Electronic Supplementary Information (ESI)

Versatile Origami Micro-Supercapacitors Array as a Wind Energy Harvester

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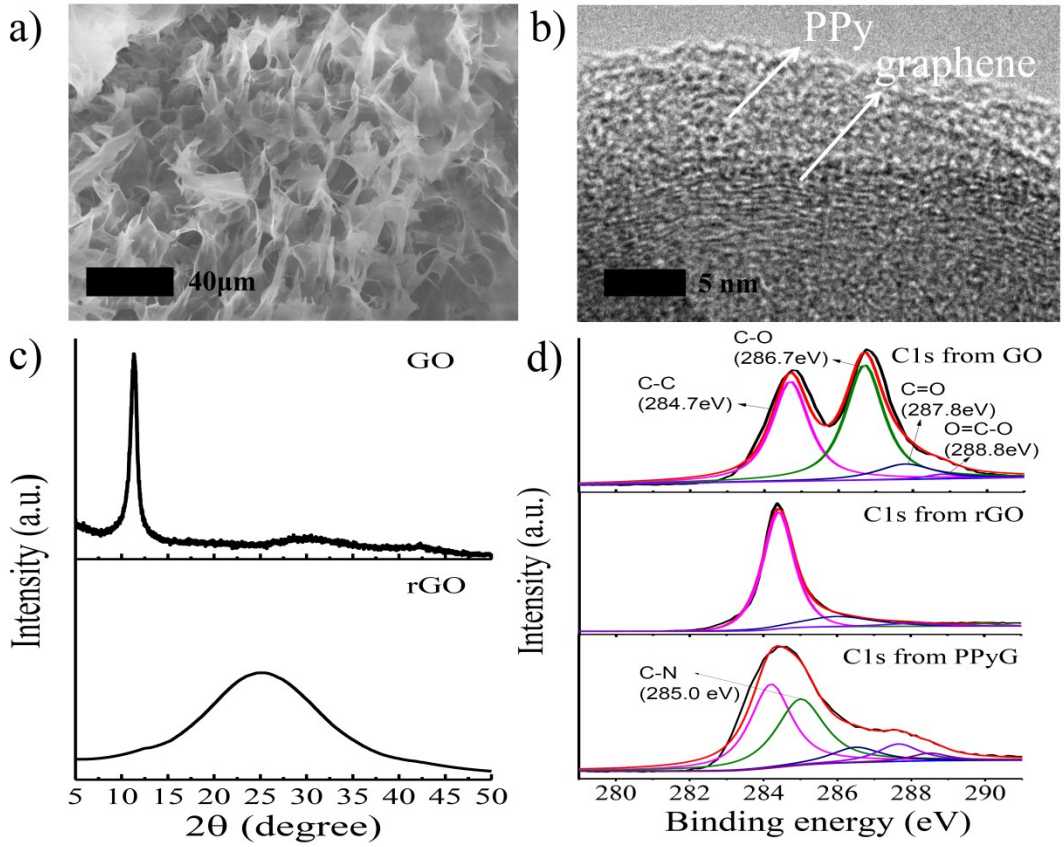
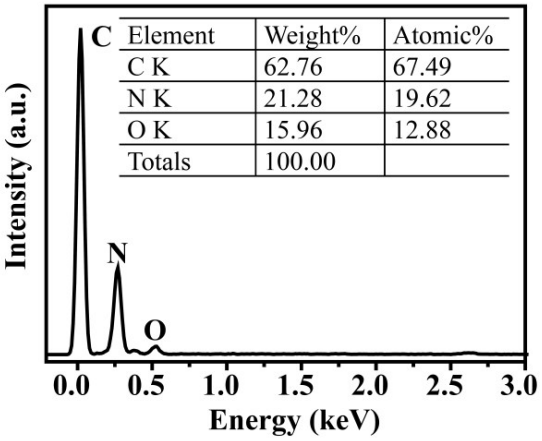


Figure S1 The characterizations of GO, rGO and PPyG composite. a) The SEM image of the original GO foam after freeze-drying treatment. b) The high-resolution TEM image of the edge of PPyG. c) The XRD spectra of GO and rGO after annealing at 1000 ^{o}C. d) The XPS spectra of high-resolution C 1s peaks for GO, rGO and PPyG, respectively.

As shown in Figure S1a, the freeze-dried GO foam displayed a typical porous structure. After high thermal treatment and electro-polymerization process, the PPyG composite was obtained. The high-resolution TEM of the PPyG composite has been carried out to investigate the interface of graphene and PPy, revealing the graphene layers are tightly coated with amorphous PPy layers (Figure S1b). Figure S1c showed the XRD patterns of GO and rGO. Instead of a sharp peak at 11.4° of GO, the rGO exhibited a broad peak at 25° after annealing treatment, indicating the recovery of graphitic crystal structure.[1]

In order to further investigate the chemical structure of the GO, rGO and PPyG, XPS spectra were carried out. As shown in Figure S1d, the high-resolution C 1s spectrum of GO revealed the presence of C-C (284.7 eV), C-N (285.0 eV), C-O (286.7 eV), C=O (287.8 eV), and O=C-O (288.8 eV) species.[2, 3] The peak area ratio of the

oxygen-related peaks (C-O, C=O, O=C-O) to C-C peak is 1.45, indicating the rich oxygen groups in the GO sheets. With the high thermal treatment at 1000 °C, the obtained rGO exhibited a sharply decreased peak area ratio of 0.265, suggesting the completely reducing of the GO. While the peak area ratio of oxygen-related bonds to C-C bond for the PPyG composite was calculated to be 0.505, which is slightly higher than that of rGO, probably attributed to the partial oxidation and chemical adsorption of oxygen for the rGO foam during electrochemical polymerization process.



Element	Weight%	Atomic%
C K	62.76	67.49
N K	21.28	19.62
O K	15.96	12.88
Totals	100.00	

Figure S2 Energy disperse spectrometer (EDS) spectrum of the PPyG composite.

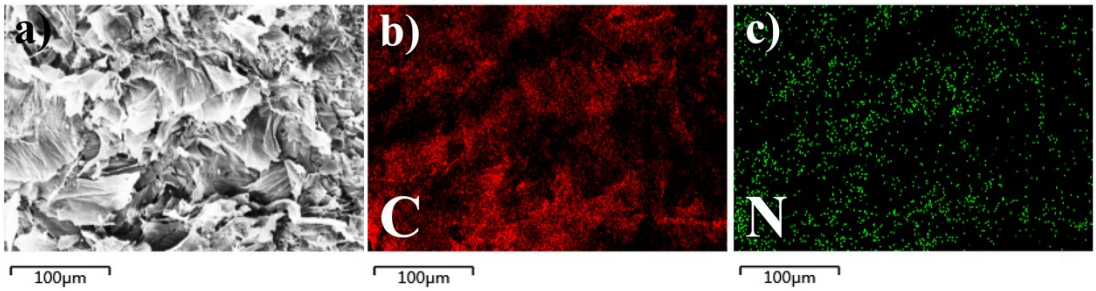


Figure S3 (a) The SEM image of the PPyG composite and the corresponding (b) carbon and (c) nitrogen elemental mapping.

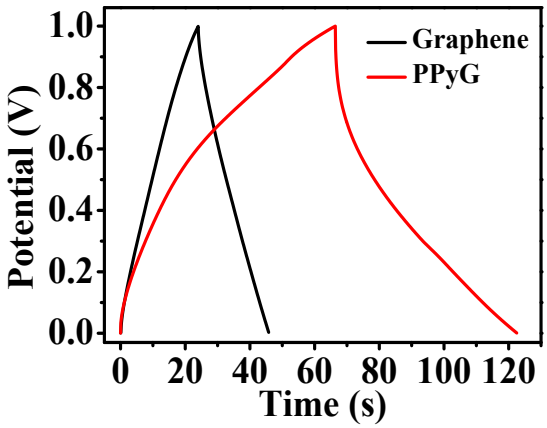


Figure S4 The charge/discharge curves of pure graphene and a single PPyG-MSC (the value of the current density is 0.345 mA cm^{-2}).

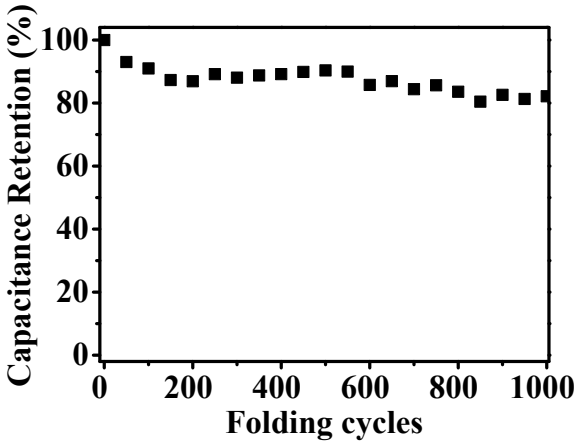


Figure S5 The cycling bending performance of a single PPyG-MSC. (82.15% capacitance retention after 1000 cycles)

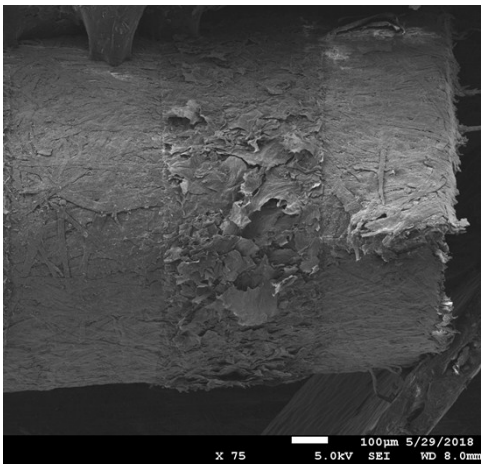


Figure S6 The SEM images of the PPyG electrode on cellulose paper after 1000 folds.

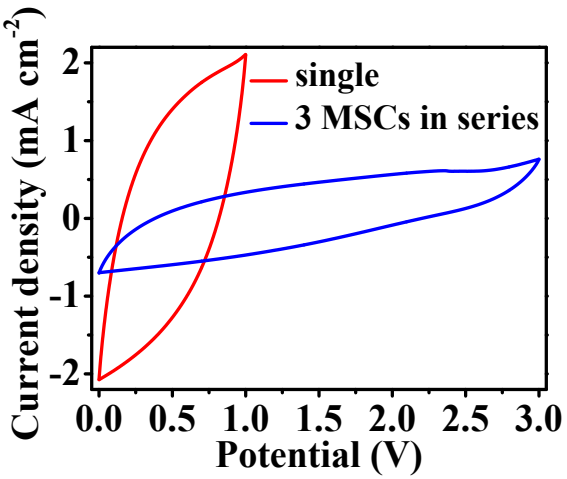


Figure S7 The cyclic voltammetry (CV) curves of a group of three supercapacitors connected in series.

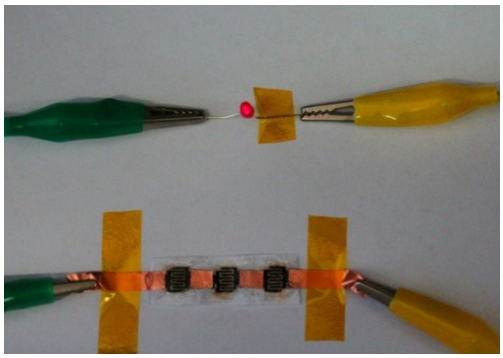


Figure S8 Optical image of an LED lighted by three PPyG-MSCs connected in series.

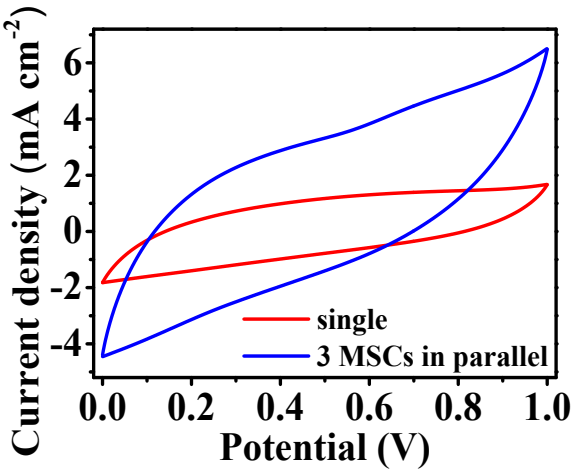


Figure S9 CV curves of a group of three supercapacitors connected in parallel.

Table S1 The performances of energy densities and power densities for the micro-supercapacitors.

Electrode materials	Substrate	Energy density (μWh cm^{-2})	Power density (mW cm^{-2})	Reference
Reduced graphene film	Silicon wafer	3.75*10^{-3}	0.7425	Ref 4
PPy nanowires	paper	0.161	0.05	Ref 5
Laser-scribed graphene	Disc	0.1773	6.384	Ref 6
Planar spray-coated MWCNT	PET	0.24	0.01	Ref 7
Graphene/ZnO	paper	0.65	0.63	Ref 8
PPy/rGO film	--	0.836	0.066	Ref 3
Laser-induced boron-doped graphene sheet	PI	1.828	0.05	Ref 9
Laser-reduced GO film	GO film	0.94772	3.7468	Ref 10
Graphene flakes/PEDOT	PET	3.105	291.8	Ref 11
PPyG composite	**paper**	**6.11**	**0.4**	**This work**

References

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