

## Supplementary Information

### One-step uniform rotation solvothermal synthesis of $\text{Li}_3\text{VO}_4@\text{rGO}$ anode material with superior cycle and rate performance

Zhihan Kong<sup>a,b</sup>, Kongjun Zhu<sup>a\*</sup>, Yu Rao<sup>a, b</sup>, Penghua Liang<sup>a,b</sup>, Jiatao Chen<sup>a, b</sup>, Wei Wang<sup>b</sup>, Chuanxiang Zhang<sup>c</sup>, Jingsong Liu<sup>b</sup>, Kang Yan<sup>a</sup>, and Jing Wang<sup>a</sup>

<sup>a</sup> State Key Laboratory of Mechanics and Control for Aerospace Structures, College of Aerospace Engineering, Nanjing University of Aeronautics and Astronautics, Nanjing, 210016, China

<sup>b</sup> College of Materials Science and Technology, Nanjing University of Aeronautics and Astronautics, Nanjing, 210016, China

<sup>c</sup> Jiangsu Key Laboratory of Advanced Structural Materials and Application Technology, Nanjing Institute of Technology, Nanjing 211167, China

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## Experimental

### Material synthesis

The graphene-wrapped  $\text{Li}_3\text{VO}_4@\text{rGO}$  hybrid was prepared via a one-step URS process. In brief, 4 mmol  $\text{NH}_4\text{VO}_3$  and 12 mmol  $\text{LiOH}\cdot\text{H}_2\text{O}$  were put in a mixed solution of 5 mL deionized water and 20 mL ethylene glycol (EG) with stirring until fully dissolved. Then, 5 mL GO dispersed solution ( $5 \text{ g L}^{-1}$ ) prepared by the modified Hummers method was added into the mixed solution after ultrasonically treated. The mixed solution was further stirred for 30 min. Then the mixed solution was poured into a 70 mL Teflon-lined autoclave and heated at  $180 \text{ }^\circ\text{C}$  for 2h with uniform rotation

at a constant speed (20 r min<sup>-1</sup>). After the reactor cooled down to the room temperature, a black precipitate was collected by suction filtration and washed for several times with deionized water and alcohol. Finally, the black precipitate denoted as the Li<sub>3</sub>VO<sub>4</sub>@rGO-R was dried at 80 °C for 12 h during vacuum atmosphere.

For comparison, Li<sub>3</sub>VO<sub>4</sub>@rGO hybrid denoted as the Li<sub>3</sub>VO<sub>4</sub>@rGO-T was also prepared by traditional solvothermal (TS) with autoclave placed in the oven without rotation. Pure Li<sub>3</sub>VO<sub>4</sub> denoted as Li<sub>3</sub>VO<sub>4</sub>-R was also prepared via the URS without adding GO dispersed solution.

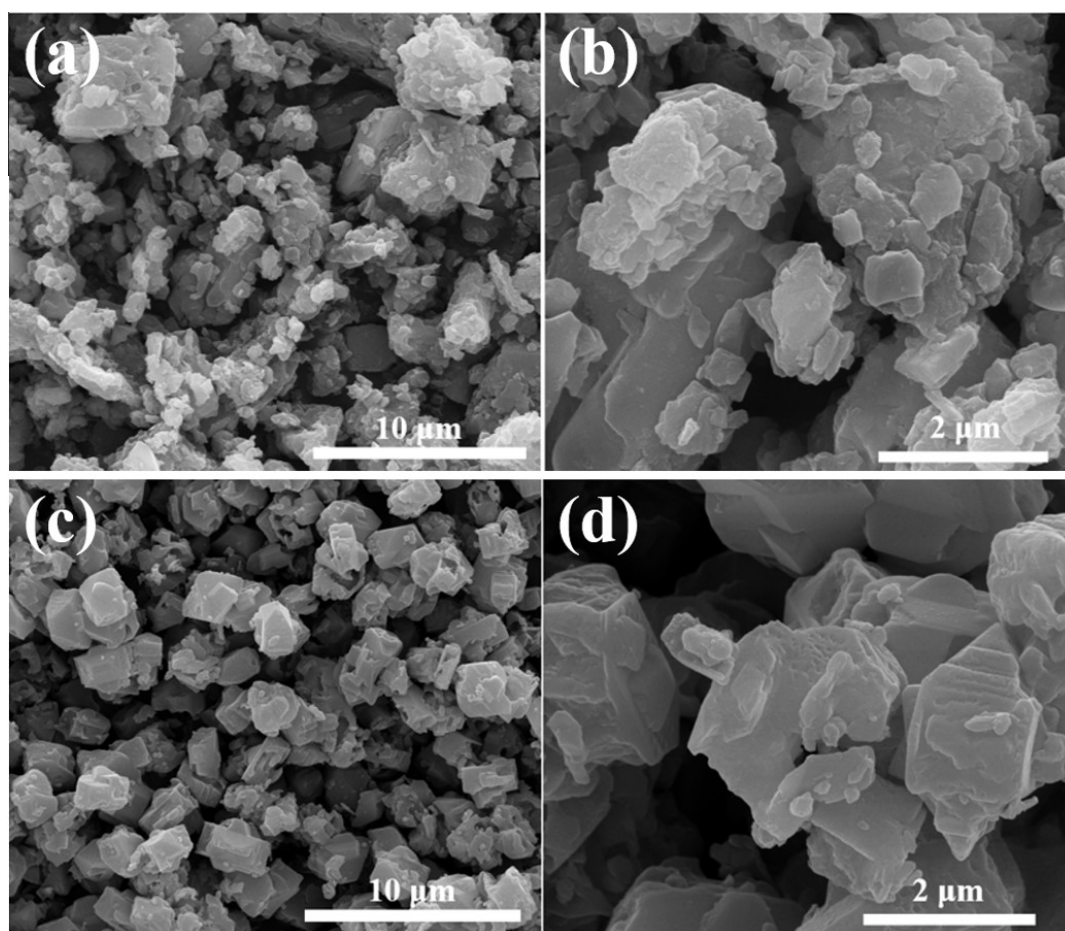
### **Materials characterization**

Field-emission scanning electron microscopy (HITACHI S-4800) and transmission electron microscopy (TEM, Tecnai G2 F30) were performed to observe the morphologies of the products. The phase structure of the products were confirmed by X-ray diffraction (XRD, Panalytical) with Cu K $\alpha$  radiation ( $\lambda$ = 0.15418 nm). The valence state and chemical environment of the products were characterized via X-ray photoelectron spectroscopy (XPS) (AXIS-Ultra DLD with Al K $\alpha$ , 15 kV, Japan) and Raman spectroscopy (Horiba Labram HR Evolution) with a 532 nm solid-state laser. The carbon content of the products were analyzed by Simultaneous thermal analysis (STA449F5 Jupiter) from 30 °C to 900 °C with a heating rate of 10 °C min<sup>-1</sup> in air. The specific surface area of the products was estimated by N<sub>2</sub> adsorption-desorption isotherms (JW-BK200B) at 77.35 K.

### **Electrochemical characterization**

The synthesized Li<sub>3</sub>VO<sub>4</sub>@rGO powder as active materials, acetylene black and polyvinylidene fluoride in the weight ratio of 7:2:1 were mixed with N-methyl-2-pyrrolidon (NMP) solvent to form slurry. Then the working electrodes were fabricated by blade coating the mixed slurry on a Cu foil and dried at 80 °C in a vacuum oven for 12 h. The active material loading on electrode slice was about 0.8–1.1 mg cm<sup>-2</sup>. The electrolyte was 1.0 M of LiPF<sub>6</sub> in a mixture of ethylene carbonate/diethyl carbonate (1:1 vol/vol), the Celgard2400 was applied as separator and Li foil was used

as counter electrode. The electrochemical properties of the  $\text{Li}_3\text{VO}_4@\text{rGO}-\text{R}$ , the  $\text{Li}_3\text{VO}_4@\text{rGO}-\text{T}$  and  $\text{Li}_3\text{VO}_4-\text{R}$  were then studied by assembling CR2032 coin-type half cells in an argon-filled glovebox. The cyclic voltammetry curves (cut-off voltage: 0.01–3 V, scan rate:  $0.1 \text{ mV s}^{-1}$ – $1.0 \text{ mV s}^{-1}$ ) and electrochemical impedance spectra in the frequency range of 0.01 Hz to 1 MHz were tested by the CHI 660E electrochemical workstation. Galvanostatic charge–discharge (GCD) tests were performed by using a LAND CT2001A cell test system with a voltage window of 0.01–3 V at  $25 \text{ }^\circ\text{C}$ .



**Fig S1.** SEM image of (a)(b)  $\text{Li}_3\text{VO}_4@\text{rGO}-\text{T}$ , (c)(d)  $\text{Li}_3\text{VO}_4-\text{R}$

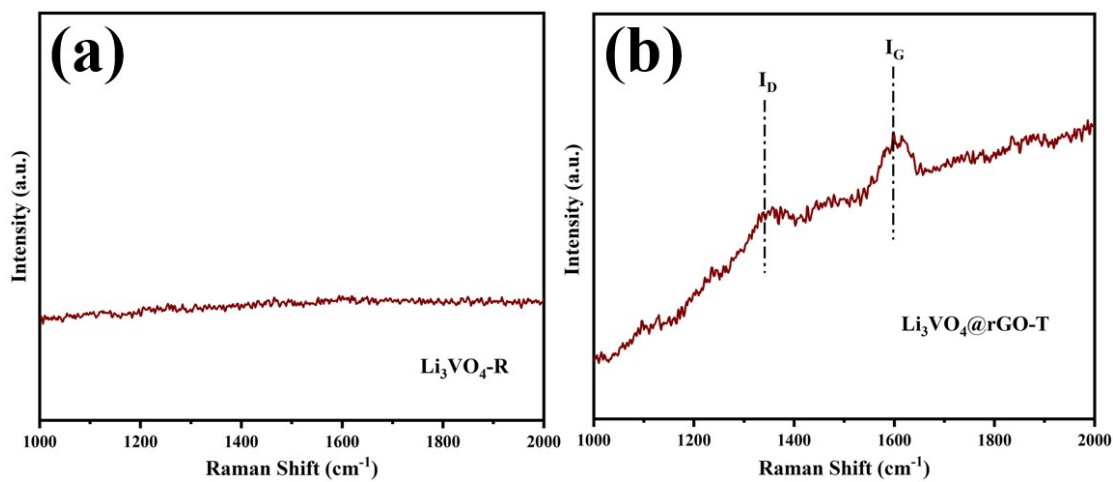


Fig S2. Raman spectra of (a)  $\text{Li}_3\text{VO}_4\text{-R}$ , (b)  $\text{Li}_3\text{VO}_4\text{@rGO-T}$

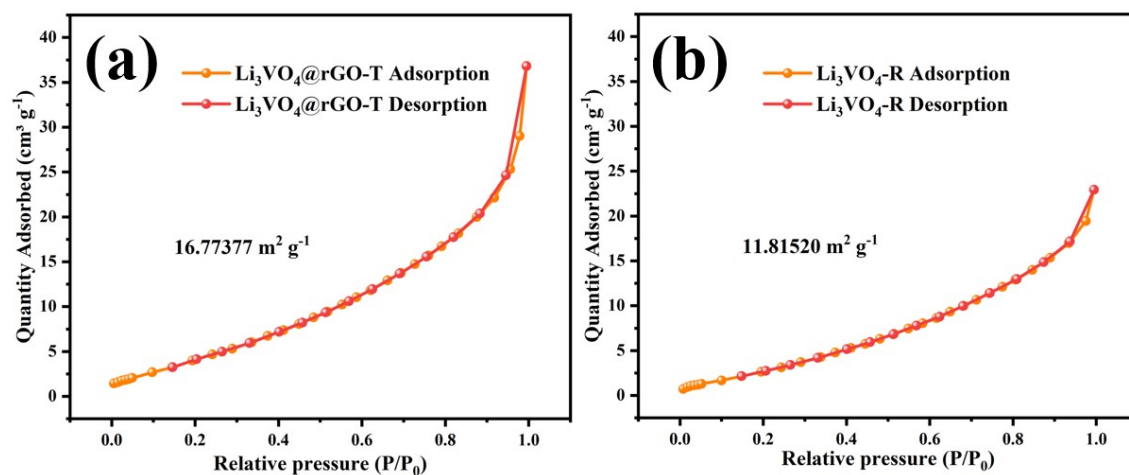
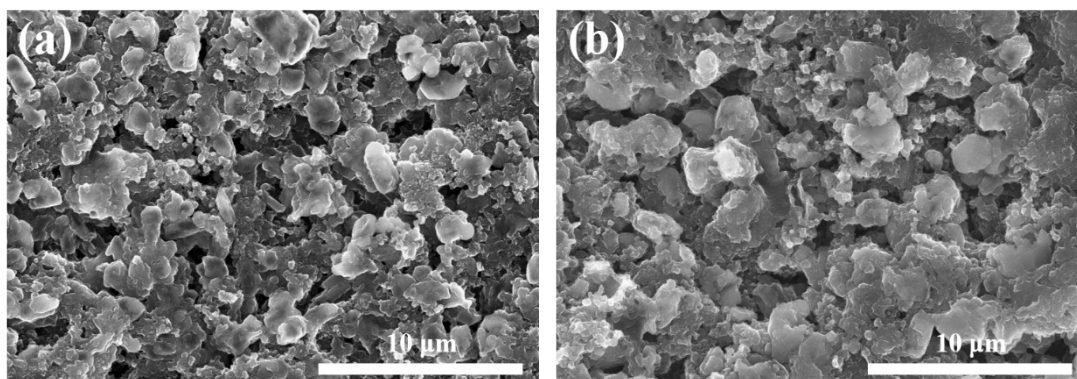
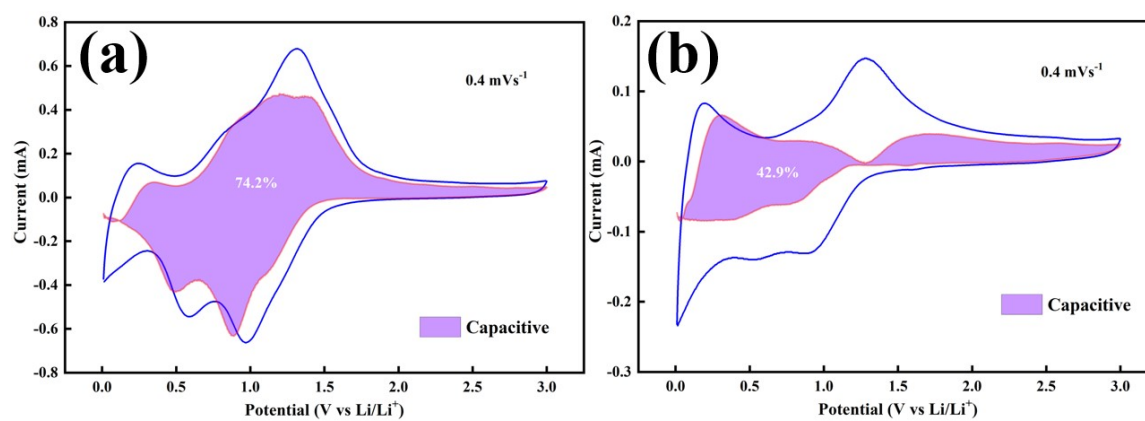


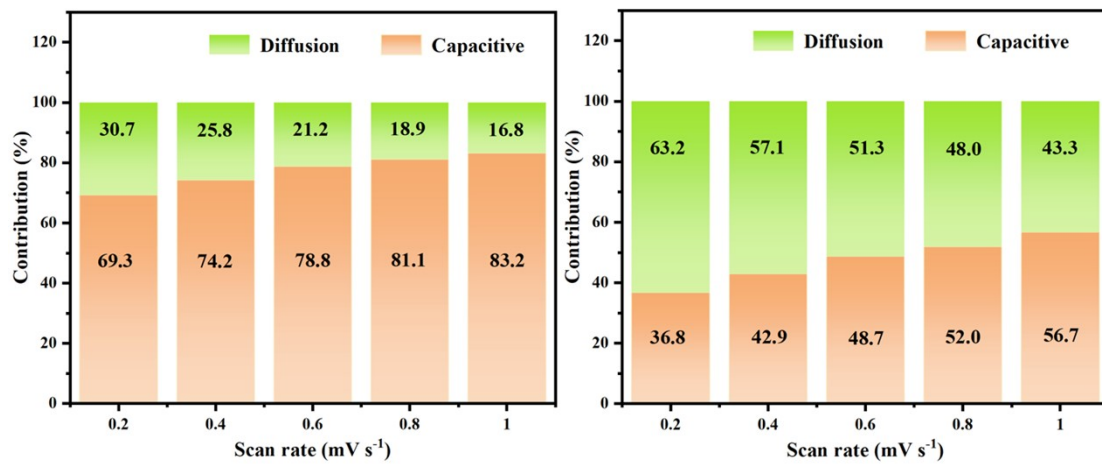
Fig S3.  $\text{N}_2$  adsorption/desorption isotherms of (a)  $\text{Li}_3\text{VO}_4\text{@rGO-T}$ , (b)  $\text{Li}_3\text{VO}_4\text{-R}$



**Fig S4.** SEM images of (a)  $\text{Li}_3\text{VO}_4@\text{rGO-R}$  and (b)  $\text{Li}_3\text{VO}_4@\text{rGO-T}$  cycled at  $5 \text{ A g}^{-1}$  after 1000 cycles



**Fig S5.** CV curves with the percentage of pseudocapacitive contribution at  $0.4 \text{ mV s}^{-1}$  of (a)  $\text{Li}_3\text{VO}_4@\text{rGO-T}$ , (b)  $\text{Li}_3\text{VO}_4\text{-R}$



**Fig S6.** percentage of pseudocapacitive contribution at various scan rates (a)

Li<sub>3</sub>VO<sub>4</sub>@rGO-T, (b) Li<sub>3</sub>VO<sub>4</sub>-R