Nickel Cobalt Hydroxides With Tunable Thin-layer Nanosheets for High-performance Supercapacitor Electrode

Luomeng Zhang
Central South University
Hui Xia (xhui73@csu.edu.cn)
Central South University https://orcid.org/0000-0001-7548-6162
Shaobo Liu
Central South University
Yishan Zhou
Central South University
Yuefeng Zhao
Shandong Normal University
Wenke Xie
Central South University

Nano Express

Keywords: Hydrothermal method, Nickel cobalt double hydroxides, Nanosheets, High performance, Supercapacitor

Posted Date: January 20th, 2021

DOI: https://doi.org/10.21203/rs.3.rs-149158/v1

Abstract

Layered double hydroxides as typical supercapacitor electrode materials can perform superior energy storage if the structures are well regulated. In this work, a simple one-step hydrothermal method is used to prepare diverse nickel cobalt layered double hydroxides (NiCo-LDHs), in which the different contents of urea are used to synthesize the different nanostructures of NiCo-LDHs. The results show that the decrease in urea content can effectively improve the dispersibility of NiCo-LDHs, adjust the thickness of materials and optimize the internal pore structures, thereby enhancing the capacitance performance of NiCo-LDHs. When the content of urea is reduced from 0.03 g to 0.0075 g under a fixed precursor materials mass ratio of nickel (0.06 g) to cobalt (0.02 g) of 3:1, the prepared sample NiCo-LDH-1 exhibits the thickness of 1.62 nm, and the clear thin-layer nanosheets structures and a large number of surface pores are formed, which is beneficial to the transmission of ions into the electrode material. After being prepared as a supercapacitor electrode, the NiCo-LDH-1 displays an ultra-high specific capacitance of 3982.5 F g-1 under the current density of 1 A g-1, and high capacitance retention above 93.6% after 1000 cycles of charging and discharging at a high current density of 10 A g-1. The excellent electrochemical performance of NiCo-LDH-1 is proved by assembling two-electrode asymmetric supercapacitor with carbon spheres, displaying the specific capacitance of 95 F g-1 at 1 A g-1 and the capacitance retention with 78% over 1000 cycles. As a result, it offers a facile way to control the nanostructure of NiCo-LDHs, confirms the important affection of urea on enhancing capacitive performance for supercapacitor electrode and provides the high possibility for the development of high-performance supercapacitors.

Full Text

This preprint is available for download as a PDF.

Figures

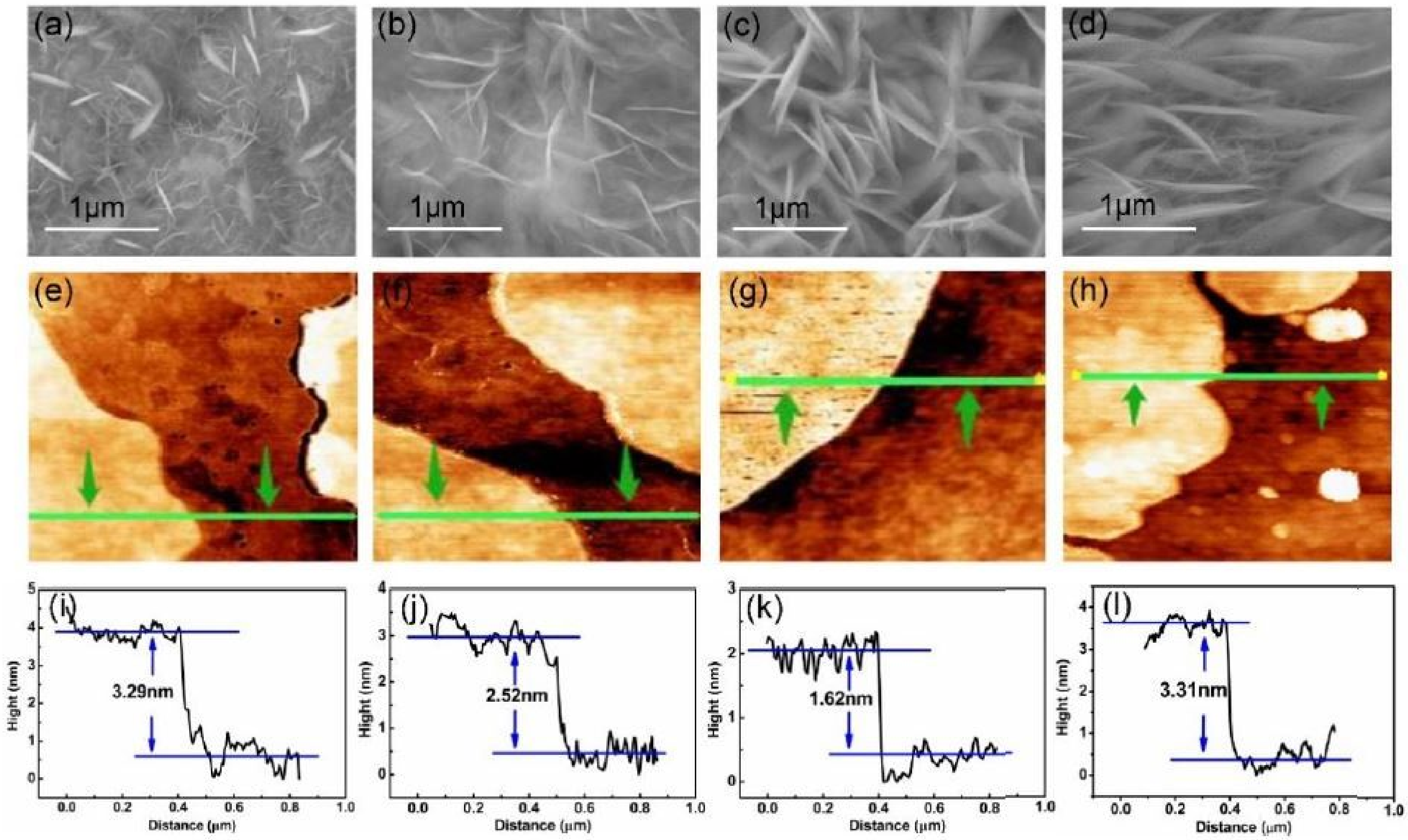

Figure 1

(a)-(d) SEM images of the samples: (a) NiCo-LDH-3, (b) NiCo-LDH-2, (c) NiCo-LDH-1, (d) NiCo-LDH-0; (e)-(h) AFM images of the sample: (e) NiCo-LDH-3, (f) NiCo-LDH-2, (g) NiCo-LDH-1, (h) NiCo-LDH-0; (i)-(l) the thicknesses of the samples: (i) NiCo-LDH-3, (j) NiCo-LDH-2, (k) NiCo-LDH-1, (l) NiCo-LDH-0.

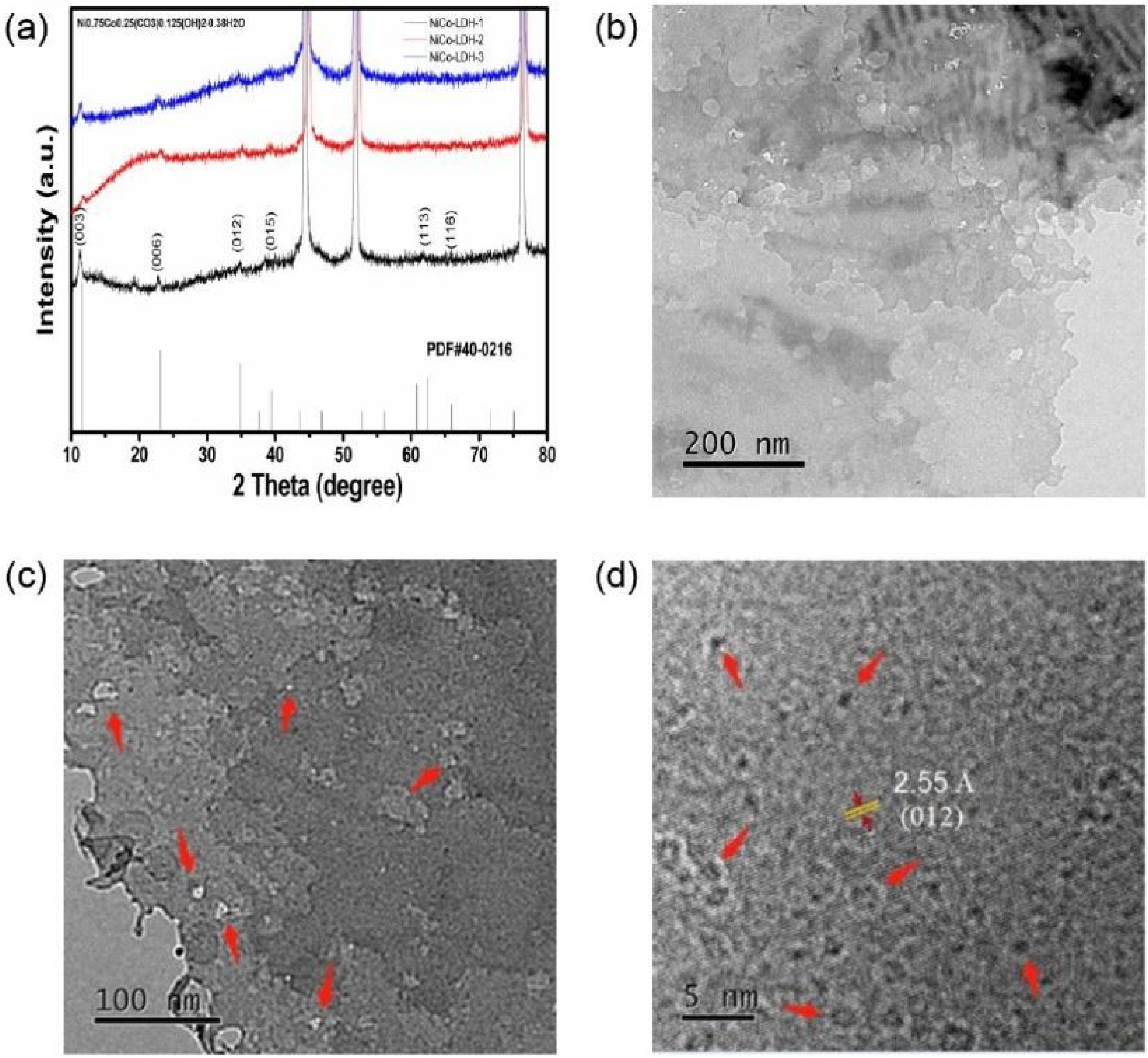

Figure 2

a) X-ray diffraction patterns of the samples; (b)-(d) TEM images of NiCo-LDH-1

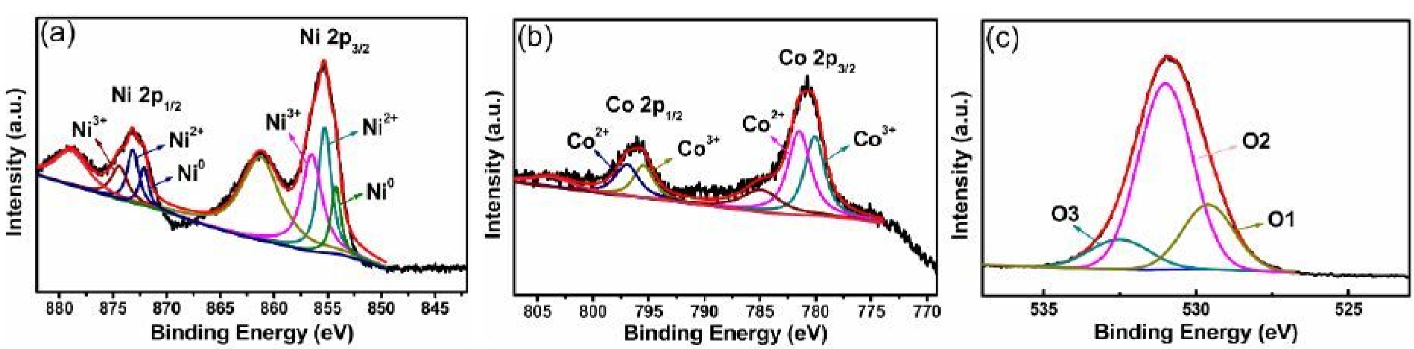

Figure 3

X-ray photoelectron spectra of (a) Ni 2p, (b) Co 2p and (c) O 1s of NiCo-LDH-1

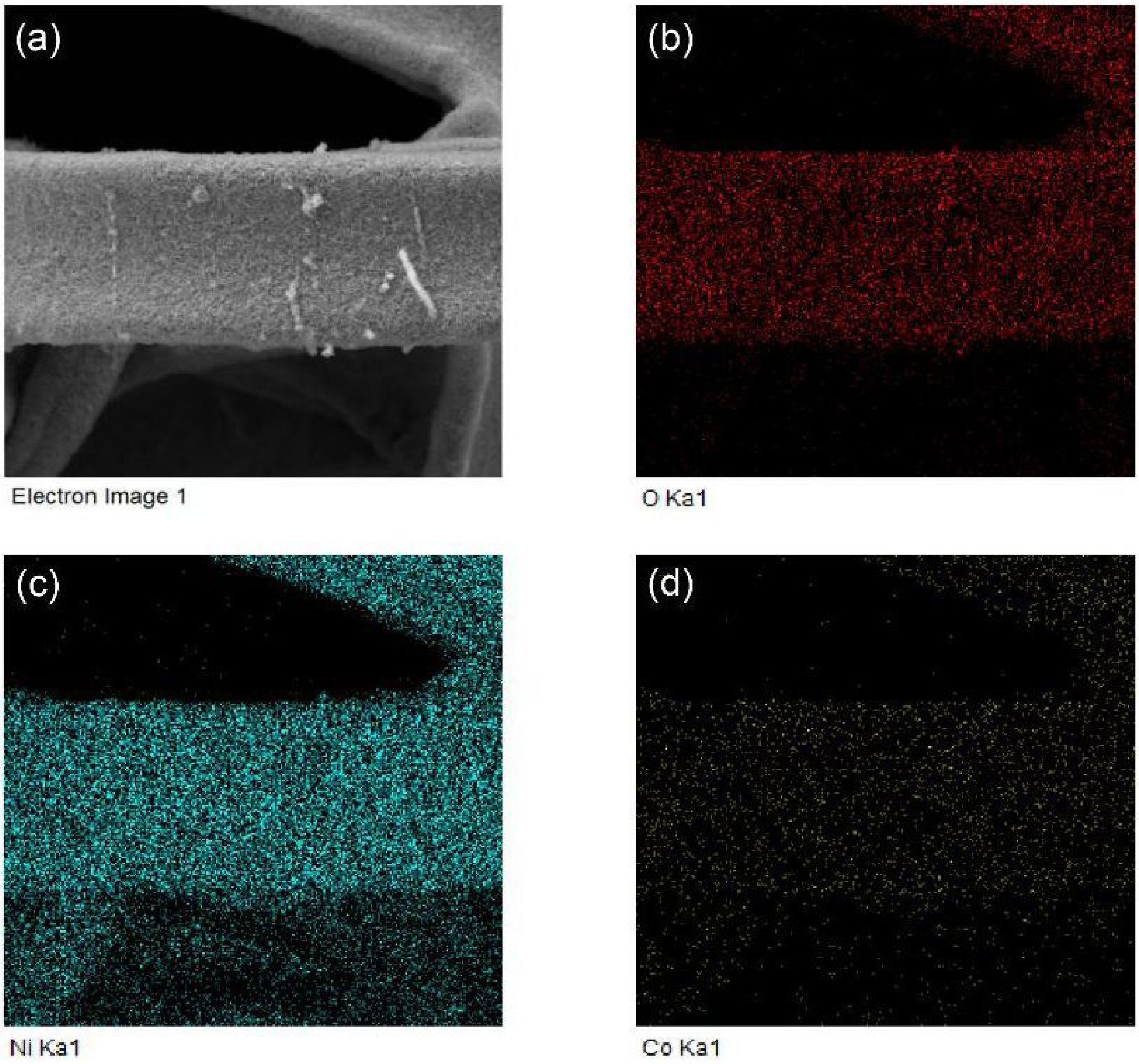

Figure 4

(a) SEM of NiCo-LDH-1; EDS element mapping diagrams of (b) Ni, (c) Co and (d) O in NiCo-LDH-1

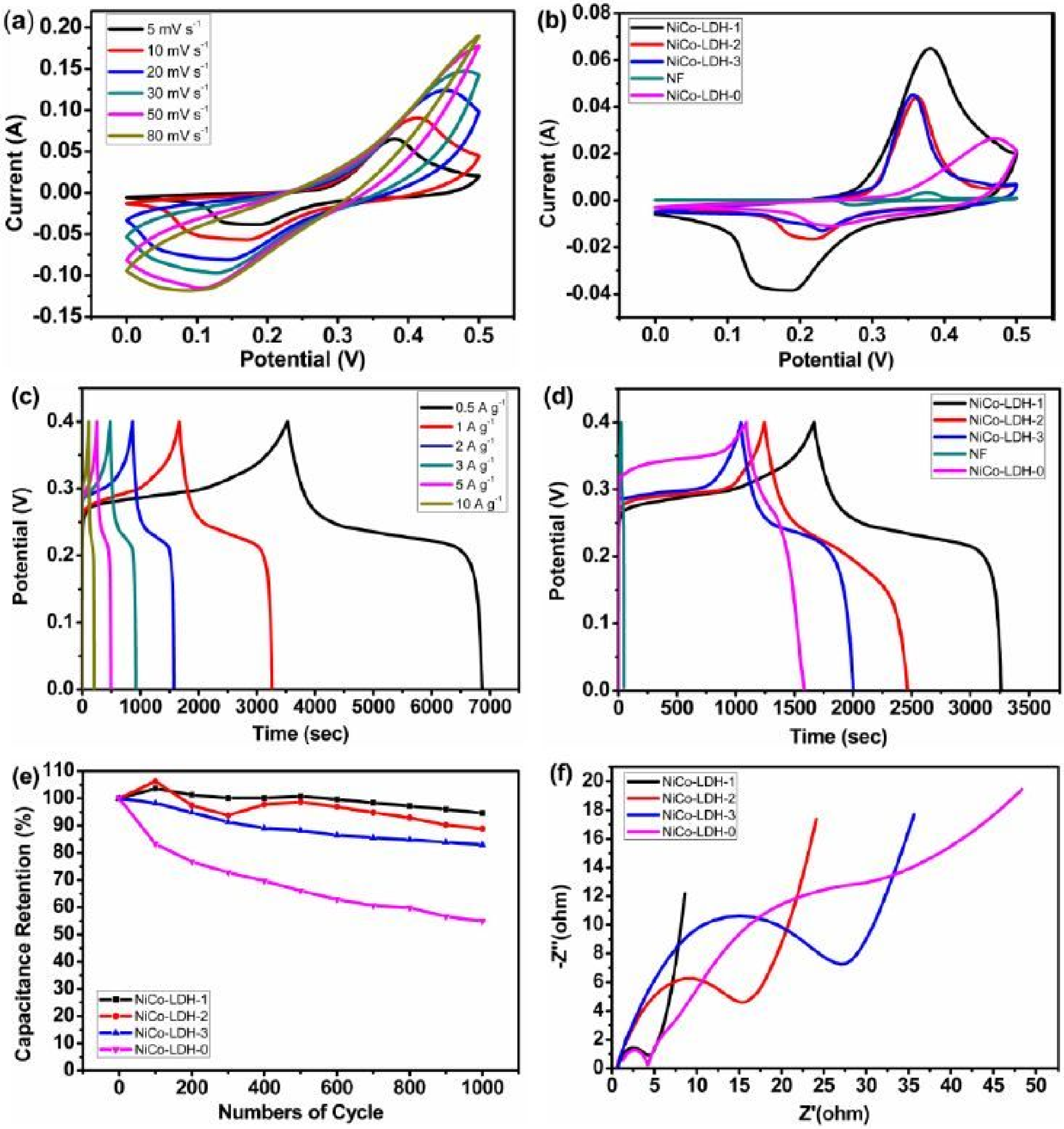

Figure 5

(a) CV curves of NiCo-LDH-1 at different scan rates; (b) CV curves of samples at scan rate of 5 mV s-1; (c) GCD curves of NiCo-LDH-1 at different current densities; (d) GCD curves of samples at 1 A g-1; (e) Cyclic stability diagram of NiCo-LDH-1, NiCo-LDH-2, NiCo-LDH-3 and NiCo-LDH-0 at 10 A g-1; (f) Nyquist plots of NiCo-LDH-1, NiCo-LDH-2, NiCo-LDH-3 and NiCo-LDH-0.

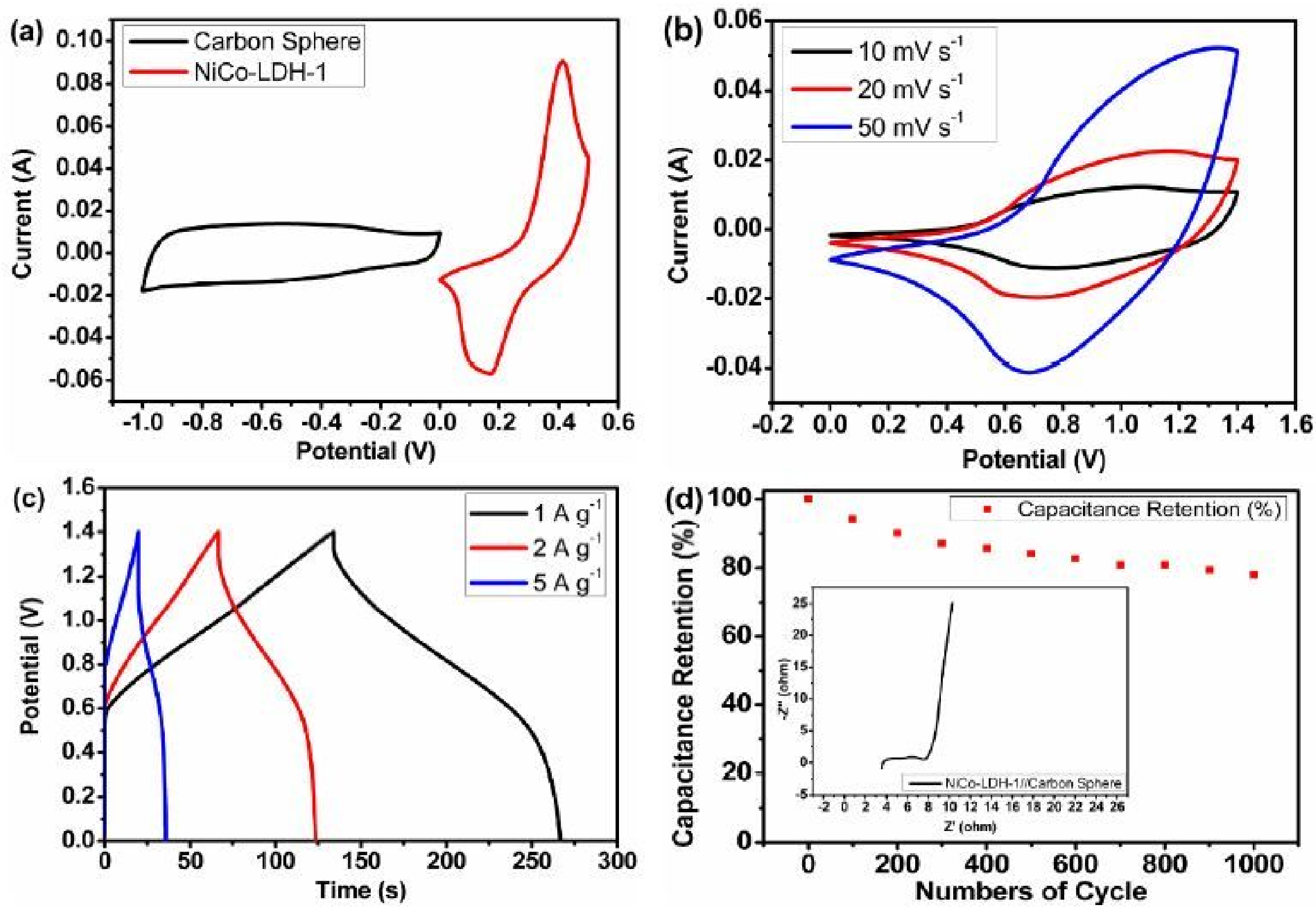

Figure 6

Electrochemical performance of the NiCo-LDH-1/carbon sphere asymmetric supercapacitor: (a) CV curves at scan rate of 10 mV s-1; (b) CV curves under different scan rates; (c) GCD curves at different current densities and (d) Cyclic stability under the current density of 10 A g-1.