## Electronic Supplementary Information for

## Simple Pyrolysis of Cobalt Alginate Fibres into Co<sub>3</sub>O<sub>4</sub>/C Nano/Microstructures for High-performance Lithium Ion Battery Anode

Daohao Li<sup>*a*</sup>, Dongjiang Yang<sup>\*,*a,b*</sup> Xiaoyi Zhu<sup>*a*</sup>, Dengwei Jing<sup>*c*</sup>, Yanzhi Xia<sup>\*,*a*</sup>, Quan Ji<sup>*a*</sup>, Rongsheng Cai<sup>*a*</sup>, Hongliang Li<sup>*a*</sup> and Yanke Che<sup>\*,*d*</sup>

<sup>*a*</sup>Collaborative Innovation Centre for Marine Biomass Fibres, Materials and Textiles of Shandong Province; College of Chemical and Environmental Engineering, Qingdao University, Qingdao, P R China.

<sup>b</sup>Queensland Micro- and Nanotechnology Centre (QMNC), Griffith University, Nathan, Brisbane, Queensland 4111, Australia.

<sup>c</sup>International Research Centre for Renewable Energy, State Key Laboratory of Multiphase Flow in Power Engineering, Xi'an Jiaotong University, Xi'an 710049, China.

<sup>d</sup>Institute of Chemistry, The Chinese Academy of Sciences, Beijing, PR China.

\*To whom correspondence should be addressed. E-mail: <u>d.yang@qdu.edu.cn;</u> <u>qdxyzh@qdu.edu.cn; ykche@iccas.ac.cn</u> Estimation of the relative volumetric energy density (D<sub>ve</sub>)

It is known that the relative volumetric energy density  $(D_{ve})$  of the Co<sub>3</sub>O<sub>4</sub>-CF electrode can be calculated as follows:

$$D_{ve} = C_v \cdot U$$
$$C_v = \frac{C}{V} = \frac{C_s \cdot M}{\frac{M}{D_t}} = C_s \cdot D_t$$

C<sub>v</sub>: volume capacity

U: voltage

C: the capacity of the active material

V: the volume of the active material

C<sub>s</sub>: the reversible capacity of active material

M: the mass of the active material

Dt: the tap density

Obviously,  $D_{ve}$  is proportional to volume capacity ( $C_v$ ). So in this work, we estimated the  $D_{ve}$  of Co<sub>3</sub>O<sub>4</sub>-CF by using C<sub>v</sub>. Given that the tap density ( $D_t$ ) and the reversible capacity ( $C_s$ ) of the Co<sub>3</sub>O<sub>4</sub>-CF is 1.51 g cm<sup>-3</sup> and 780 mAh g<sup>-1</sup>, respectively, C<sub>v</sub> value of the Co<sub>3</sub>O<sub>4</sub>-CF is 1178 mAh cm<sup>-3</sup>.



 1. Spinning solution tank of 5 wt % alginate sodium
 2. Polypropylene filter of 10 μm
 3. Metering pump

 4. Spinneret
 5. Coagulation bath of CaCl<sub>2</sub>
 6. Filament roller
 7. Stretch bath
 8. Stretch roller

Fig. S1 Wet spinning process for the preparation of Ca-AF.



Fig. S2 The TGA curve of the Co<sub>3</sub>O<sub>4</sub>-CF in air.

TGA measurement showed the thermal decomposition of  $Co_3O_4$ -CF with a heating rate of 10 °C min<sup>-1</sup> in air (Fig. S2). The  $Co_3O_4$ -CF began to decompose at 180 °C and rapidly decomposed when the temperature was higher than 870 °C, and the process of decomposition for the sample was finished when the temperature was arised to 950 °C. The whole process of thermal decompositions for the  $Co_3O_4$ -CF is the result of decomposition of carbon, and the residue is  $Co_3O_4$ , which determines a mass ratio of 85.5:14.5 ( $Co_3O_4$  NPs:carbon) of the two materials in the  $Co_3O_4$ -CF.



Fig. S3 The FTIR spectra of the samples.

FTIR spectra of the samples are presented in Fig. S3. For Ca-AF and Co-AF, the absorption bands at 1619 and 1403 cm<sup>-1</sup> were due to the respective asymmetric and symmetric stretching vibrations of carboxylate anions, and the absorption peak at 2915 cm<sup>-1</sup> can be assigned to the C-H asymmetric stretching vibration. It is illustrated that the two precursors own same functional groups. For commercial Co<sub>3</sub>O<sub>4</sub> and Co<sub>3</sub>O<sub>4</sub>-CF, the absorption bands at 663 and 570 cm<sup>-1</sup> were the Co-O stretching vibration of Co<sub>3</sub>O<sub>4</sub>, which illustrated that the Co<sub>3</sub>O<sub>4</sub>-CF, after calcination in N<sub>2</sub> atmosphere and subsequent oxidation process for Co-AF, the Co<sup>2+</sup> cations convert to Co<sub>3</sub>O<sub>4</sub> species.



Fig. S4 The cycling performance of commercial  $Co_3O_4$  at 89 mAh g<sup>-1</sup>.