Electronic Supplementary Material (ESI) for RSC Advances.


# Enhanced electrochemical performance of lamellar structured Co-$Ni(OH)_2$ /reduced Graphene Oxide (rGO) via hydrothermal synthesis

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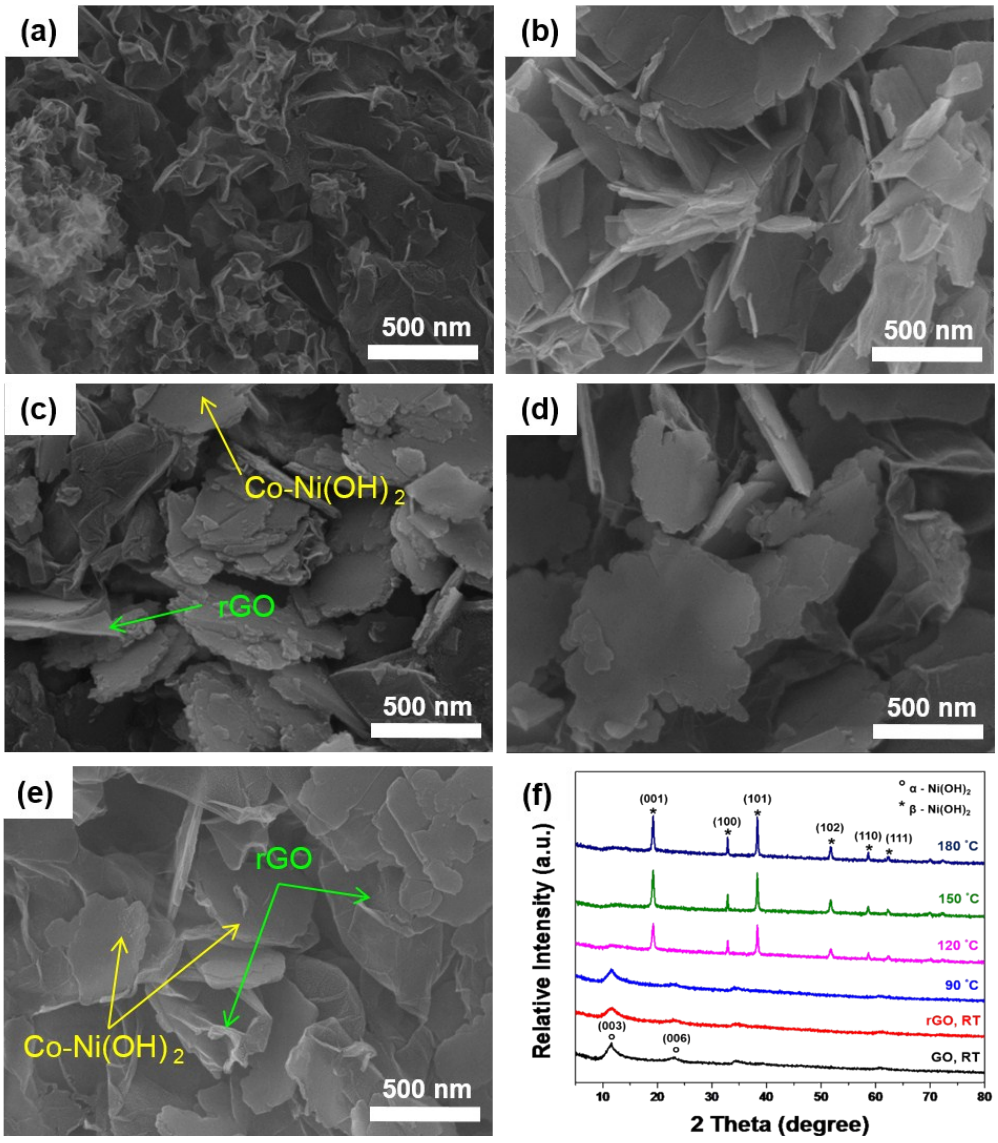


Fig. S1 SEM images of lamellar Co-Ni(OH)$_2$/rGO composites at different hydrothermal synthesis temperatures: (a) RT, ( b) 90 ˚C, (C) 120 ˚C (d) 150 ˚C, (e) 180 ˚C, and (f) their respective XRD patterns. All images are of lamellar Co-Ni(OH)$_2$/rGO prepared at a GO to metal precursor ratio of 1:10 ratio for 10 h.

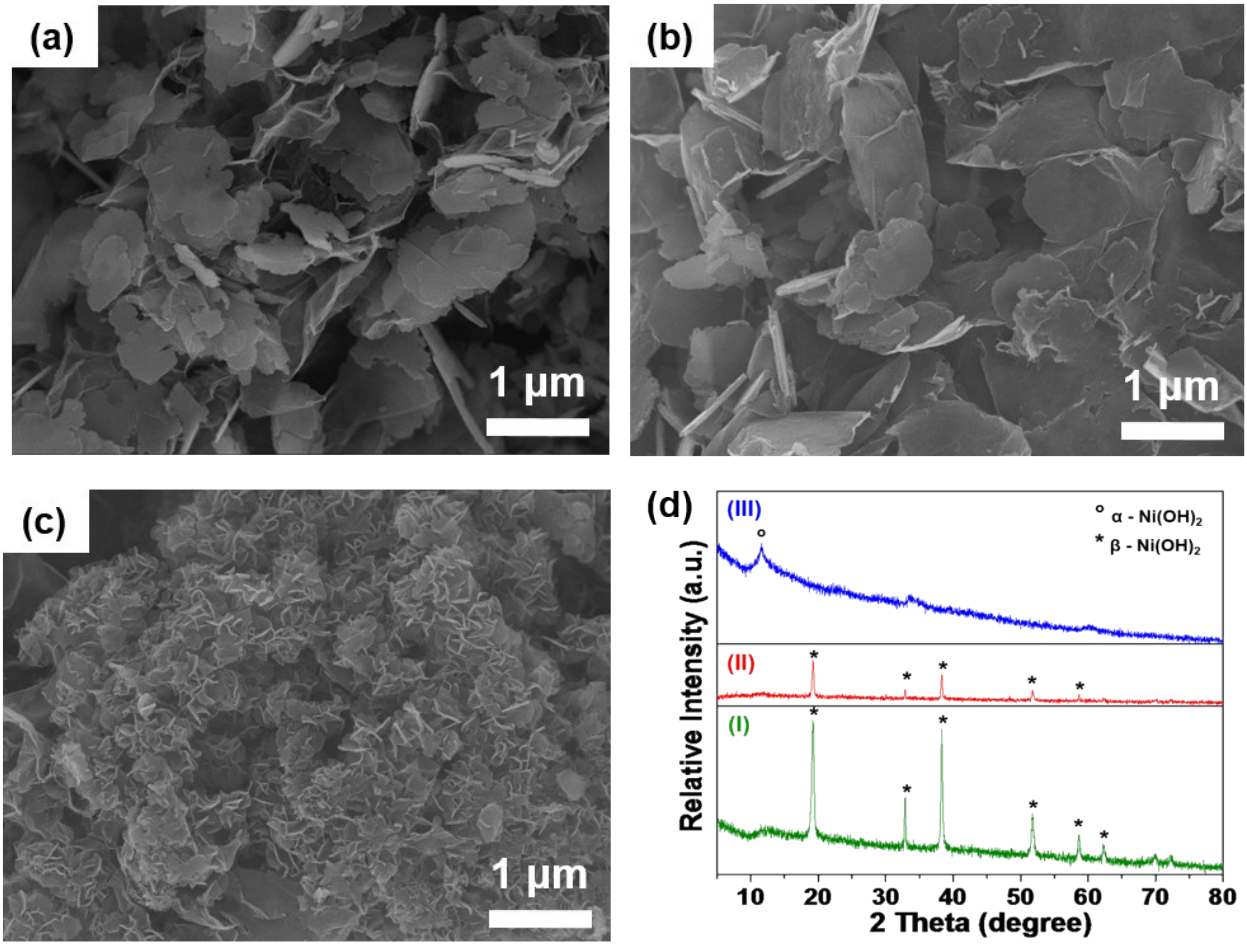


Fig. S2 SEM images of the as prepared lamellar Co-$Ni(OH)_2$/rGO at 150 °C and different GO to metal precursor ratios of (a) 1:10, (b) 1:7.5, (C)1:5 and (d) their respective XRD patterns where I, II, and III indicate1:10, 1: 7.5, and III is 1:5 ratios, respectively.

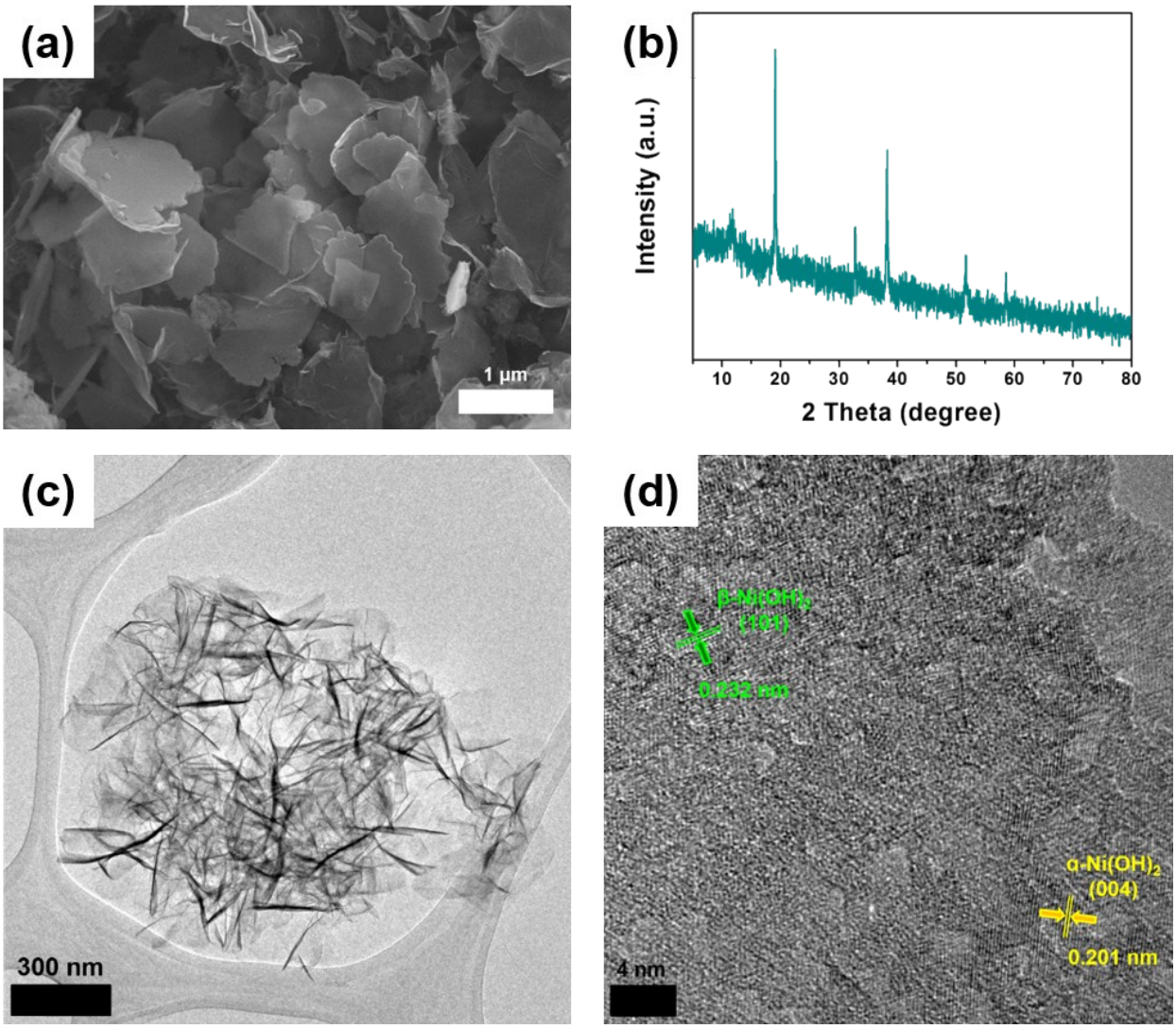


Fig. S3 (a) FESEM, (b) XRD, (c) TEM, and (d) HRTEM images of lamellar Co-$Ni(OH)_2$/rGO structure synthesized at 150˚C, 1:5 ratio, and 12 h.

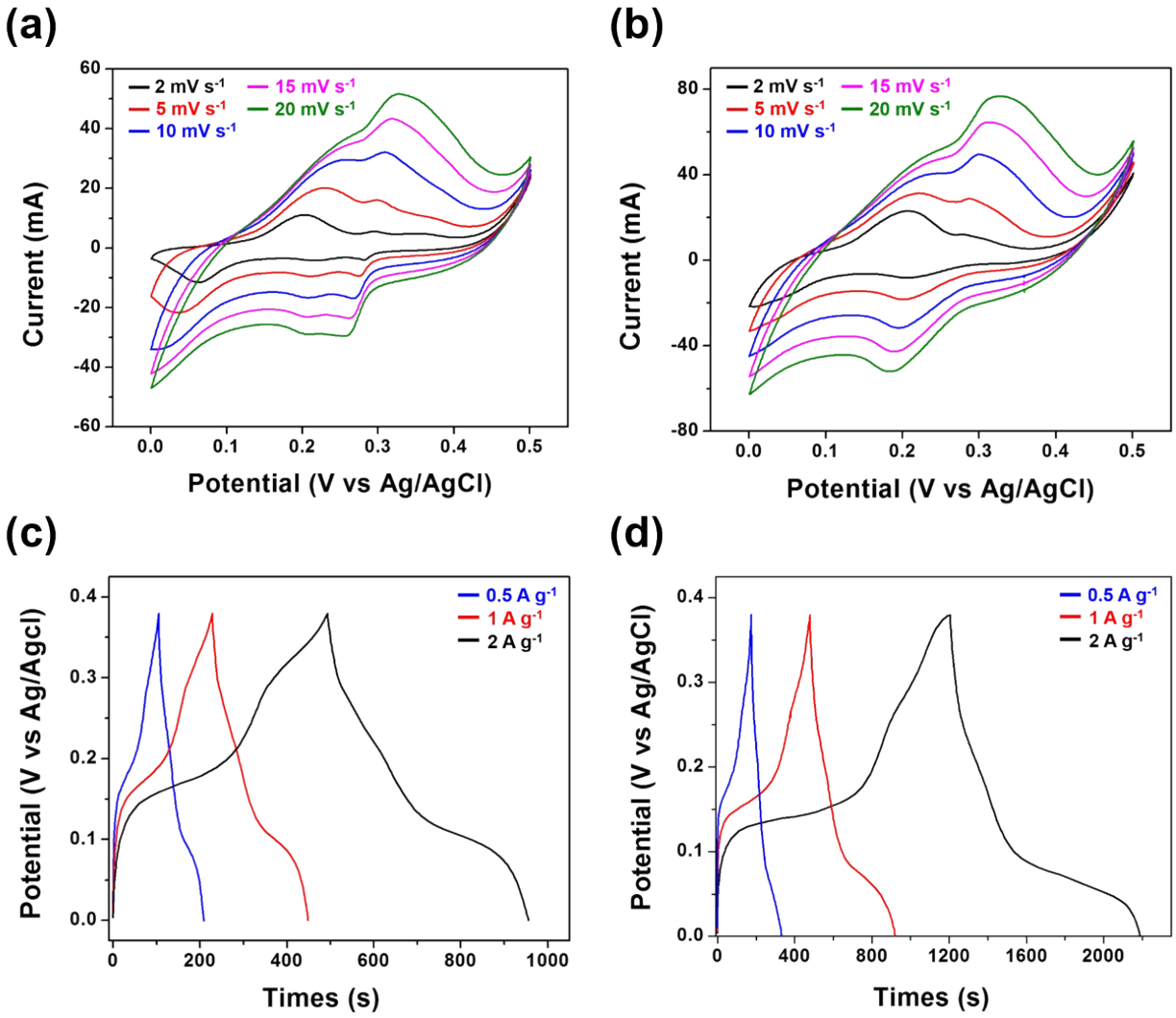


Fig. S4CV and GCD curves of lamellar Co-Ni$(OH)_2$/rGO synthesized at 150˚C and for 10 h in a GO tometal precursor ratios(a and c) 1:10 and (b and d) 1:5.

The specific capacitance of the electrodes was calculated on the basis of their CV and GCD curves using the equations $Cs = \frac{1}{ms(V_f - V_i)}\int_{V_i}^{V_f} I(V)dV$ and Cs = (I×t)/(m× ΔV), respectively, where Cs is the specific capacitance of the electrode (F $g^{-1}$), m is the mass of the electrode material (g), s is potential scan rate (mV $s^{-1}$), $V_f$ and $V_i$ are the integration limits of the voltammetric curve (V),

andI(V) denotes the response current (mA) in the CV tests while I is the discharge current (mA), t is the discharge time (s), and ΔV is the potential range (0.38 V) in the GCD tests.

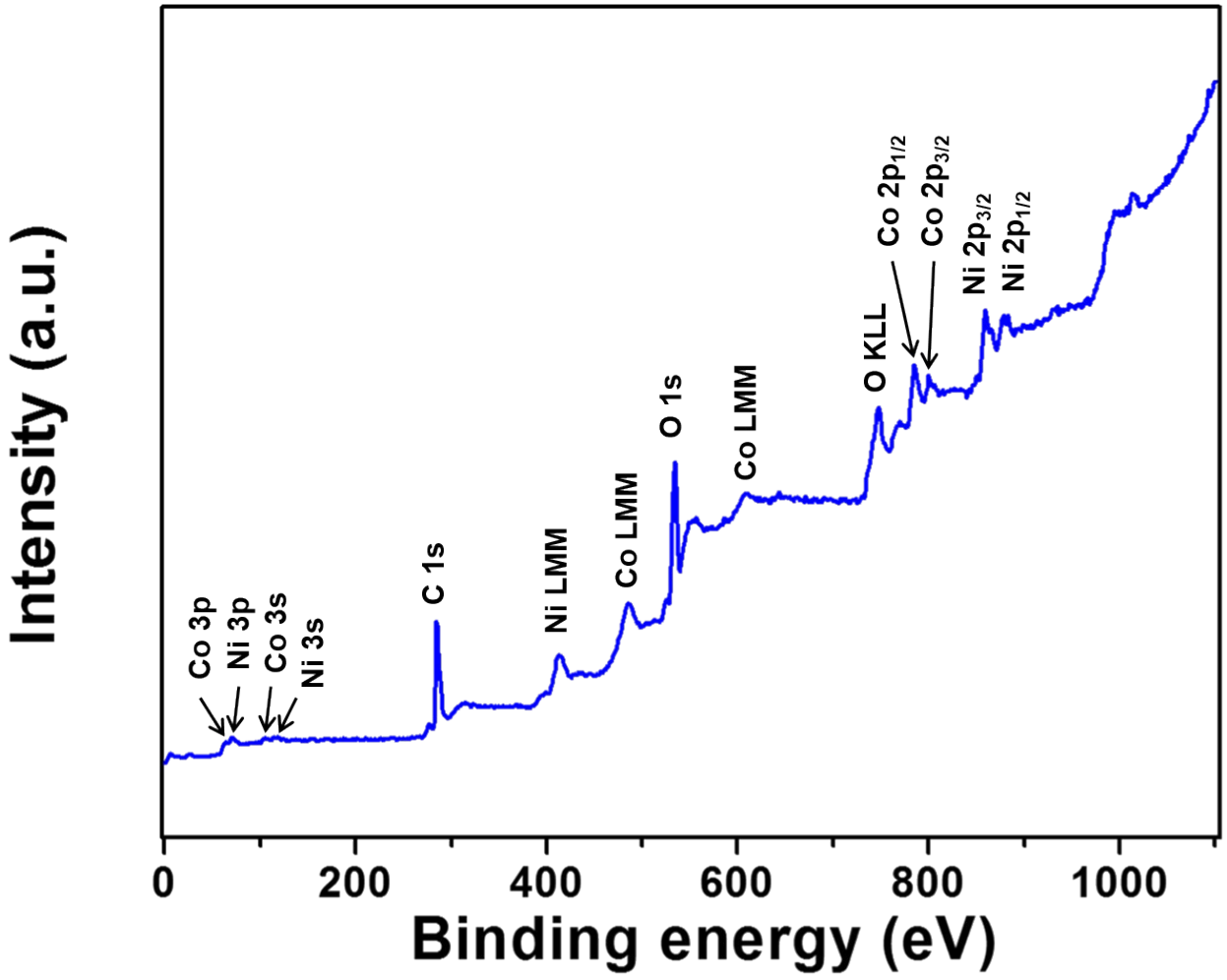


Fig. S5 XPS survey spectrum of lamellar Co-Ni$(OH)_2$/rGO synthesized at 150˚C, 1:5, and 12 h.

Table S1 Cs values based on CV curves of lamellar Co-$Ni(OH)_2$/rGO composites synthesized at different hydrothermal synthesis temperatures for different scan rates.

| Specific Capacitance , Cs (F $g^{-1}$) | | | | | |
|---|---|---|---|---|---|
| Scan rate (mV $s^{-1}$) | Temperature ( °C) | | | | |
| | RT | 90 °C | 120 °C | 150 °C | 180 °C |
| 20 | ~ 149 | ~ 160 | ~ 182 | ~ 327 | ~ 141 |
| 15 | ~ 255 | ~ 224 | ~ 257 | ~ 360 | ~ 170 |
| 10 | ~ 290 | ~ 253 | ~ 315 | ~ 404 | ~ 194 |
| 5 | ~ 335 | ~ 296 | ~ 408 | ~ 455 | ~ 226 |
| 2 | ~ 395 | ~ 349 | ~ 515 | ~ 500 | ~ 264 |

Table S2 Cs values based on CV and GCD curves of lamellar Co-$Ni(OH)_2$/rGO composites synthesized at 150˚C.

| Specific Capacitance , Cs (F $g^{-1}$) | | | | |
|---|---|---|---|---|
| Scan rate (mV $s^{-1}$) | 1:5 ratio, 10 h | 1:7.5 ratio, 10 h | 1:10 ratio, 10 h | 1:5 ratio, 12 h |
| 2 | ~ 646 | ~ 521 | ~ 500 | ~ 617 |
| 5 | ~ 472 | ~ 396 | ~ 455 | ~ 539 |
| 10 | ~ 375 | ~ 333 | ~ 404 | ~ 416 |
| 15 | ~ 329 | ~ 292 | ~ 360 | ~ 344 |
| 20 | ~ 297 | ~ 265 | ~ 327 | ~ 294 |

(a) Cs vs (GO to metal precursor ratios and synthesis time) for different scan rates calculated from CV tests.

| Specific Capacitance , Cs (F $g^{-1}$) | | | | |
|---|---|---|---|---|
| Current density (A $g^{-1}$) | 1:5 ratio, 10 h | 1:7.5 ratio, 10 h | 1:10 ratio, 10 h | 1:5 ratio, 12 h |
| 0.5 | ~ 1294 | ~ 536 | ~ 611 | ~ 811 |
| 1 | ~ 1171 | ~ 530 | ~ 581 | ~ 784 |
| 2 | ~ 891 | ~ 461 | ~ 542 | ~ 730 |

(b) Cs vs (GO to metal precursor ratios and synthesis time) for different current density calculated from GCD tests.

Table S3 A comparison of Co-$Ni(OH)_2$/rGO in this study with other cobalt and nickel based materials for supercapacitors

| Material | Method of synthesis | Mass loading [mg $cm^{-2}$] | Cs [F $g^{-1}$] | Current density [A $g^{-1}$] | Remarks | Reference |
|---|---|---|---|---|---|---|
| Co-$Ni(OH)_2$/rGO | Co precipitation followed by hydrothermal | 4.5-5.5 | 811 | 0.5 | High mass loading | This study |
| rGO/$Co(OH)_2$ | One-pot process at 95 °C | - | 474 | 1 | - | [1] |
| Ni-Co binary hydroxide | Hydrolysis in the presence of a surfactant | 1 | 1030 | 3 | small mass loading | [2] |
| Ni-Co binary hydroxide | Hydrolysis in the presence of a surfactant | 2.8 | 804 | 3 | small mass loading | [2] |
| $NiCo_2O_4$@RGO | Hydrothermal | 5.6–10.2 | 737 | 1 | - | [3] |
| $NiCo_2O_4$–rGO | Hydrothermal (water-ethanol mixture) | 3.5 | 882 | 1 | Small mass loading | [4] |
| $Co(OH)_2$/graphene /Ni foam nano-electrodes | RF-PECVD and electrodeposition | - | 693.8 | 2 | - | [5] |
| Co−Al LDHs/graphene nanosheets | Hydrothermal | - | 581.6 | 2 | - | [6] |
| $NiCo_2O_4$–RGO | Self-assembly and subsequent thermal treatment | 2 | 835 | 1 | Small mass loading | [7] |

**References**


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