New Journal of Chemistry

Support Information for

Controlled synthesis of CoO/C and Co/C nanocomposites via molten salt method and their lithium-storage properties

By Shasha Chu[a], Chao Yang[a], Xin Xia[c], Jide Wang[a], Yanglong Hou [b]*, Xintai Su[a]*

[a] Ministry Key Laboratory of Oil and Gas Fine Chemicals, College of Chemistry and Chemical Engineering, Xinjiang University, Urumqi 830046, China. Tel. & fax: +86 991 8581018; E-mail: suxintai827@163.com.

[b] Department of Materials Science and Engineering College of Engineering, Peking University, Beijing 100871, China. Tel. & fax: +86 10 62753115; E-mail: hou@pku.edu.cn

[c] College of Textile and Clothing, Xinjiang University, Urumqi 830046, China.

KEYWORDS: CoO/C, Co/C, hybrid, nanocomposite, anode materials, lithium-ion batteries

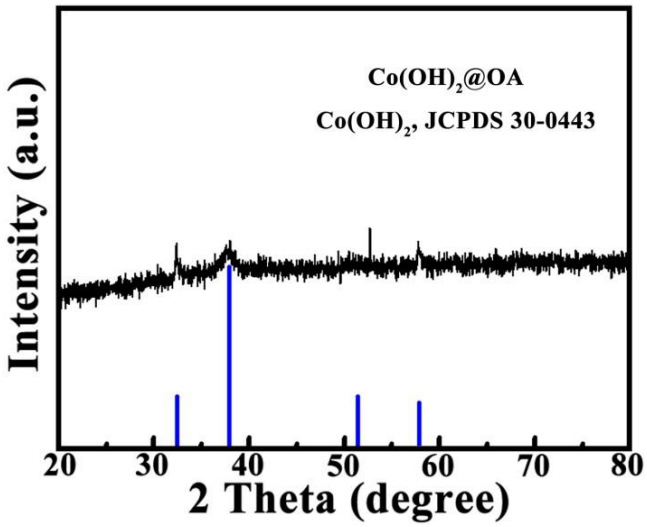

Fig. S1 XRD pattern of $Co(OH)_2$@OA complex precursor prepared via two-phase reflux method.

Fig. S1 was the XRD pattern of $Co(OH)_2$@OA complex precursor. The diffraction peaks of the $Co(OH)_2$ well agrees with the standard hedagonal β-$Co(OH)_2$ (JCPDS No. 30-0443).

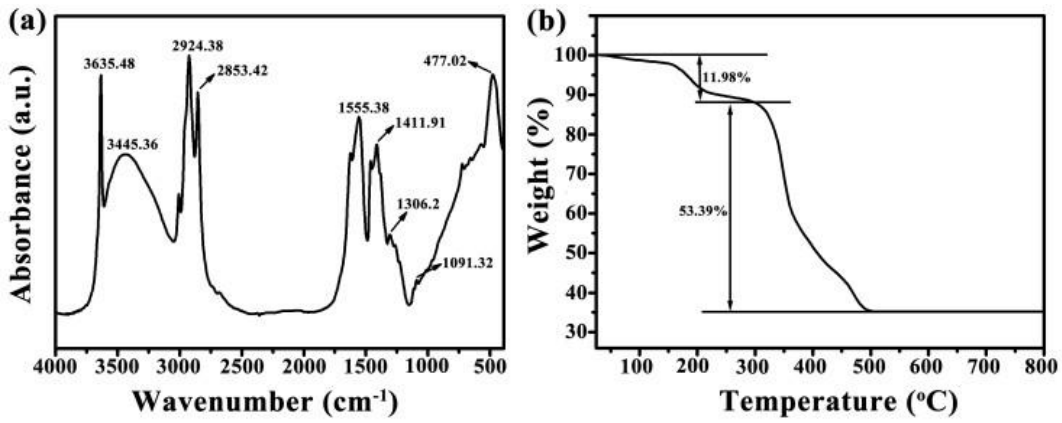

Fig. S2 FT-IR spectra (a) and TGA curve (b) of $Co(OH)_2$@OA complex precursor prepared via two-phase reflux method.

The Fourier transform infrared (FT-IR) spectra of the $Co(OH)_2$@OA complex was shown in Fig. S2a. The $Co(OH)_2$ nanocrystals with chemisorbed–oleate showed two strong vibrational bands at 2853 and 2924 cm^{-1} due to the methyl ν_s (-CH_3) and the ν_{as} (-CH) groups, which were present in oleic acid.[1] Meanwhile, the bands at 1555 cm^{-1} and 1411 cm^{-1} in the spectrum are the characteristic of the asymmetric ν_{as} (COO-) and symmetric ν_s (COO-) stretching which take place as the carboxylate ligands bond to the Co^{2+} cations, indicating the adsorption of oleic acid onto the surface of the $Co(OH)_2$ particles.[2] Fig. S2b shows the TGA curve of $Co(OH)_2$@OA precursor via the decomposition process under Ar flow of 100 mL min^{-1} with a heating rate of 10 ^oC min^{-1} from room temperature to 800 ^oC. The weight loss with an initial 11.98% from room temperature to 300 ^oC was attribute to the evaporation of a small amount of moisture from the oleic acid and the decomposition of weakly bound functional group (-COOH) from surfactant layer. The second weight loss of about 53.39% between 300 and 500 ^oC was confirmed to the decomposition of oleic acid.

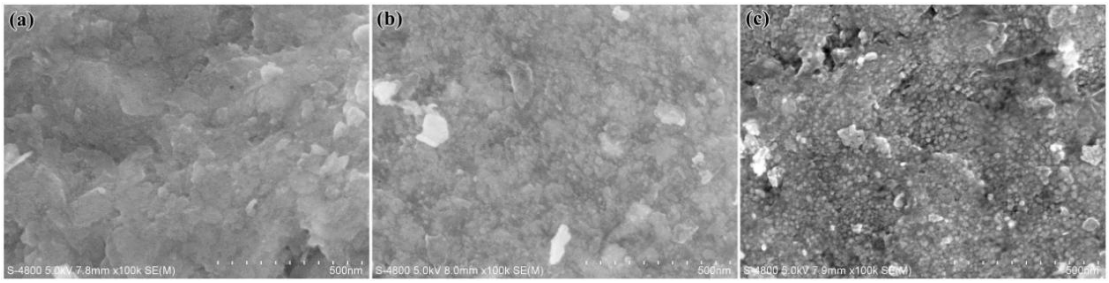

Fig. S3 SEM images of the CoO/C nanocomposites (a-c) prepared at 350 ^{o}C, 400 ^{o}C, 500 ^{o}C and (d) TGAcurve of CoO/C nanocomposites prepared at 400 ^{o}C.

Fig. S3. shows SEM images of CoO/C nanocomposites prepared at different temperatures (from 350 to 500 ^{o}C). The CoO nanoparticles are successfully anchored on the surface of the carbon nanosheet. The hybrid CoO/C nanosheets are thickness (Fig. S3a), and no obvious particles are on the surface, indicated the very small size of CoO. Fig. S3b showed that the CoO nanoparticles are irregular wrapped by the carbon sheet. In Fig. S3c, the morphology of carbon nanosheets is clearly observed, where small CoO (10-15 nm) nanoparticles are anchored onto.

nanocomposites	Cobalt contents(%)
C350	47.37%
C400	47.87%
C500	48.27%
C600	53.46%

Table S1. cobalt contents of Co-based/carbon nanocomposites based on elemental analysis.

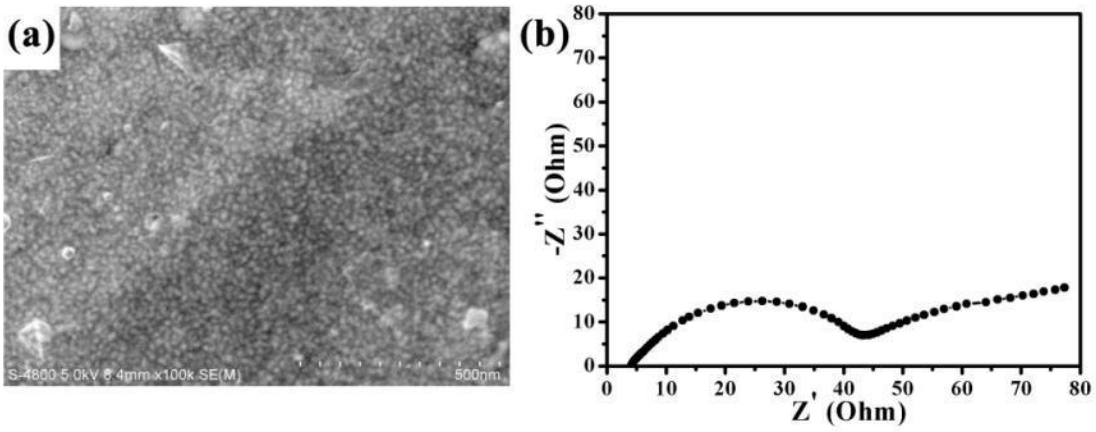

Figure S4 (a) SEM image of C600; (b) Nyquist plots of measured EIS spectra of C600 sample at fresh coin cells over the frequency range from 100 kHz to 0.01 Hz.

Fig. S4a shows the SEM image of Co/C nanocomposites prepared at 600 ^{o}C. The Co nanoparticles were strongly anchored on the surface of carbon layer with a high density, implying the strong interaction between Co nanoparticles and carbon layers. The size of Co nanoparticles was much smaller which wrapped by the carbon nanosheet, this structure is favorable for achieving high durability and high rate capability. Fig. S4b shows the Nyquist plot of the Co/C electrodes at fresh coin cells. The Nyquist plots displayed a depressed semicircle in the high-middle frequency region, which could be assigned to the charge transfer resistance (Rct), and an inclined line in the low frequency region, which represents the Warburg impedance. As can be seen, the semicircle diameter of C600 was smaller than C500, indicating enhanced electron and lithium ion transport.

References

1. J. Wang, J. Dominguez, A. Montoya, S. Castillo, J. Navarrete, M. Moran-Pineda, J. R. Gasga and X. Bokhimi, *Chem. Mater.*, 2002, **14**, 4676-4683.
2. T. S. Sreeremya, K. M. Thulasi, A. Krishnan and S. Ghosh, Ind. Eng. Chem. Res., 2012, **51**, 318-326.