Electronic Supplementary Material (ESI) for Nanoscale.

Supplementary Information

Dual-ion acceptable vanadium carbide nanowire cathode integrated with carbon clothes for long cycle stability

Sanghee Nam[a], Pitchai Thangasamy[a], Saewoong Oh[a], Manmatha Mahato[a], Nikhil Koratkar[b], Il-Kwon Oh[*,a]

[a] National Creative Research Initiative for Functionally Antagonistic Nano-Engineering, Department of Mechanical Engineering, Korea Advanced Institute of Science and Technology (KAIST), 291 Daehak-ro, Yuseong-gu, Daejeon 34141, Republic of Korea.

[b] Department of Mechanical, Aerospace and Nuclear Engineering, Rensselaer Polytechnic Institute, 110 8th Street, Troy, NY 12180, USA.

[*] Corresponding author

Phone: +82-42-350-1520, Fax: +82-42-350-1510, e-mail: ikoh@kaist.ac.kr

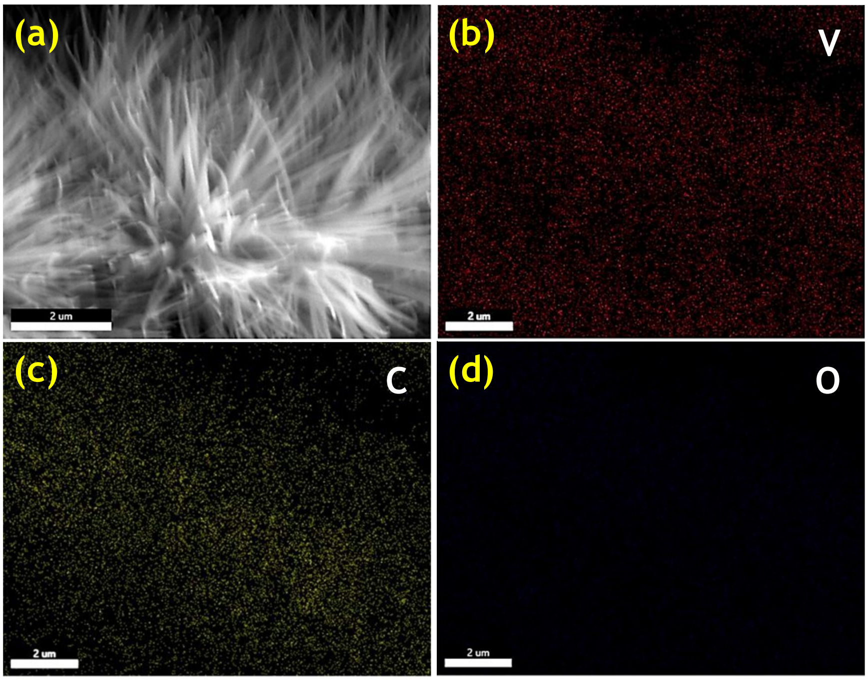

Fig. S1. Elemental study obtained with SEM EDS mapping.

Elemental analysis for V, C and O of V_8C_7 NWs

Table S1. Elemental analysis for C and O in weight percent and V, C and O in atomic percent

Material	Chemical composition				
	wt%		at%		
	C	O	V	C	O
V_8C_7 NWs	16.94	0.42	53.1	38.4	8.5

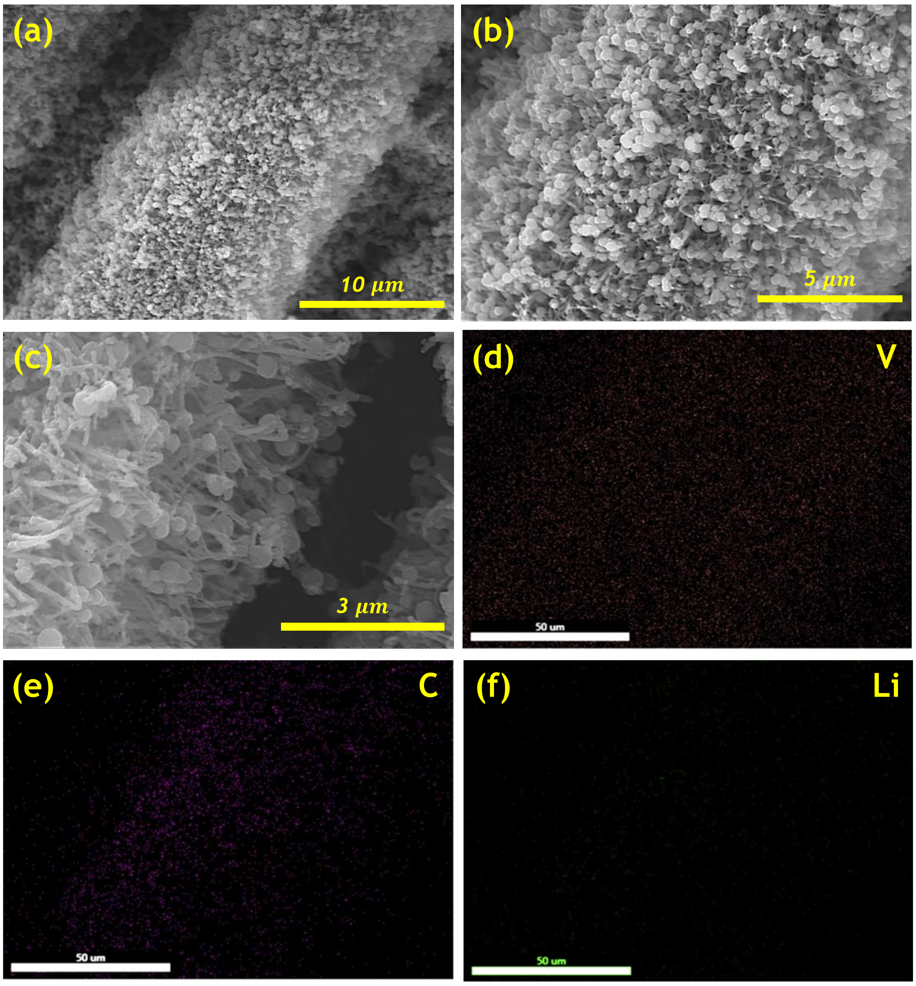

Fig. S2. Morphological change of V_8C_7 NWs (a-d) and elemental analysis (e-h) after 10 cycle to charge and discharge.

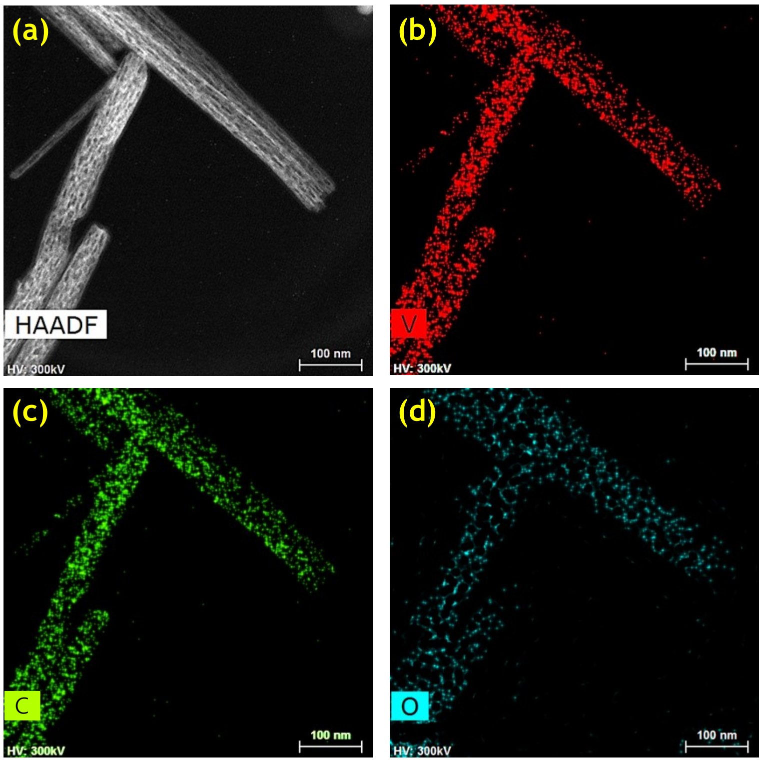

Fig. S3. Elemental study obtained with HAADF TEM EDS mapping.

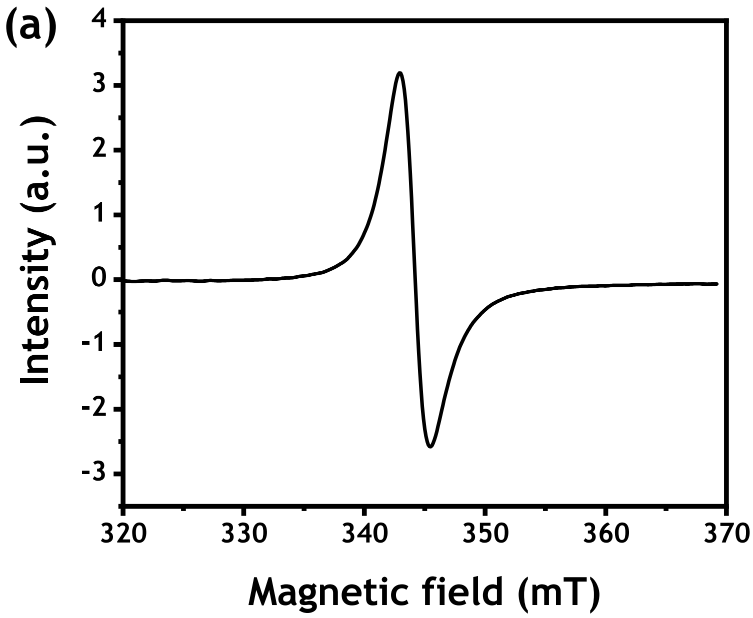

Fig. S4. Electron paramagnetic resonance study of V_8C_7 NWs.

Reaction equations in detail during synthesis of the V_8C_7 NWs from precursors.

The chemical reactions involved during ultra-sonication subject, hydrothermal synthesis and annealing process can be described as follows:

$2NH_4VO_3 + C_2H_2O_4 \rightarrow 2VO_2 + 2NH_3 + 2CO_2 + 2H_2O$

$9VO_2 + 2C \rightarrow V_5O_9 + V_4O_7 + 2CO$

$2V_5O_9 + V_4O_7 + 4C \rightarrow 7V_2O_3 + 4CO$

$V_2O_3 + (5\text{-}2x)C \rightarrow 2VC_{1\text{-}x} + 3CO$

$8VC_{1\text{-}x} + (8x\text{-}1)C \rightarrow V_8C_7$

Calculation for resistivity and electrical conductivity from sheet resistance measured.

$$\rho\ [\Omega\ cm^{-1}] = R_s\ [\Omega\ sq^{-1}] \times t\ [cm]$$

$$\sigma\ [S\ m^{-1}] = \frac{1}{\rho}$$

where ρ is resistivity, σ is electrical conductivity, R_s is sheet resistance, and t is thickness of material.

Thickness of our materials were average 150 $\times$ 10^{-6} m.

Table S2. Sheet resistance and calculated electrical conductivity of V_8C_7 NWs, V_2O_5 NWs and other vanadium-based materials.

Material	Resistivity	Conductivity	Temperatur	Reference

			e [K]	
V_8C_7 NWs	15.54 mΩ cm^{-1} 26.22 mΩ cm^{-1} 22.47 mΩ cm^{-1} 22.89 mΩ cm^{-1}	6.435×10^3 S m^{-1} 5.342×10^3 S m^{-1} 5.565×10^3 S m^{-1} 5.921×10^3 S m^{-1}	RT	This work
V_2O_3 NWs	32.09 mΩ cm^{-1} 32.06 mΩ cm^{-1} 32.08 mΩ cm^{-1} 32.10 mΩ cm^{-1}	3.116×10^3 S m^{-1} 3.119×10^3 S m^{-1} 3.117×10^3 S m^{-1} 3.115×10^3 S m^{-1}	RT	This work
V_2O_5 NWs	37.32 Ω cm^{-1} 37.20 Ω cm^{-1} 37.26 Ω cm^{-1} 37.38 Ω cm^{-1}	4.019×10^1 S m^{-1} 4.032×10^1 S m^{-1} 4.027×10^1 S m^{-1} 4.013×10^1 S m^{-1}	RT	This work
V_8C_7	3.2 $\mu\Omega$ cm^{-1}	-	1,378.15 K	[1]
Ordered V_8C_7	30 $\mu\Omega$ cm^{-1}	-	RT	[1]
Annealed V_8C_7	40 $\mu\Omega$ cm^{-1}	-	RT	[1]
Disordered V_8C_7	49 $\mu\Omega$ cm^{-1}	-	RT	[1]
Quenched V_8C_7	70 $\mu\Omega$ cm^{-1}	-	RT	[1]
V_2O_3 nanosheet	-	2.500×10^1 S m^{-1}	RT	[2]
VO_2	-	1.000×10^2 S m^{-1}	340 K	[3]

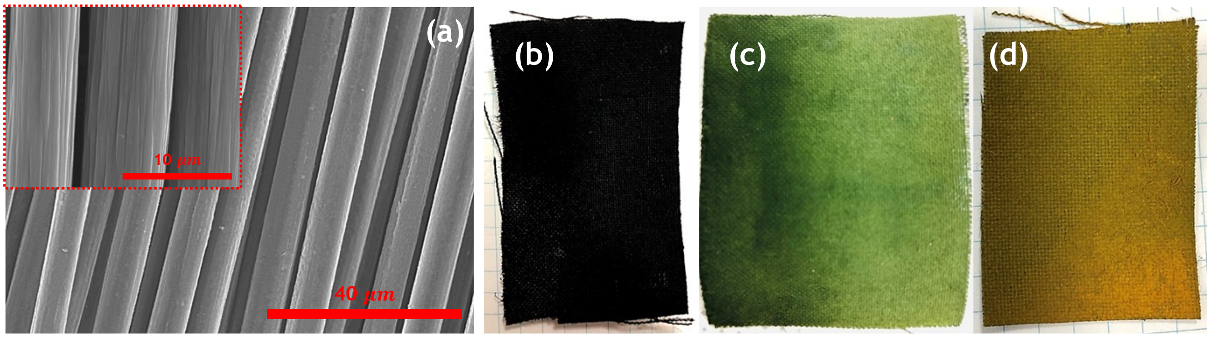

Fig. S5. (a) SEM images of bare carbon clothes, (b) V_8C_7 NWs, (c) V_2O_3 NWs, and (d) V_2O_5 NWs grown on the carbon clothes.

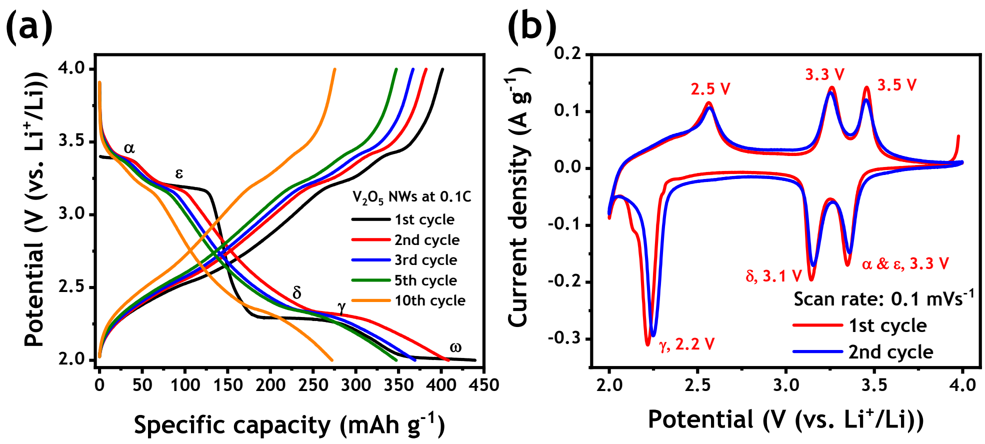

Fig. S6. Charge-Discharge curves (a) and CV measurement (b) of V_2O_5 NWs for LIBs.

Table S3. The list of other vanadium compounds in the potential window between 2 and 4 V (vs. Li^+/Li).

Material	**Specific capacity [mAh g^{-1}]**	**Cycle number**	**Capacity fading per cycle [%]**	**Current density [mA g^{-1}]**	**Referenc e**
V_8C_7 Nanowires	303	200	0.4	30	This work
1D nanostructure	312	20	1.4	50	[4]
1D nanorods	274	30	0.6	15	[5]
1D nanorods	288	50	0.18	10	[6]
3D uniform yolk-shell microspheres	280	30	0.7	30	[7]
2D self-assembled nanobelt membrane	290	50	0.28	500	[8]
2D porous nanostructured films	294	40	0.45	300	[9]
3D hierarchical urchin-like microflowers	274	50	0.4	300	[10]
3D nanostructured hollow	241	110	0.191	300	[11]

microspheres					
3D hollow microspheres	256	50	0.22	300	[12]
2D leaf-like nanosheets	264	100	0.22	500	[13]
3D hierarchical microspheres	266	100	0.25	300	[14]
3D yolk-shell powders	271	100	0.26	1,000	[15]

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