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Growth of Ni-Co binary hydroxide on reduced graphene oxide surface by a successive ionic layer adsorption and reaction (SILAR) method for high performance asymmetric supercapacitor electrode

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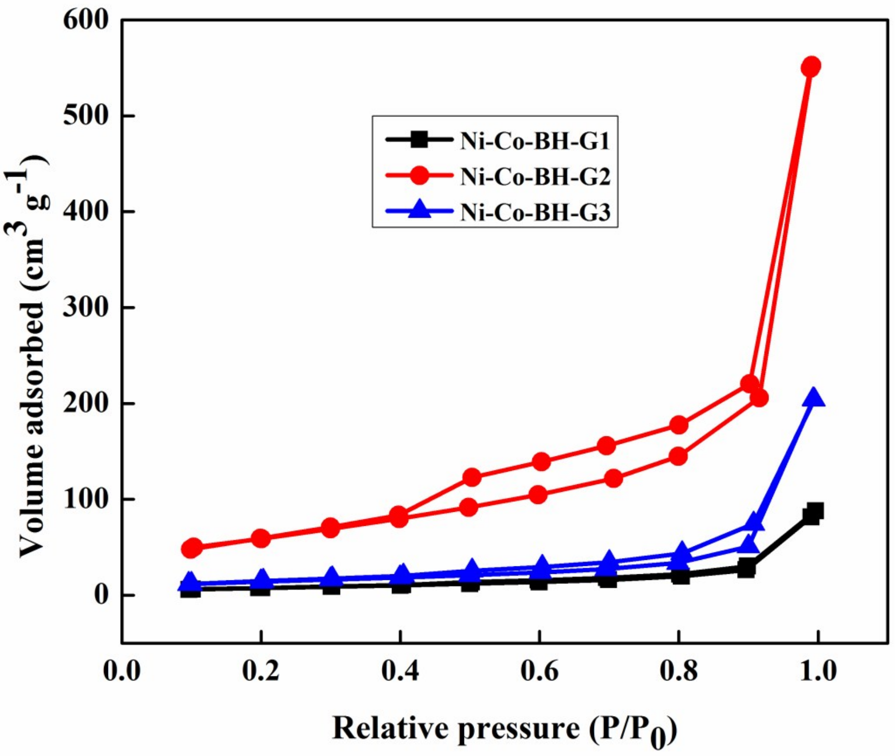

Fig. S1 N_2 adsorption-desorption isotherms.

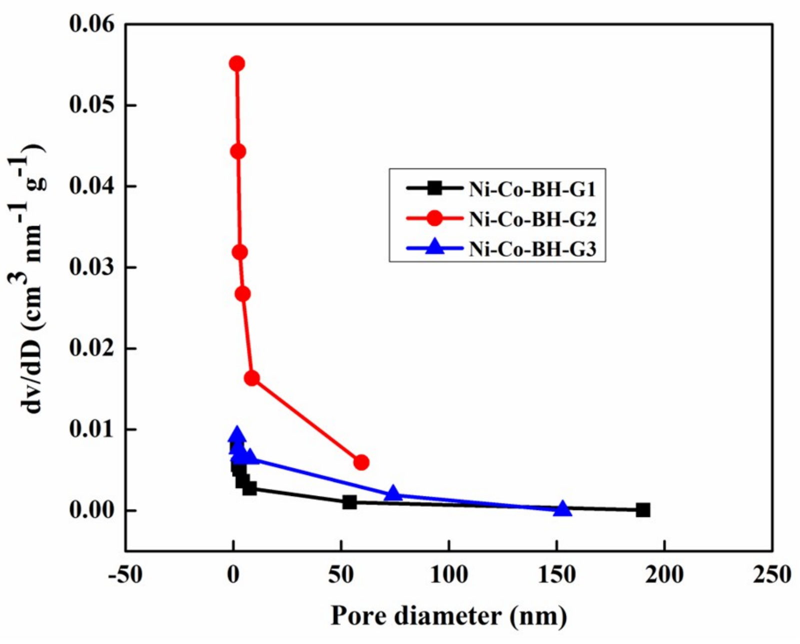

Fig. S2 BJH pore size distribution profile.

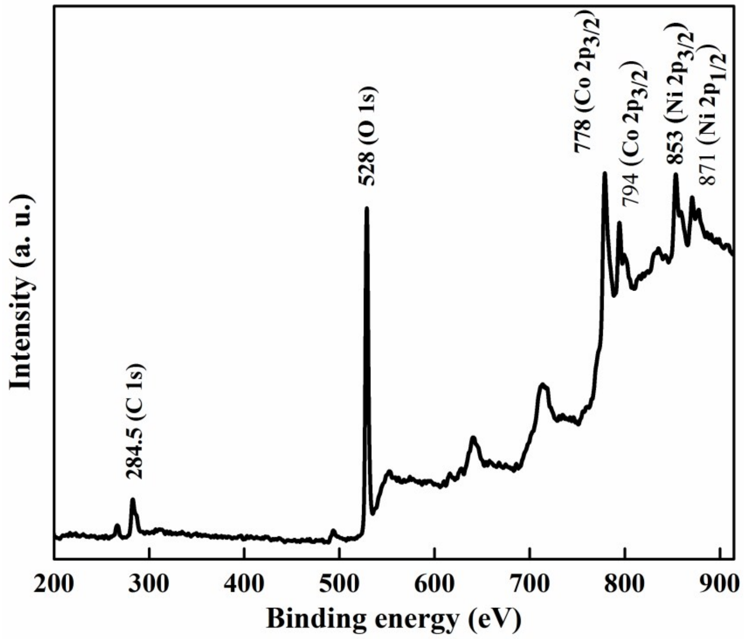

Fig. S3 XPS survey spectra of Ni-Co-BH-G2.

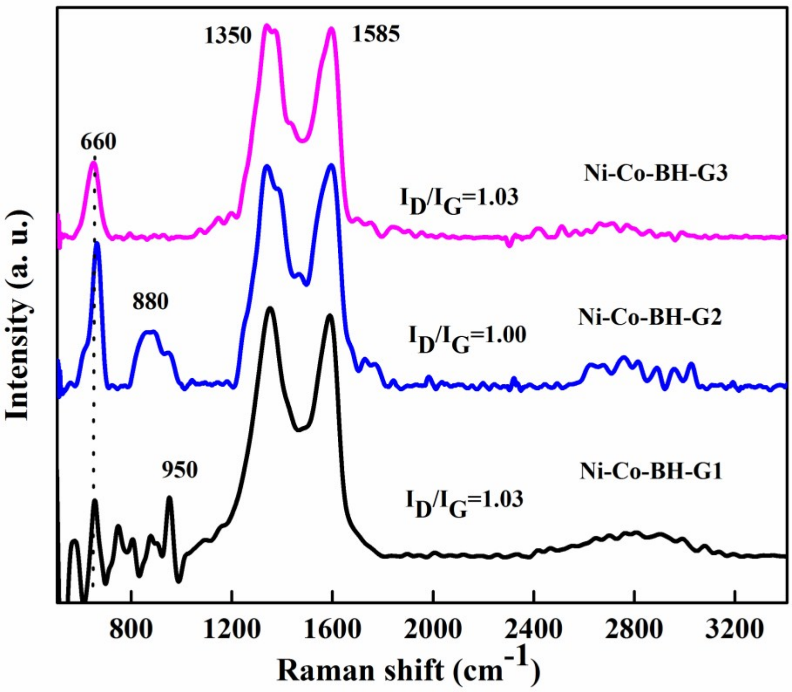

Fig. S4 Raman spectra of Ni-Co-BH-G composites.

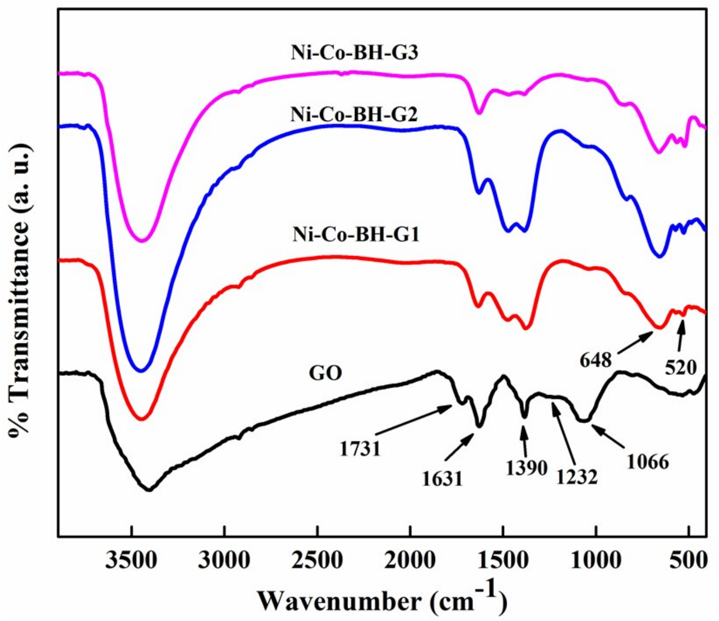

Fig. S5 FT-IR spectra of Ni-Co-BH-G composites.

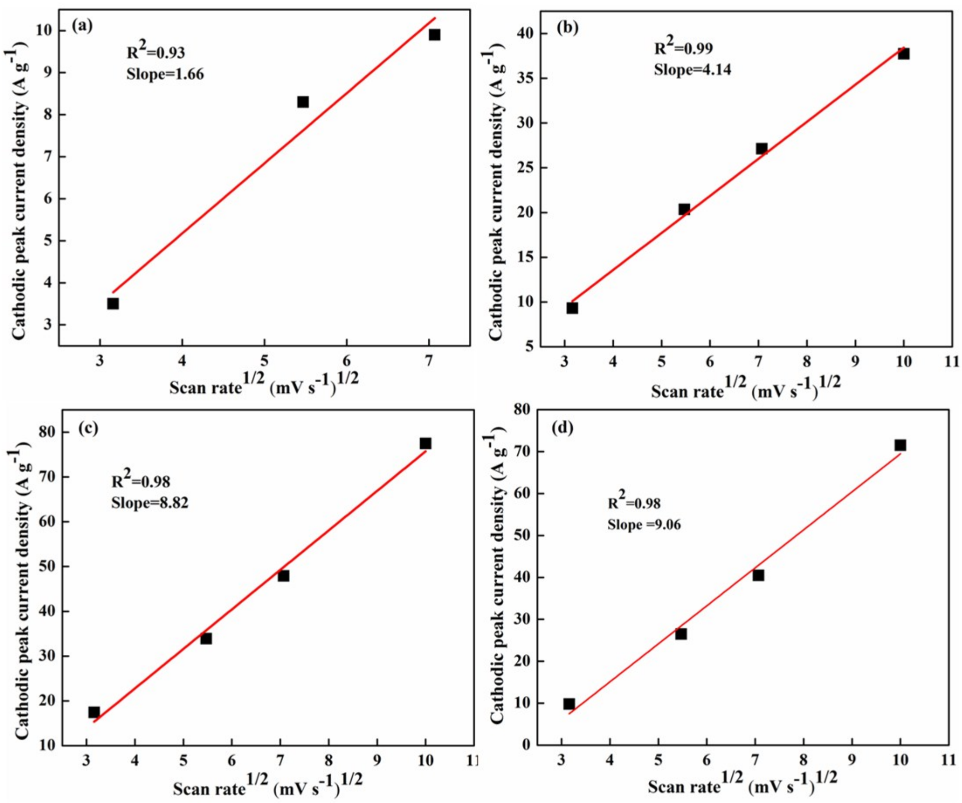

Fig. S6 Linearly fitted cathodic peak current density vs. square root of the san rate plots of (a) Ni-Co-BH, (b) Ni-Co-BH-G1, (c) Ni-Co-BH-G2, and (d) Ni-Co-BH-G3.

The plot of cathodic peak current density vs. square root of the scan rate showed a straight line for Ni-Co-BH-G2 and Ni-Co-BH-G3 as shown in the supplementary Fig. S6. In case of Ni-Co-BH the cathodic peak current density vs. square root of the scan rate was not fitted well with a straight line. Data obtained from the pure Ni-Co-BH can be fitted only up to square root of the 50 mV s^{-1} and the fitting is poor (R^2=0.93). On the contrary, the Ni-Co-BH-G1, Ni-Co-BH-G2 and Ni-Co-BH-G3 exhibited better linear fit with the R^2 value ~0.98-0.99. The slope of these fitted plots can be helpful to measure the efficiency of the diffusion controlled charge-transfer process at high scan rates.[1-3] Ni-Co-BH-G3 provided highest slope value suggesting better diffusion controlled charge-transfer process at high scan rates.[2-3]

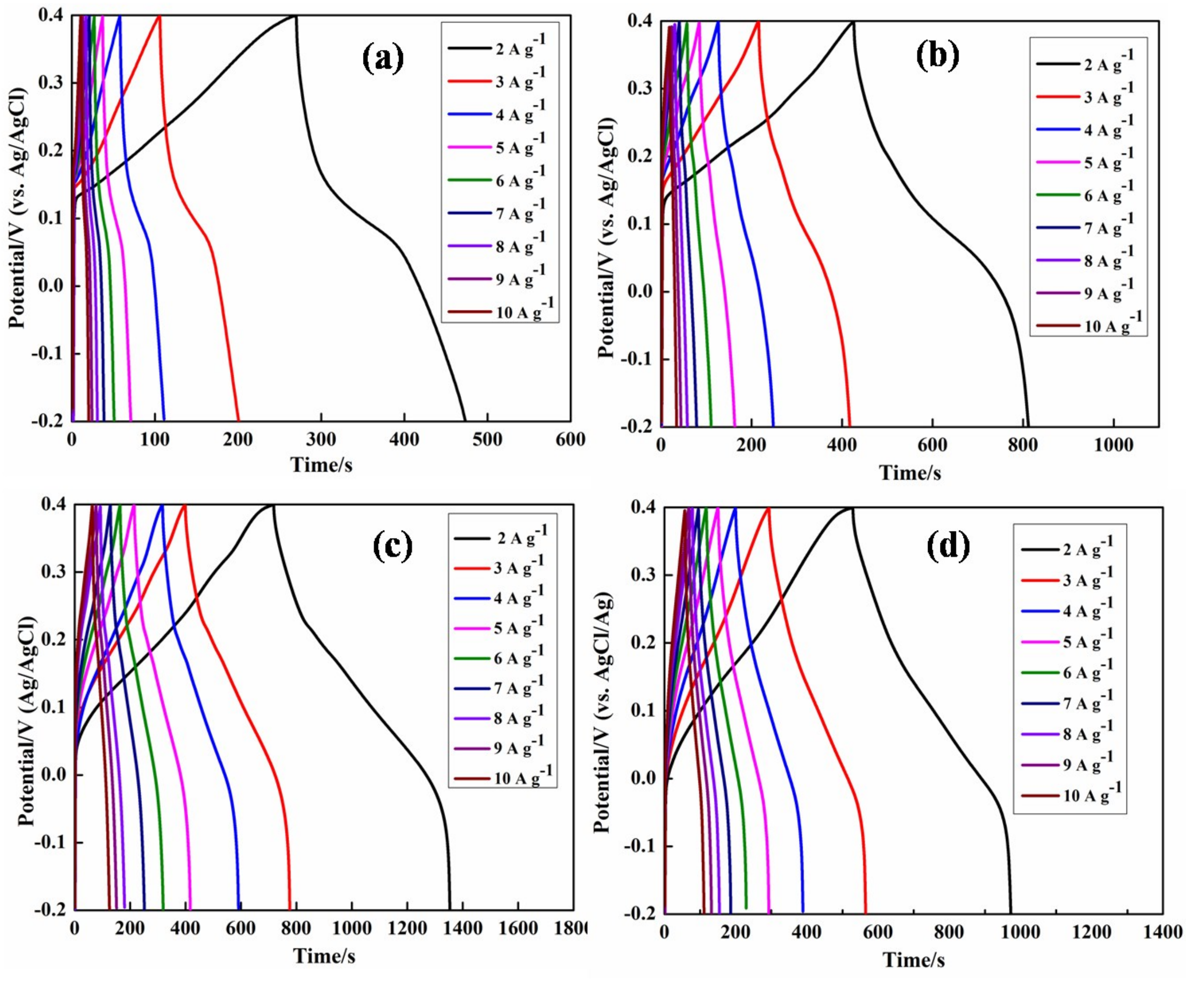

Fig. S7 Galvanostatic charge-discharge curves of (a) Ni-Co-BH, (b) Ni-Co-BH-G1, (c) Ni-Co-BH-G2 and (c) Ni-Co-BH-G3

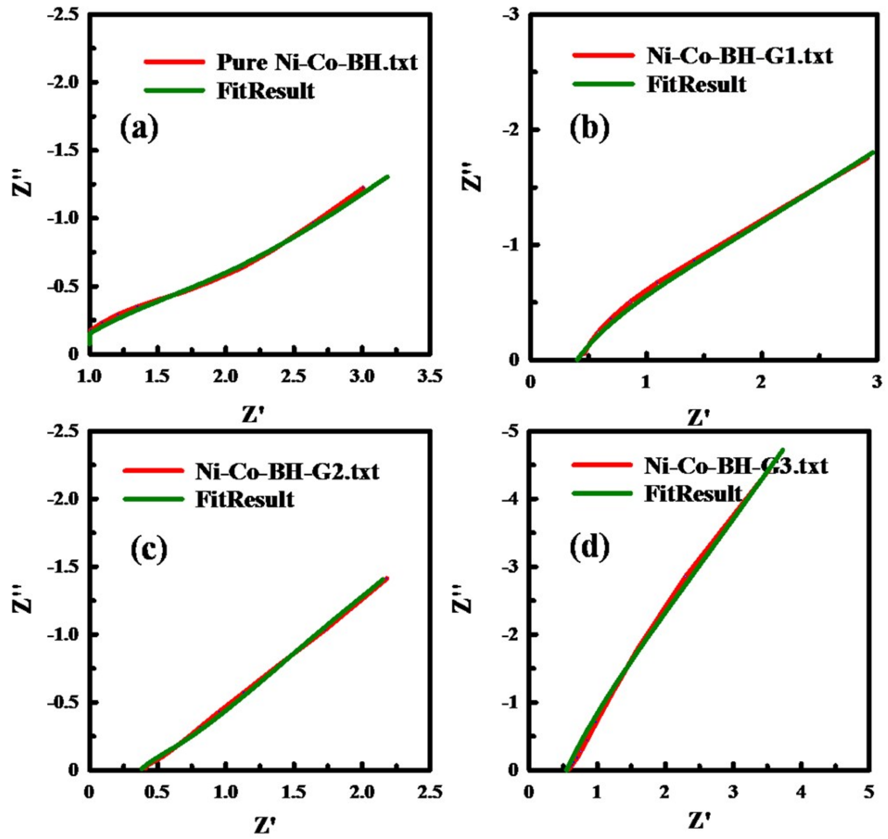

Fig. S8 Z-View fitted Nyquist plot of (a) pure Ni-Co-BH, (b) Ni-Co-BH-G1, (c) Ni-Co-BH-G2 and (c) Ni-Co-BH-G3.

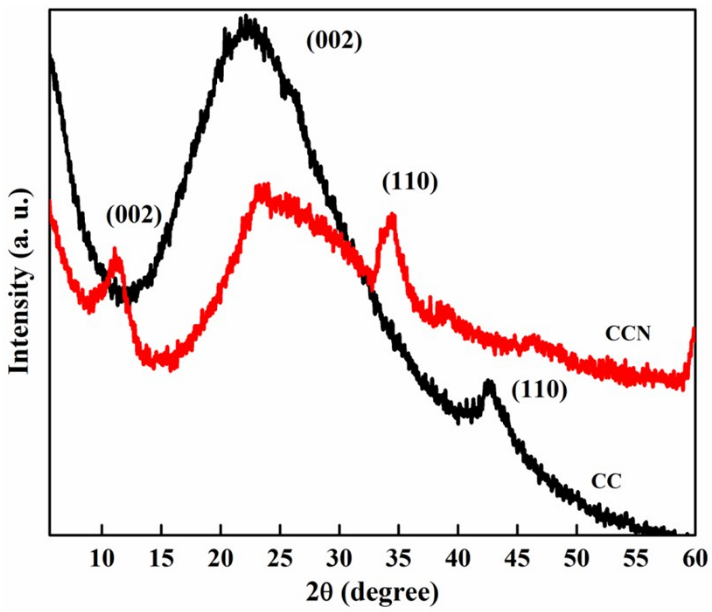

Fig. S9 The XRD pattern of CCN

The XRD pattern of CC showed two peaks at ~25 (002) and 43° (110) for graphitic carbon.[4] The peaks were shifted to ~11 (002) and 35 ° (110) in the XRD pattern of CCN. This might be due to the exfoliation of CC to form CCN at high temperature (450° C) and strong acid (HNO_3) condition. [4-6]

The electrochemical performances of the CCN was analysed in three electrode configuration with 6 (M) KOH electrolyte (Fig. S10). The CCN provided a high electrochemical performance in a voltage window of 0.1 to -1 V.

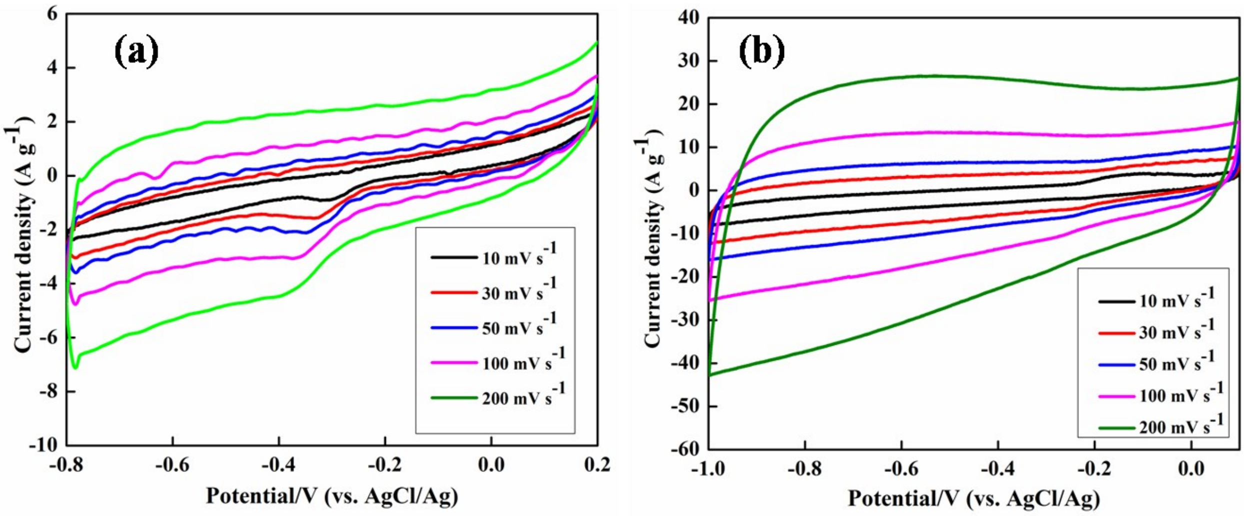

Fig. S10 CV curves of (a) pure CC and (b) CCN in three electrode system with (6) KOH electrolyte at different scan rates.

The current density values were significantly increased with CCN in comparison to CC. The nearly rectangular CV (EDL) with a very good current response in the voltage window of 0.1 to -1 V suggests that it can be used as a negative electrode material in supercapacitors. [6-8] The CV curves retained their quasi rectangular shape even at the high scan rate of 200 mV s^{-1}, signifying fast electrolyte diffusion of the CCN.[6-8]

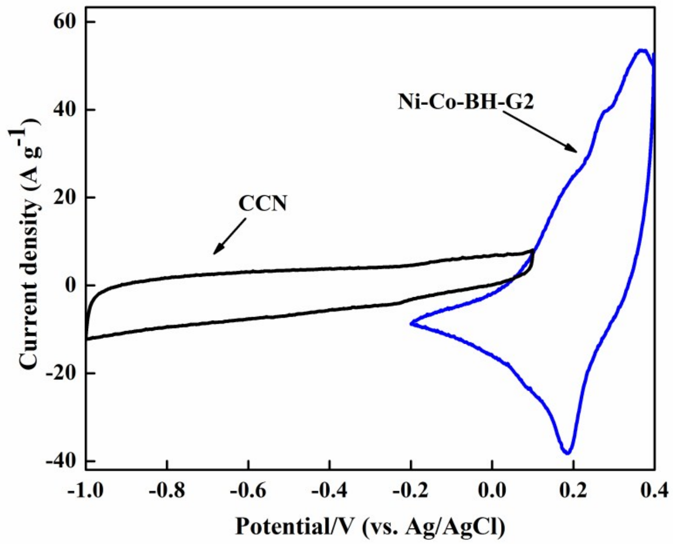

Fig. S11 Comparative CV curves of CCN and Ni-Co-BH-G2 in three electrode system at scan rate of 30 mV s^{-1}.

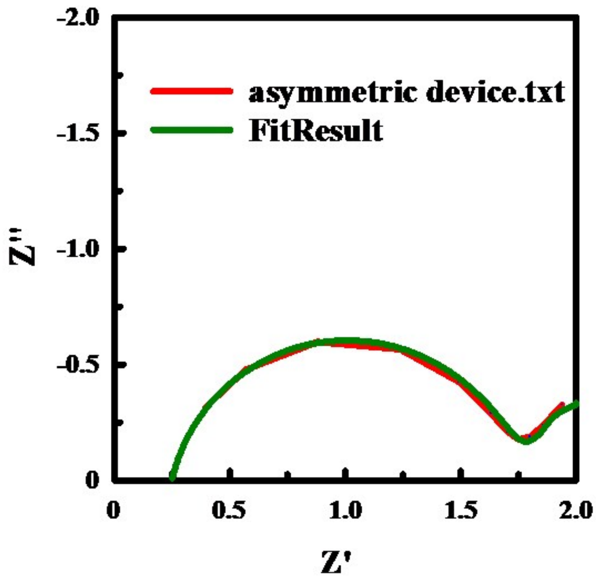

Fig. S12 The Z-View fitted Nyquist plot of Ni-Co-BH-G2//CCN.

Table S1. Surface area, average pore diameter and pore volume of the Ni-Co-BH-G composites.

Samples	Average pore dia (nm)	Pore volume ($cm^3\ g^{-1}$)	Surface area ($m^2\ g^{-1}$)
Ni-Co-BH-G1	3.64	0.13	28.05
Ni-Co-BH-G2	3.64	0.84	97.05
Ni-Co-BH-G3	3.62	0.30	51.50

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