Supporting information

Hybrid LiV_3O_8/carbon encapsulated $Li_{1.2}Mn_{0.54}Co_{0.13}Ni_{0.13}O_2$ with improved electrochemical properties for lithium-ion batteries

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The Thermo-gravimetric (TG) measurement was carried out in air over the temperature range of 25°C-600 °C at a rising rate of 10 °C min^{-1} using a TQA 50 instrument. Fig. S1 presents the TG and DTG curves of the mixture of sucrose and NH_4VO_3 with a mass ratio of 4.5:2.0 (a), and the precursor of the LMSSVC (b).

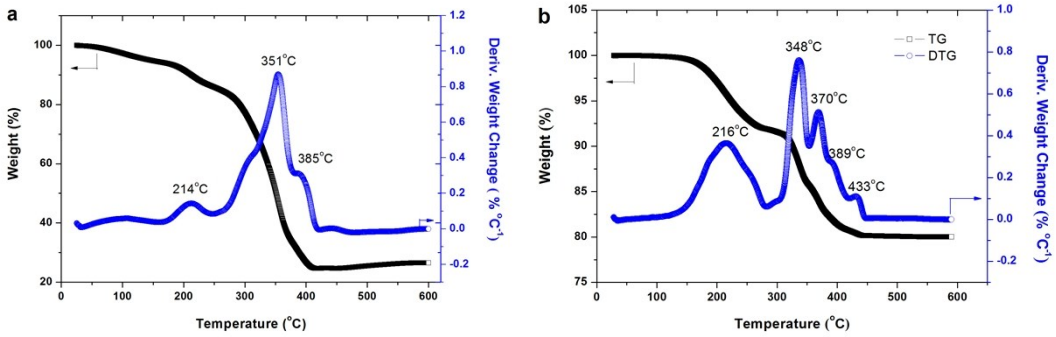

Fig. S1. TG and DTG curves of the mixture of sucrose and NH_4VO_3 (a) and the precursor of LMSSVC (b) in air.

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It is found that NH_4VO_3 is decomposed at 214 ^oC to form V_2O_5 while the sucrose is carbonized at 351 ^oC in the mixture (Fig. S1a). The weak exothermic peak at 385 ^oC might be relative to crystallization of V_2O_5. When the temperature is raised to 450 ^oC, the mixture lost its weight slightly and retained about 25% of its initial weight. Therefore, the mixture was fired at 250 ^oC for 3h in static air and 450 ^oC for 2 h to prepare vanadium oxide/carbon composite. The LMSSVC precursor displayed the similar decomposition temperatures of the sucrose (348 ^oC) and NH_4VO_3 (216 ^oC), and the similar crystallization temperature (389 ^oC). Besides, two additional exothermic peaks appeared at 370 ^oC and 433 ^oC, which possibly result from chemical leaching effect and phase transformation, forming the LiV_3O_8 and spinel components, respectively.

The as-prepared LMSSVC (12.46 g) was dissolved into a concentrated HCl acid and filtered. The black filter residue was washed to pH=7 by water, carefully collected and dried at 80 ^oC under vacuum overnight. The dried filter residue weighed to about 4.78±0.03 wt% of the LMSSVC. The concentration of V in the acidic solution was determined by ICP-AES thus the calculated amount of LiV_3O_8 equals to ~1.85 g in the 12.46 g of LMSSVC. Consequently, the contents of LiV_3O_8 and carbon are 14.85 wt% and 4.78 wt%, respectively.

The crystal structure of the mixture of NH_4VO_3 and sucrose after fired in static air was determined from the XRD pattern, which is shown in Fig. S2. It can be seen that the diffraction peaks are in good with those of the standard card of JCPDS No. 41-1426, which belongs to the orthorhombic V_2O_5. The carbon did not show its diffraction peaks because of its amorphous phase.

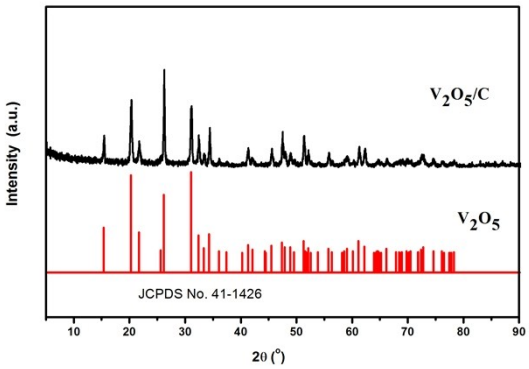

Fig. S2. XRD diffraction pattern of the mixture after fired at 250 °C in static air for 3 h and then at 450 °C for 2 h.

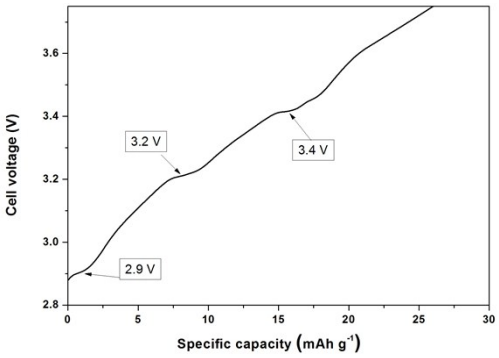

Fig. S3. Charging curve of the LMSSVC at 0.1C rate in the first cycle over the voltage range of 2.8-3.75 V at room temperature.