Electronic Supplementary Material (ESI) for RSC Advances.

Supporting information

Multidimensional structure of $CoNi_2S_4$ materials: structural regulation promoted electrochemical performance in a supercapacitor

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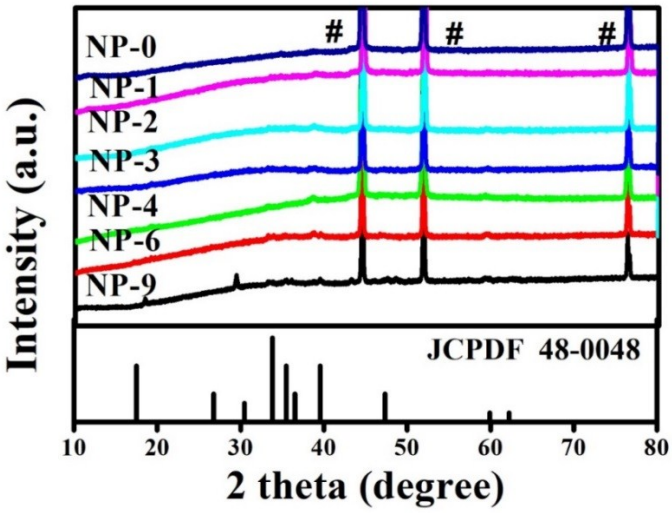

Figure S1. XRD pattern of NP-0, NP-1, NP-2, NP-3, NP-4, NP-6 and NP-9.

Figure S1 shows the XRD patterns of the precursor located on the Ni foam substrate. The strong peaks at 44.5°, 51.8° and 76.4° are matched with the Ni foam. The other diffraction peaks at approximately 17.512°, 26.749°, and 33.832° can be indexed to the (020), (220), (211) reflections, which match well with $Co_2(CO_3)_{0.5}(OH)$ (JCPDS Card No. 48-0083). This is not surprising because the partial substitution of Ni ions for Co ions only results in insignificant changes in the structure. Therefore, it is reasonable to

deduce the formation of $NiCo_2(CO_3)_{1.5}(OH)_3$ in the precursor sample [1]. Figure S2 shows the XRD pattern of the as-synthesized NS sample. Except for the diffraction peaks from the Ni foam, the other diffraction peaks at 31.47°, 38.17°, 50.25° and 55° are indexed to the (311), (400), (411) and (440) planes of $CoNi_2S_4$ (JCPDS Card No. 24-0334).

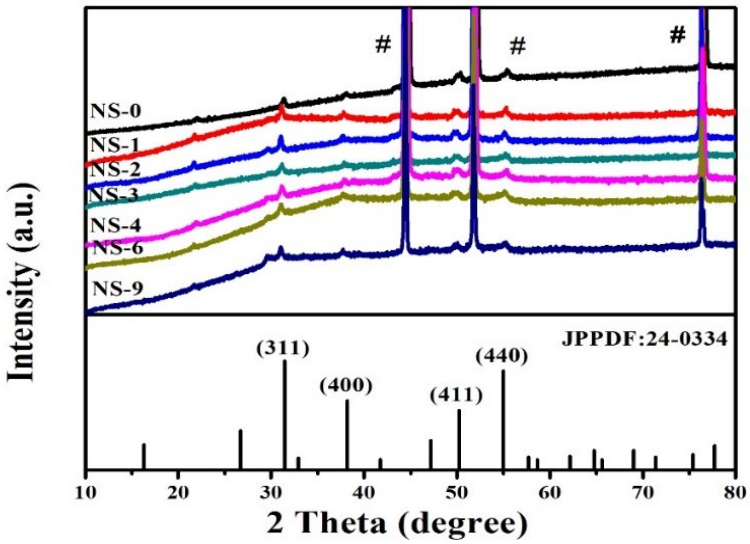

Figure S2. XRD pattern of NS-0, NS-1, NS-2, NS-3, NS-4, NS-6 and NS-9.

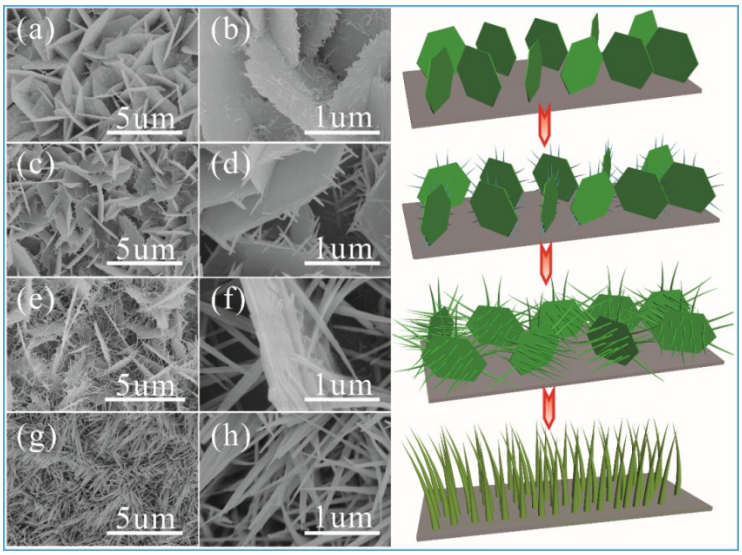

Figure S3. SEM images of the precursor obtained at different reaction stages with 3 mmol NH_4F and setting the run time at: (a, b) 0.5 h, (c, d) 1 h, (e, f) 8 h, and (g, h) 12 h. The right images are a schematic illustration of the morphologic evolution with increasing reaction time.

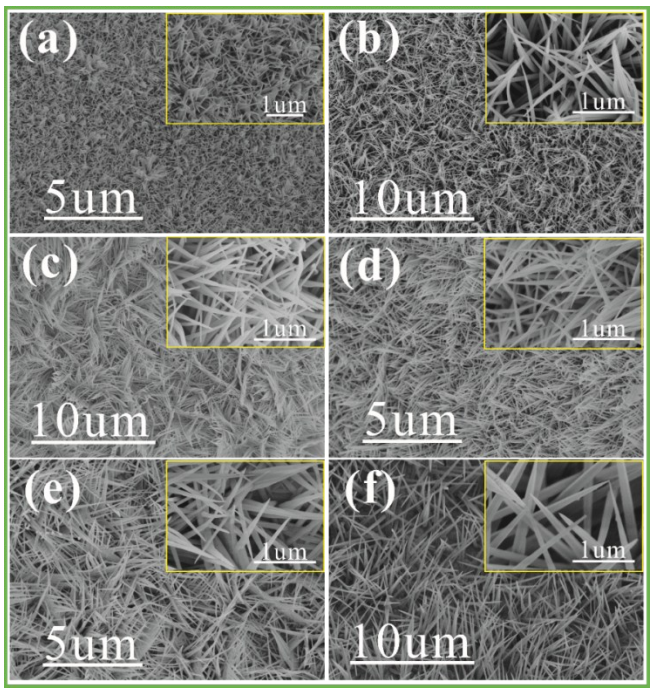

Figure S4. The evolution process of the precursor morphology affected by the concentration of NH_4F. (a-f) SEM images of NP-0, NP-1, NP-2, NP-4, NP-6 and NP-9, respectively.

From Figure S4, we can see that the small 2D nanoflake and 1D nanowire arrays of the Co-Ni precursor tend to form without adding any NH_4F into the reaction system (Figure S4a). When a low concentration of NH_4F is added into the reaction system, the small 2D nanoflakes disappear, and the intercrossing of 1D nanowire arrays to each other becomes dominant (Figure S4b). When the amount of NH_4F is 3 mmol, the hybrid-dimensional structure composed of 2D microsheets and 1D nanowires occupies the dominant position (Figure S3e-f). With a further increase of the concentration of NH_4F, the 2D microsheets disappear and turn into a dense nanowire array again (Figure S4e-f)[2-4].

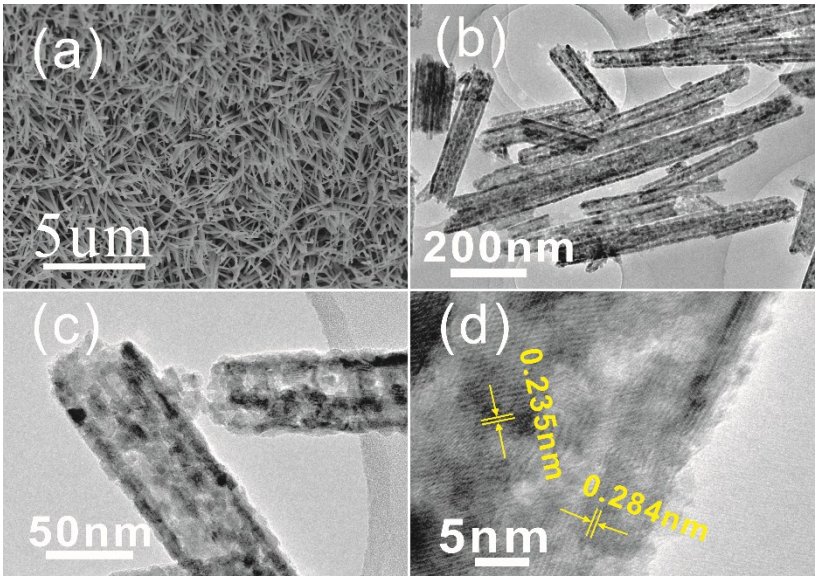

Figure S5. SEM images of the NS-9 sample (a). TEM, HRTEM and SRED images of the NS-9 sample (b-d), respectively.

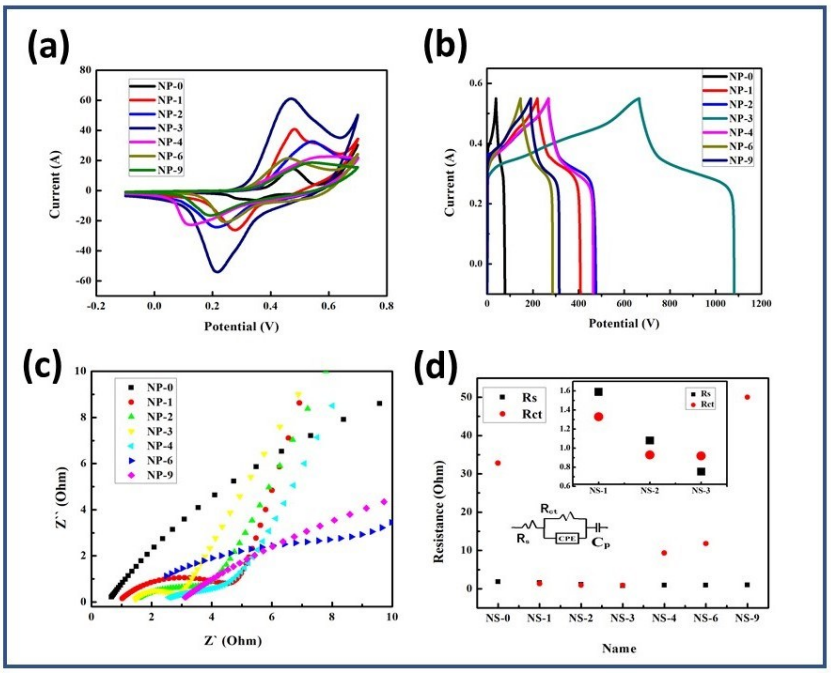

Figure S6. (a) CV curves of the NP samples at a scan rate of 10 mV s^{-1}. (b) GCD curves of the NP sample at a current density of 3A g^{-1}. (c) Impedance Nyquist plots of the NP samples. (d) Derived R_s and R_{ct} from the Nyquist plots for each sample.

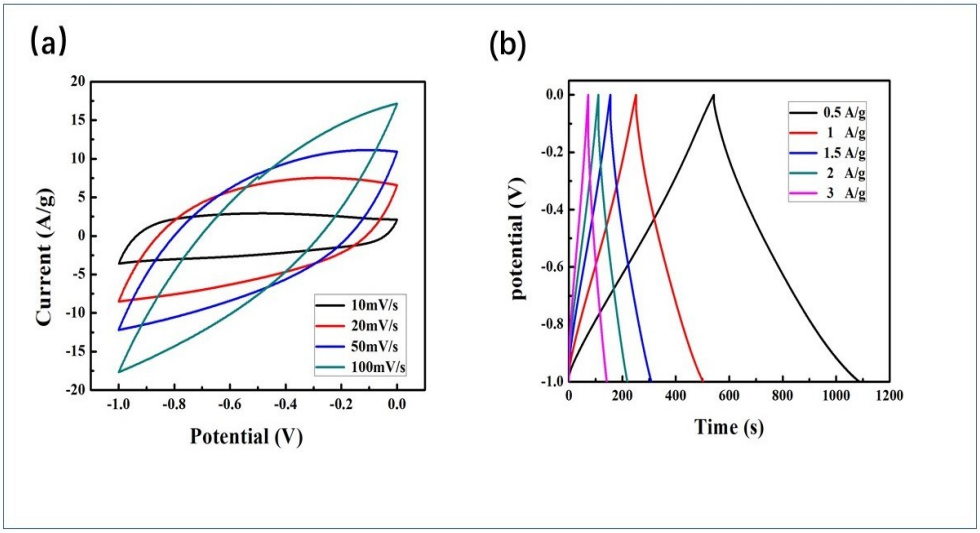

Figure S7. (a) CV curves of the AC at different scan rates and (b) discharge curves of the AC at different current densities.

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