Electronic Supplementary Information (ESI)

B/N co-doped carbon nanosphere frameworks as high-performance electrodes for supercapacitors

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1. Supplementary Methods:

Preparation of the electrode

The Ti foil was cut into rectangle pieces with dimension of 1.5x1 cm and 1x0.5 cm rectangle end was left as current collector. Around 1 mg sample with weight ratio (B/N-CNS: super-P: PVDF=85:10:5) was coated on the Ti foil surface. The electrodes were dried in vacuum at 70 ℃ for 12 h.

Preparation of the solid gel electrolyte

The gel electrolyte was prepared by mixing 1 g H_2SO_4 and 1 g PVA in 10 ml deionized water at 85 ℃ for 1 h under vigorous stirring. The resulting gel solution was cooled to room temperature. The electrode was soaked in the gel solution for 5 minutes. After that, the gel electrolyte was further dipped onto the surface of the electrode to ensure the contact.

Preparation of the sandwich-structured symmetrical supercapacitor

After the electrode was sufficiently infiltrated with the gel electrolyte and solidified for 12 h at room temperature, the as-prepared two electrodes were symmetrically integrated into one cell. And a piece of adhesive tape was adhered on the outer layer of the Ti foil to prevent the shot circuit (Fig. S6).

2. Supplementary Figures:

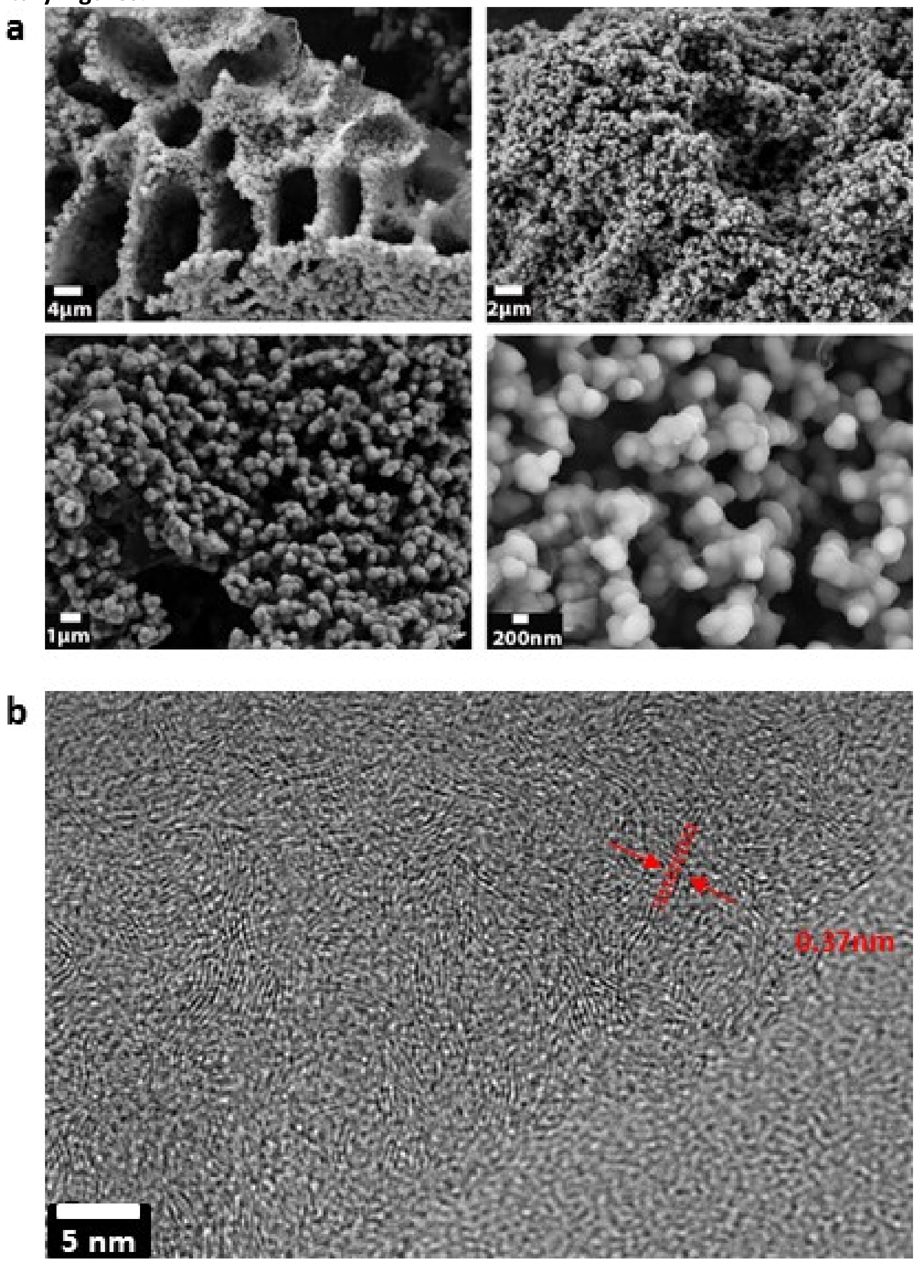

Fig. S1 a) SEM images showing the morphology of B/N co-doped carbon nanospheres frameworks at different magnifications. b) HRTEM image of B/N co-doped carbon nanosphere frameworks.

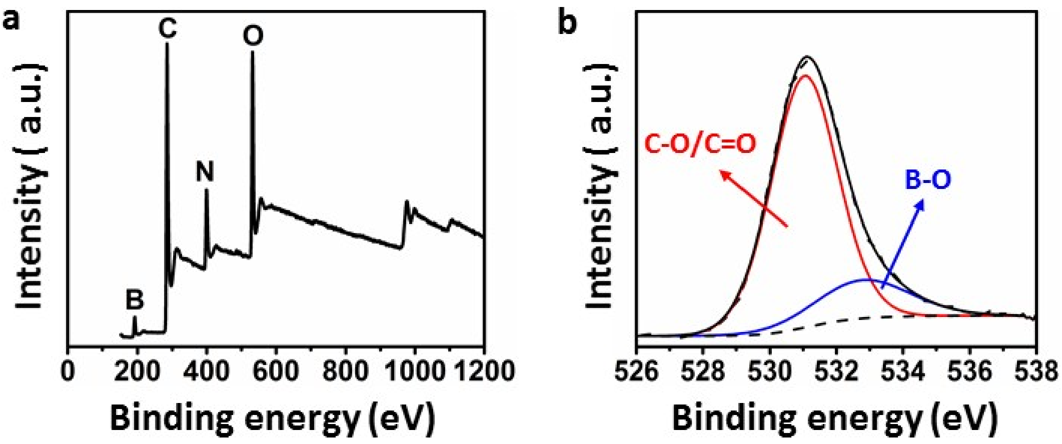

Fig. S2 a) XPS survey spectrum and b) O 1s spectrum of B/N co-doped carbon nanosphere frameworks.

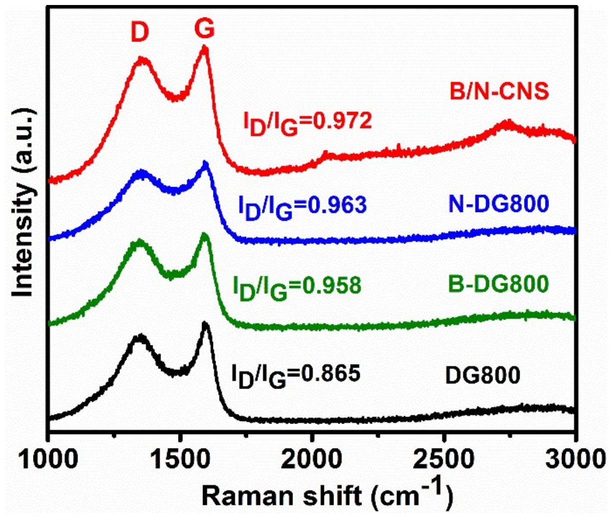

Fig. S3 Raman spectra of B/N co-doped carbon nanosphere frameworks (B/N-CNS), N doped carbon (N-DG800), B doped carbon (B-DG800) and pure carbon (DG800).

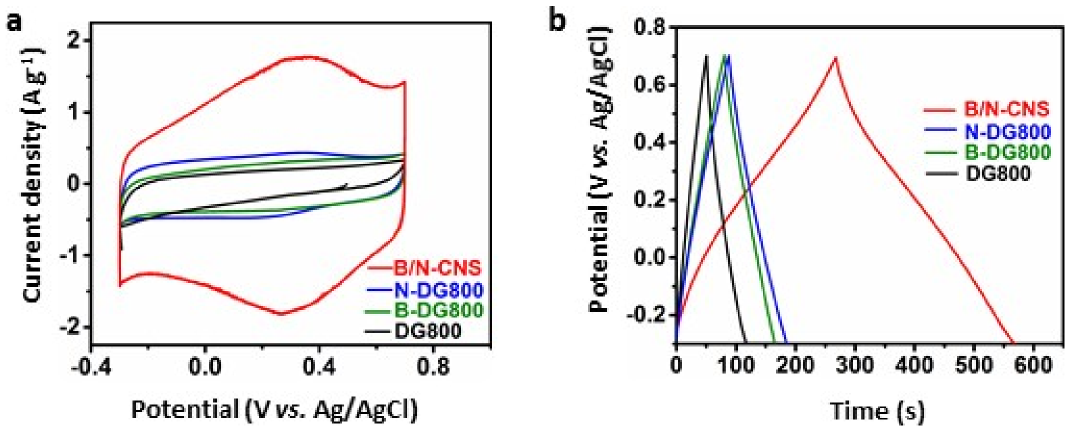

Fig. S4 a) CV curves (at 5 mV s^{-1}) and GCD curves (at 1A g^{-1}) of B/N co-doped carbon nanosphere frameworks (B/N-CNS), N doped carbon (N-DG800), B doped carbon (B-DG800) and undoped carbon (DG800).

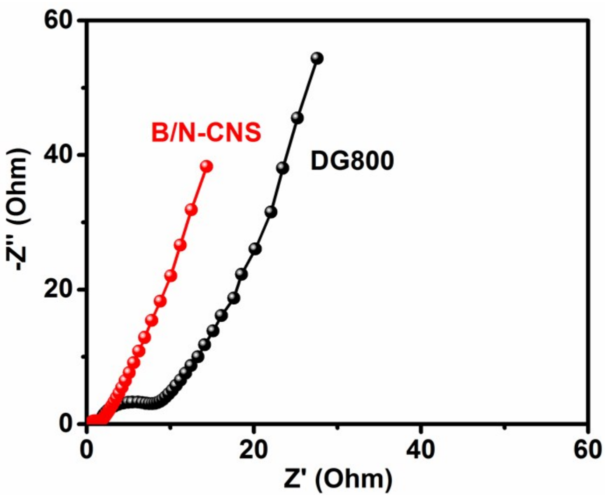

Fig. S5 Nyquist plots of electrochemical impedance of B/N co-doped carbon nanosphere frameworks (B/N-CNS) and undoped carbon (DG800) in the frequency range of 100 kHz to 10 mHz.

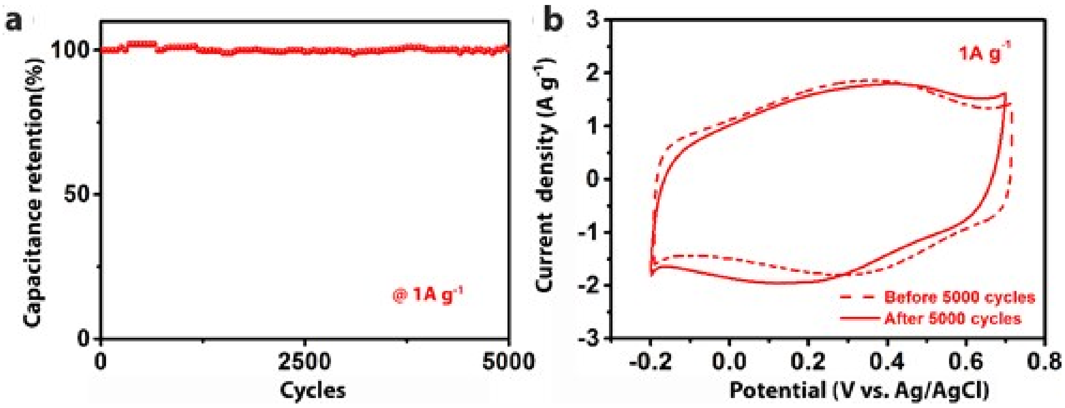

Fig.S6 Long cycle stability of B/N-CNS framework electrodes in 1 M H_2SO_4 electrolyte at 1 A g^{-1}. a) Capacitance retention within 5000 cycles at 1 A g^{-1}. b) CV curves before and after 5000 cycles at 1 A g^{-1}.

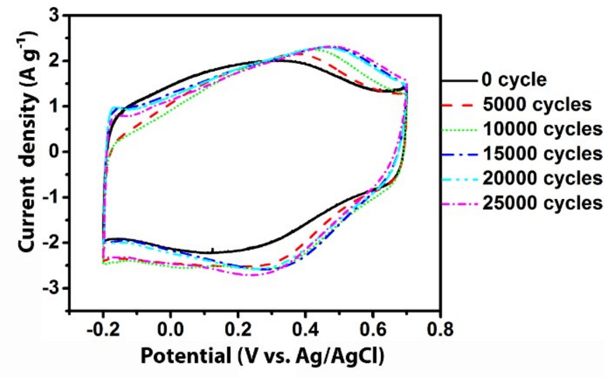

Fig. S7 The CV curves (5 mV s^{-1}) after 5000, 15000, 20000 and 25000 cycles of charge-discharge at 10 A g^{-1}. It could be observed that the area of the CV curves increased within 10000 cycles and remained nearly unchanged after 10000 cycles, in accordance with the retention rate.

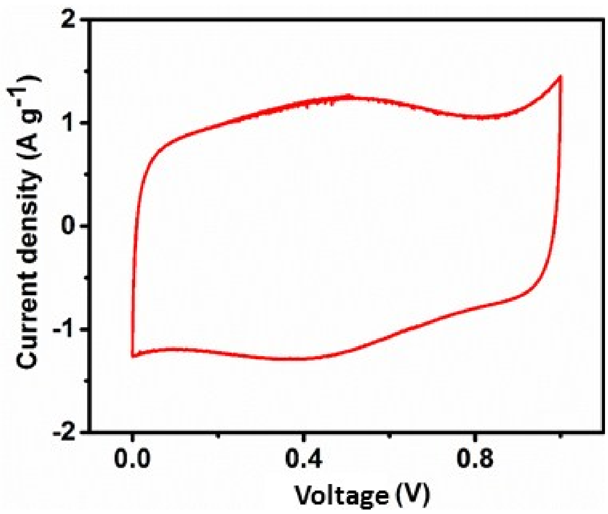

Fig. S8 The CV curve of symmetric supercapacitor based on two electrodes of B/N-CNS framework at a scan rate of 5 mV s^{-1} with a 1 V voltage window. The CV curve shape is symmetrical.

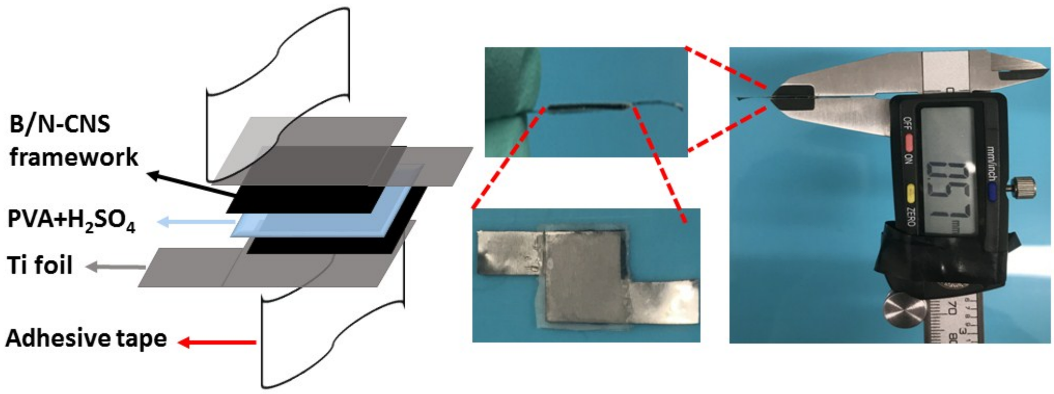

Fig. S9 Schematic configuration and pictures of the all-solid sandwich-structured symmetric supercapacitor cell. The loading mass was around 1 mg B/N-CNS framework for a single Ti foil. The thickness and weight for one cell was around 0.57 mm and 200 mg, respectively. Two cells in series connection were able to power a LED bulb.

3. Supplementary tables:

Table S1 Capacitive performance comparison of B/N-CNS framework and other reported B, N doped carbon nanomaterials.

Samples	Maximum specific capacitance ($F\ g^{-1}$)*	Corresponding current density ($A\ g^{-1}$)	Cycles	Retention (%)	Corresponding current density ($A\ g^{-1}$)	Refs
B/N-CNS framework	423	0.2	30000	106	10	This work
B/N-carbon nanosheets film	358	0.1	10000	105	5	3
Polyaniline/boron-doped graphene	247	0.5	10000	90	10	4
B/N co-doped porous carbon	304	0.1	10000	93	2	5
N/B co-doped local graphitized carbon framework	247	0.5	4000	96.2	1	6
BCN-3:1 nanosheets	244	1	2500	96	5	7
BCN 700 nanosheets	130.7	0.2	2000	97.5	5	8
Vertical aligned-BCN nanotubes	320.1	0.2	1000	95	1	9

* The maximum specific capacitances calculated here and estimated in the literature are based on the GCD process with corresponding discharge current density.

References

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