V_2O_5 Nanosheets Supported on 3D N-Doped Carbon Nanowall Arrays as an Advanced Cathode for High Energy and High Power Fiber-Shaped Zinc-Ion Battery

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1. Materials

2-Methylimidazole ($C_4H_6N_2$, 98%), Cobalt nitrate ($Co(NO_3)_2·6H2O$, 99%), Iron chloride hexahydrate ($FeCl_3·6H_2O$, 99%), Zinc chloride ($ZnCl_2$, 98%), Zinc sulfate heptahydrate ($ZnSO_4·7H2O$, 99.5%) sodium sulfate (Na_2SO_4, 99%) and PVA (98.0~99.0%) were provided by Aladdin. Isopropanol (C3H8O), Methanol (CH_4O, 99.9%), boric acid (H_3BO_3, 99.8%), ethanol (C_2H_6O, 99.7%), and Hydrochloric acid (HCl, 36%~38%) were purchased from Sinopharm Chemical Reagent, China., Triisopropoxyvanadium(V) oxide ($C_9H_{21}O4_V$, 97%)were provided by Tokyo Chemical Industry CO., LTD.

2. Electrochemical Performance Measurements

The electrochemical characterizations of obtained electrode materials was analyzed by cyclic voltammetry curves, galvanostatic charge/discharge curves, and electrochemical impedance spectroscopy measured on an electrochemical workstation (CHI 760E, Chenhua). The electrochemical performance of the aqueous V-MOF-12//Zn, V-MOF-24//Zn and V-MOF-48//Zn batteries was characterized in a two-electrode cell with an aqueous electrolyte containing 2 M $ZnSO_4$.

The calculation equation of the electrode volume :

$$V = \frac{\pi D^2 L}{4} \quad (1)$$

where V (cm^3) represents the total volume of the electrodes, D (cm) is the diameter of the electrodes with electrochemical active materials and L (cm) is the length of the electrodes.

3. Characterizations of materials

The morphologies and microstructures of the electrodes and pressure sensor were analyzed by using a scanning electron microscope (Hitachi S-4800, 5 KV). The crystal structure and chemical composition of samples were characterized by X-ray diffraction (Rigaku D/MAX2500 V) and X-ray photoelectron spectrometer (ESCALab MKII). Transmission electron microscopy images were

measured by a high-resolution transmission electron microscope (FEI Tecnai G2 20).

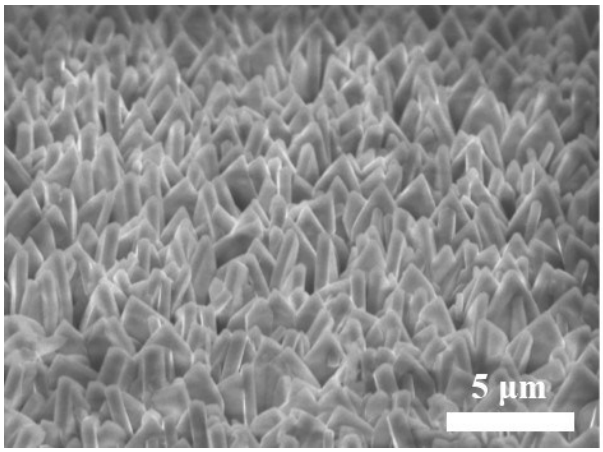

Figure S1 The SEM image of CNTF@Co-MOF.

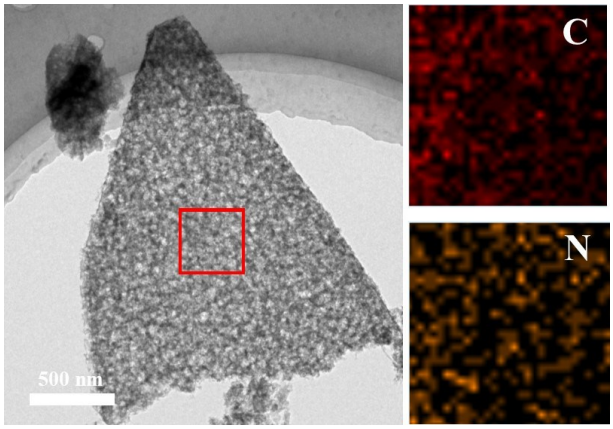

Figure S2 EDX mappings of C and N elements measured from NC nanowall.

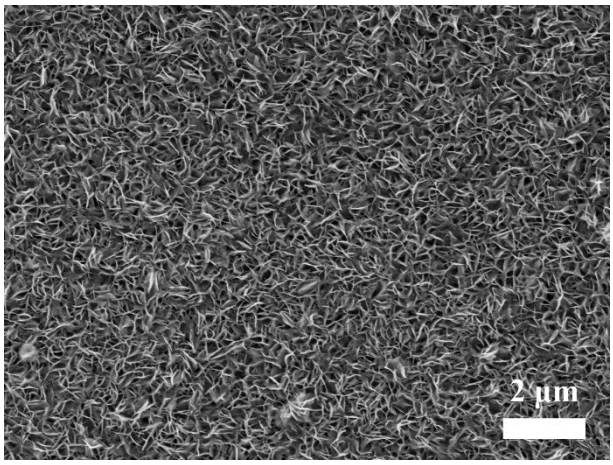

Figure S3 The SEM images of CNTF@V_2O_5.

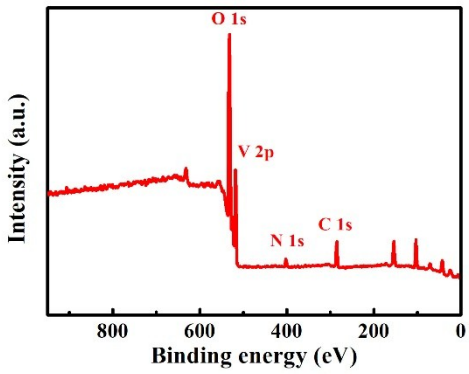

Figure S4 The XPS spectrums (Fig. SX) of CNTF@NC@V_2O_5.

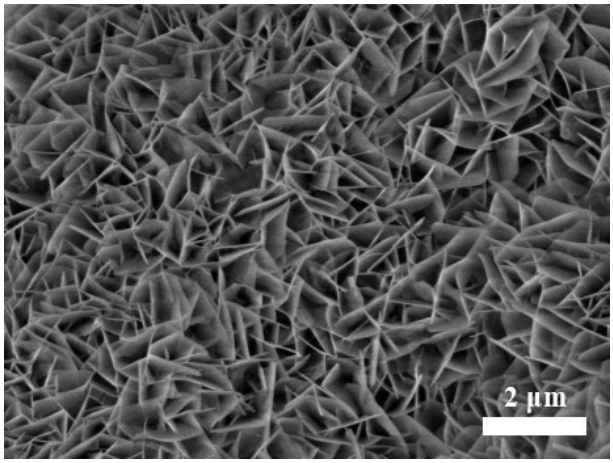

Figure S5 The SEM image of CNTF@Zn.

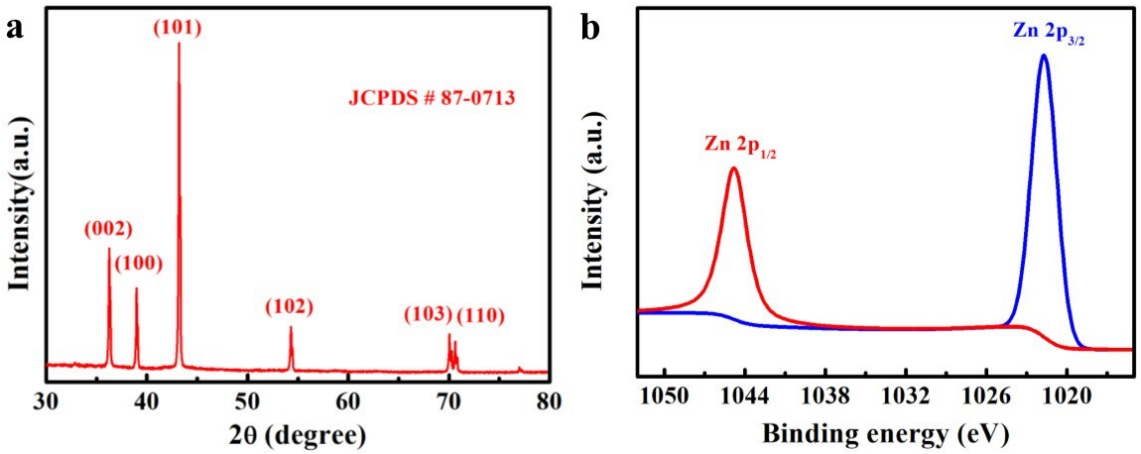

Figure S6 The XRD pattern and XPS spectrum of Zn nanosheets.

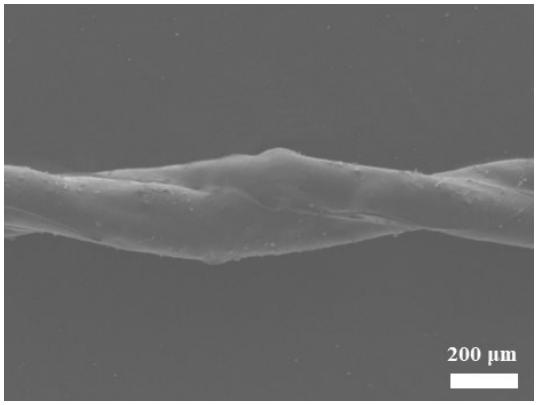

Figure S7 The SEM image of the assembled fiber-shaped Zn-ion battery.

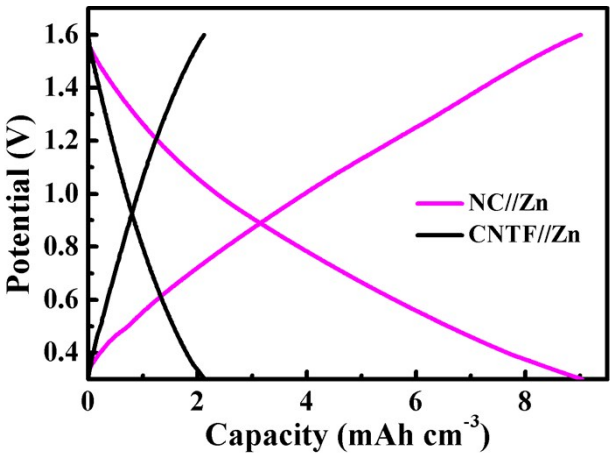

Figure S8 The GCD curves of CNTF//Zn and CNTF@NC//Zn batteries at a current density of 0.3 A cm^{-3}.

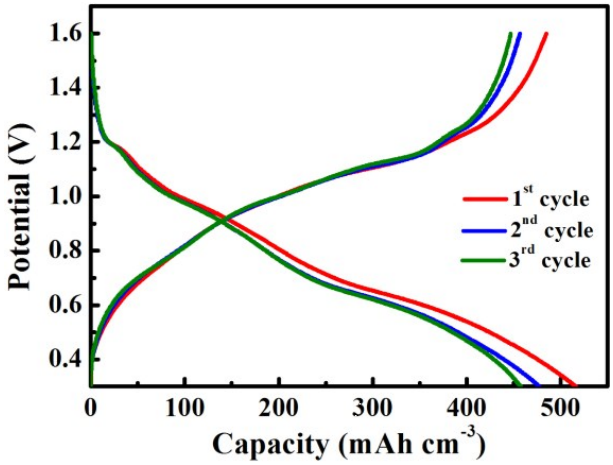

Figure S9 The GCD curves of initial three cycles for the NC@V_2O_5//Zn battery.

Table S1 The volumetric capacities based on the whole volume of cathode and anode

Current densities ($A\ cm^{-3}$)	**0.146**	**0.293**	**0.585**	**1.17**	**2.93**	**4.39**	**7.32**	**14.6**
Capacities ($mAh\ cm^{-3}$)	**222.93**	**203.27**	**192.05**	**181.61**	**167.83**	**150.24**	**133.17**	**106.10**

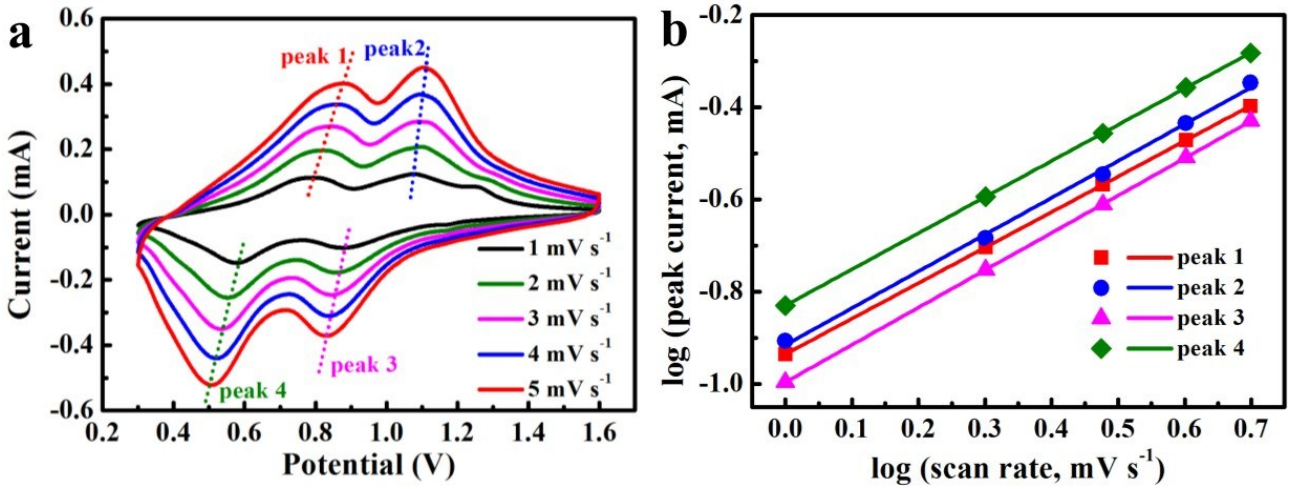

Figure S10 The CV curves of V_2O_5//Zn battery at various scan rates.

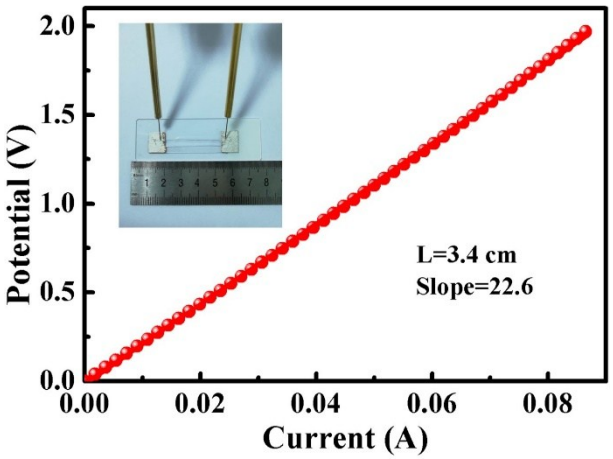

Figure S11 Current-voltage characteristic curve of the CNTF@NC@V_2O_5.

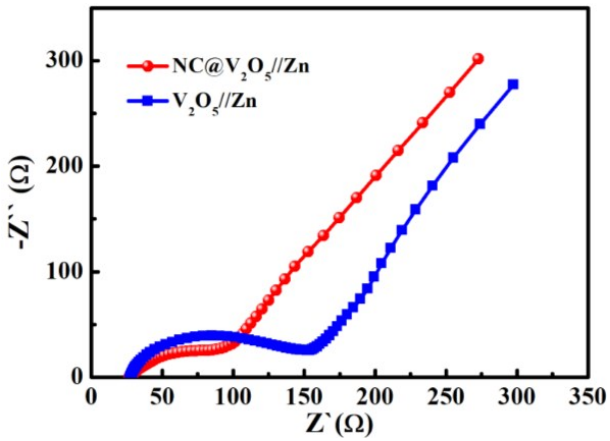

Figure S12 The Nyquist plots of NC@V_2O_5//Zn and V_2O_5//Zn batteries.

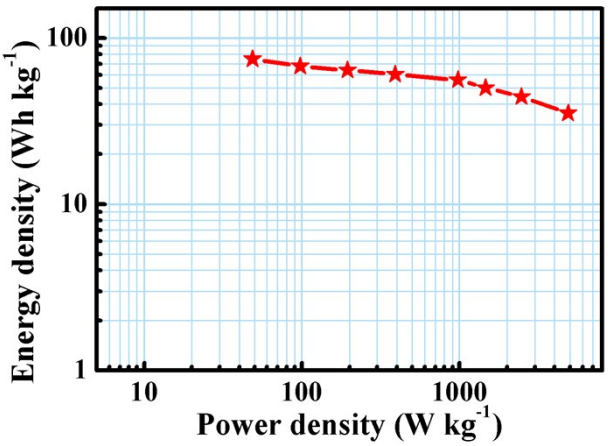

Figure S13 Specific energy and power densities of the device.

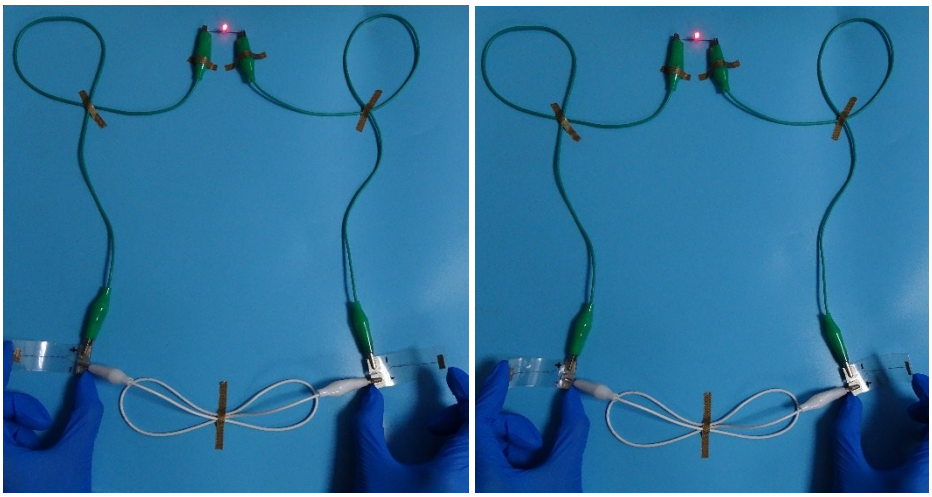

Figure S14 A LED powered by two fiber-shaped batteries in series under various bend angles.