Supporting information：

Interface coupling 1D/2D/2D $CoTe_2$/graphene/carbon heterostructure as high-performance anode material for potassium ion battery

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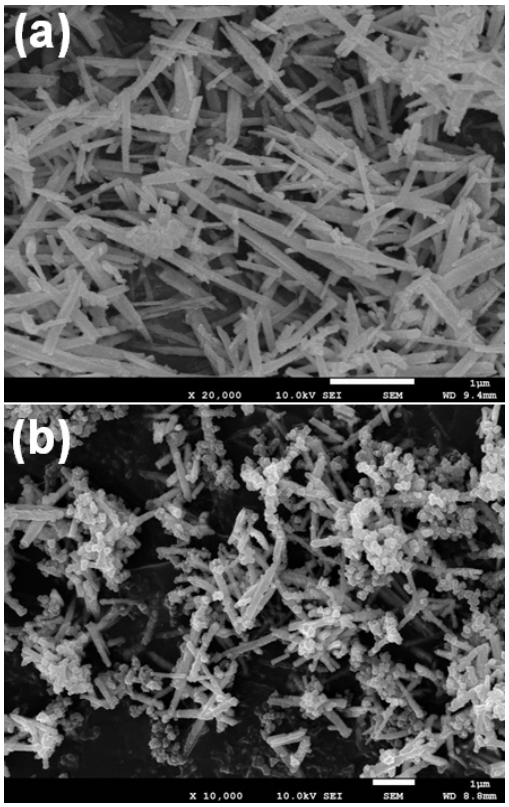

Fig. S1. SEM images of the $CoTe_2$ and $CoTe_2$@C samples.

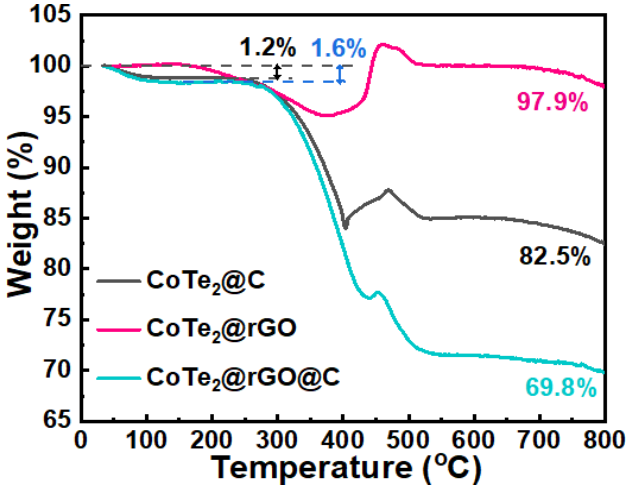

Fig. S2. TGA curves of the $CoTe_2$@C, $CoTe_2$@rGO and $CoTe_2$@rGO@C samples.

Calculation of carbon content

The content of $CoTe_2$ in $CoTe_2$@rGO@C was measured by thermogravimetric analysis (TGA) and analyzed based on the weight loss of carbon combustion (Fig. S2) and the weight increment from the oxidation of elemental $CoTe_2$ to $Co_2Te_3O_8$ ($2CoTe_2 + 5O_2 + C \rightarrow Co_2Te_3O_8 + CO_2\uparrow + Te\uparrow$). Therefore, the content of $CoTe_2$ in $CoTe_2$@rGO@C could be calculated by the following formula:

$$W_{CoTe_2} = W_{Co_2Te_3O_8} \times \frac{2M_{CoTe_2}}{M_{Co_2Te_3O_8}}$$

where M represents molar mass, and W represents the mass fraction.

Finally, the mass fraction of C is obtained as:

$$W_C = 100\% - W_{CoTe_2} - W_{H_2O}$$

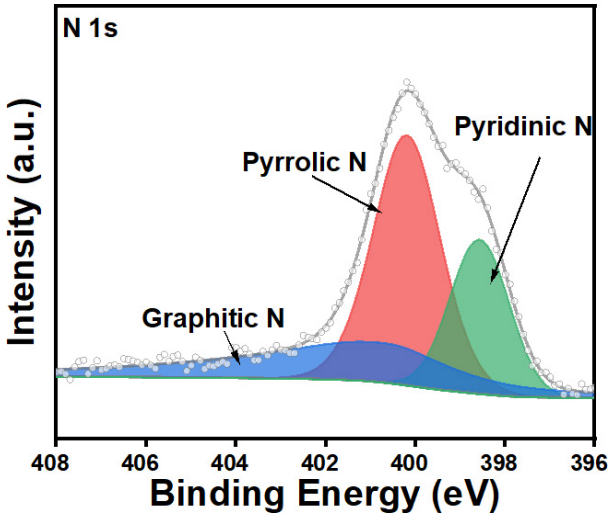

Fig. S3. XPS high-resolution spectra of N 1s for $CoTe_2$@rGO@C sample.

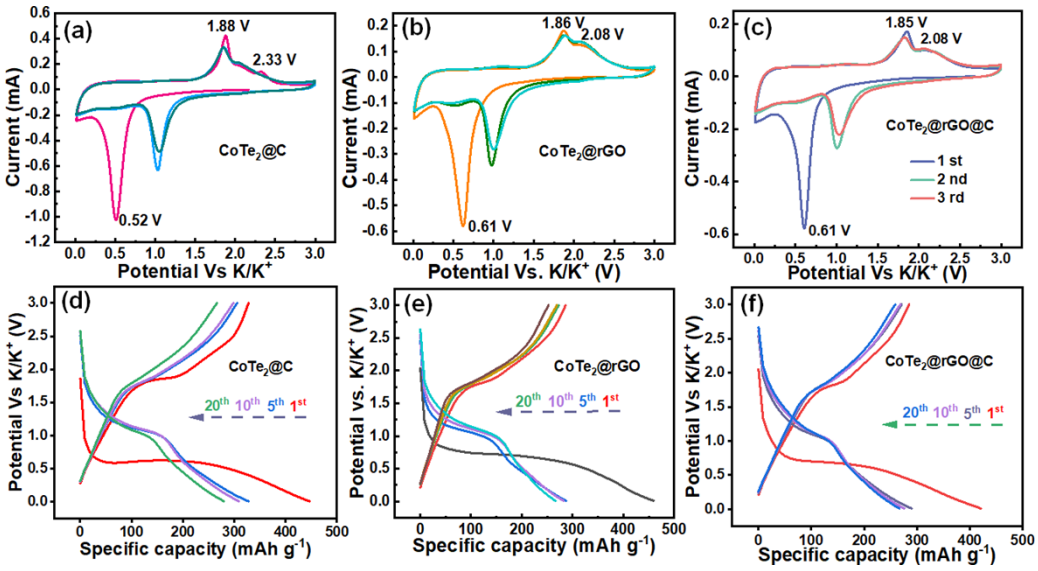

Fig. S4. CV curves of (a) $CoTe_2$@C, (b) $CoTe_2$@rGO and (c) $CoTe_2$@rGO@C anodes. Charge-discharge curves of the (d) $CoTe_2$@C, (e) $CoTe_2$@rGO and (f) $CoTe_2$@rGO@C anodes.

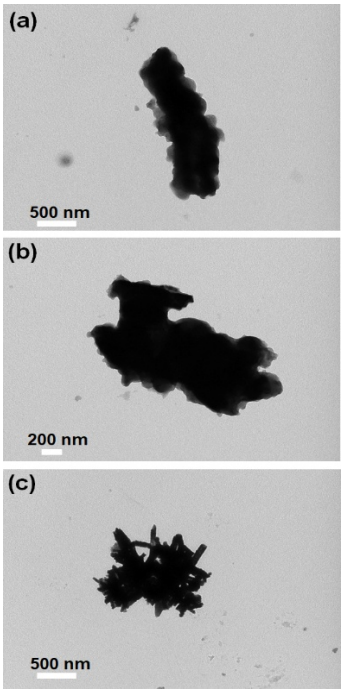

Fig. S5. TEM images of the $CoTe_2$@C, $CoTe_2$@rGO and $CoTe_2$@rGO@C anodes after cycling at 500 mA g^{-1} for 400 cycles.

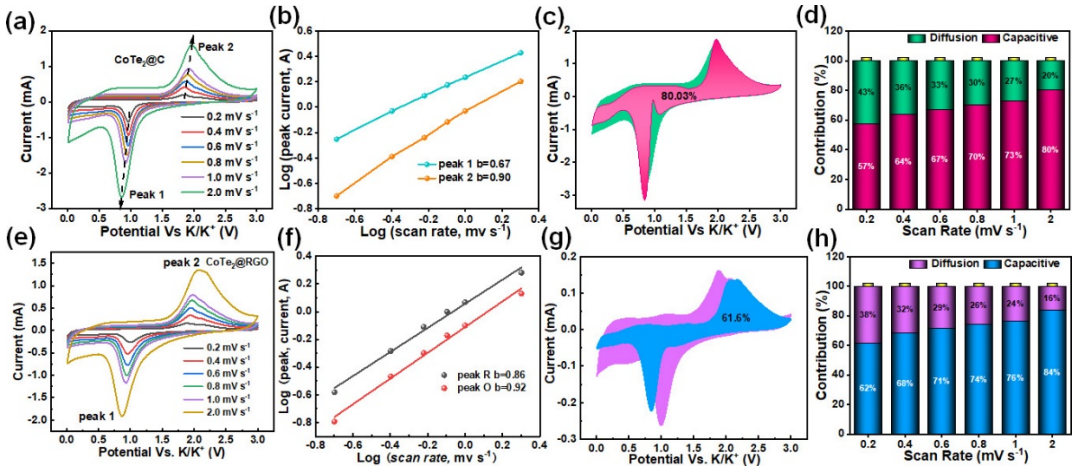

Fig. S6. CV curves of (a) $CoTe_2$@C and (e) $CoTe_2$@rGO anodes at different scan rates. Log (*i*) versus Log (*v*) plots of (b) $CoTe_2$@C and (f) $CoTe_2$@rGO anodes. (c) Capacitive contribution to the total current of (c) $CoTe_2$@C and (g) $CoTe_2$@rGO anodes at 2.0 mV s^{-1}. Capacitive contribution to the total current of (d) $CoTe_2$@C and (h) $CoTe_2$@rGO at different scan rates.

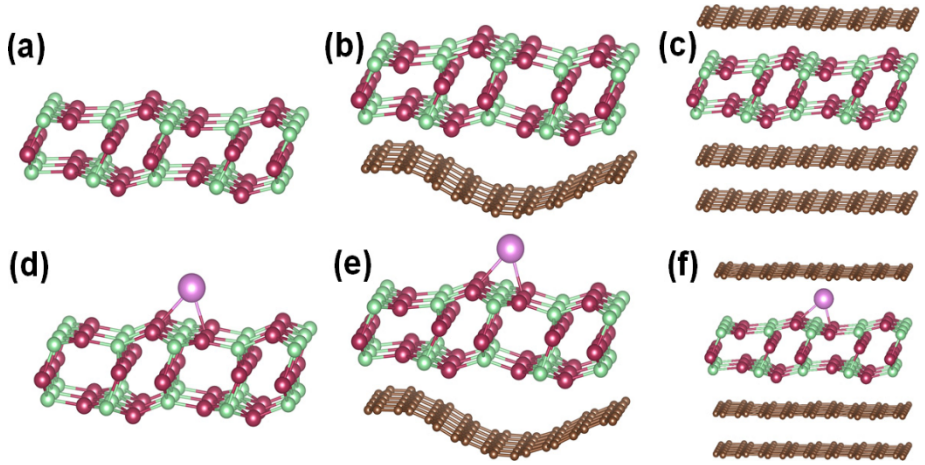

Fig. 7. Structural models of the (a) $CoTe_2$, (b) $CoTe_2$@rGO and (c) $CoTe_2$@rGO@C. K-ion adsorption models of (d) $CoTe_2$, (e) $CoTe_2$@rGO and (f) $CoTe_2$@rGO@C.

Table S1. Comparison of the electrochemical performance of various anode materials between this work and the previous works.

Anodes	**Current densities (mA g^{-1})** / **Discharge capacities (mAh g^{-1})**						**Ref.**
$CoTe_2$@rGO@C	200	500	1000	2000	3000	5000	This work
	396.5	307.7	274.6	235.4	202.5	163.8	
$CoTe_2$/C	100	200	400	600	800	2000	[1]
	416.5	346	272.1	237.5	216.5	163.7	
$CoTe_2$@rGO@NC	50	100	200	500	1000	5000	[2]
	253.3	222.5	197.1	168.3	144.1	44.4	
$CoTe_2$@NPCNF@NC	50	100	200	500	1000	2000	[3]
	526	438.9	353.4	266.9	209.3	148.9	
MoS_2/CNC(10:1)	50	100	200	500	1000		[4]
	220	201	183	160	139		
MoS_2@HPCS	50	100	200	500	1000	2000	[5]
	420.7	367	343.8	243.9	162.7	93.1	
DWHNS Sn/MoS_2@C	50	100	200	400	500	1000	[6]
	250.5	238.8	196.5	145.6	126.8	74.9	

Table S2. Fitting results of the $CoTe_2$, $CoTe_2$@rGO and $CoTe_2$@rGO@C anodes.

Anode	R_s (Ω)	R_f (Ω)	R_{ct} (Ω)
$CoTe_2$@C	8.31	85.32	1152.5
$CoTe_2$@rGO	5.14	47.53	1089.3
$CoTe_2$@rGO@C	4.01	7.56	568.2

Table S3. Impedance fitting value after cycling of $CoTe_2$@rGO@C anode.

Cycle	R_s (Ω)	R_f (Ω)	R_{ct} (Ω)
1th	4.01	7.56	568.2
5th	3.97	7.01	519.4
10th	4.98	8.21	593.6

References

[1] S. Yang, G.D. Park, Y.C. Kang, *Appl Surf Sci.,* 2020, **529**, 147140.

[2] Q. Zhou, L. Yuan, T. Li, S. Qiao, M. Ma, Y. Wang, S. Chong, *J. Colloid. Interface Sci.*, 2023, **646**, 493-502.

[3] Q. Li, J. Peng, W. Zhang, L. Wang, Z. Liang, G. Wang, J. Wu, W. Fan, H. Li, J. Wang, S. Huang, *Adv Energy Mater.*, 2023, **13**, 2300150.

[4] H. Wang, J. Niu, J. Shi, W. Lv, H. Wang, P.A. Van Aken, Z. Zhang, R. Chen, W. Huang, *Small.*, 2021, **17**, 2102263.

[5] J. Hu, Y. Xie, X. Zhou, Z. Zhang, *ACS Appl Mater Interfaces.*, 2020, **12**, 1232-1240.

[6] Y. Zhou, M. Zhang, Q. Han, Y. Liu, Y. Wang, X. Sun, X. Zhang, C. Dong, F. Jiang, *Chem. Eng. J.,* 2022, **428**, 131113.