

Electronic Supplementary Information for

Simple Pyrolysis of Cobalt Alginate Fibres into Co₃O₄/C Nano/Microstructures for High-performance Lithium Ion Battery Anode

Daohao Li ^a, Dongjiang Yang^{*,a,b}, Xiaoyi Zhu ^a, Dengwei Jing ^c, Yanzhi Xia^{*,a},
Quan Ji ^a, Rongsheng Cai ^a, Hongliang Li ^a and Yanke Che^{*,d}

^aCollaborative Innovation Centre for Marine Biomass Fibres, Materials and Textiles of Shandong Province; College of Chemical and Environmental Engineering, Qingdao University, Qingdao, P R China.

^bQueensland Micro- and Nanotechnology Centre (QMNC), Griffith University, Nathan, Brisbane, Queensland 4111, Australia.

^cInternational Research Centre for Renewable Energy, State Key Laboratory of Multiphase Flow in Power Engineering, Xi'an Jiaotong University, Xi'an 710049, China.

^dInstitute of Chemistry, The Chinese Academy of Sciences, Beijing, PR China.

*To whom correspondence should be addressed. E-mail: d.yang@qdu.edu.cn;
qdxzyzh@qdu.edu.cn; ykche@iccas.ac.cn

Estimation of the relative volumetric energy density (D_{ve})

It is known that the relative volumetric energy density (D_{ve}) of the $\text{Co}_3\text{O}_4\text{-CF}$ 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_v : volume capacity

U : voltage

C : the capacity of the active material

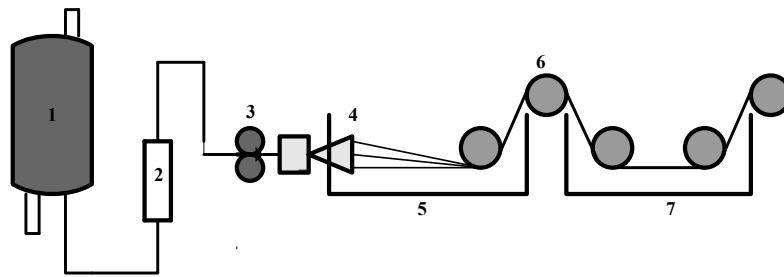
V : the volume of the active material

C_s : the reversible capacity of active material

M : the mass of the active material

D_t : the tap density

Obviously, D_{ve} is proportional to volume capacity (C_v). So in this work, we estimated the D_{ve} of $\text{Co}_3\text{O}_4\text{-CF}$ by using C_v . Given that the tap density (D_t) and the reversible capacity (C_s) of the $\text{Co}_3\text{O}_4\text{-CF}$ is 1.51 g cm^{-3} and 780 mAh g^{-1} , respectively, C_v value of the $\text{Co}_3\text{O}_4\text{-CF}$ is 1178 mAh cm^{-3} .



1. Spinning solution tank of 5 wt % alginate sodium 2. Polypropylene filter of 10 μm 3. Metering pump
4. Spinneret 5. Coagulation bath of CaCl₂ 6. Filament roller 7. Stretch bath 8. Stretch roller

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

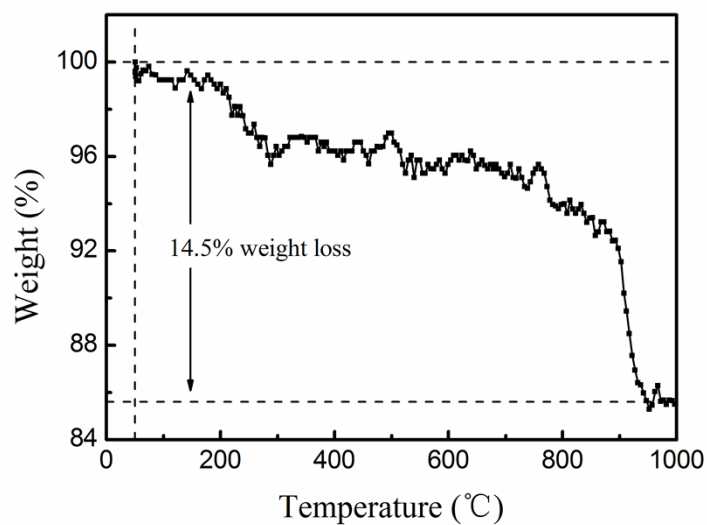


Fig. S2 The TGA curve of the $\text{Co}_3\text{O}_4\text{-CF}$ in air.

TGA measurement showed the thermal decomposition of $\text{Co}_3\text{O}_4\text{-CF}$ with a heating rate of $10\text{ }^\circ\text{C min}^{-1}$ in air (Fig. S2). The $\text{Co}_3\text{O}_4\text{-CF}$ began to decompose at $180\text{ }^\circ\text{C}$ and rapidly decomposed when the temperature was higher than $870\text{ }^\circ\text{C}$, and the process of decomposition for the sample was finished when the temperature was arised to $950\text{ }^\circ\text{C}$. The whole process of thermal decompositions for the $\text{Co}_3\text{O}_4\text{-CF}$ 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 $\text{Co}_3\text{O}_4\text{-CF}$.

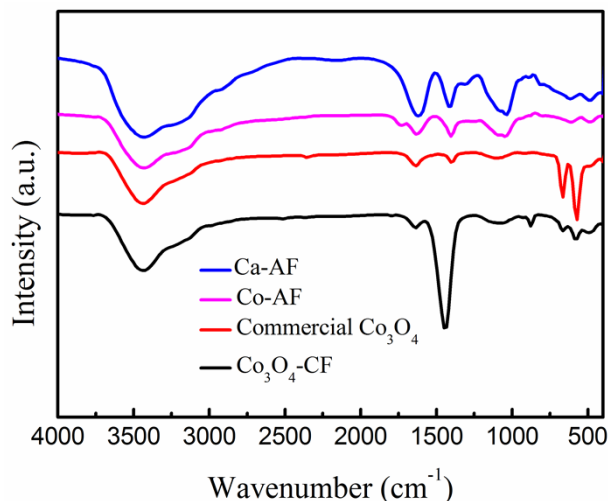


Fig. S3 The FTIR spectra of the samples.

FTIR spectra of the samples are presented in Fig. S3. For Ca-AF and Co-AF, the absorption bands at 1619 and 1403 cm^{-1} were due to the respective asymmetric and symmetric stretching vibrations of carboxylate anions, and the absorption peak at 2915 cm^{-1} can be assigned to the C-H asymmetric stretching vibration. It is illustrated that the two precursors own same functional groups. For commercial Co_3O_4 and $\text{Co}_3\text{O}_4\text{-CF}$, the absorption bands at 663 and 570 cm^{-1} were the Co-O stretching vibration of Co_3O_4 , which illustrated that the Co_3O_4 NPs were existed in carbon fibres. Compared the FTIR spectra of Co-AF and $\text{Co}_3\text{O}_4\text{-CF}$, after calcination in N_2 atmosphere and subsequent oxidation process for Co-AF, the Co^{2+} cations convert to Co_3O_4 species.

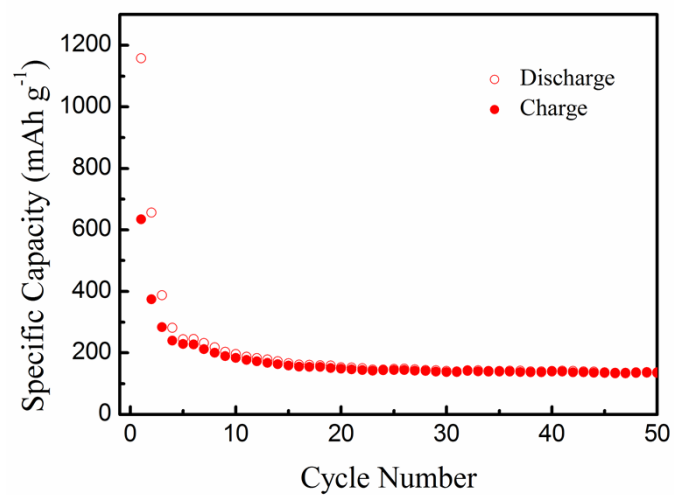


Fig. S4 The cycling performance of commercial Co_3O_4 at 89 mAh g^{-1} .