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Supplementary material

Thermally Fabricated Cobalt Telluride in Nitrogen-rich Carbon Dodecahedra as High-Rate Potassium and Sodium Ion Battery Anodes

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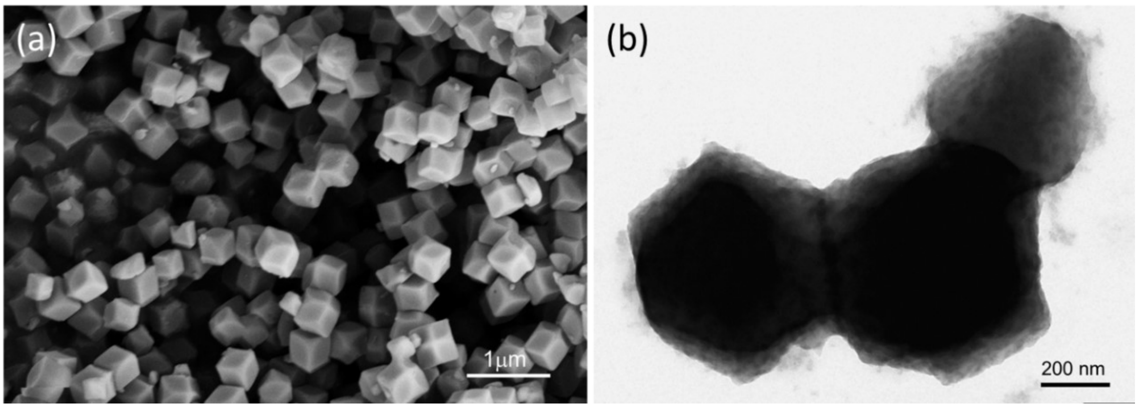

Fig. S1 Morphological characterization of as-synthesized ZIF-67 precursors, highlighting their rhombic dodecahedral morphology. (a) Low magnification FESEM and (b) High magnification TEM image.

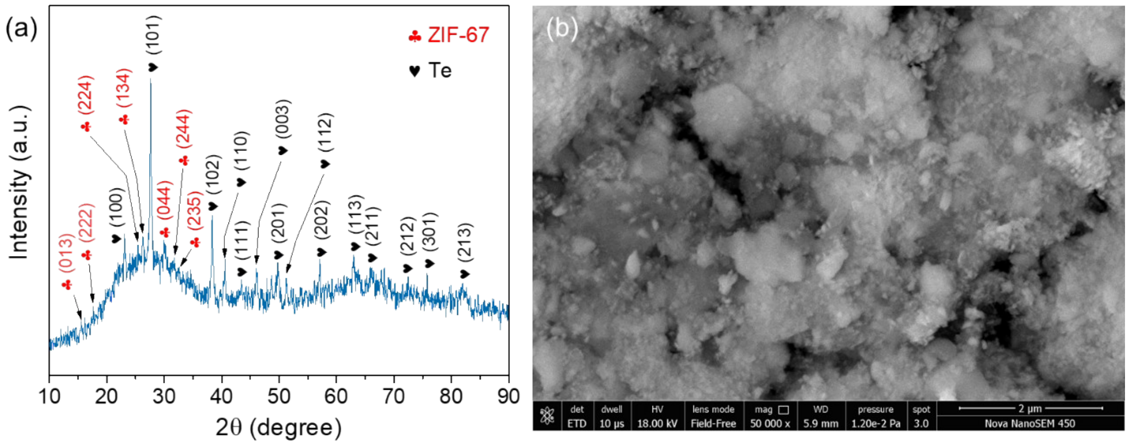

Fig. S2 XRD pattern (a) and FESEM image (b) of the mixture of ZIF-67 and Te powder used to synthesize CoTe@NCD hybrid structure.

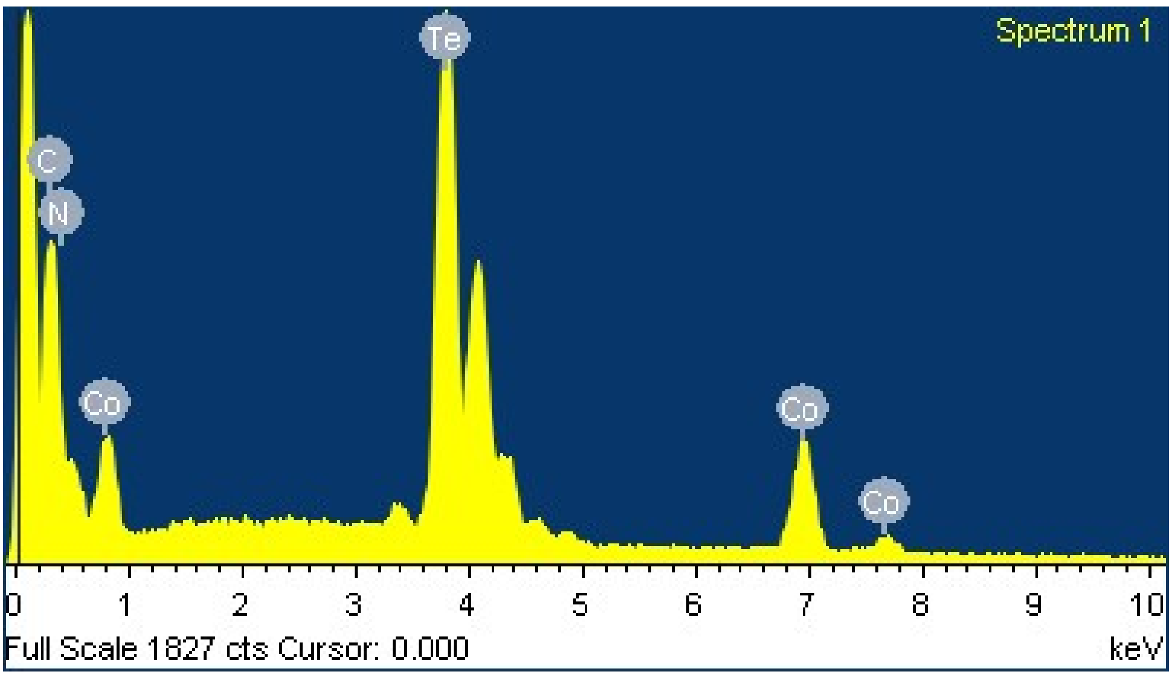

Fig. S3 EDS spectrum of CoTe@NCD showing the presence of Co, Te, and N.

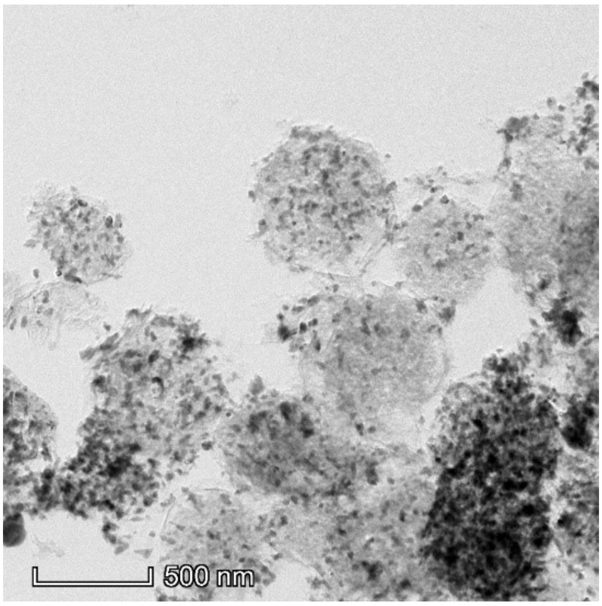

Fig. S4 Low magnification TEM image of a collection of CoTe@NCD particles.

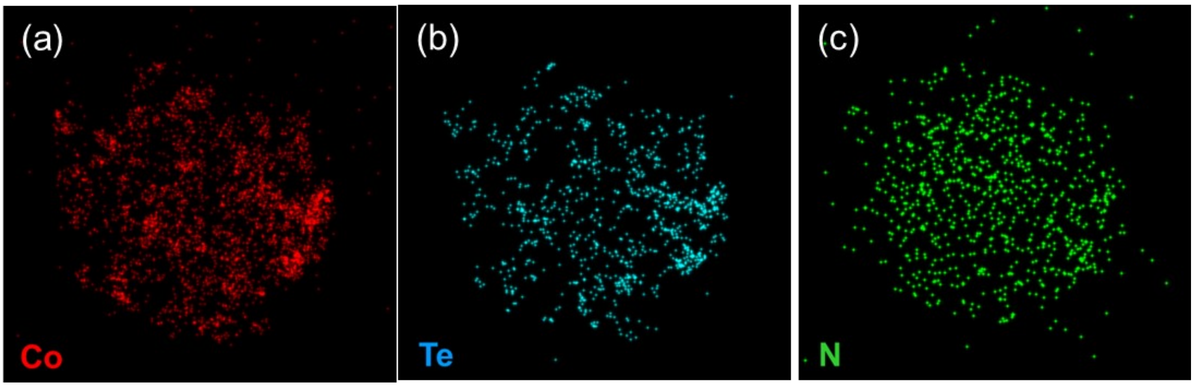

Fig. S5 Electron Energy Loss Spectroscopy (EELS) maps of Co, Te, and N in a single CoTe@NCD particle.

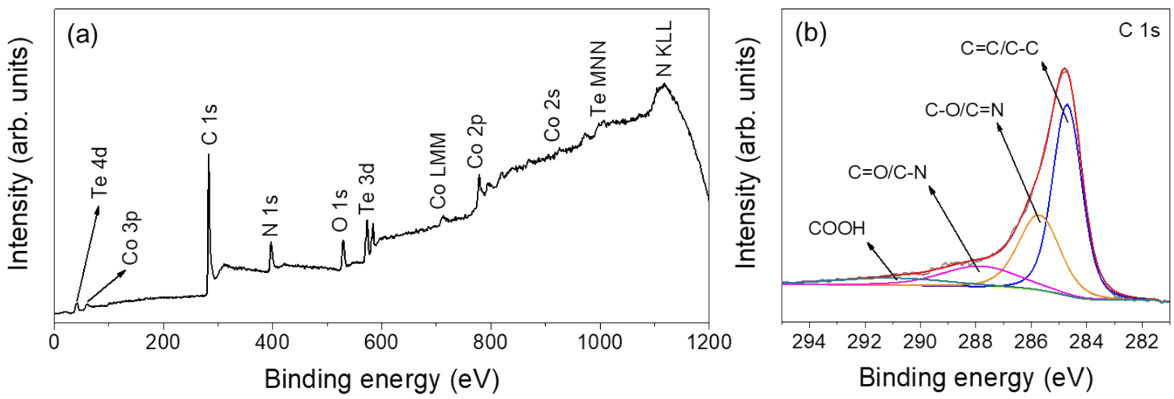

Fig. S6 Core-level XPS spectra of CoTe@NCD. (a) Low resolution survey spectrum. (b) high resolution of C 1s.

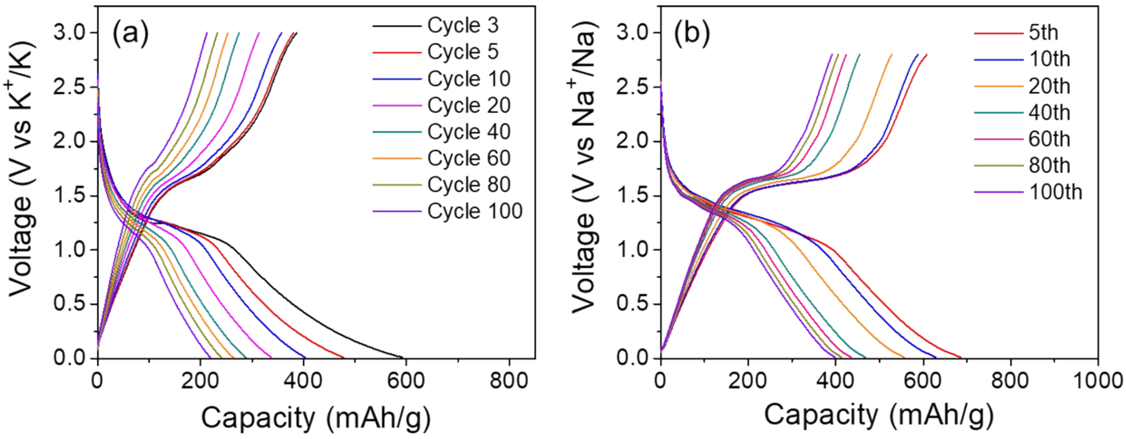

Fig. S7 GCD profiles for CoTe@NCD obtained during cycling as (a) KIB anode, and (b) NIB anode.

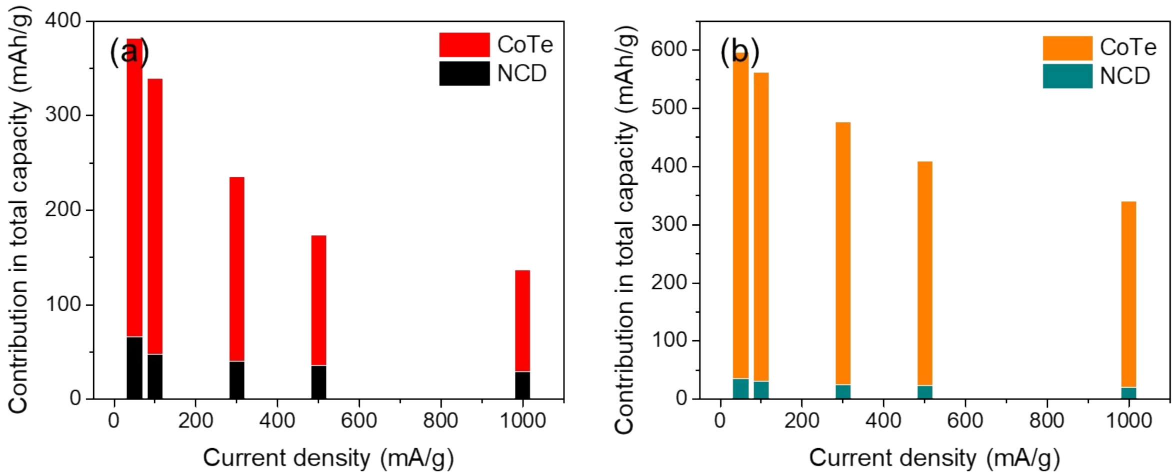

Fig. S8 Capacity contribution from CoTe and NCD to the total capacity exhibited by CoTe@NCD hybrid (a) as KIB anode. (b) as NIB anode.

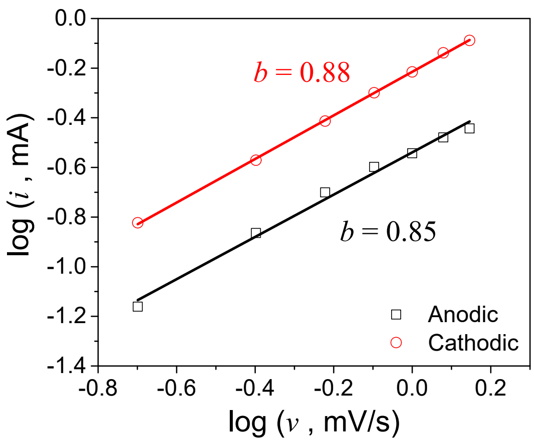

Fig. S9 Plot of log(*i*) vs. log(*v*) to calculate the *b* values for cathodic and anodic currents in the CVs of CoTe@NCD as KIB anode.

Table S1 Comparison of cycling performance of CoTe@NCD versus state-of-the-art PIB anodes from literature, tested vs. K^+/K.

Sl. no.	Material	Current density (mA/g)	Cycling performance	Ref. # Publish year
1.	**CoTe/NCD**	**50**	**213 mAh/g after 100 cycles**	**This study**
2.	Sn-C composite	25	110 mAh/g after 30 cycles	1 2016
3.	Pure CoSe	50	~25 mAh/g after 40 cycles	2 2020
4.	Pure FeP	50	100 mAh/g after 100 cycles	3 2020
5.	FeP/C composite	50	182.5 mAh/g after 50 cycles	4 2019
6.	$SnP_{0.94}$@GO	50	~190 mAh/g after 50 cycles	5 2019
7.	Sn_4P_3/C	50	~50 after 100 cycles	6 2017
8.	K-Te battery	84	52 mAh/g after 100 cycles	7 2020
9.	GeP_5	50	~20 mAh/g after 50 cycles	8 2018
10.	Co_3O_4 -Fe_2O_3/C	50	220 mAh/g after 50 cycles	9 2017
11.	Cobalt terephthalate (CoTP)/Super P composite	60	150 mAh/g after 100 cycles	10 2017
12.	FeP nanocubes	100	~80 mAh/g after 100 cycles	11 2019
13.	CoP/NC	100	150 mAh/g after 100 cycles	12 2020
14.	Co@Graphitic Nanotubes	100	~85 mAh/g after 100 cycles	13 2020
15.	$K_2Ti_8O_{17}$	20	110.7 mAh/g after 50 cycles	14 2016
16.	$K_2Ti_4O_9$	30	80 mAh/g after 10 cycles	15 2016

Table S2 Comparison of rate capability of CoTe@NCD versus state-of-the-art cobalt-based, phosphide-based, and carbon-based anodes from literature, tested vs. K^+/K.

Sl. No.	Material	Electrolyte	Voltage window (vs. K^+/K)	1st reversible discharge capacity (1st CE)	Rate performance	Ref. # Publish year
1.	**CoTe/NCC**	**0.8 M KPF_6 in EC/ DEC/PC (2:1:2 v/v/v)**	**0.01-3 V**	**395 mA/g @ 50 mA/g (50%)**	**340 mAh/g @ 100 mA/g 208 mAh/g @ 300 mA/g 174 mAh/g @ 500 mA/g 136 mAh/g @ 1 A/g**	**This study**
2.	Te NWs/CNT/rGO composites	Potassium bis(trifluoromethane sulphonyl) imide dissolved in tetraethylene glycol dimethyl ether	0.5-3.0 V	332 @ 42 mA/g (59.69%)	252 @ 84 mA/g, 201 @ 210 mA/g, and 172 @ 420 mA/g	[7] 2020
3.	Co_2P/NCC	0.8 M KPF_6 in EC / DEC / PC (2:1:2 v/v/v)	0.01-3 V	270 mA/g @ 50 mA/g (42.1%)	196 mAh/g @ 100 mA/g, 155 mAh/g @ 300 mA/g, 137 mAh/g @ 500 mA/g, 113 mAh/g @ 1 A/g	[16] 2020
4.	N, P-Codoped Porous Carbon Sheets/CoP Hybrids	1M KPF_6 in a mixture of EC, DMC, and DEC (v/v/v = 1:1:1)	0.01-3 V	174 mAh/g @ 50 mA/g (19.6%)	134 mAh/g @ 100 mA/g 94 mAh/g @ 500 mA/g 54 mAh/g @ 2 A/g	[17] 2018
5.	C-Co_2P@rGO	KPF_6 (1.0 mol L^{-1}) in an EC/DEC/EMC solution (3:3:4, v/v/v)	0.01-3 V	143 mAh/g @ 20 mA/g (~35%)	~100 mAh/g @ 100 mA/g ~ 75mAh/g @ 500 mA/g 50 mAh/g @ 2 A/g	[18] 2019
6.	ZIF-8@ZIF-67-Derived Nitrogen-Doped Porous Carbon	0.8 m KPF_6 in EC:DEC (1:1; v:v)	0.01–2.5 V	~210 mAh/g @ 50 mA	175 mAh/g @ 100 mA/g 150 mAh/g @ 200 mA/g 135 mAh/g @ 500 mA/g, 125 mAh/g @ 1 A/g,	[12] 2020
7.	Oxidizing-acid treated melamine foam carbons (OMFCs)-60	0.8 M KPF_6 in EC/ DEC (1:1, v/v)	0.01-3 V	~200 mAh/g @ 50 mA/g (26.7%)	170 mAh/g @ 100 mA/g 110 mAh/g @ 500 mA/g 80 mAh/g @ 1 A/g	[19] 2019
8.	CoSe-S@Carbon	1M KPF_6 in EC:DMC:EMC (1:1:1, v/v/v) with 2.0% FEC	0.01-3 V	~225 mAh/g@ 100 mA/g	225 mAh/g@ 100 mA/g, 55 mAh/g@ 200 mA/g, 3.3 mAh/g @ 500 mA/g	[20] 2020
9.	Pristine $Co_{0.85}Se$ hollow cubes	1M KPF_6 in EC:DEC (1:1, v/v)	0.01-2.5V	233 mAh/g @ 50 mA/g	173 mAh/g @ 100 mA/g 138 mAh/g @ 500 mA/g 110 mAh/g @ 1 A/g	[21] 2020
10.	Co@graphitic nanotubes	0.8M KPF_6 in EC:DEC (1:1, v/v)	0.01-3 V	200 mAh/g @ 50 mA/g	121 mAh/g @ 100 mA/g 49 mAh/g @ 500 mA/g	[13] 2020

					21 mAh/g @ 1 A/g	
11.	Cobalt terephthalate (CoTP)/Super P composite	1M potassium bis(fluorosulfonyl)amide (KFSI) in EC/DMC (1:1, v/v)	0.005-2 V	216 mAh/g @ 60 mA/g	100 mAh/g @ 120 mA/g 27 mAh/g @ 480 mA/g	[10] 2017
12.	$Co_{0.85}Se$-QDs/C-2	1M KFSI and dimethyl ether (DME)	0.01-2.5 V	~180 mAh/g @ 50 mA/g	~110 mAh/g @ 100 mA/g ~75 mAh/g @ 500 mA/g	[22] 2019
13.	FeP@C nano-boxes	0.8 M KPF_6 in EC/DEC (1:1 v/v)	0.01-2.5 V	201 mAh/g @ 100 mA/g (47%)	101 mAh/g @ 500 mA/g 65 mAh/g @ 1 A/g 37 mAh/g @ 2 A/g	[11] 2019
14.	FeP nanocubes	0.8 M KPF_6 in EC/DEC (1:1 v/v)	0.01-2.5 V	160 mAh/g @ 100 mA/g	75 mAh/g @ 500 mA/g 50 mAh/g @ 1 A/g 35 mAh/g @ 2 A/g	[11] 2019
15.	FeP/C composite	0.8 M KPF_6 in EC/DEC (1:1 v/v)	0.01-3 V	218 mAh/g @ 50 mA/g (45.1%)	186 mAh/g @ 100 mA/g 113 mAh/g @ 500 mA/g 79 mAh/g @ 1 A/g	[4, 23] 2019, 2020
16.	N-CNF@FeP	0.8 M $KClO_4$ in EC/DEC (1:1 v/v)	0.01-3 V	222 mAh/g @ 50 mA/g (57%)	195 mAh/g @ 100 mA/g 140 mAh/g @ 400 mA/g 103 mAh/g @ 800 mA/g	[3] 2020
17.	Bimetallic Fe-Ni phosphide	0.8 M KPF_6 in EC:DEC (1:1; v:v)	0.01-2.5 V	168 mAh/g @ 50mA/g	107 mAh/g @ 100 mA/g 64 mAh/g @ 500 mA/g 46 mAh/g @ 2 A/g	[24] 2020
18.	$SnP_{0.94}$@GO	1.0M KFSI in EC/DEC	0.01-2 V	190 mAh/g @ 50 mA/g (42%)	146 mAh/g @ 100 mA/g 118 mAh/g @ 500 mA/g 84 mAh/g @ 1 A/g	[5] 2019

Table S3 Comparison of cycling performance of CoTe@NCD versus state-of-the-art NIB anodes from literature, tested vs Na^+/Na.

Sl. no.	Material	Current density (mA/g)	Cycling performance	**Ref. # Publish year**
1.	**CoTe/NCD**	**100**	**335 mAh/g after 200 cycles**	**This study**
2.	CoTe nanorods/rGO composites	100	200 mAh/g after 200 cycles	[25] 2019
3.	CoS/Super P composite	100	51 mAh/g after 100 cycles	[26] 2016
4.	CoS⊂carbon NWs	100	294 mAh/g after 100 cycles	[26] 2016
5.	Cu_2Se@C porous	100	268 mAh/g after 100 cycles	[27]

	octahedra			2018
6.	CoSe⊂carbon NWs	100	299 mAh/g after 100 cycles	[26] 2016
7.	$CoSe_2$@PCP	100	291.3 mAh/g after 50 cycles	[28] 2017
8.	Co_3O_4 ⊂carbon NWs	100	176 mAh/g after 100 cycles	[26] 2016
9.	CoP	100	315 mAh/g after 25 cycles	[29] 2015
10.	Vanadium carbide @C	100	160 mAh/g after 100 cycles	[30] 2020
11.	$CoTe_2$	50	<50 mAh/g after 40 cycles	[31, 32] 2020
12.	Co_2P@N-C@rGO	50	225 mAh/g after 100 cycles	[33] 2018
13.	Co_2P-3D PNC	50	306 mAh/g after 100 cycles	[34] 2018
14.	$FePO_4$ nanosheets	170	127 mAh/g after 200 cycles	[35] 2016
15.	Ni_2P@C/GA	100	253.6 mAh/g after 100 cycles	[36] 2017

Table S4 Comparison of rate capability of CoTe@NCD versus state-of-the-art cobalt-based, phosphide-based, and carbon-based anodes from literature, tested vs. Na^+/Na.

Sl. No.	Material	Electrolyte	Voltage window (vs. Na^+/Na)	1st reversible discharge capacity (1st CE)	Rate performance	Ref. # Publish year
1.	**CoTe/NCD**	**1M $NaClO_4$ in EC:DEC (v/v/v = 1:1)**	**0.01-2.8V**	**597 mAh/g @ 50 mA/g (50%)**	**562 mAh/g @ 100 mA/g, 477 mAh/g @ 300 mA/g, 410 mAh/g @ 500 mA/g, 340 mAh/g @ 1A/g, 206 mAh/g @ 2 mA/g**	**This study**
2.	$CoTe_2$/graphene	1 M $NaCF_3SO_3$ in diglyme	0.01-2.8V	382 mAh/g at 50 mA/g	295 mAh/g @ 1 A/g, 272 mAh/g @ 2 A/g,	[31] 2018
3.	CoTe nanorods/rGO composites	1M of $NaClO_4$ in Ethylene carbonate/ Dimethyl carbonate (EC/DMC)	0.01-2.8V	459 mAh/g @ 50 mA/g (56%)	410 mAh/g @ 100 mA/g, 353 mAh/g @ 300 mA/g, 312 mAh/g @ 500 mA/g, 253 mAh/g @ 1 A/g, 176 mAh/g @ 2 A/g	[25] 2019
4.	Polyhedral $CoTe_2$-C Nanocomposites	0.7 M $NaClO_4$ in EC/DEC containing 5% FEC additive	0-3V	323 mAh/g @ 50 mA/g,	256 mAh/g @ 350 mA/g, 240 mAh/g @ 700 mA/g	[32] 2020

5.	Co_2P/N-doped carbon	1 M $NaClO_4$ in propylene carbonate (PC) solvent with 5 vol% FEC additive	0.01-3.0 V	322 mAh/g @ 50 mA/g	283 mAh/g @ 100 mA/g, 264 mAh/g @ 200 mA/g, 244 mAh/g @ 400 mA/g, 210 mAh/g @ 1 A/g, 182 mAh/g @ 2 A/g	[34] 2018
6.	CoP	1.0 M $NaClO_4$ in EC/DEC (1:1 v/v), with or without 5 vol.% FEC additive	0-1.5V	570 mAh/g @ 100 mA/g	310 mAh/g @ 500 mA/g, 200 mAh/g @ 1 A/g, 80 mAh/g @ 2 A/g	[29] 2015
7.	$FeTe_2$-rGO	1.0 M $NaClO_4$ in EC/DMC (1:1 v/v), with 5 vol.% FEC additive	0-3V	421 mAh/g @ 100 mA/g	384 mAh/g @ 500 mA/g	[37] 2016
8.	CoSe@PCP	1.0 M $NaClO_4$ in EC/PC (1:1 w/w), with 5 vol.% FEC additive	0.005-3.0V	360.3 mAh/g @ 50 mA/g	315 mAh/g @ 250 mA/g, 279 mAh/g @ 1 A/g,	[28] 2017
9.	CoS⊂carbon NWs	$NaClO_4$/propylene carbonate solution with 5 wt% FEC additive	0.005-3V	379 mAh/g @ 100 mA/g	350 mAh/g @ 200 mA/g, 316 mAh/g @ 500 mA/g, 285 mAh/g @ 1 A/g	[26] 2016
10.	CoSe⊂carbon NWs	$NaClO_4$/propylene carbonate solution with 5 wt% FEC additive	0.005-3V	350 mAh/g @ 100 mA/g	327 mAh/g @ 200 mA/g, 308 mAh/g @ 500 mA/g	[26] 2016
11.	Co_3O_4 ⊂carbon NWs	$NaClO_4$/propylene carbonate solution with 5 wt% FEC additive	0.005-3V	341 mAh/g @ 100 mA/g	264 mAh/g @ 200 mA/g, 220 mAh/g @ 500 mA/g, 155 mAh/g @ 1 A/g 140 mAh/g @ 2 A/g	[26] 2016
12.	Hard Carbon	0.7 M $NaClO_4$ in EC/DEC containing 5% FEC additive	0-3V	290 mAh/g @ 25 mA/g	235 mAh/g @ 50 mA/g, 150 mAh/g @ 125 mA/g, 70 mAh/g @ 250 mA/g, 41 mAh/g @ 500 mA/g	[32] 2020

Table S5 Performance comparison of CoTe@NCD towards KIB and NIB applications

CoTe@NCD used as	Discharge capacity @ 50 mA/g	Initial coulombic efficiency	Discharge capacity @ 100 mA/g	Discharge capacity @ 500 mA/g	Discharge capacity @ 2000 mA/g	Cycle stability after 100 cycles
KIB anode	382 mAh/g	50%	340	174	58	213.0 mAh/g @ 50 mA/g
NIB anode	620 mAh/g	57%	560	416	207	399.4 mAh/g @ 100 mA/g

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