Electronic Supplementary Information (ESI)

Scalable Fabrication of Micron-Scale Graphene Nanomeshes

for High-Performance Supercapacitor Applications

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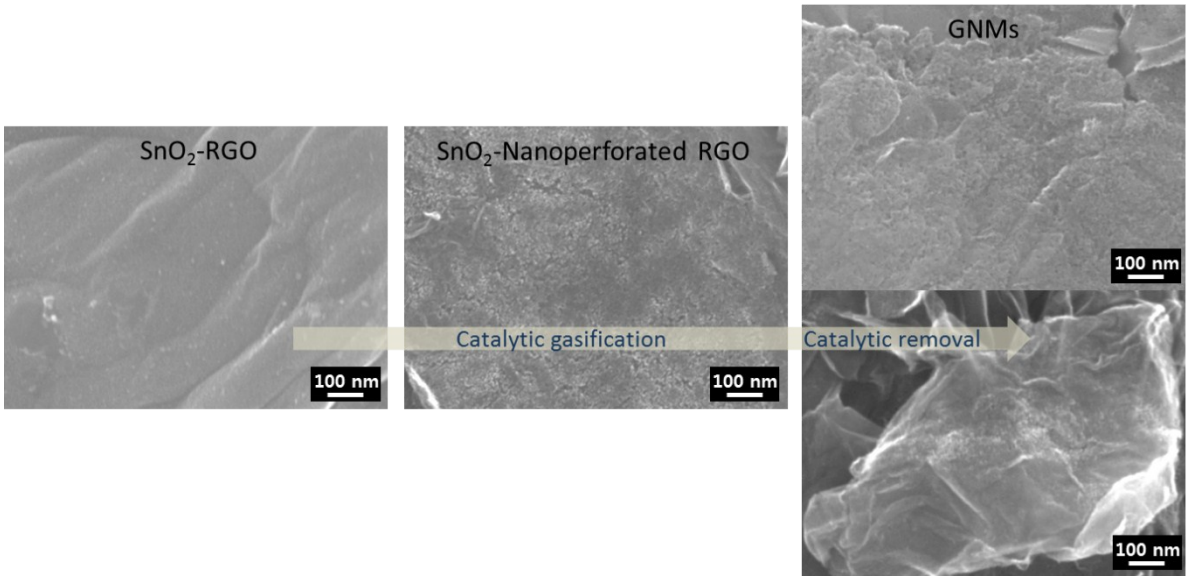
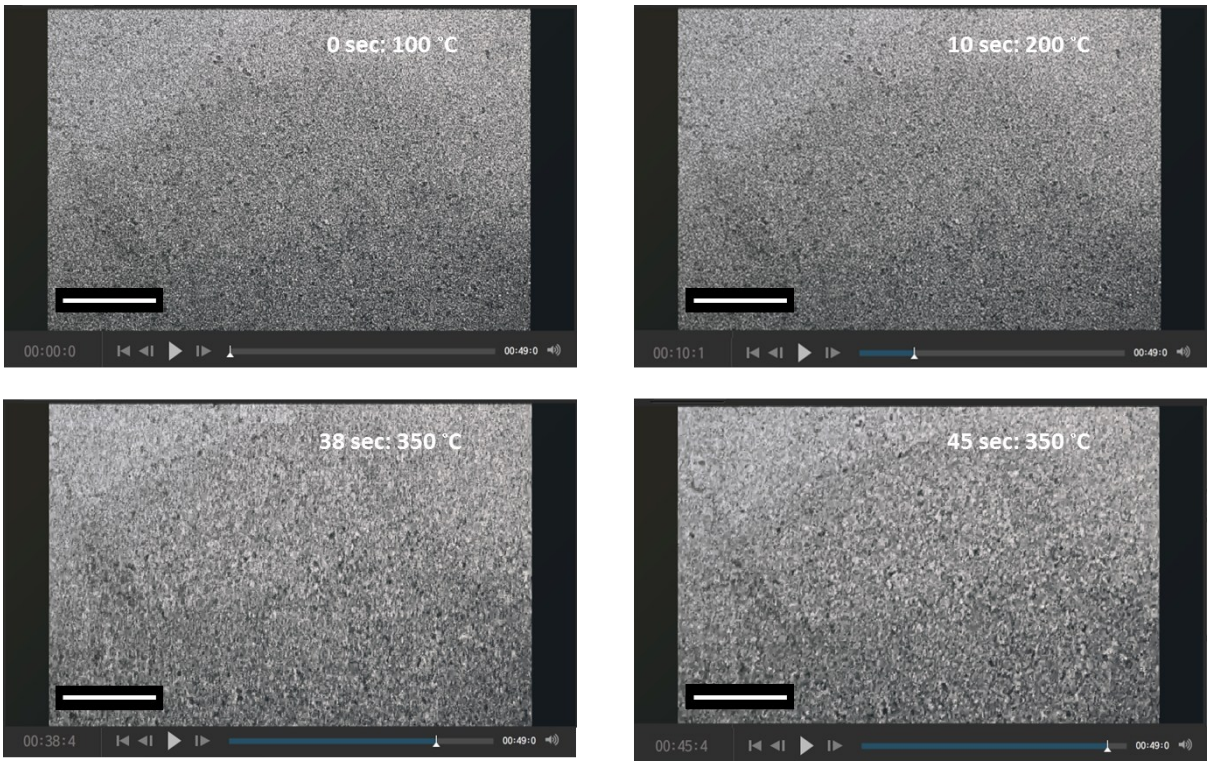
Figure S1



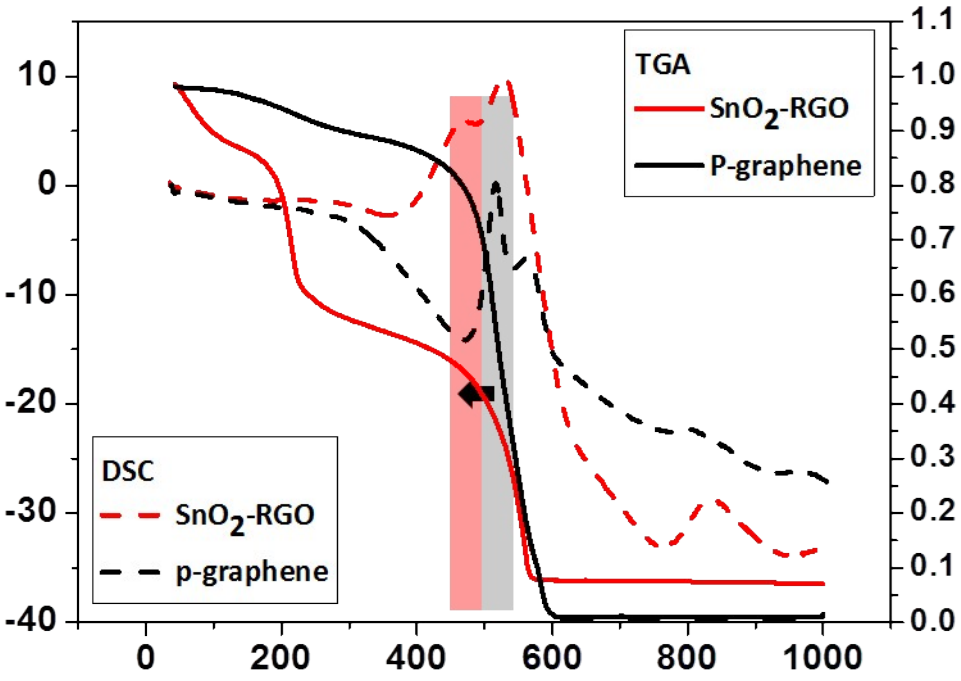
SEM images of SnO_2-RGO, SnO_2-nanoperforated RGO via carbon catalytic gasification, and GNMs

Figure S2



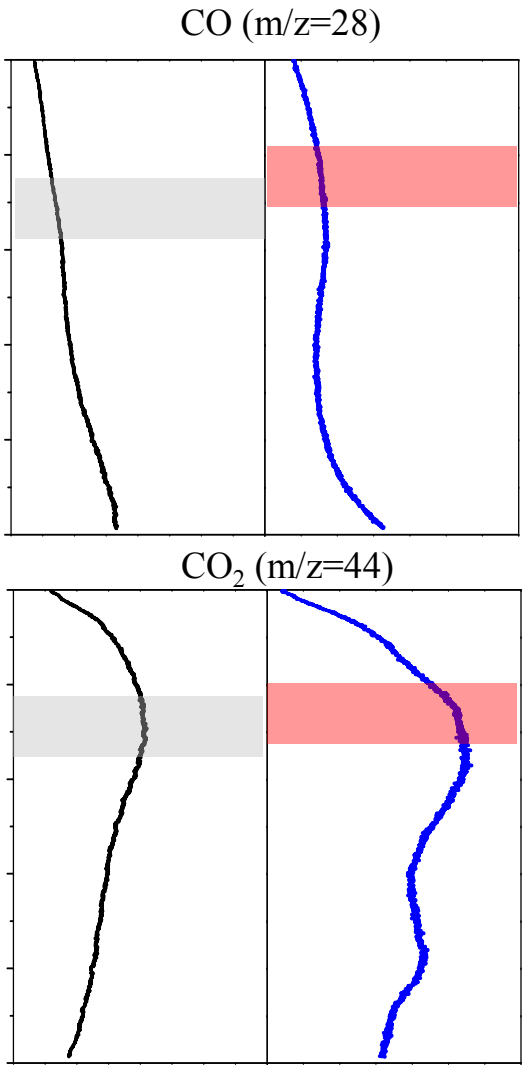
Snapshot in situ TEM images were recorded (x4) at 100–350 °C; at approximately 350 °C, SnO_2 on RGO induced carbon decomposition to introduce nanopores on the RGO sheets. Scale bars, 10 nm

Figure S3



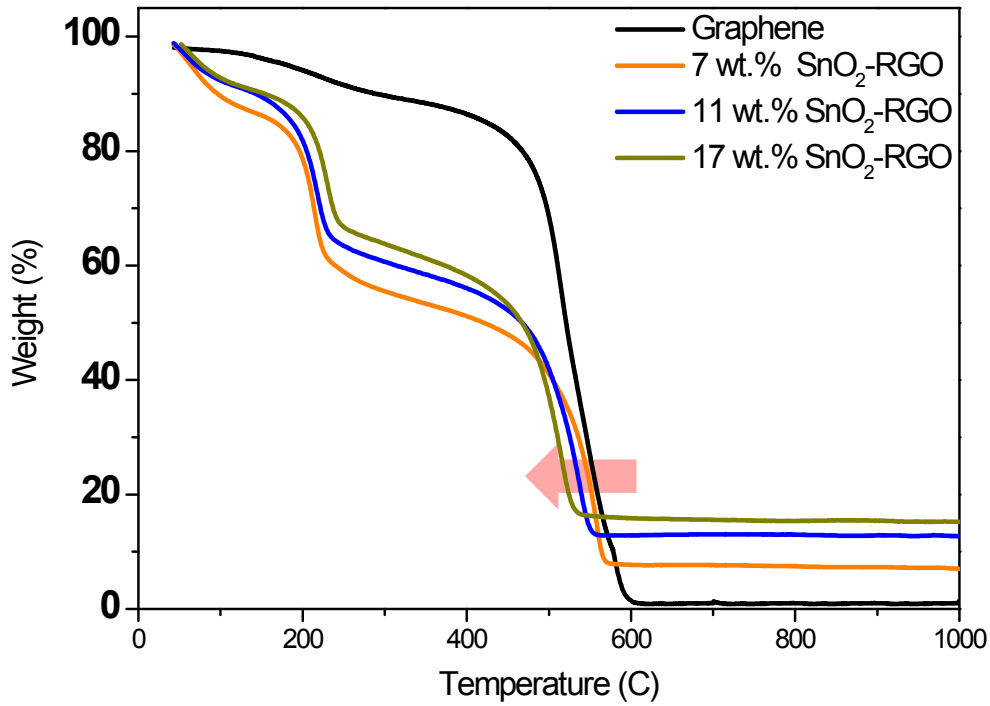
TG/DSC of P-graphene and SnO_2-RGO

Figure S4



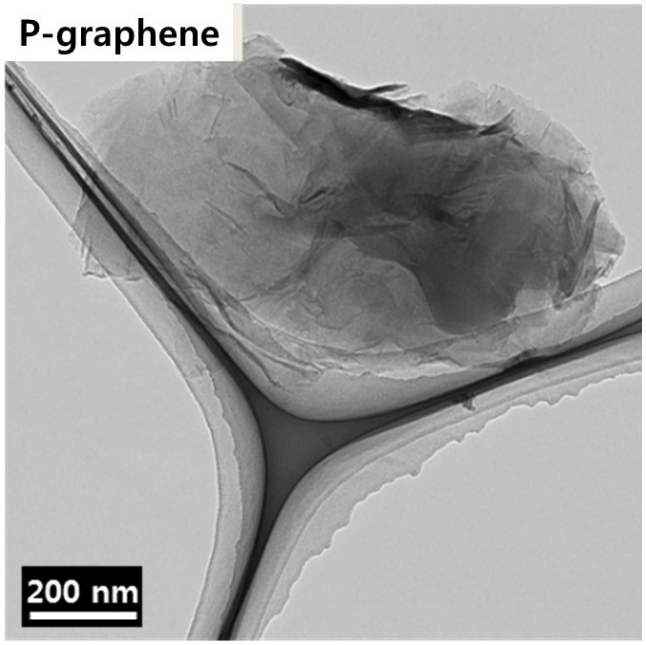
Py-GC/MS. During the catalytic carbon gasification, CO and CO_2 release peaks were observed for P-graphene and SnO_2-RGO

Figure S5



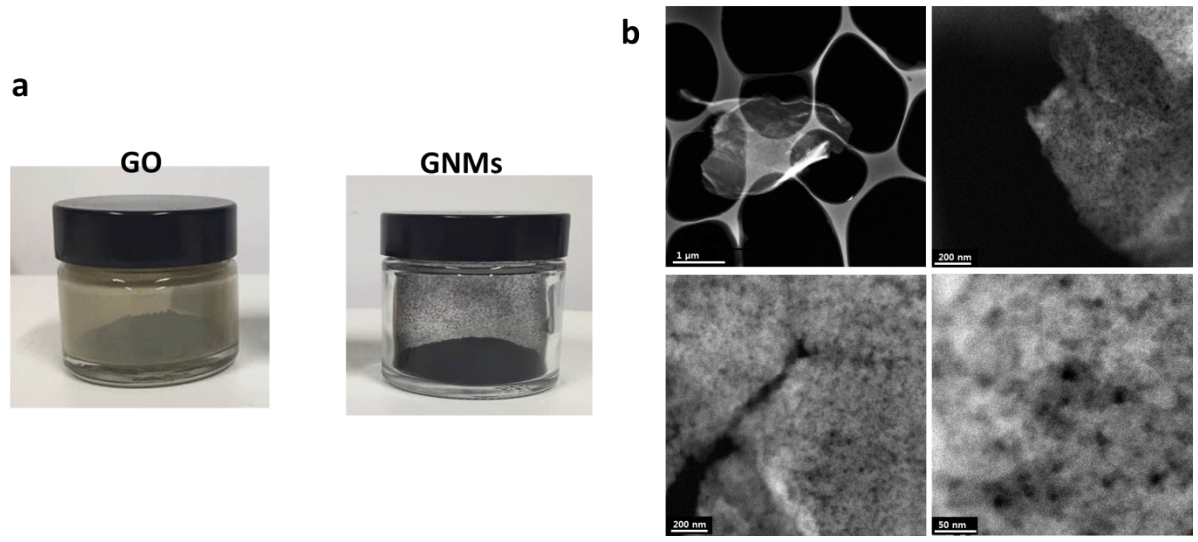
TGA profiles of P-graphene, 7wt.% SnO_2-RGO, 11wt.% SnO_2-RGO, and 17wt.% SnO_2-RGO. The catalytic carbon decomposition temperature decreased with increasing amounts of SnO_2.

Figure S6



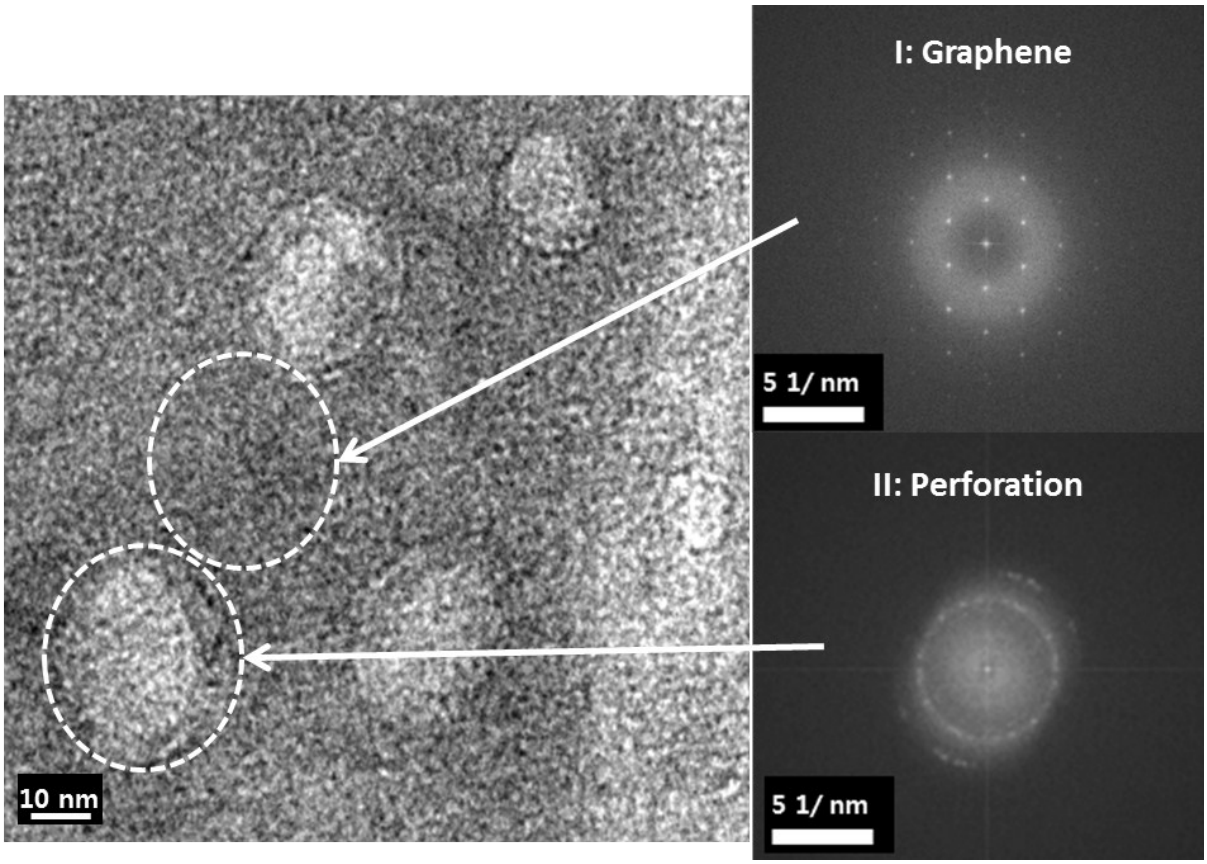
TEM image of P-graphene.

Figure S7



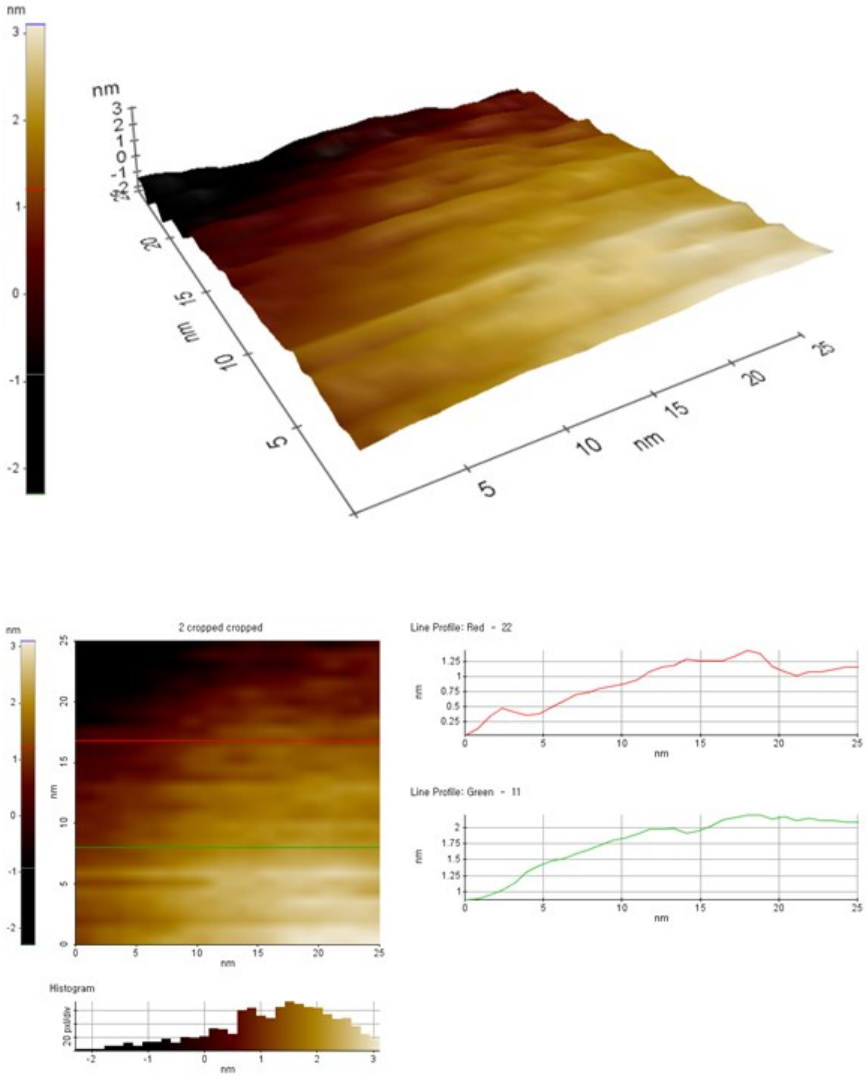
(a) Photographs showing scalable preparation of GNMs and (b) STEM images of GNMs

Figure S8



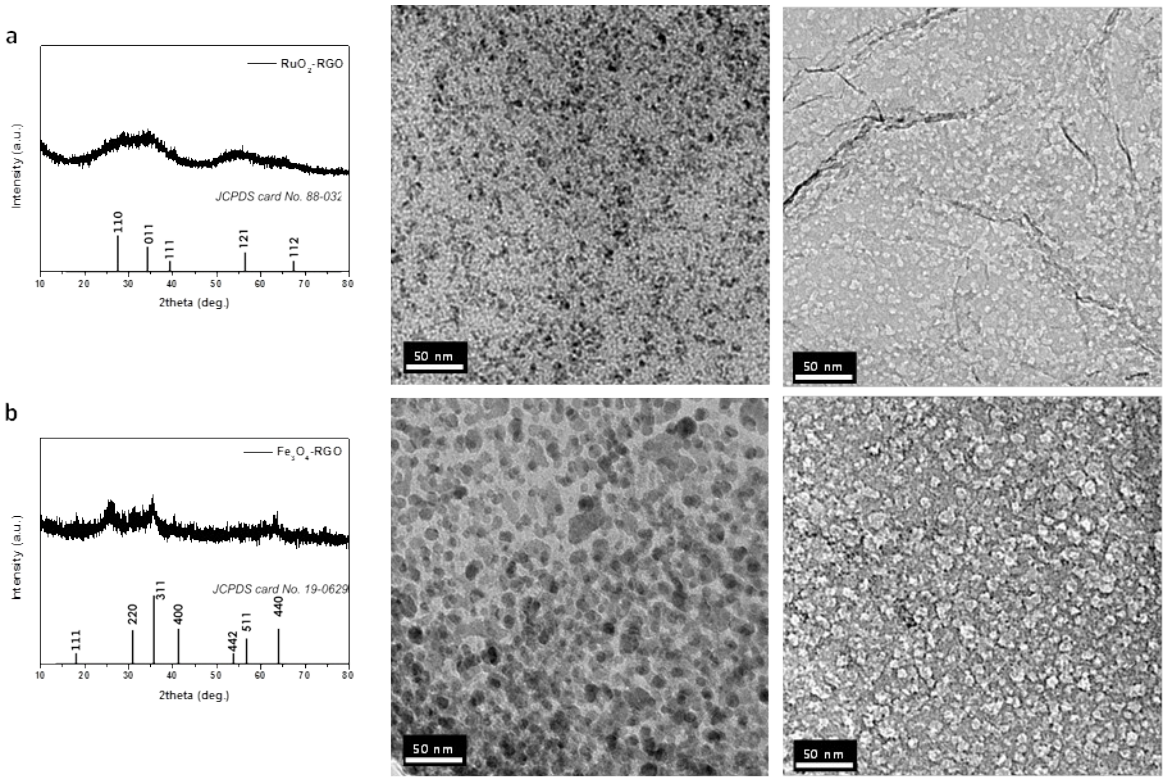
TEM image and FFT patterns of (I) non-perforated and (II) perforated areas on GNMs.

Figure S9



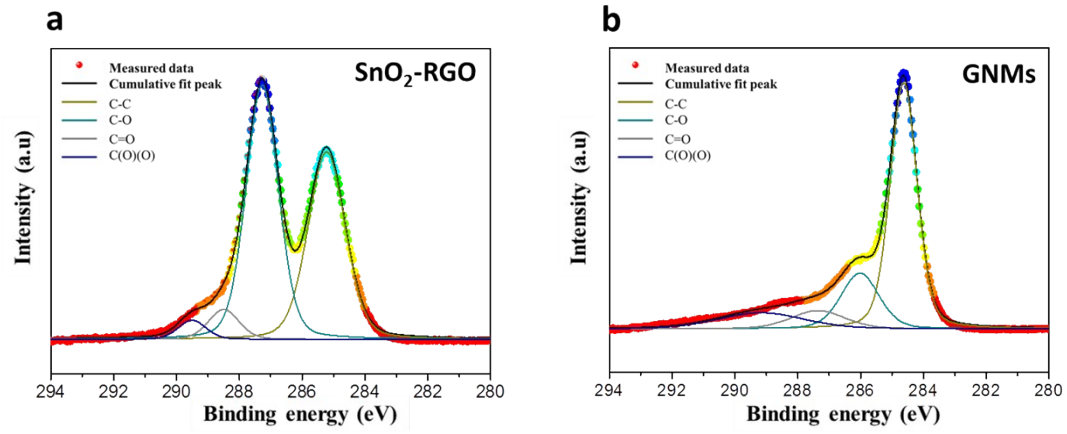
AFM image and height profile of P-graphene.

Figure S10



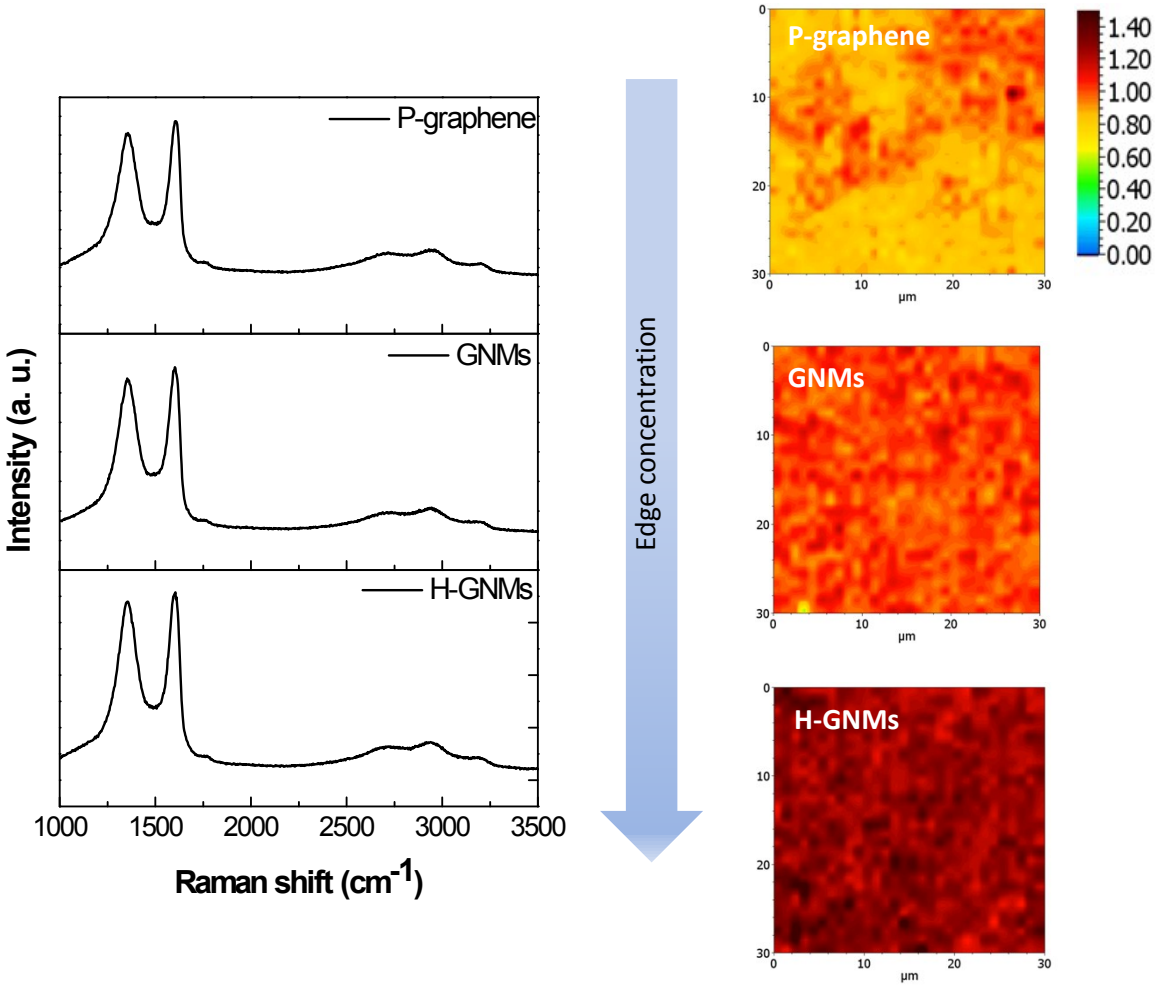
XRD patterns and TEM images of (a) Fe_3O_4-RGO, (b) RuO_2-RGO, and GNM nanosheets fabricated from Fe_3O_4-RGO and RuO_2-RGO.

Figure S11



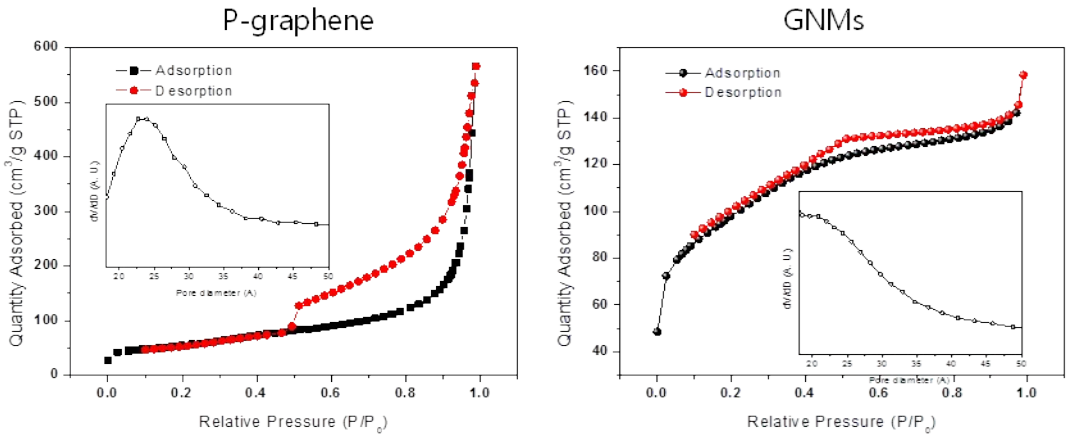
C 1s XPS spectra of (a) SnO_2-RGO and (b) GNMs. The O/C ratio of SnO_2-RGO decreases remarkably during the preparation of GNMs, indicating the successful removal of most of the epoxide and hydroxyl functional groups.

Figure S12



Raman spectra and mapping images (30 μm x 30 μm) of P-graphene, GNMs, and H-GNMs. The differences in D/G ratio of P-graphene and NPG are clearly observed by color differences.

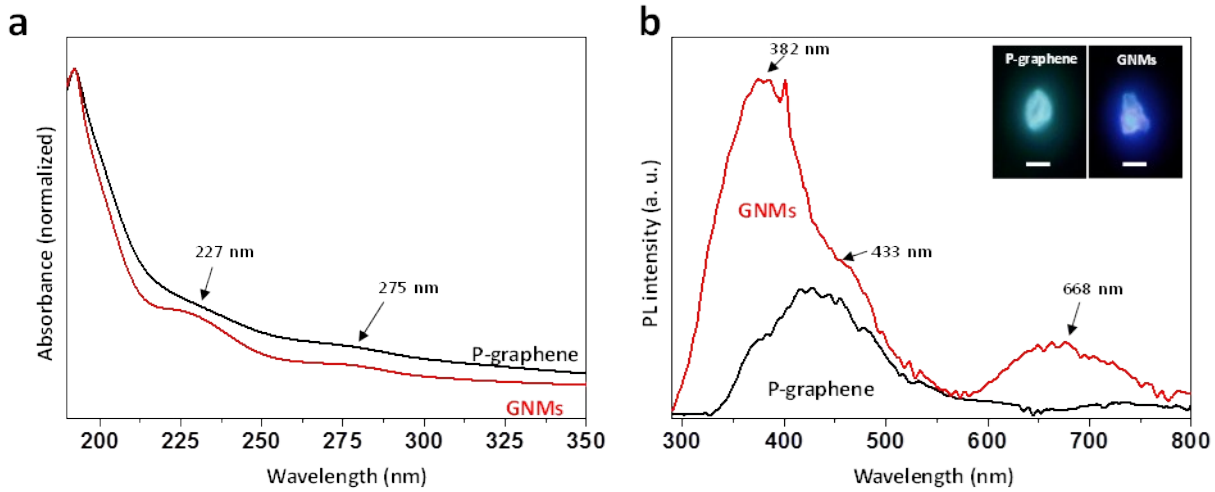
Figure S13



	BET surface area (m^2/g)	External surface area (m^2/g)	Micropore area (m^2/g)
P-graphene	210	161	27
GNMs	261	225	81

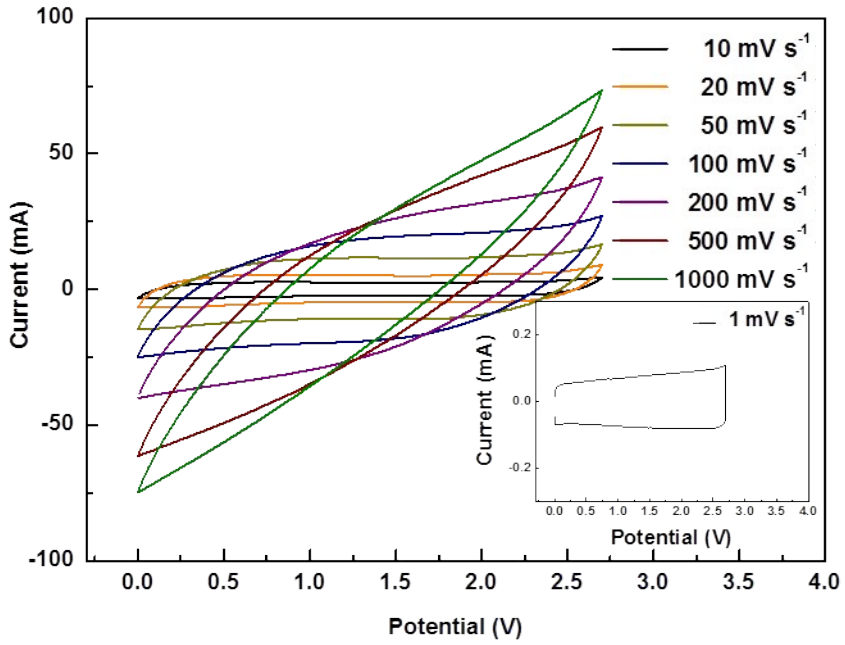
N_2 adsorption−desorption isotherm of P-graphene and GNMs.

Figure S14



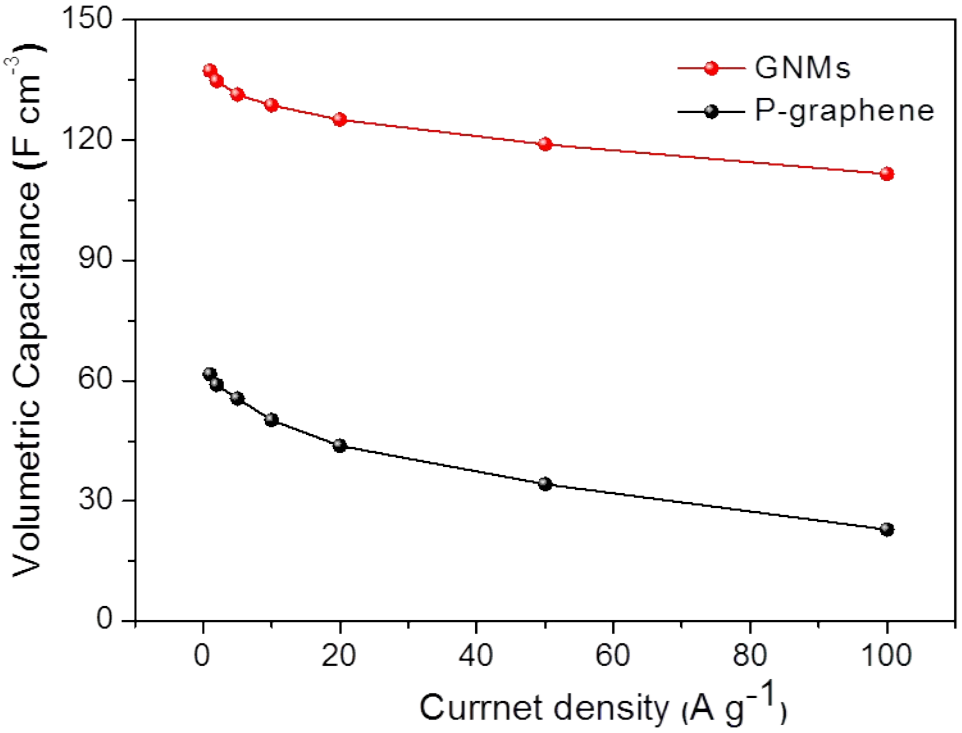
(a) UV-vis absorption and fluorescence spectra and (b) PL spectra of P-graphene and GNM (0.01 mg/ml in ethanol/H_2O (1/1 v/v ratio)) Inset: digital images indicate blue and green PL emissions of P-graphene and GNM. Scale bar, 20 μm.

Figure S15



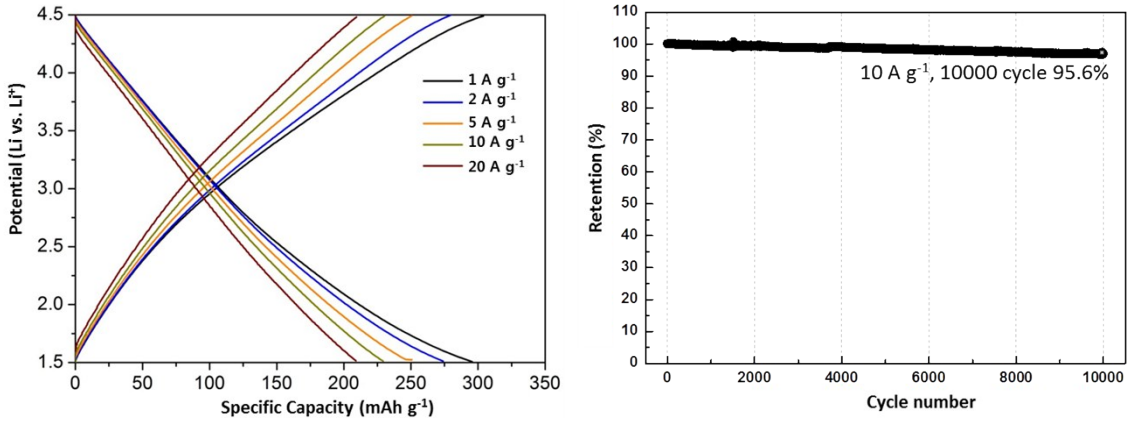
Cyclic voltammogram for P-graphene. Compared with GNMs, P-graphene shows poor cyclic voltammetric behaviors.

Figure S16



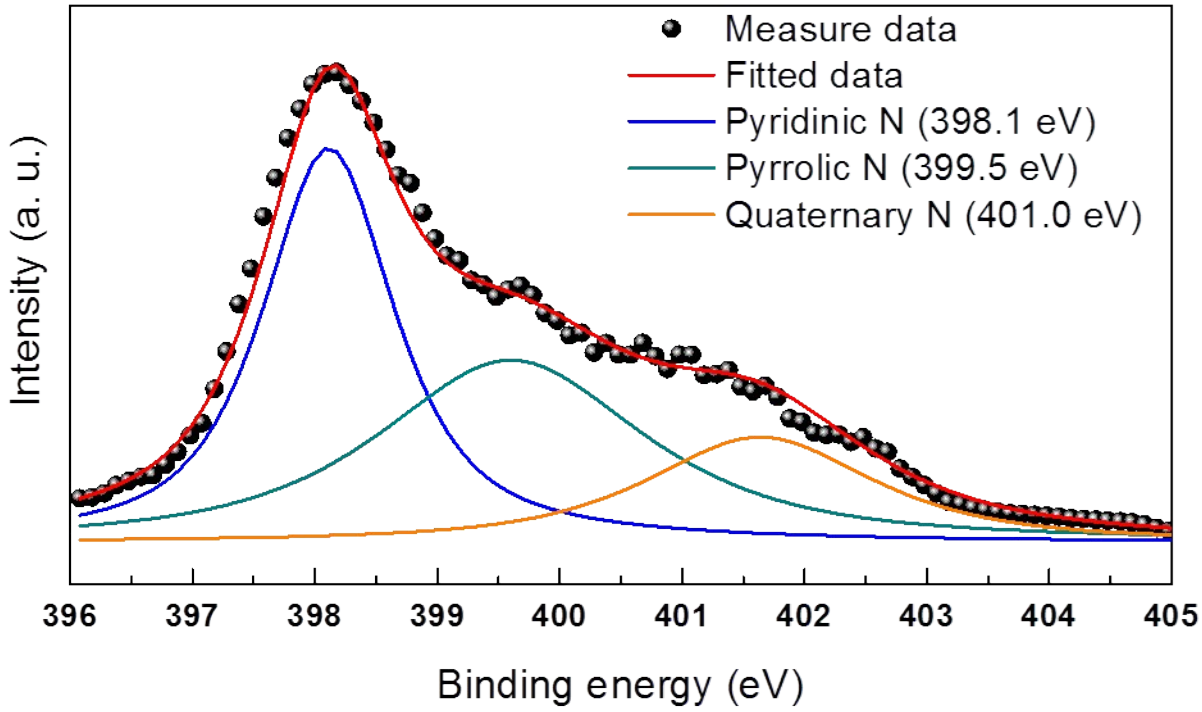
Volumetric capacitance of GNMs (packing density: 0.54 g cm^{-1}) and P-graphene (packing density: 0.38 g cm^{-1}) electrodes.

Figure S17



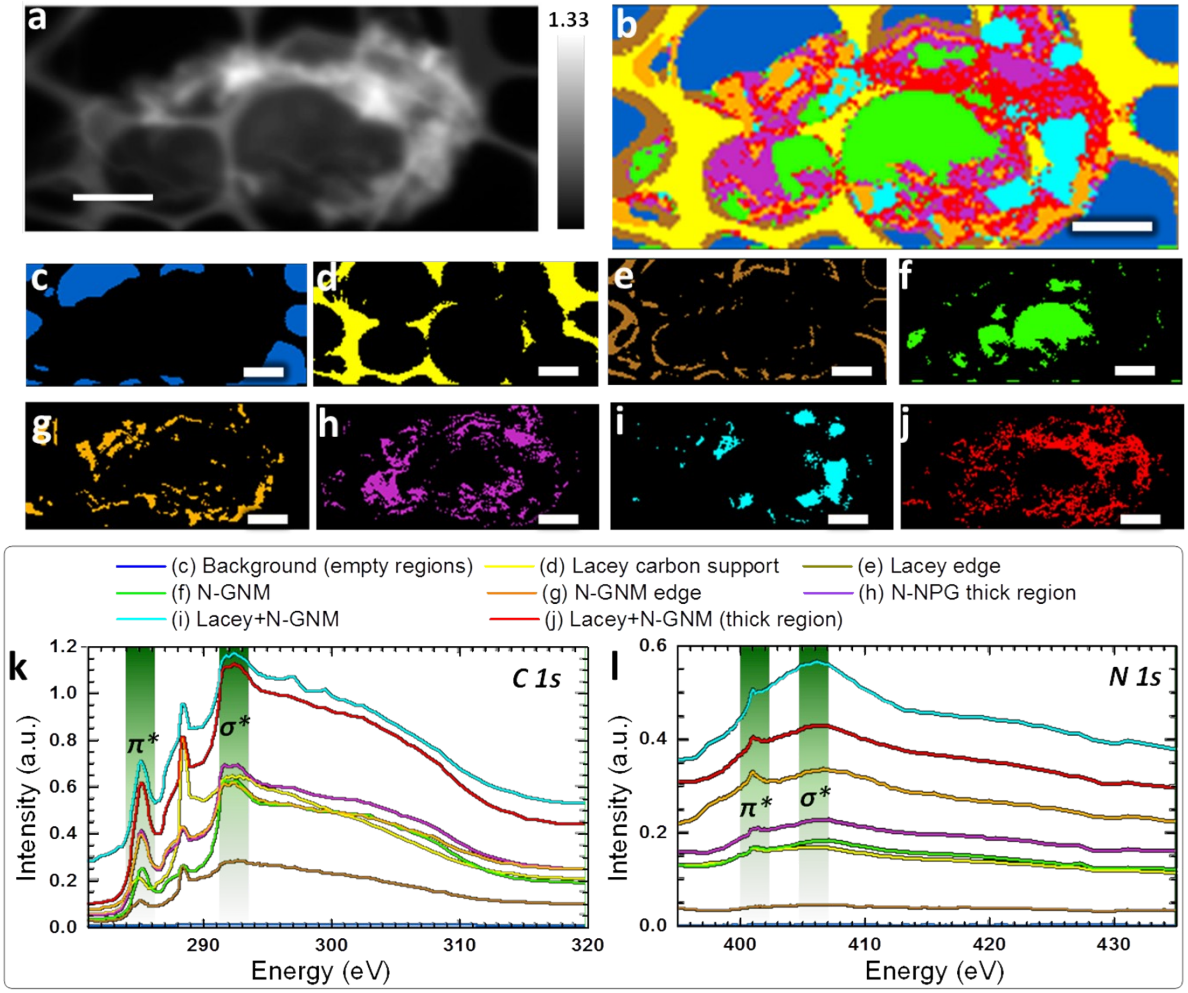
Electrochemical properties of GNM electrodes in the three-electrode test using 1 M $LiPF_6$ in EC/DMC (1:1 v/v).

Figure S18



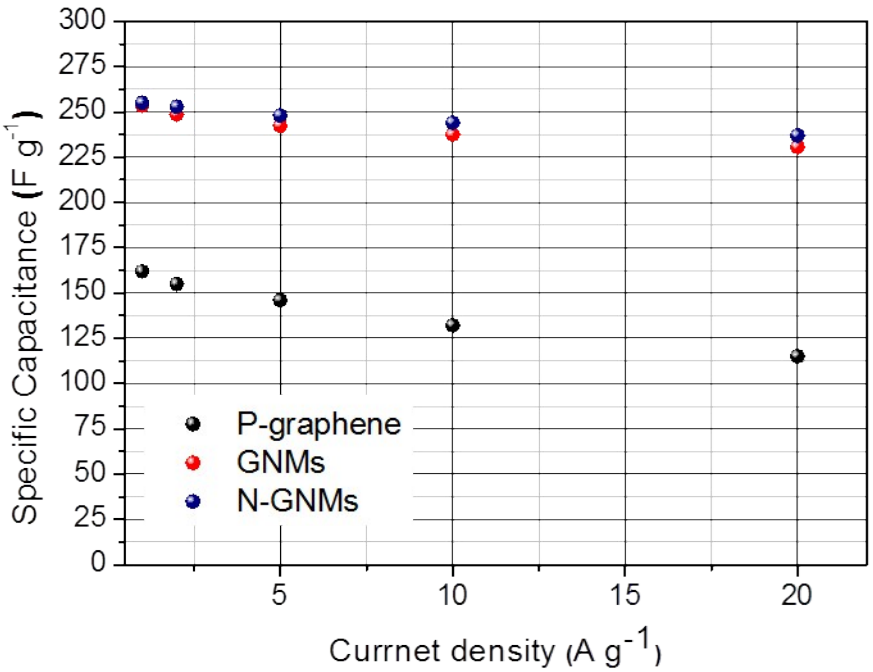
High-resolution XPS spectra of the N 1s region of NG.

Figure S19



(a) The overall morphology of a selected single N-GNM sheet; the vertical gray scale represents the optical density. (Scale bar, 1 μm) (b) The color composite map was generated from the average OD image by combining individual component maps (Scale bar, 1 μm) (c-j) using principal component analysis; the corresponding. (Scale bars, 1 μm) (k) C and (l) N K-edge NEXAFS spectra were derived from the same regions.

Figure S20



Rate capabilities of P-graphene, GNMs and N-GNMs at various current densities between 1 and 20 A g^{-1}. The N-GNMs (specific capacitances of 255, 252, 248, 244 and 236 F g^{-1} at current densities of 1, 2, 5, 10 and 20 A g^{-1}) exhibit slightly enhanced specific capacitance and rate capability than GNMs electrode.

Table S1

Sample	Carbon (wt. %)	Oxygen (wt. %)	Nitrogen (wt. %)	Hydrogen (wt. %)
P-graphene	81.18	17.49		1.33
NG	90.77	3.83	4.42	0.98
L-GNMs	81.14	18.01		0.85
N-(L)-GNMs	91.74	2.29	4.74	1.23
GNMs	80.37	18.36		1.27
N-GNMs	88.3	5.49	5.09	1.12
H-GNMs	78.64	19.85		1.51
N-(H)-GNMs	86.18	6.47	6.19	1.16

Elemental analysis of different oxidation and N states of N-doped P-graphene and N-doped GNMs