Supporting Information

Three-dimensional nitrogen-doped graphene framework decorated with atomic layer deposited ultrathin V_2O_5 layer for lithium sulfur battery with high sulfur loading

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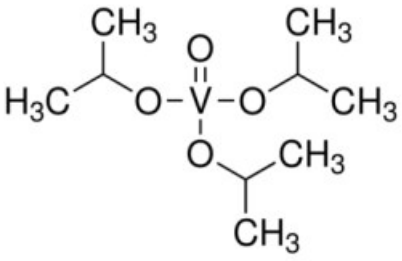
Precursor:

Vanadium(V) triisopropoxy oxide (VTIP)



CAS Number:5588-84-1
Heated to 70 ˚C

	Instruction	#	Value
0	Heater	9	150
1	Heater	8	150
2	Stabilize	9	
3	Stabilize	8	
4	Flow		20
5	Wait		1800
6	Flow		5
7	Wait		2
8	Stopvalve		0
9	Pulse	1	0.15
10	Wait		5
11	Stopvalve		1
12	Flow		20
13	Wait		20
14	Flow		5
15	Wait		2
16	Stopvalve		0
17	Pulse	0	0.03
18	Wait		5
19	Stopvalve		0
20	Flow		20
21	Wait		20
22	goto	6	100
23	Flow		5

Fig. S1. Details about precursor and operation of ALD process.

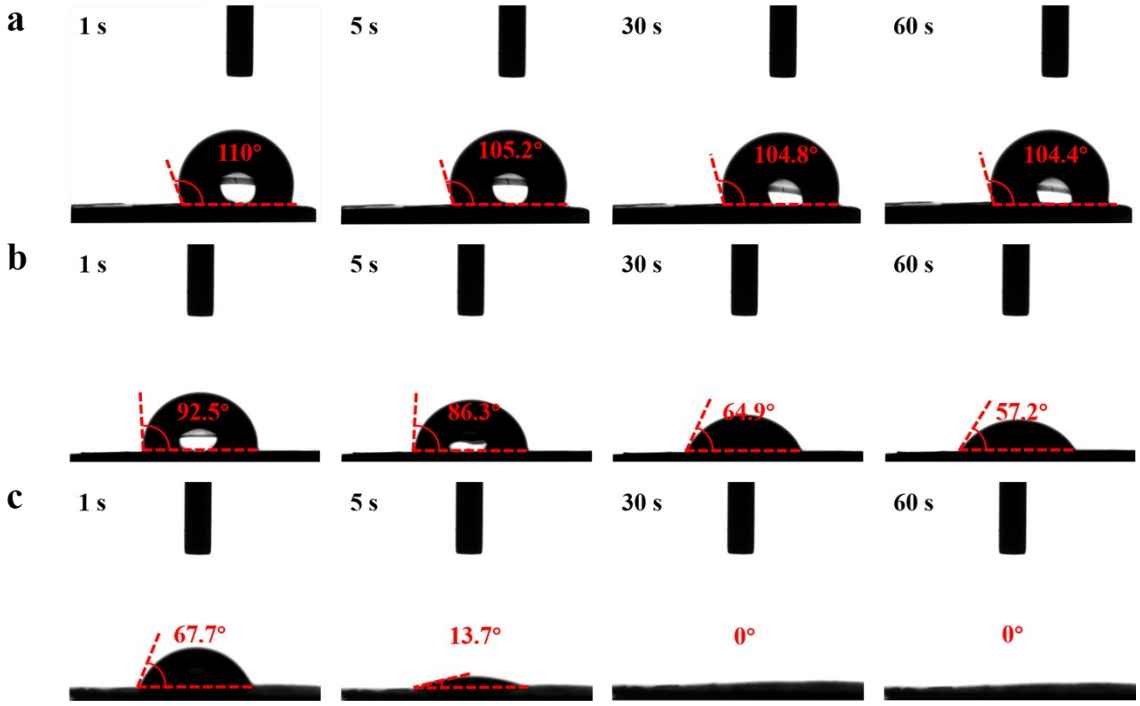


Fig. S2. Contact angle tests of (a) 3DG, (b) 3DNG, (c) 3DNG with plasma enhanced.

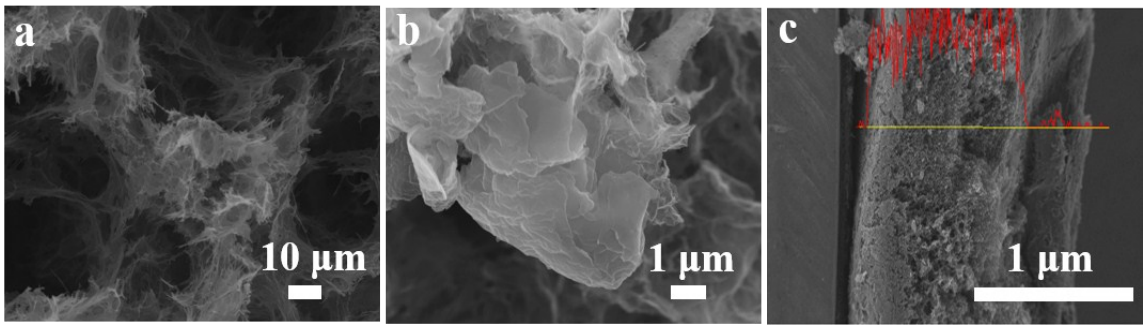


Fig. S3. (a, b) SEM images of TVO@3DNG, (c) element V linear analysis of TVO@3DNG.

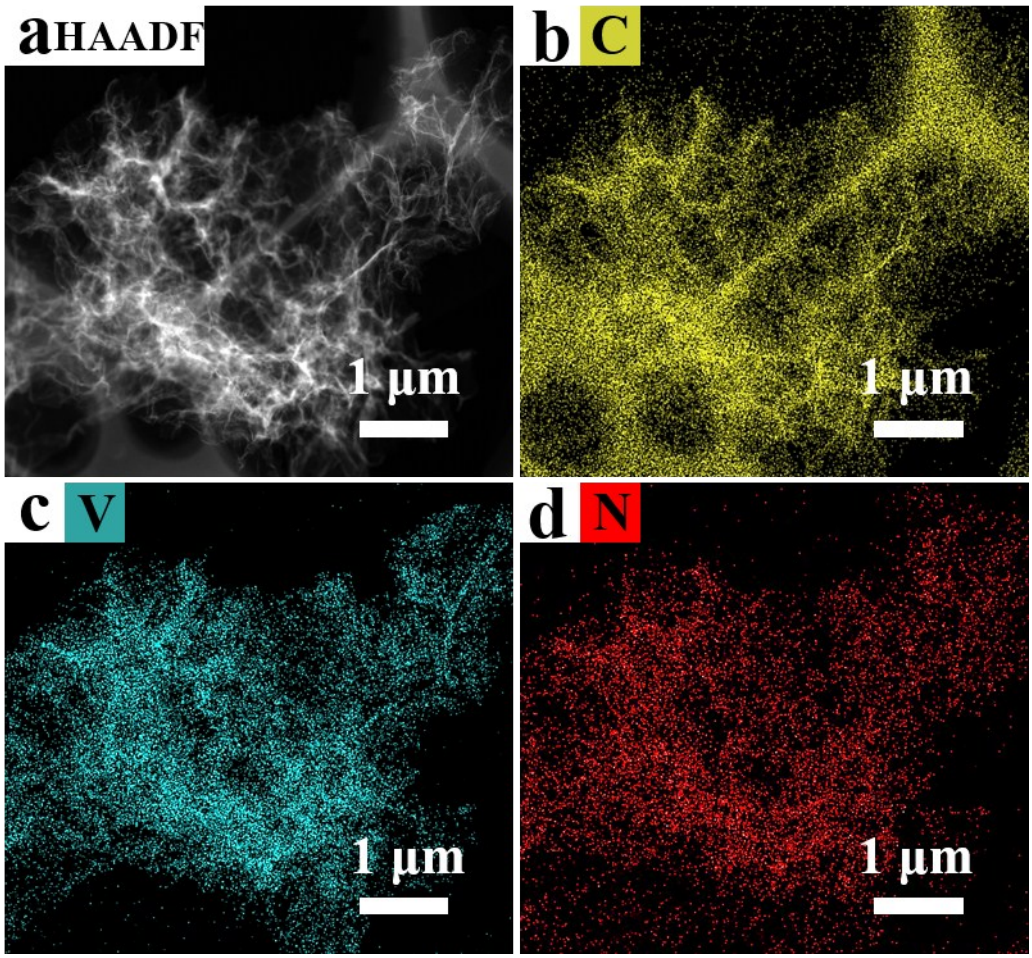


Fig. S4. TEM mapping analysis of the remaining elements of 100-ALDVO@3DNG cathode.

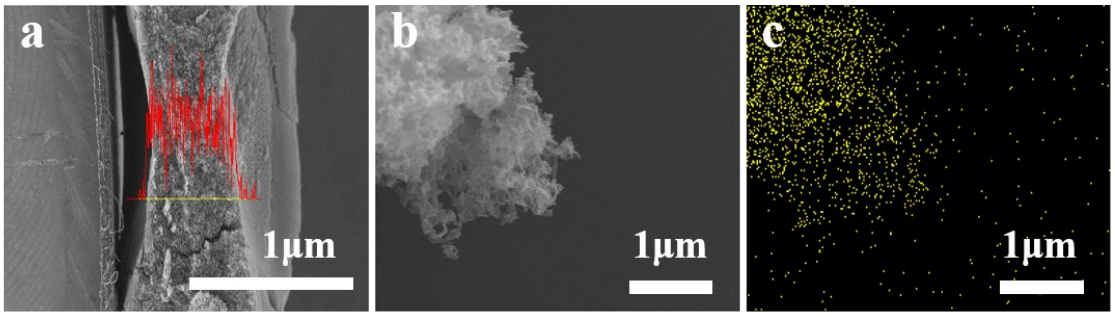


Fig. S5. (a) linear analysis in the cross section of 100-ALDVO@3DNG cathode. (b, c) V element EDS mapping analysis of 100-ALDVO@3DNG.

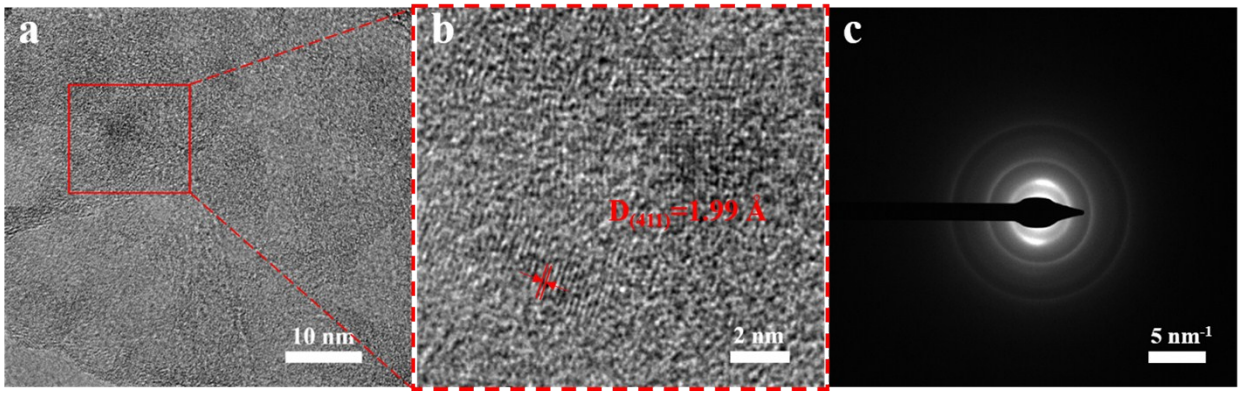


Fig. S6. （a）HRTEM image of 100-ALDVO@3DNG inner graphene surface, (b) enlarged image in red box of (a); (c) SEAD pattern of 100-ALDVO@3DNG.

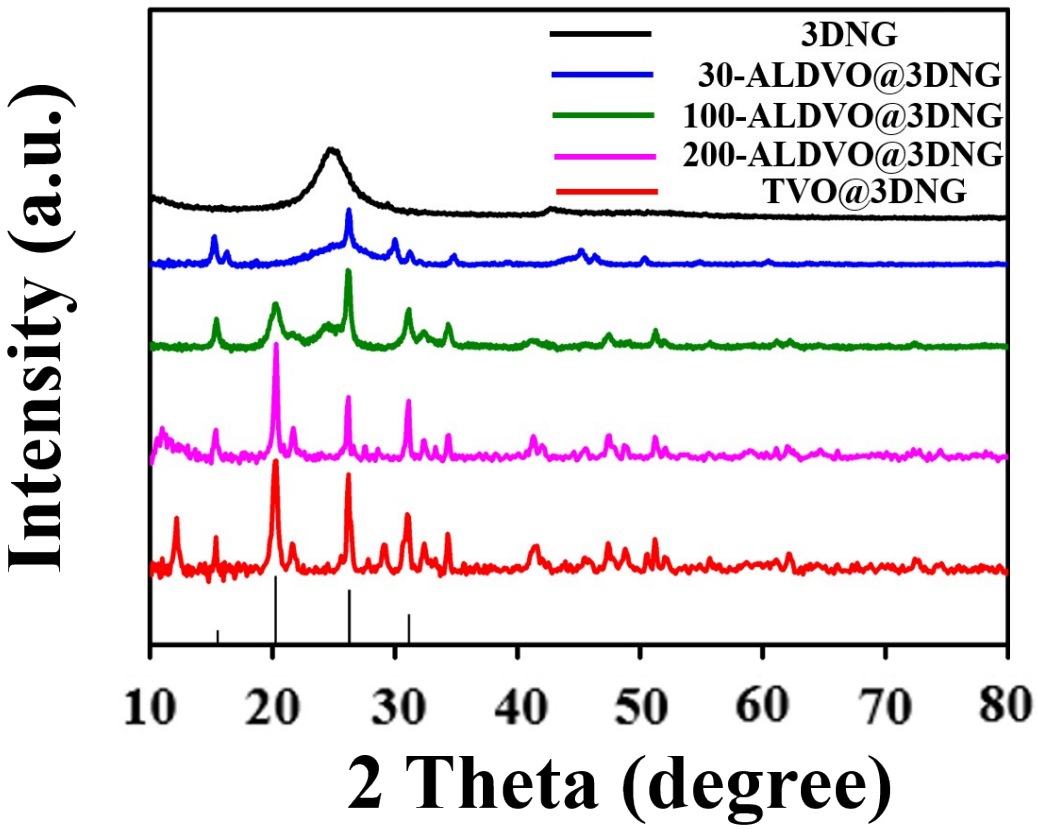


Fig. S7. Comparison of XRD curves of different samples.

Table S1. Electrochemical performance comparison of various ALD process applied in Li-S batteries.

Materials	Rate (1 C= 1675 mA g^{-1})	Capacity (mAh g^{-1})	Ref.
V_2O_5/3DNG	**0.2 C** **0.5 C** **2 C** **3.86 mA cm^{-2}**	**1341.8(100 cycles)** **1102(100 cycles)** **542(350 cycles)** **1204(Initial)**	**This Work**
Al_2O_3/C-S	0.5 C 2 C	646(100 cycles) 540(Initial)	33
V_2O_5/CNTs	0.1 C 0.2 C	1209(Initial) 800(Initial)	38
Al_2O_3/C	0.2 C	1136(Initial)	34
NG/S-TiO_2	0.1 C 1 C	1374(Initial) 918.3 (500 cycles)	37
Al_2O_3/C	0.2 C	423	32

Table S2. Comparison of areal capacity of the 100-ALDVO@3DNG cathode with that of recent publications in Li–S batteries which have high sulfur loadings more than 4 mg cm^{-2}

Mass loading (mg cm^{-2})	Rate (mA cm^{-2})	Areal capacity (mAh cm^{-2})	Ref.
11.5	**3.86**	**14.9(Initial) 11.2(100 cycles)**	**This work**
5	1.68	5.1(Initial) 4(50 cycles)	52
8.1	3.4	7.69(Initial) 6.8(50 cycles)	53
4.2	0.35 2	4.8(Initial) 2.44(60 cycles)	54
10.2	1	10.8(Initial) 6.0(50 cycles)	55
5.4	4.52	5.43(Initial) 4.3(200 cycles)	56
12	4.02	10.2(Initial) 5.04(100 cycles)	57
10.02	3.41	6.52(Initial) 5.14(500 cycles)	58
4	5.8	2.8(Initial) 2.08(500 cycles)	59
4	0.67	3.33(Initial) 1.68(100 cycles)	60
4.2	0.7	5.707(Initial) 4.09(160cycles)	61
6	1.01	6.648(Initial) 4.25(200 cycles)	62
12.1	4.05	12.6(Initial) 11.1(30 cycles)	63
5	0.83	4.87(Initial) 2.56(50 cycles)	64
8	2.68	9.6(Initial) 7.72(60 cycles)	65