**Supporting information**

# Three-dimentional $Li_3V_2(PO_4)_3$/C nanowires and nanofibers hybrid membrane as a self-standing, binder-free cathode for lithium ion batteries

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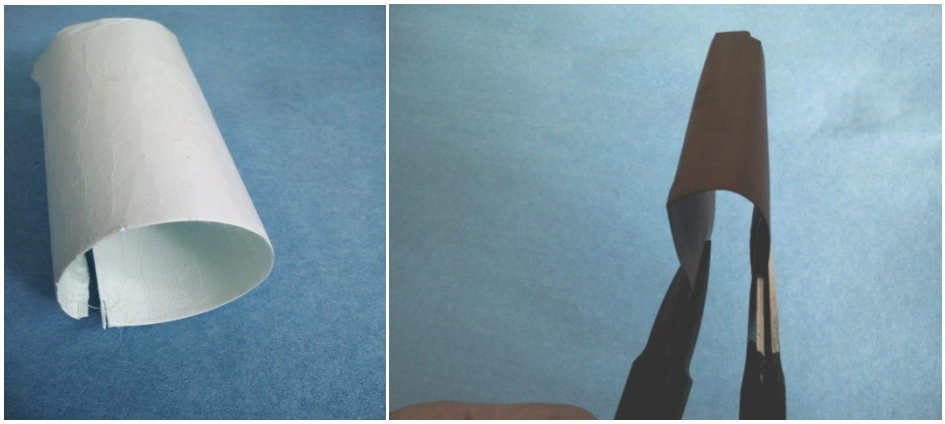
Fig. S1 shows the photograph of LVP/C nanowire and nanofiber hybrid membrane. It can be seen that a smooth and uniform precursor membrane was achieved by electrospinning, and after thermal-treatment, the self-standing, binder-free hybrid membrane shows good flexibility.



(a) (b)

Fig.S1 Photograph of LVP/C nanowire and nanofiber hybrid membrane
(a),precursor; (b), thermal treated

Fig.S2 shows the TG/DTA curves of the composite membrane. It can be seen that the total weight loss is about 14.9%, very close to the data from C-S analyzer. And the whole process is a exothermic process due to the oxidation of carbon.

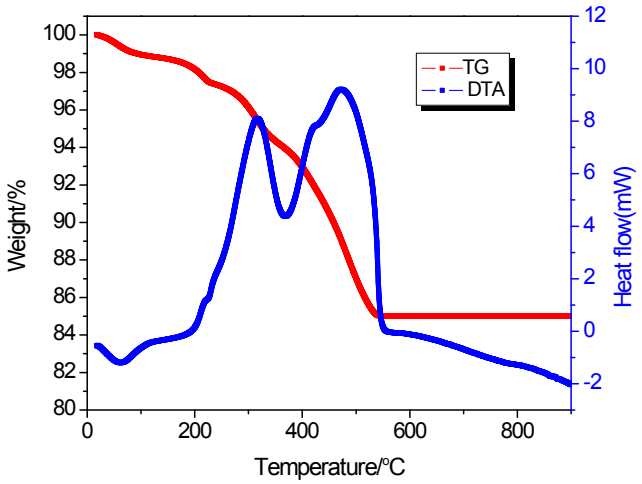



Fig.S2 TG/DTA curves of the LVP/C nanowire and nanofiber hybrid membrane

Fig. S3 shows the cycle performance of pure LVP/C nanofiber membrane electrode in the potential rage of 3.0~4.8V. It can be seen that the discharge capacity was decreased from 108mAh/g to 77.5 mAh/g at 5C after 800 cycles.

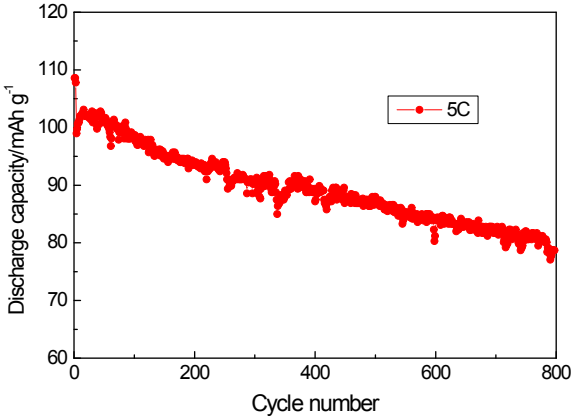



Fig. S3 Cycle performance of pure LVP/C nanofiber membrane electrode in the potential rage of 3.0~4.8V.

Fig.S4 shows an equivalent circuit model according to the simulation. In this circuit, Rs represents the Ohmic resistance of the electrode system, including the electrolyte and the cell components. Rct represents the interfacial charge transfer resistance, which is connected to the semicircle in the high frequency region. Rh represents the resistance of the SEI film. CPE is the double layer capacitance. Zw represents Warburg impedance, which is described as a diffusive resistance of the Li ion within the electrode pores. The related values for resistance of Rs, Rh, and Rct are depicted in Table S1. The very high frequency impedance is similar for each material, which means they have the same ohmic resistance in the cell. Because of a hybrid of nanowire and fiber, the Re and Rct of hybrid electrode is lower than that of pure fiber electrode, which illustrates that the ion conductivity is improved greatly. Meanwhile, two semi-circles can be seen at high frequency region, which means there were two interfacial reaction in the electrode. The small semicircle belongs to the reaction of Li+ and SEI film of LVP nanowires, the other is due to the embedded LVP in carbon fibers.

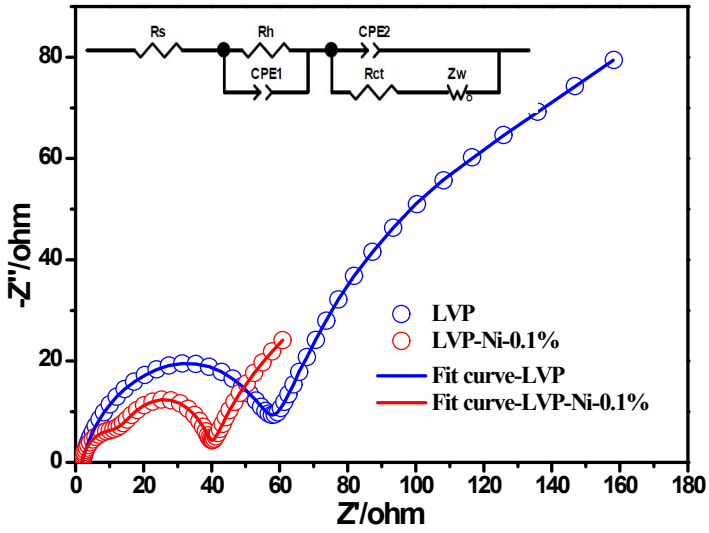



Fig.S4 The equivalent circuit for the Nyquist plot of LVP/C nanowire and nanofiber hybrid membrane

Table S1 EIS prameters

| | Rs | Rh | Rct |
|---|---|---|---|
| LVP-Ni | 1.82 | 10.92 | 27.12 |
| LVP | 1.97 | 26.44 | 35.96 |