Electronic Supplementary Information

T-Nb_2O_5 nanoparticles confined in carbon nanotubes with fast ion diffusion rate as lithium storage

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Material characterization

Compositions of samples were characterized by X-ray diffraction (XRD; Bruker D8/Cu Kα radiation). Morphology analysis was conducted by utilizing Hitachi's field-emission scanning electron microscopy (SEM, S-4800) and transmission electron microscopy and high resolution transmission electron microscope (HRTEM, JEOL JEM-2010F). Thermogravimetric analysis (TGA) was conducted by the Netzsch STA 449C from room temperature to 800 ^{o}C with a heating rate of 10 ^{o}C min^{-1}. Brunauer-Emmett-Teller (BET) specific surface area and pore structure analysis (DFT method) were measured by nitrogen adsorption/desorption with an Autosorb-iQ Pressure Sorption Analyzer (Quantachrome Instruments USA) at 77 K. The preparation of the working electrodes follows the previous procedure.[1,2] Cyclic voltammetry curves were accounted on a CHI-660C workstation with a sweep rate of 0.1 mV s^{-1}. Galvanostatic charge and discharge processes were conducted on a Land (CT2001A China) at 0.01-3.00 V (versus Li^{+}/Li). The mass loading of the T-Nb_2O_5/CNT active material is 0.968 and 0.992 mg for LIBs and SIBs, respectively.

Explanation on equation:

$$i = av^b \quad (1)$$

a and b are changeable factors. The b value of 0.5 shows that the Li^+ storage is completely regulated by the diffusion controlled process, whereas a b value of 1 means that the surface-controlled process completely occupies a dominant position.

Determination of diffusion coefficient

$$i_p = (2.69 \times 10^5) n^{3/2} A D^{1/2} C v^{1/2} \quad (2)$$

i_p: peak current (A)

n: the transferred number of electrons in the electrochemical reaction

A: the surface area of the electrode (1.13 cm^{-2})

D: the Li^+ diffusion coefficient of the active material

C: the concentration of lithium ions in the anode

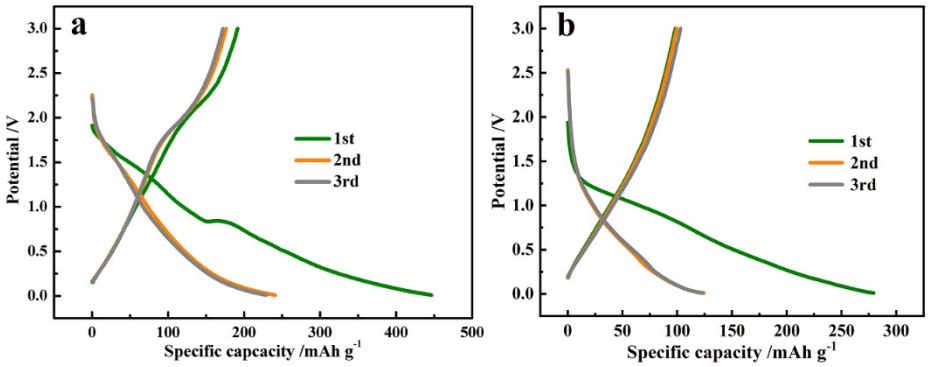

Figure S1. Galvanostatic charge-discharge curves for the first three cycles of T-Nb_2O_5/CNT for LIBs at 0.4 A g^{-1} (a) and SIBs at 0.1 A g^{-1} (b).

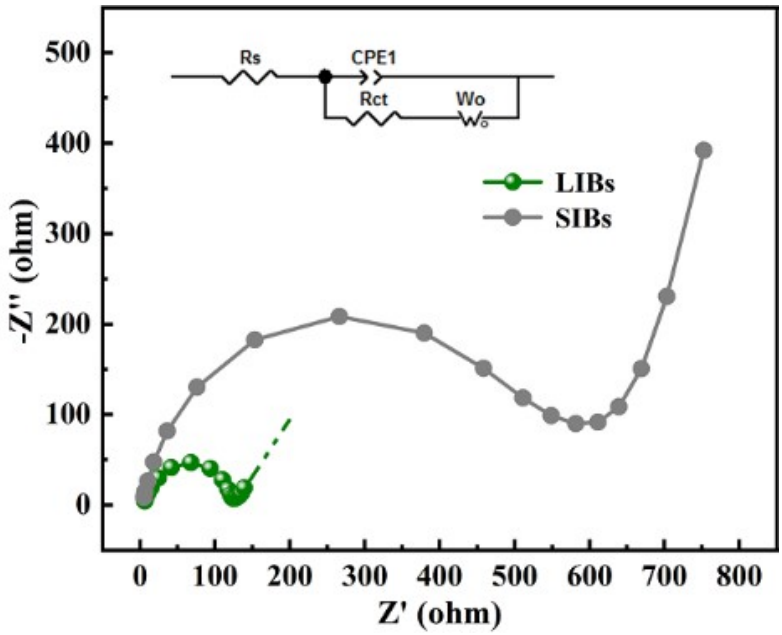

Figure S2. Electrochemical impedance spectra of T-Nb_2O_5/CNT for LIBs and SIBs.

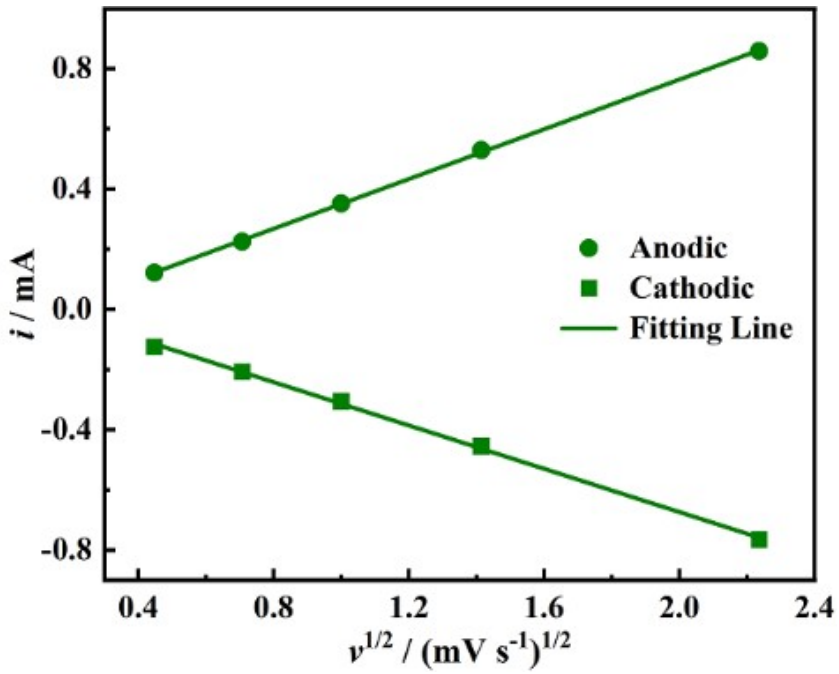

Figure S3. Relationship between peak current (*i*) and the square root of the scan rate ($v^{1/2}$) of the T-Nb_2O_5/CNT electrode.

Table S1. Comparison of Li^+ diffusion coefficient for different niobium-based anodes.

Materials	D_{Li}^+(cm^2/s, lithiation)	D_{Li}^+(cm^2/s, delithiation)	Ref
$TiCr_{0.5}Nb_{10.5}O_{29}$/CNTs	3.34×10^{-14}	3.41×10^{-14}	3
$TiNb_2O_7$/CNTs	9.27×10^{-16}	1.37×10^{-15}	4
$TiNb_6O_{17}$	4.28×10^{-14}	5.48×10^{-14}	5
$CrNb_{11}O_{29}$	1.51×10^{-13}	3.57×10^{-13}	6
$Ti_2Nb_{14}O_{39}$	9.07×10^{-14}	5.52×10^{-14}	7
M-$MoNb_{12}O_{33}$	4.0×10^{-14}	8.6×10^{-14}	8
N-$GeNb_{18}O_{47}$	1.596×10^{-15}	1.552×10^{-15}	9
$TiNb_2O_7$@C	2.39×10^{-12}	2.13×10^{-12}	10
$Mg_2Nb_{34}O_{87}$	3.23×10^{-13}	6.36×10^{-13}	11
$Cu_2Nb_{34}O_{87}$	3.1×10^{-13}	3.9×10^{-13}	12
T-Nb_2O_5/CNT	6.61×10^{-12}	4.98×10^{-12}	This

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