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Supporting Information

Crumpled nitrogen- and boron-dual-self-doped graphene sheets as an extraordinary active anode material for lithium ion batteries

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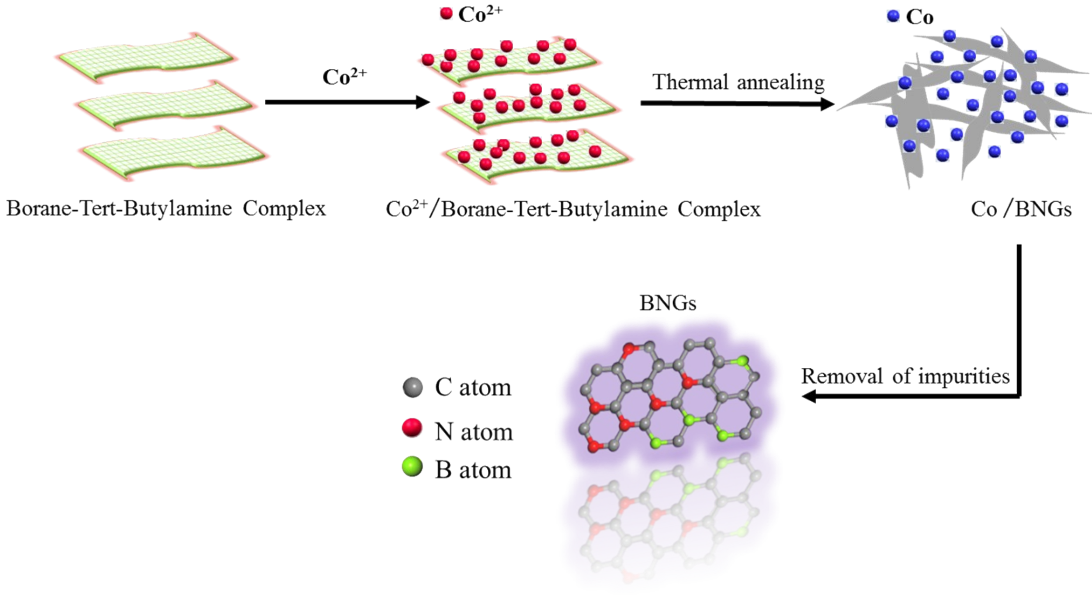

Scheme S1 Schematic illustration of the preparation procedure for NBGs.

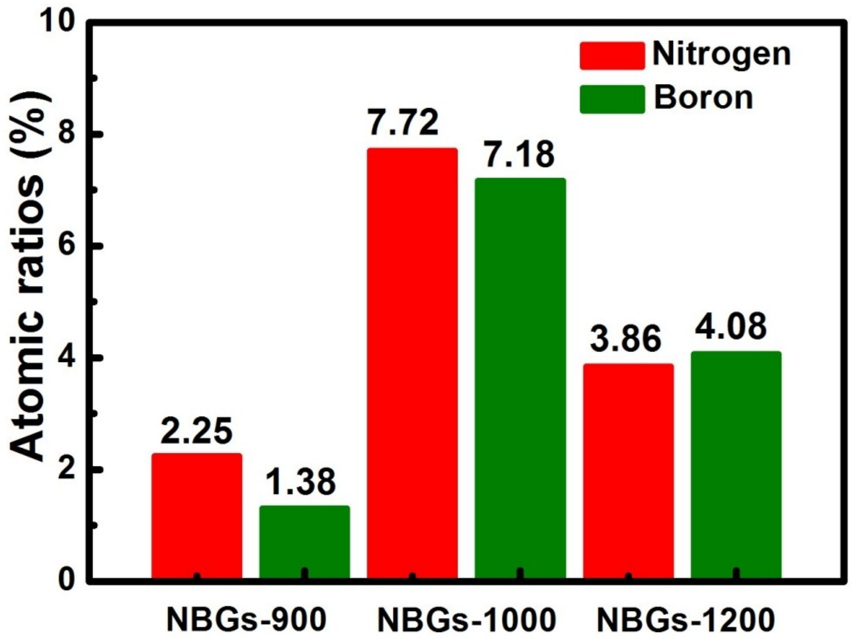

Fig. S1 Surface atomic ratios of NBGs–900, NBGs–1000 and NBGs–1200.

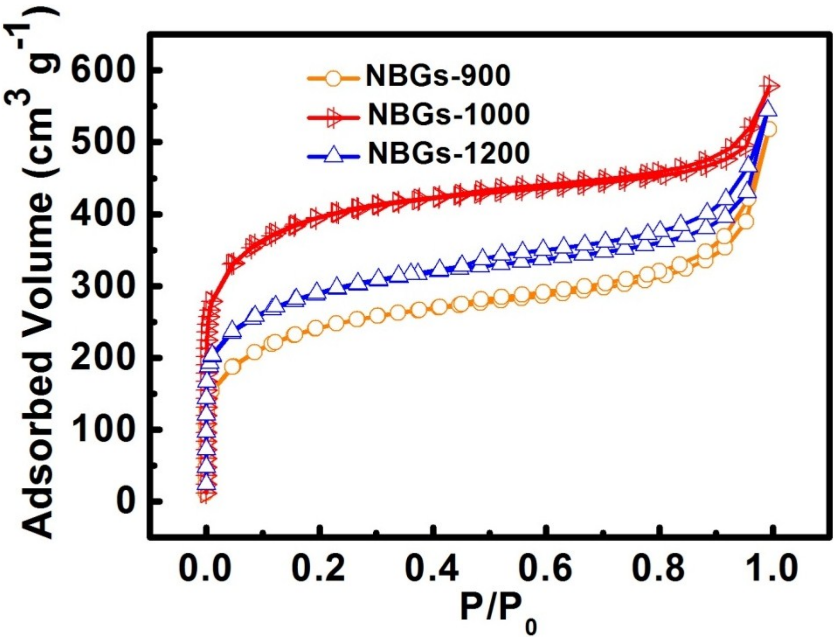

Fig. S2 N_2 adsorption/desorption isotherms of NBGs.

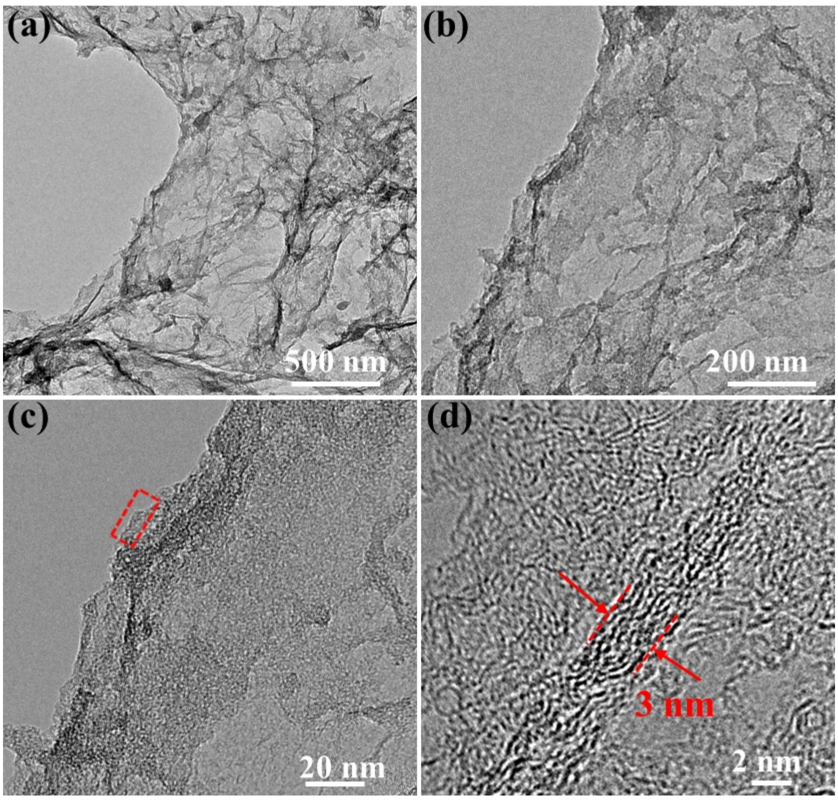

Fig. S3 (a-c) TEM images, and (d) HRTEM image of NBGs–900.

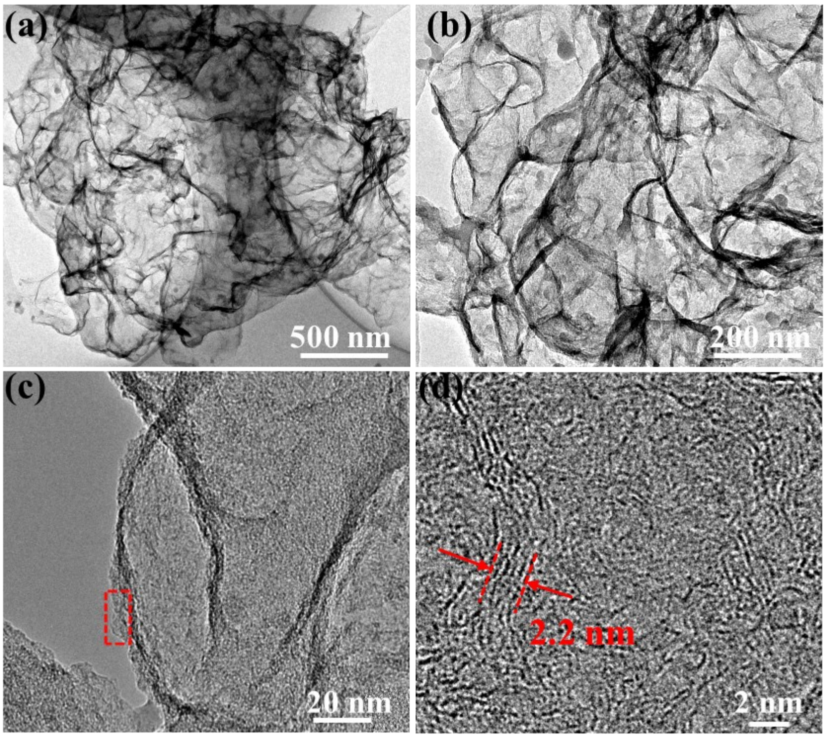

Fig. S4 (a-c) TEM images, and (d) HRTEM image of NBGs–1200.

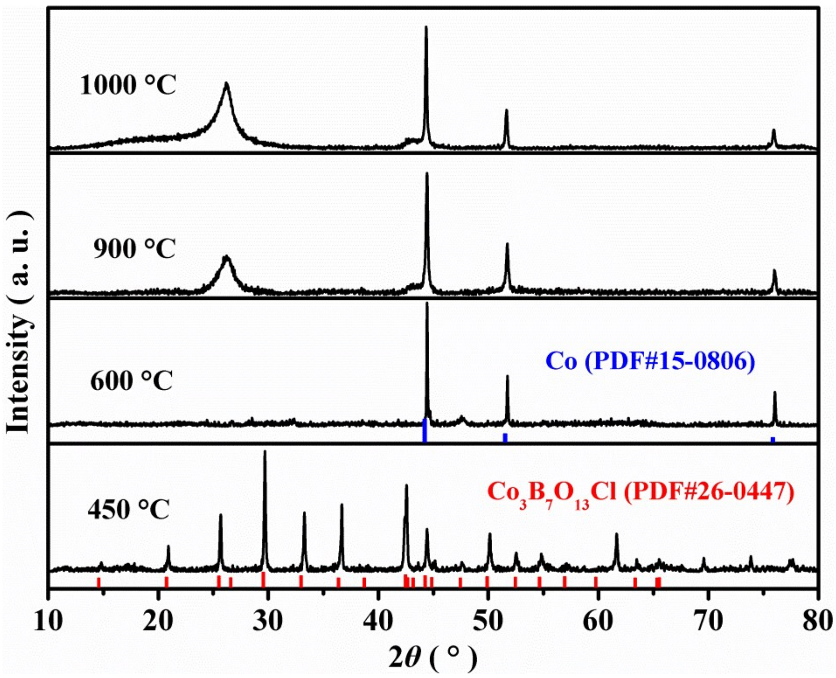

Fig. S5 XRD patterns of NBGs at different temperatures.

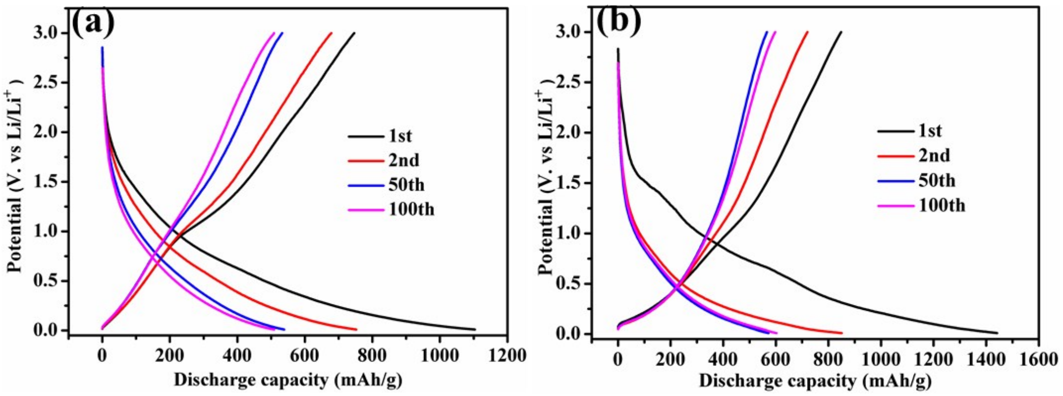

Fig. S6 Voltage profiles of NBGs–900 and NBGs–1000 at a current of 0.05 A g^{-1} in a voltage range from 0.01 V to 3 V (*vs* Li/Li^{+}).

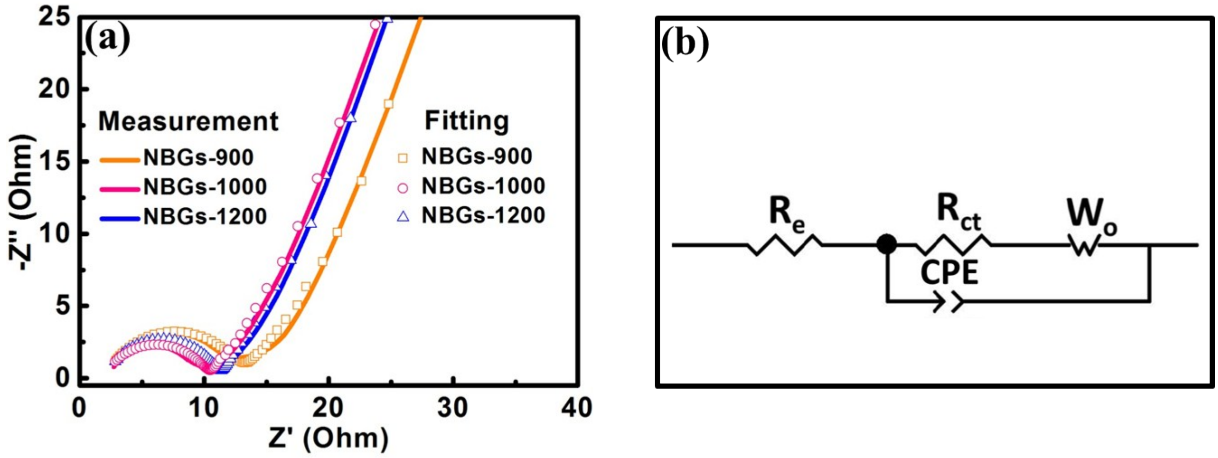

Fig. S7 (a) Electrochemical impedance spectroscopies (EIS) of NBGs and (b) equivalent circuit: R_e, R_{ct}, CPE and W_o corresponding to the resistances of electrolyte, charge transfer resistance at the electrode/electrolyte interface, constant phase element impedance and warburg impedance.

Before cycling, electrolyte resistances (R_e) of NBGs–900, NBGs–1000, and NBGs–1200 are 2.6, 2.2 and 3 Ω. Charge-transfer resistances (R_{ct}) of NBGs–900, NBGs–1000, and NBGs–1200 are 12.5, 8.9 and 10.3 Ω, respectively.

Table S1. Comparison of heteroatomic doping levels of NBGs–1000 and other representative graphene-based materials

Graphene-based materials	Doping atoms	Doping methods	Doping levels (at.%)	Ref.
Nitrogen-doped graphene	Nitrogen	Hydrothermal method with ammonium tungstate	2.85	[1]
Boron-doped graphene	Boron	CVD with phenyboronic	1.5	[2]
Phosphorus-doped graphene	Phosphorus	Thermal annealing using triphenylphosphine	1.81	[3]
Doped graphene sheets	Nitrogen Boron	Heat treatment in NH_3 and BCl_3	3.06 0.88	[4]
Nitrogen and sulfur codoped graphene	Nitrogen Sulfur	Thermal treatment with 2-aminothiophenol	1.76 0.86	[5]
Nitrogen and boron co-doped graphene	Nitrogen Boron	Hydrothermal reaction with NH_3BF_3	3.0 0.6	[6]
Nitrogen and fluorine dual-doped mesoporous graphene	Nitrogen Fluorine	Thermal treatment of GO/ PANI and NH_4F	1.96 0.13	[7]
Phosphorus and nitrogen dual-doped graphene sheets	Nitrogen Phosphorus	CVD using $(NH_4)_3PO_4$	2.6 0.6	[8]
NBGs–1000	Nitrogen Boron	Self-doping by borane-tert-butylamine	7.72 7.18	This work

Table S2. The performances of NBGs-1000 and some representative graphene-based anode materials

Materials	Discharge current (mA g^{-1})	Capacity (mAh g^{-1})		Decay rate of per cycle	Ref.
Nitrogen and fluorine co-doped graphene	100	1073 (2nd cycle)	765 (50th cycle)	0.57%	[9]
Graphene sheets	74.4	887 (2nd cycle)	730 (200th cycle)	0.088%	[10]
Porous graphene films	50	1062 (2nd cycle)	715 (50th cycle)	0.65%	[11]
Graphene hollow spheres	100	824 (2nd cycle)	760 (100th cycle)	0.077%	[12]
Graphene/N-doped carbon	100	1100 (2nd cycle)	669 (200th cycle)	0.195%	[13]
Nitrogen-doped graphene nanosheets	100	454 (2nd cycle)	452 (100th cycle)	0.004%	[14]
Graphene sheets	50	848 (2nd cycle)	741 (50th cycle)	0.25%	[15]
Nitrogen-self-doped graphene	50	1177 (2nd cycle)	682 (95th cycle)	0.44%	[16]
Nitrogen-doped graphene	100	950 (2nd cycle)	600 (50th cycle)	0.73%	[17]
Sulfur/nitrogen dual-doped porous graphene	50	780 (2nd cycle)	440 (100th cycle)	0.43%	[18]
NBGs–1000	50	909 (2nd cycle)	877 (125th cycle)	0.028%	This work

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