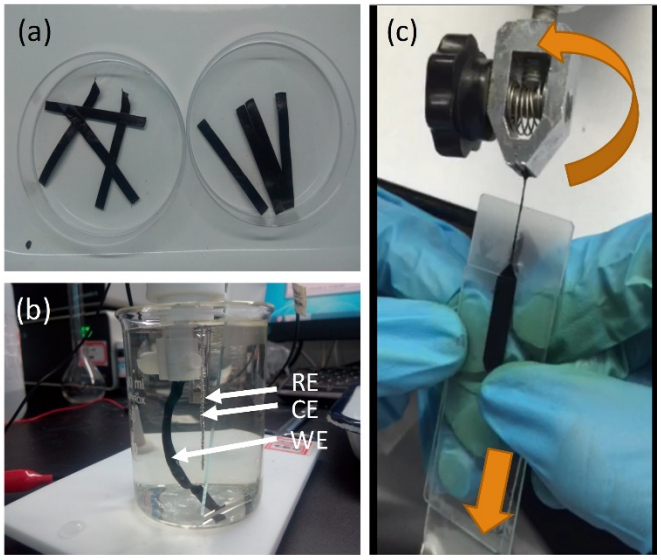


**Fig. S1** Optical images of (a) CNT strips, (b) 3-electrode system for PPy deposition, (c) Spinning process.

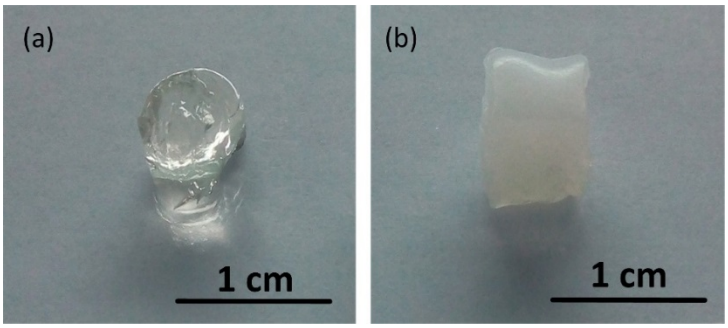


**Fig. S2** (a) PVA-$H_2SO_4$ gel electrolyte. (b) PVA-$H_2SO_4$ gel electrolyte with HQ.

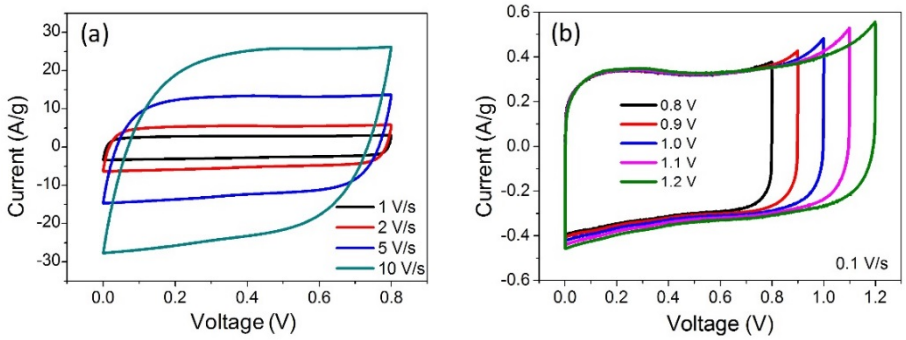


**Fig. S3** CV curves of a pure CNT FSSC at (a) high scan rates, and (b) wide voltage windows.

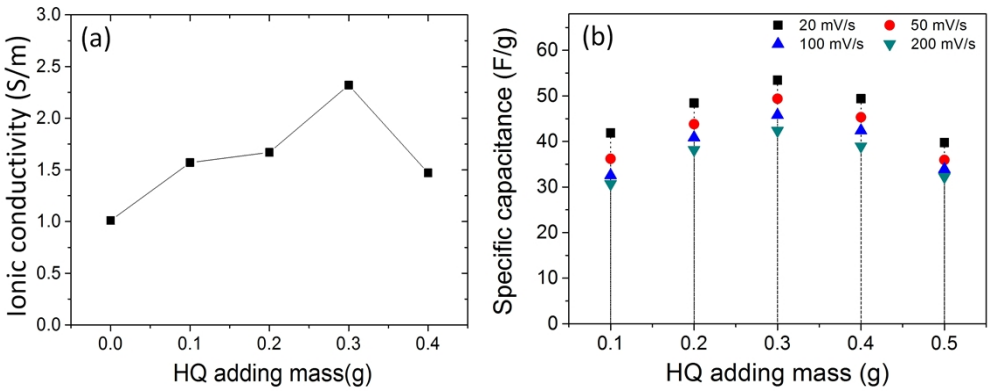


**Fig. S4** (a) Plot of ionic conductivity vs. weight of HQ in 10 mL PVA/$H_2SO_4$ gel solution. (b) Dependence of specific capacitance of the CNT-PPy-HQ FSSCs on the weight of HQ in 10 mL PVA/$H_2SO_4$ gel solution.

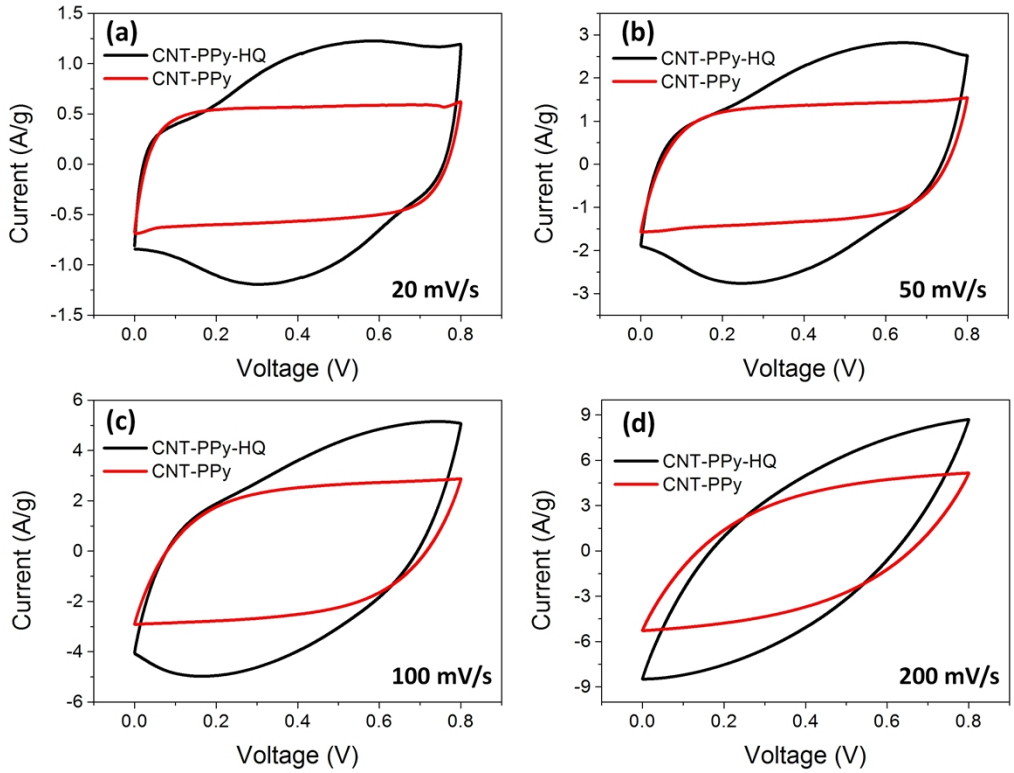


**Fig. S5** CV curves of the CNT-PPy FSSC and the CNT-PPy-HQ FSSC at various scan rate. (a) 20 mV/s, (b) 50 mV/s, (c) 100 mV/s, (d) 200 mV/s.

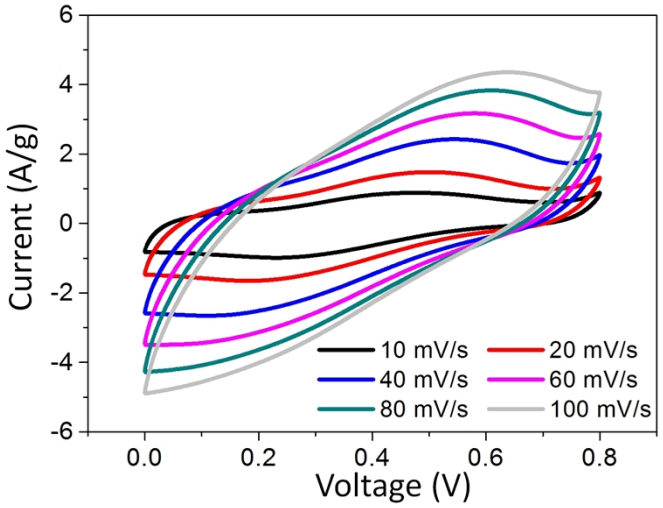


**Fig. S6** CV curves of a CNT-PPy-HQ FSSC at various scan rates of 10~100 mV/s. This FSSC is used for bending, knotting and tensile tests in Fig. 7b-d.

## Table

Table S1 Comparison of capacitive performances of FSSCs

| Electrode materials | Electrolyte | $C_s$ F/g | $C_l$ mF/cm | $C_a$ mF/cm$^2$ | $C_v$ F/cm$^3$ | Ref. |
|---|---|---|---|---|---|---|
| CNT fiber | PVA-$H_2SO_4$ | 4.9~5.2 | 2.0~2.2 | 32~34 | 3.2~3.3 | |
| CNT fiber | PVA-$H_2SO_4$-HQ | 7.8~8.0 | 3.1~3.2 | 48~49 | 4.7~4.9 | This |
| CNT-PPy fiber | PVA-$H_2SO_4$ | 33.6~36.1 | 118.5~127.4 | 574~588 | 15.9~17.0 | work |
| CNT-PPy fiber | PVA-$H_2SO_4$-HQ | 50.1~55.7 | 181.6~202.0 | 1051~1168 | 38.2~42.5 | |
| CNT-$MnO_2$ fiber & CNT fiber [a] | PVA-KOH | -- | 0.261 | 27.98 | 35.19 | 2 |
| CNT-MC fiber | PVA-$H_2SO_4$-PySH | -- | 17.51 | 507.02 | 0.184 | 3 |
| $MnO_2$-CNP-CF fiber & CNP-CF fiber [a] | PVA-LiCl | -- | -- | -- | 4.6 | 4 |
| $MnO_2$-PPy-CF fiber & $V_2O_5$-PANI-CF fiber [a] | LiCl (liquid) | -- | -- | 613 | 19.52 | 5 |
| $MnO_2$-RGO-CF fiber & CH-CW fiber [a] | PAAK-KCl | -- | -- | 50.8 | 2.53 | 6 |
| G fiber [b] | PVA-$H_2SO_4$ | 182 | 4.63 | 205 | -- | 7 |
| CNT fiber | PVA-$H_2SO_4$ | -- | -- | 4.28 | 11.4 | 8 |
| rGO-CNT-CMC fiber | PVA-$H_3PO_4$ | -- | 5.3 | 117 | 158 | 9 |
| $MnO_2$-RGO fiber | PVA-$H_2SO_4$ | 36 | 0.143 | 9.6 | -- | 10 |
| rGO fiber | PVA-$H_2SO_4$ | 40 | 0.0271 | 1.7 | -- | 11 |
| rGO-CNT fiber | PVA-$H_3PO_4$ | 31.5 | 0.0271 | 4.97 | -- | 12 |
| Pen ink-Au-plastic fiber | $H_2SO_4$ (liquid) | -- | 0.504 | 19.5 | -- | 13 |

$C_s$/$C_l$/$C_a$/$C_V$ are the specific/liner/areal/volumetric capacitance of the FSSCs. Capacitances in this manuscript are evaluated from GCD curves at current densities of 0.2~1.0 A/g. There are three device structures in the literature: asymmetric, coaxial, and symmetric. The superscript of "a" means a FSSC with asymmetric structure. The superscript of "b" means a FSSC with coaxial structure. The else are FSSCs with symmetric and parallel structure. In previous papers by Yu et al.[1] and Xu et al.[2], the comparison of specific capacitance for different FSSCs are also provided.

## References


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