

Supplementary File For

Facile synthesis of sandwich-type porous structured Ni(OH)₂/NCNWs/rGO composite for high performance supercapacitor

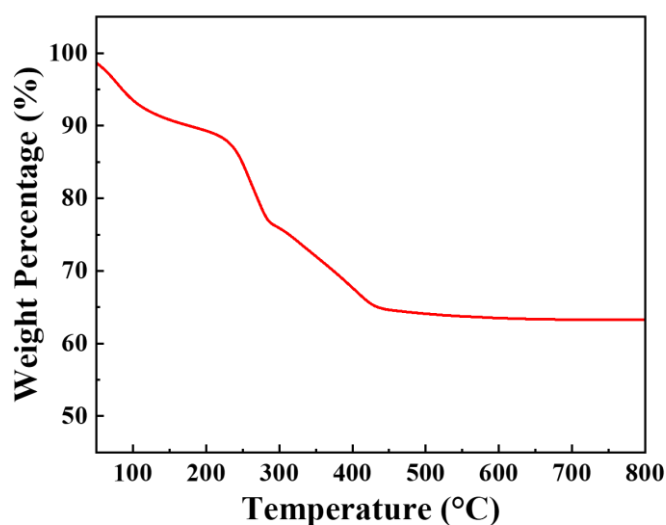
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Table S1 The C_{sp} of reported materials consisting of graphene, PANI, N-CNF, g-C₃N₄ and Ni(OH)₂.

Electrode materials	Preparation method	C_{sp} (F/g)	Electrolyte	Test Condition	Ref.
EGM/rGO	Self-assembly	231	EMIMBF ₄	1 A/g	[1]
PANI/rGO	Hydrothermal	854	1 M H ₂ SO ₄	1 A/g	[2]
β -Ni(OH) ₂ /rGO	Hydrothermal	802	3 M KOH	2 A/g	[3]
Ni(OH) ₂ /N-CNF	Coprecipitation	1045	6 M KOH	1 mV/s	[4]
Ni(OH) ₂ /HGO	Hydrothermal	1431	6 M KOH	5 A/g	[5]
Ni(OH) ₂ /g-C ₃ N ₄ /rGO	Hydrothermal	1785	6 M KOH	2 A/g	[6]

**Figure S1.** TGA curve of Ni₉/NCNWs/rGO.

The thermogravimetric analysis (TGA) was performed for the Ni₉/NCNWs/rGO powders to find the weight percentage of Ni(OH)₂ and NCNWs/rGO in pure O₂. As shown in Figure S1, three weight loss regions can be observed. There is a first weight loss under 250 °C where the structurally bonded water of Ni(OH)₂ is removed, and the weight loss is about 13.1%. Another weight loss is between 250 °C and continues to 300 °C due to the reaction of NCNWs/rGO and O₂, about 9.9% for weight loss. The third region is between 300 °C to 450 °C, where the Ni(OH)₂ decomposes to NiO, about 17.5% for weight loss. The curve of Ni₉/NCNWs/rGO almost does not change after 450 °C showing that NCNWs/rGO in the Ni₉/NCNWs/rGO has been fully burned. The TG analysis shows that the homemade nickel hydroxide has adsorbed/intercalated H₂O molecules, which is in agreement with the results of FTIR (**Figure 3c**). The presence

of H₂O molecules could enhance the electrochemical performance by facilitating proton diffusion through interlayer molecular channels, owing to their function as ionic transport pathways [7]. The solid composite contains 9.9 wt% NCNWs/rGO, with the remaining 91 wt% related to Ni(OH)₂ crystallites. Therefore, the mass ratio of Ni(OH)₂ and NCNWs/rGO in the Ni₉/NCNWs/rGO is determined to be 9:1

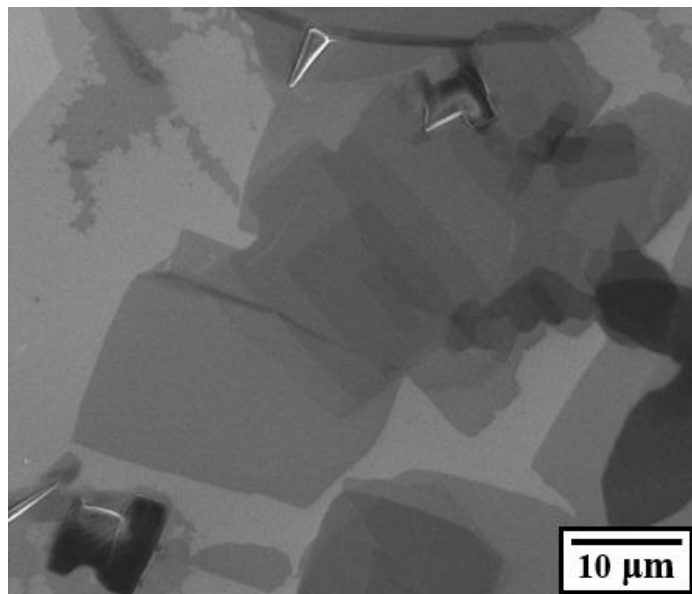


Figure S2. SEM image of rGO nanosheets.

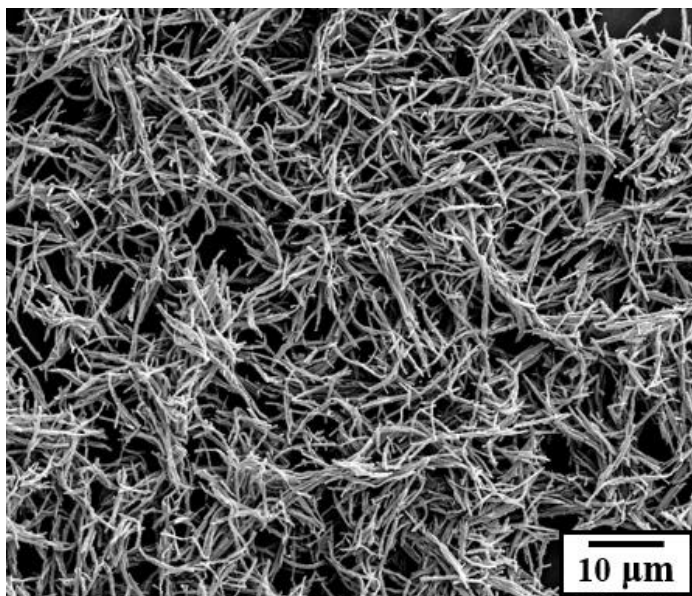


Figure S3. SEM image of PPy NWs.

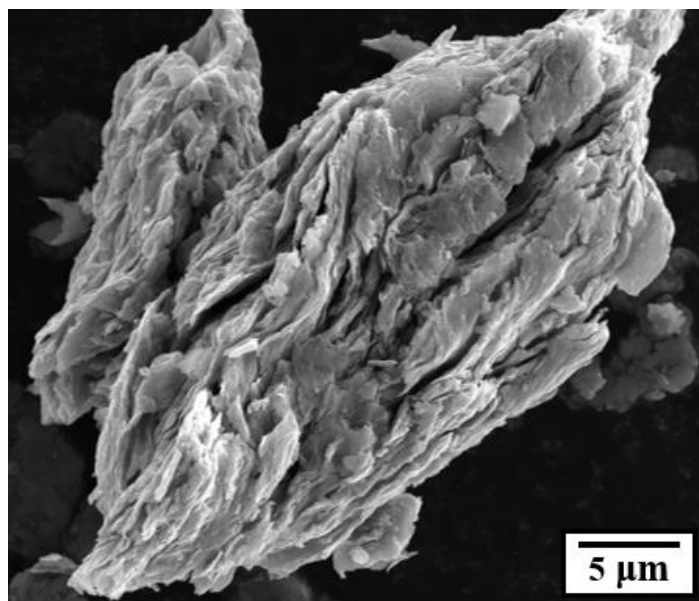


Figure S4. SEM image of Ni(OH)₂/rGO

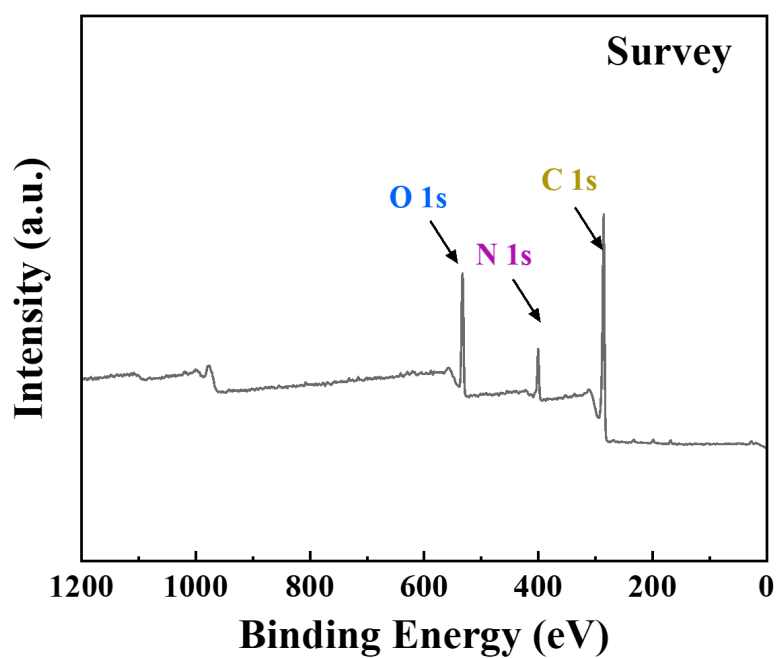


Figure. S5 XPS spectra of PPy NWs/GO before high temperature treatment.

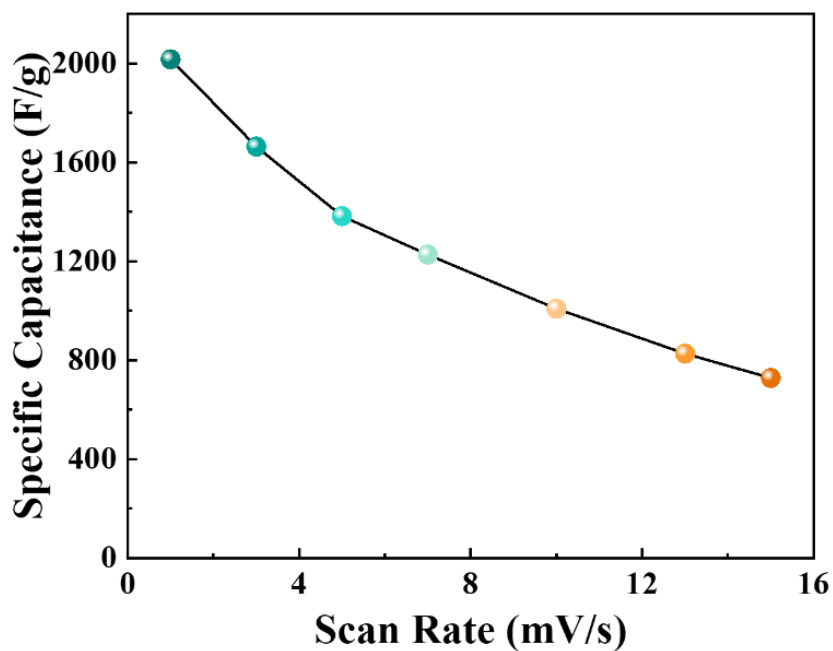


Figure S6. specific capacitance at different scan rate.

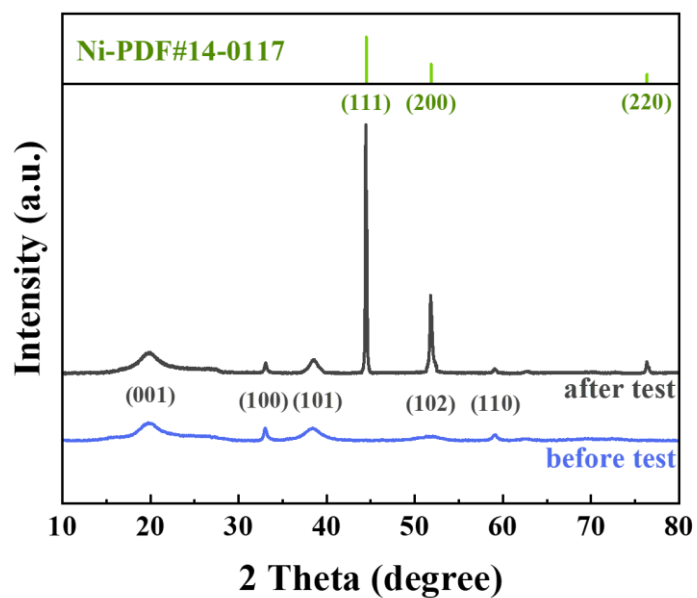


Figure S7. XRD image of the compression between Ni(OH)₂/NCNWs/rGO and the electrode after cycling stability test.

As shown in Figure S7, after 10000 cycles test, the diffraction peaks at 19.86°, 33.06°, 38.51° and 59.07° could be indexed to the crystal plane of (001), (100), (101) and (110) of Ni(OH)₂ (JCPDS

No. PDF#14-0117), and peaks at 44.44°, 76.34° are belong to the crystal plane of (111) and (220) of nickel (JCPDS No. PDF#04-0850). The result confirmed the good cycling stability of Ni(OH)₂/NCNWs/rGO.

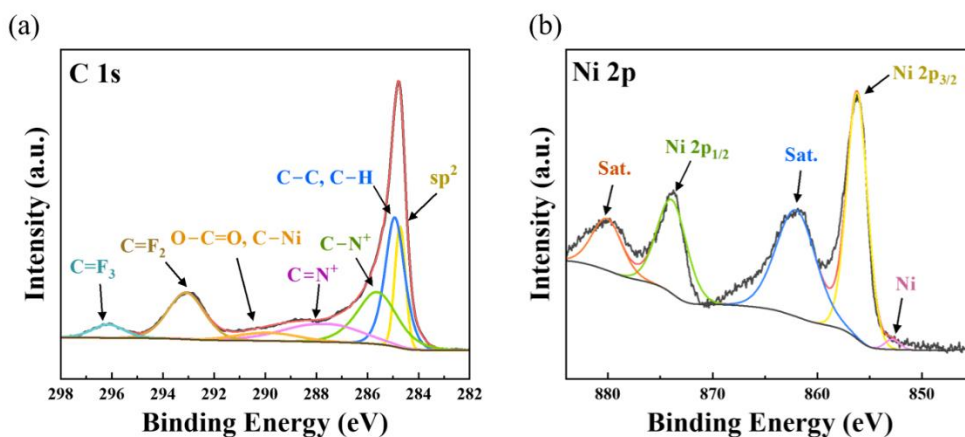


Figure S8. High-resolution XPS spectra of the Ni(OH)₂/NCNWs/rGO electrode after cycling stability test. (a) C 1s, (b) Ni 2p.

As shown in Figure S8a, the peak located at 284.7 eV is due to sp² carbon, and the peak at 284.95 eV is belong to sp³ carbon atoms. The three peaks located at 285.65 eV, 287.7 eV and 289.95 eV can be attributed to C-N⁺, C=N⁺ O-C=O and C-Ni, respectively. The other two peaks at 293.1 eV and 296.1 eV are respectively related to C=F₂ and C=F₃, both due to the addition of PTFE during the preparation of the pole sheet. In Figure S7b two main bands corresponding to spin-orbit splitting, Ni 2p_{3/2} is located at about 856.25 eV, Ni 2p_{1/2} at about 874.05 eV and two satellite peaks, which are indexed to Ni²⁺. The peak located at 852.85 eV is due to metal nickel.

References

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