Electronic Supplementary Material (ESI) for Journal of Materials Chemistry A.

Fig. S1. Photograph of the delignified sorghum. *Note: To capture a photograph, a solid sample was intentionally prepared through freeze-drying.

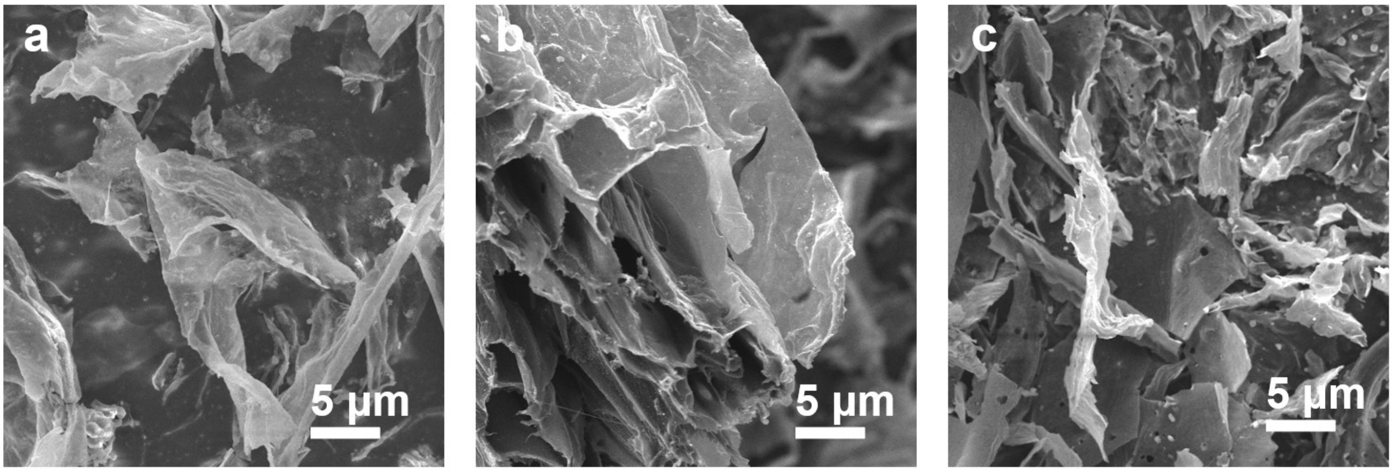

Fig. S2. FESEM images of (a) NSSC-400, (b) NSSC-800 and (c) NSSC-1000.

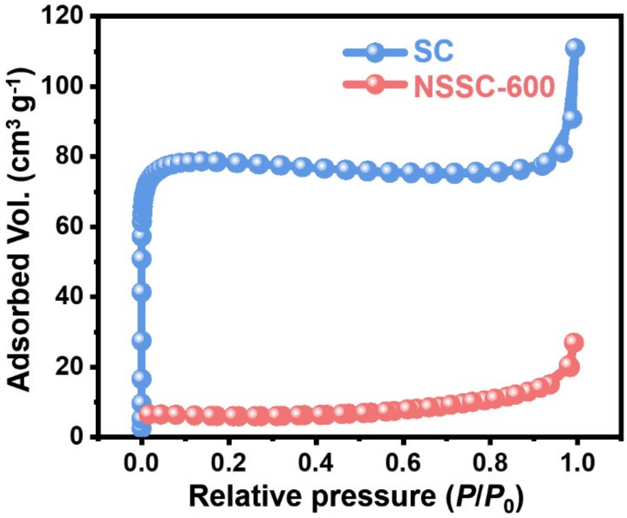

Fig. S3. Nitrogen adsorption-desorption isotherms of SC and NSSC-600.

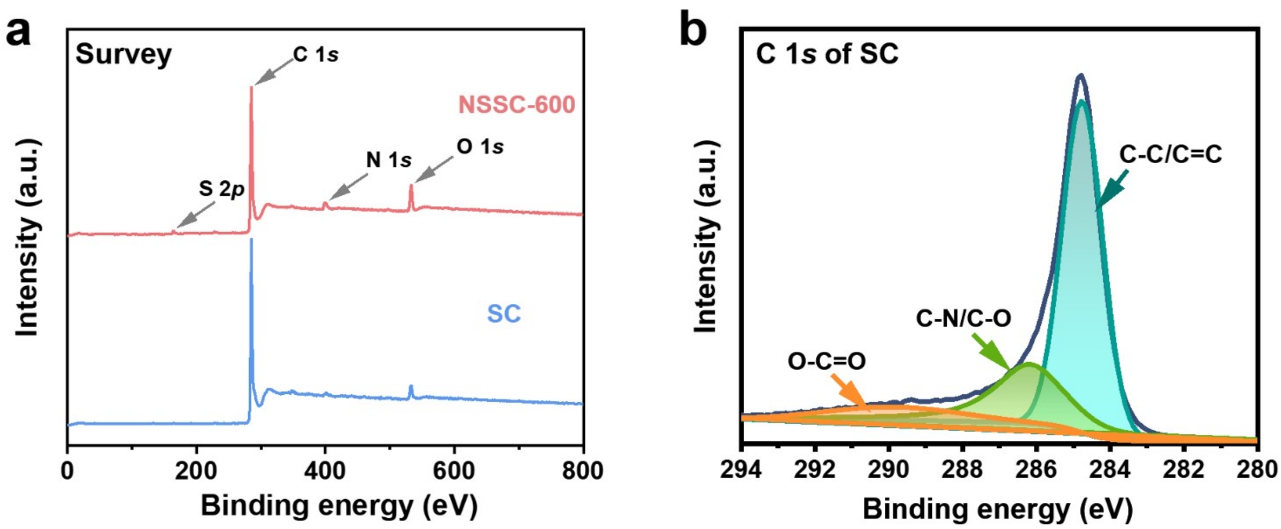

Fig. S4. (a) Survey XPS spectra of SC and NSSC-600. (b) High-resolution XPS for (a) C 1*s* of SC.

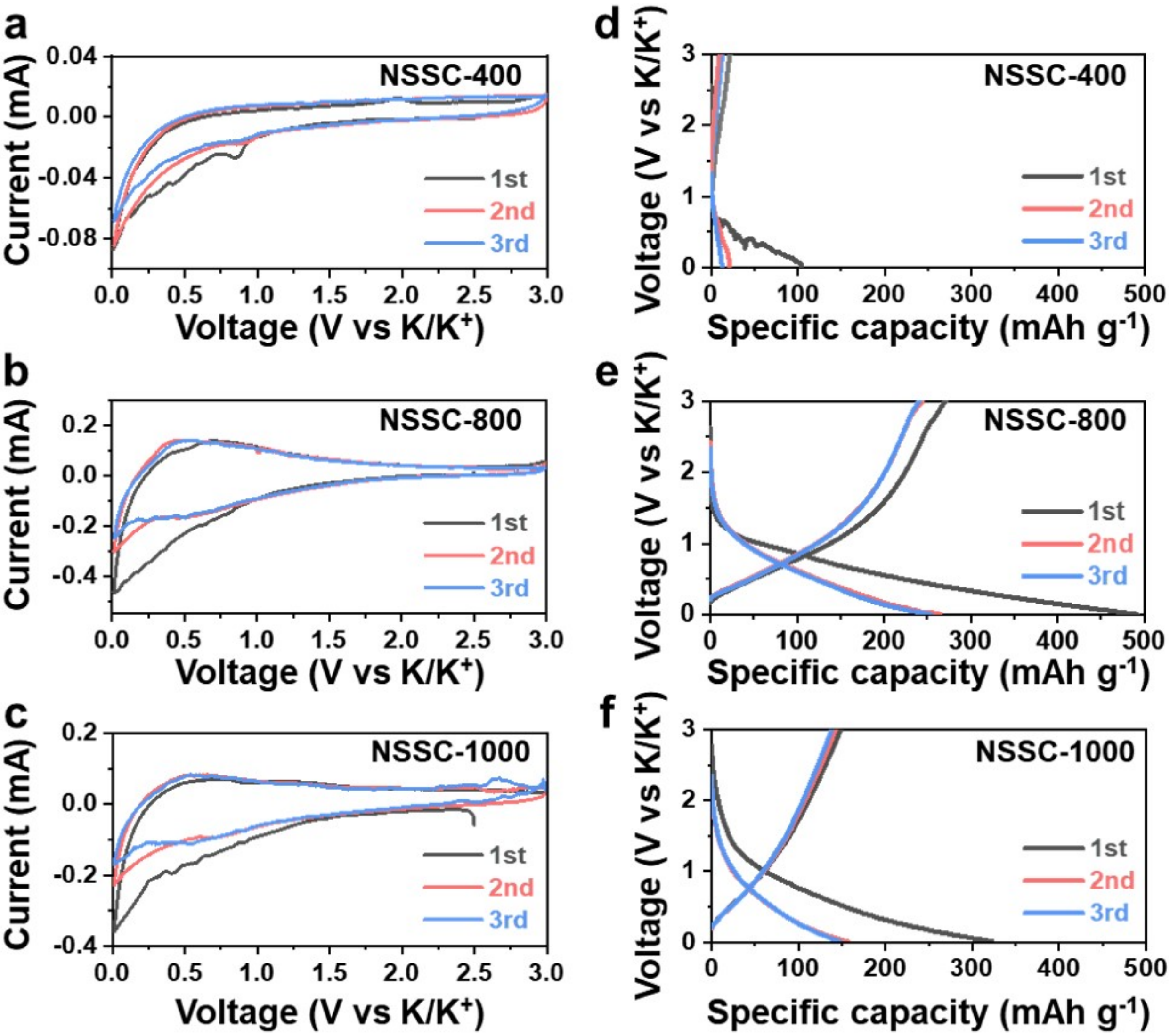

Fig. S5. CV curves of (a) NSSC-400, (b) NSSC-800 and (c) NSSC-1000. GCD curves of (d) NSSC-400, (e) NSSC-800 and (f) NSSC-1000.

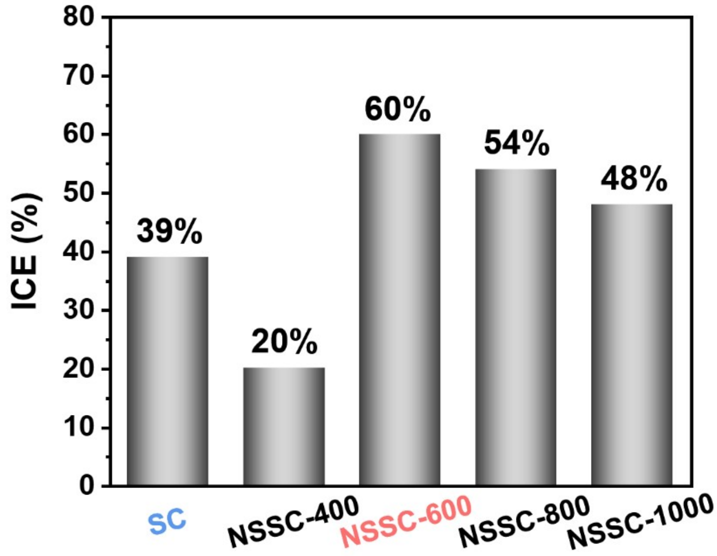

Fig. S6. Initial coulombic efficiency of SC, NSSC-400, NSSC-600, NSSC-800, and NSSC-1000 at the current density of 100 mA g^{-1}.

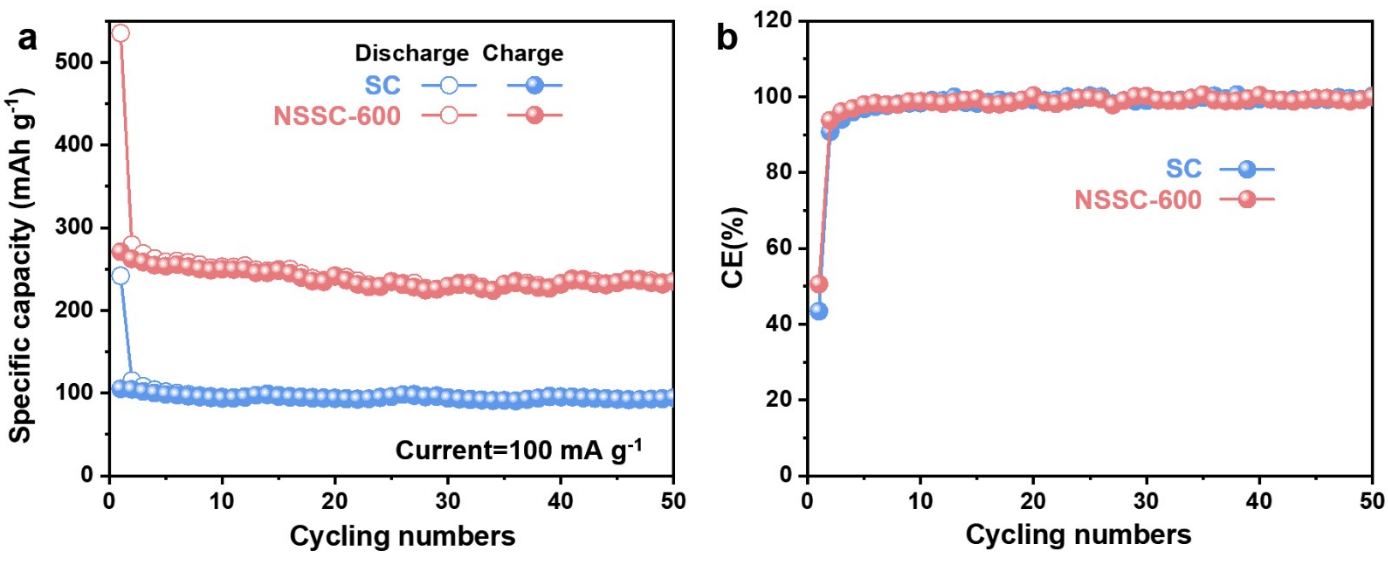

Fig. S7. (a) Cycling performance and (b) CE of SC and NSSC-600 at 100 mA g^{-1}.

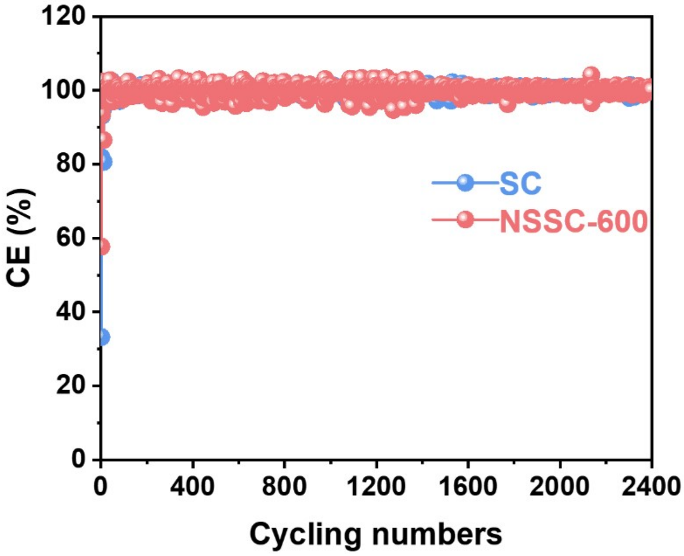

Fig. S8. Coulombic efficiency of SC and NSSC-600 at the current density of 1 A g^{-1}.

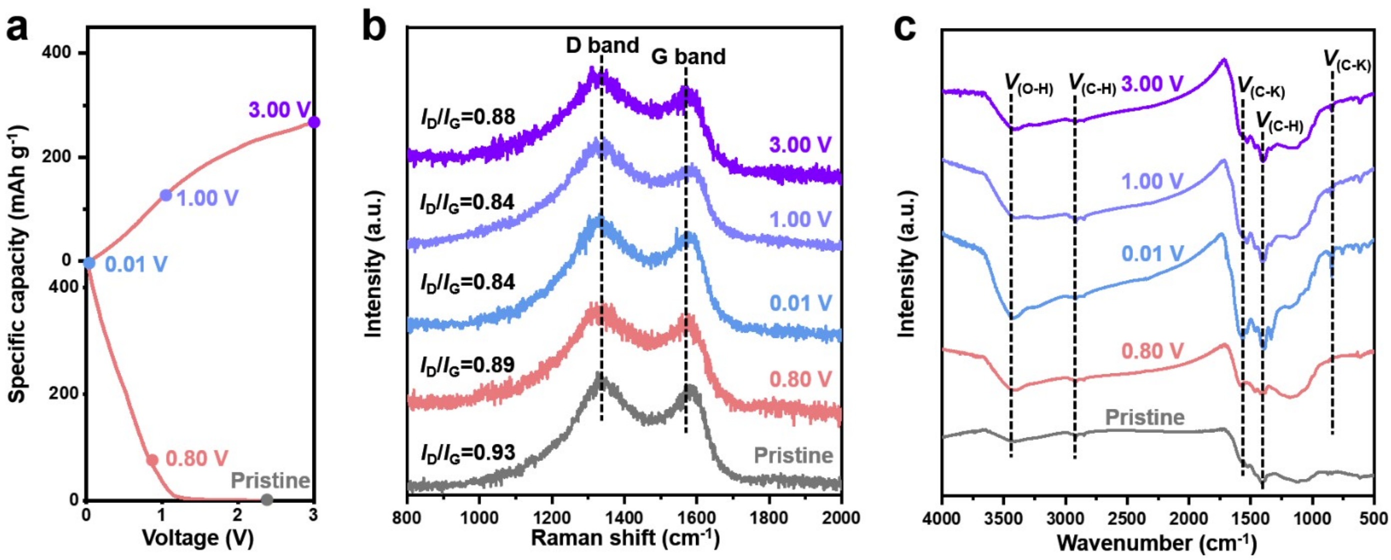

Fig. S9. (a) Charge-discharge profile, the corresponding (b) *ex situ* Raman of NSSC-600 and (c) *ex situ* FTIR spectra of NSSC-600 from 0.01 to 3.00 V.

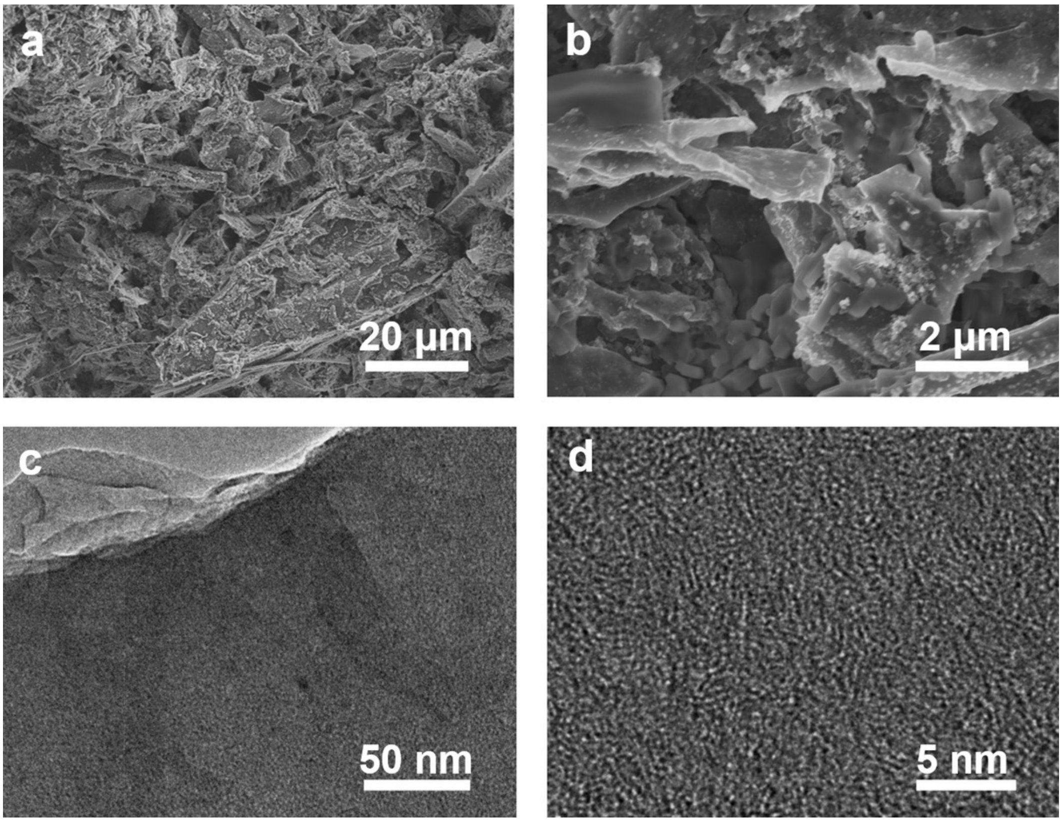

Fig. S10. (a, b) FESEM, (c) TEM and (d) high-resolution TEM images of NSSC-600 after 50 cycles at 100 mA g^{-1}. Note: Some particles shown in (a) and (b) are the conductive agents added during electrode preparation.

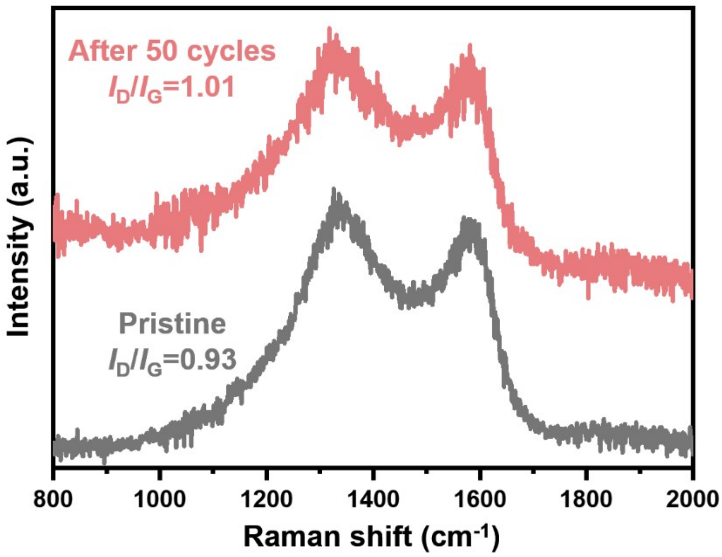

Fig. S11. Raman spectra of NSSC-600 before and after 50 cycles at 100 mA g^{-1}.

Table S1. The content of C, H, N and S in NSSC-*x* obtained by CHNS analysis.

	S (at%)
NSSC-400	0.96
NSSC-600	1.62
NSSC-800	1.23
NSSC-1000	1.41

Table S2. The obtained parameters based on DFT calculation.

System	E_2 (eV)	E_1 (eV)	μK (eV)	$\triangle E_a$ (eV)
C	-318.95	-316.82	-0.253	-1.87
N-C	-320.06	-317.62	-0.253	-2.19
S-C	-322.55	-319.16	-0.253	-3.13
N-S-C	-323.55	-319.90	-0.253	-3.40

Table S3 Summary table of previously reported N, S co-doped carbons for KIBs.

Electrode material	raw material	Cycling stability[capacity (mAh g^{-1}) @Cycle number @current density (A g^{-1})]	Rate capability [capacity (mAh g^{-1}) @ current density (A g^{-1})]	ICE(%)	Ref.
N, S co-doped porous carbon nanotubes	Polymerized dopamine and CdS	188@500@2	151@5	18.7	1
N, S co-doped graphene nanoribbons	MWCNTs	224.0@400@0.5	211.7@2	55.06	2
N, S co-doped porous carbon	Glucan	~140@100@0.5	~60@1	/	3
N, S co-doped carbon nanosheet	Ethylene glycol with Sb_2S_3 template	187@2780@1	251@2	~25	4
N, S co-doped porous carbon	Sodium polyacrylate with NaCl-template	156.8@1000@0.5	158.7@0.5	48.4	5
N/S Co-doped Graphene Nanosheets	F127 with melamine and cyanuric acid	188.8@2000@1	204.3@2	~21	6
NSSC	Sorghum stalk	110@2400@1	131@1	60	Our work

Table S4. Summary table of previously reported biomass derived hard carbon for KIBs.

Electrode material	raw material	Cycling stability[capacity (mAh g^{-1}) @Cycle number @current density (A g^{-1})]	Rate capability [capacity (mAh g^{-1}) @ current density (A g^{-1})]	ICE(%)	Ref.
Hard carbon	Magnolia grandiflora Lima leaf	96@2000@2		50.3	7
Porous carbon	Potato	172@400@0.5	152@1	82.8	8
N-doped hard carbon	Corn stalk core	176@260@1	118@2	65	9
N/P-doped hierarchical hard carbon	Animal bone	205@450@0.058	113@0.58	~58	10
Biomass carbon	Tea-waste	211@1000@1	223@1	85.6	11
Cage-like porous carbon	Ganoderma lucidum spore	124.6@700@1	133@1	56	12
N-doped porous carbon	Bagasse	100.4@400@0.2	~50@1	~25	13
Porous N-doped carbon microsphere	Shrimp shells	180@4000@0.5	156@5	~65	14
N-doped carbon nanofibers	Bio-waste chitin	103.4@500@0.56	84.7@1.4	37.8	15
Porous carbon nanofiber foam	Bacterial cellulose	156@500@0.5	164 @1	~20	16
Sulfur-doped charcoal	Bamboo	203.8@300@0.2	124.2@1	56	17
Loofah-derived carbon	Loofah	~80@400@0.1	~60@0.2	~31	18
N/O Co-doped porous carbon	Cyanobacteria	104.3@1000@1	155@1	38.7	19
O/N-doped hard carbon	Maple leaves	141.9 @1000@1	144.8@1	30.1	20
O/S co-doped hard carbon	Cotton	120@500@2	135@2	46.4	21
Hard-carbon	Oak	112@150@0.1	41@0.5	56	22
Co-activation of carbon	Artemisia hedinii	110@500@0.07	75@0.418	25.5	23

Porous hard carbon spheres	Camellia shells	215@100@0.1	123@1	44.1	24
NSSC	Sorghum stalk	110@2400@1	131@1	60	Our work

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