Electronic Supplementary Material (ESI) for Nanoscale.

Supporting Information

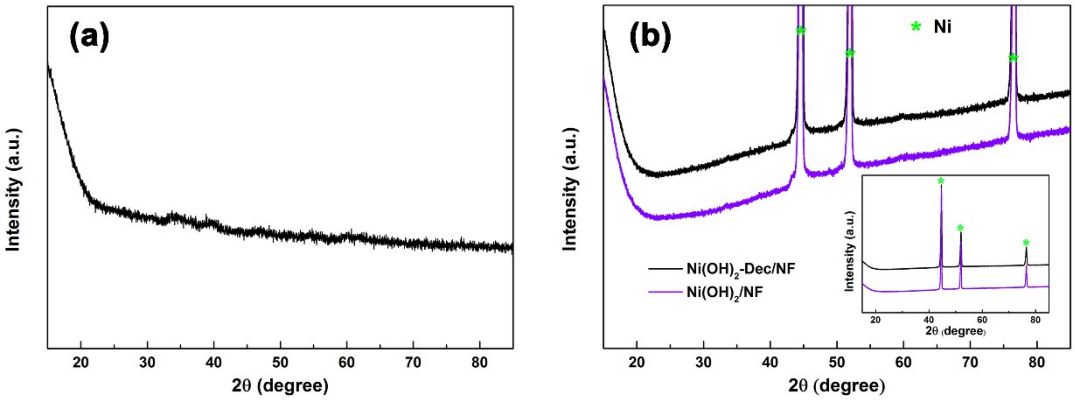

Figure S1. (a) XRD pattern of CoQDs powder; (b) comparison of enlarged XRD patterns of (a) $Ni(OH)_2$/NF and $Ni(OH)_2$-CoQD/NF (the inset is the original scale of XRD patterns).

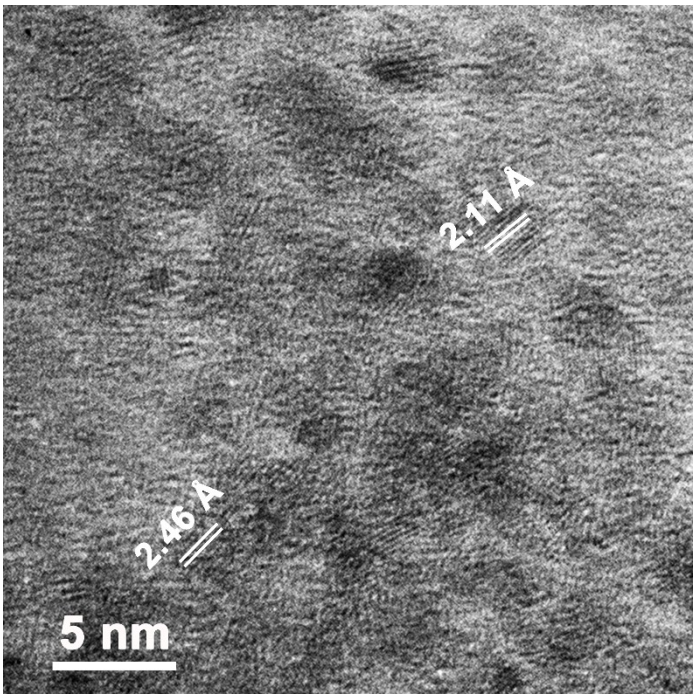

Figure S2. TEM image of CoQDs powder sample.

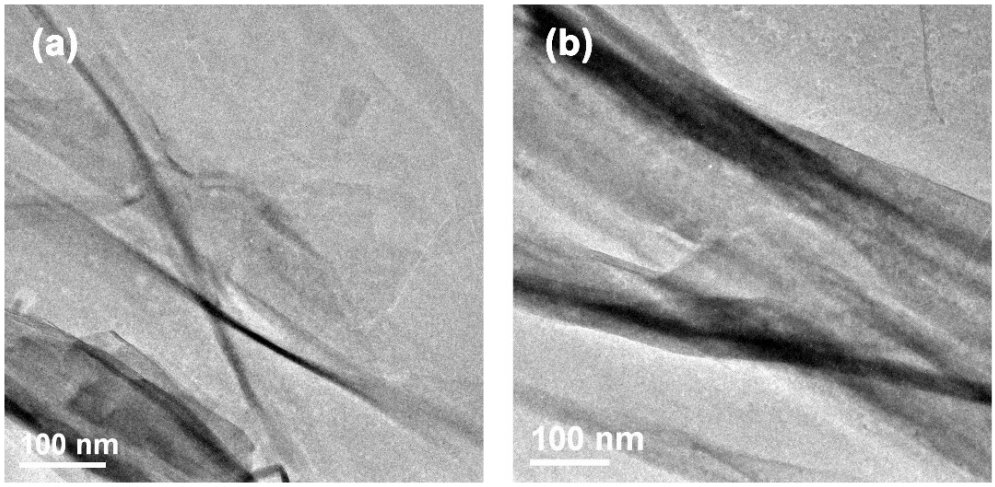

Figure S3. TEM image of (a) $Ni(OH)_2$ nanosheets and (b) $Ni(OH)_2$-CoQD hybrid nanosheets at a low magnification.

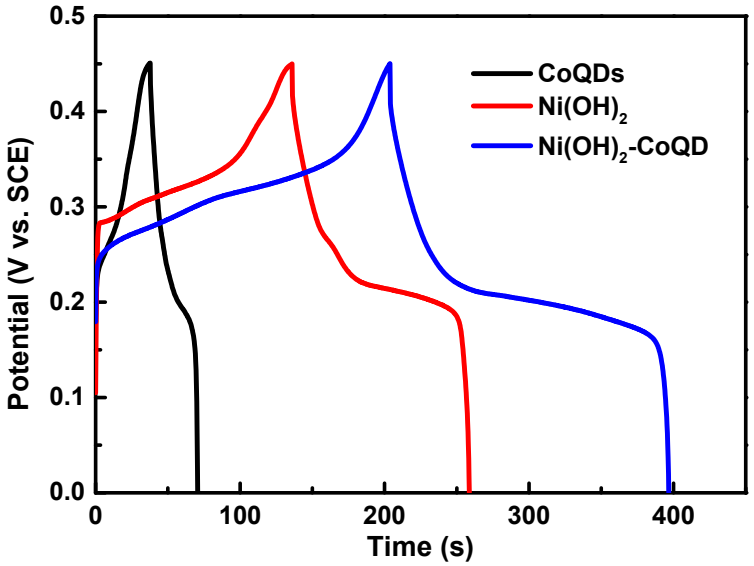

Figure S4. Comparison of galvanostatic charge/discharge curves of CoQDs electrode, $Ni(OH)_2$ electrode and $Ni(OH)_2$-QD electrode at 5 mA cm^{-2}.

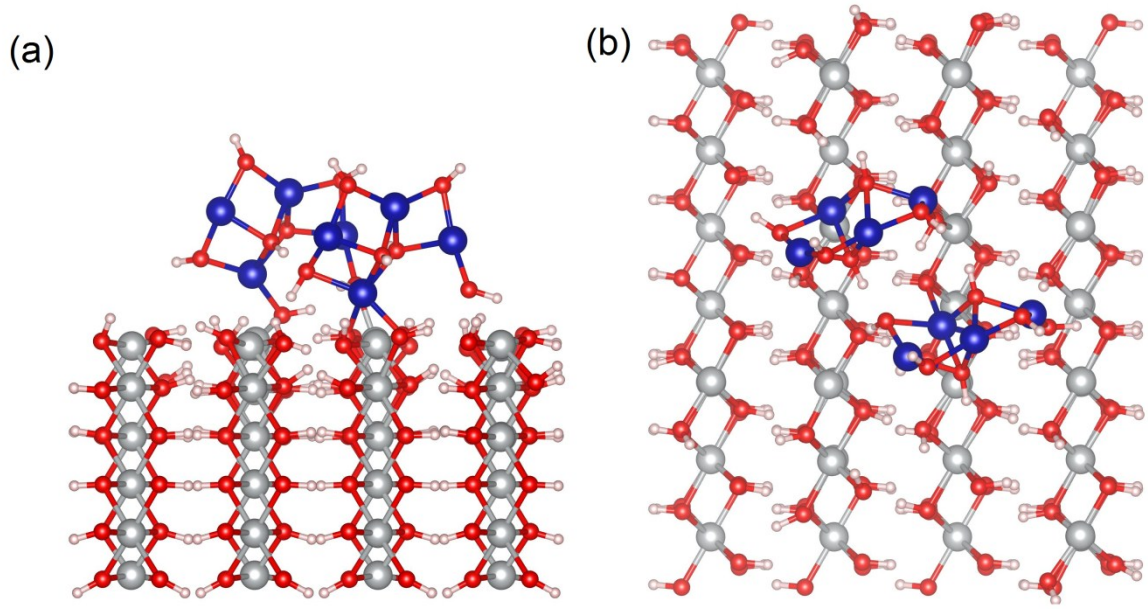

Figure S5. The optimized Co QDs adsorbed $Ni(OH)_2$ (110) surface. The light pink, red, light blue, and blue balls represent H, O, Ni, and Co atoms, respectively.

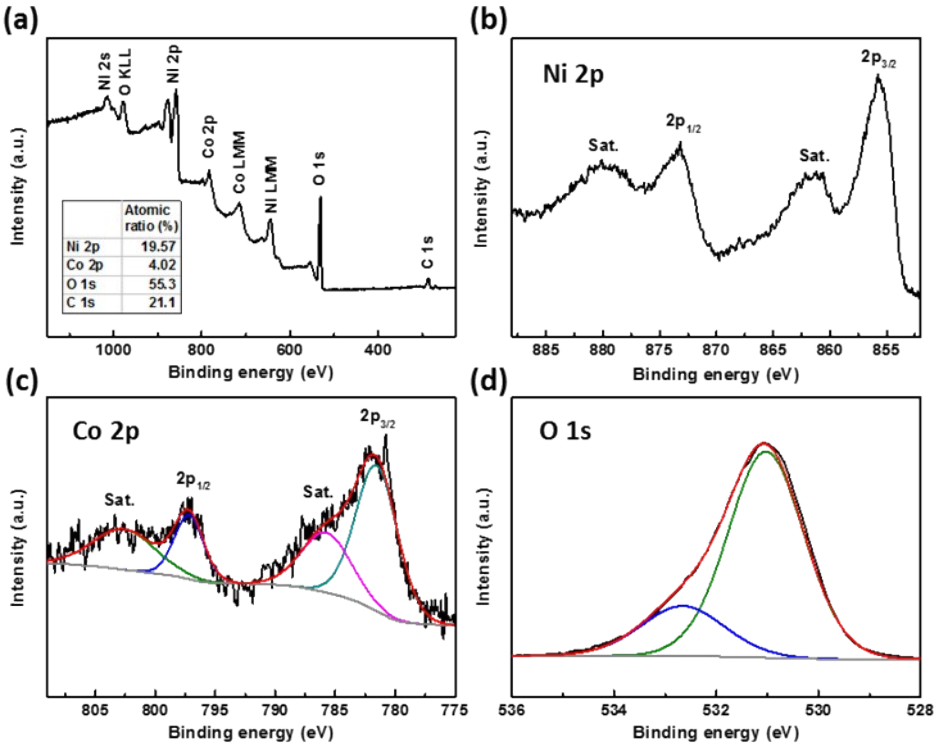

Figure S6. (a) XPS spectra of $Ni(OH)_2$-CoQD on NF (before charged). High resolution XPS spectra of (b) Ni, (c) Co and (d) O.

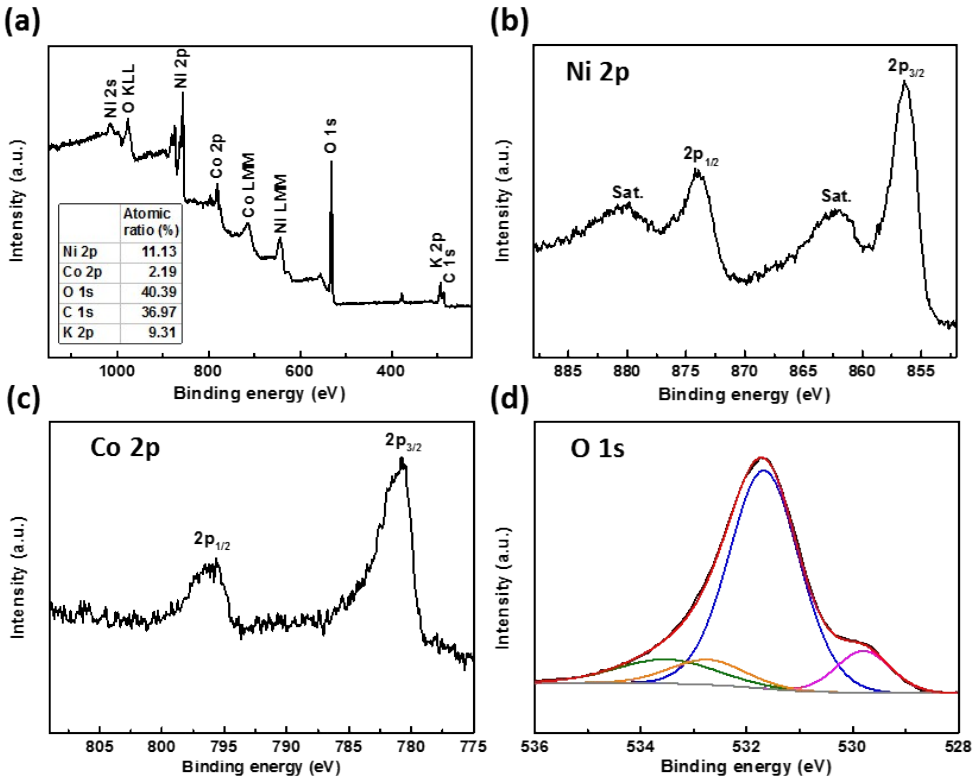

Figure S7. (a) XPS spectra of $Ni(OH)_2$-CoQD on NF (after charged). High resolution XPS spectra of (b) Ni, (c) Co and (d) O.

In the Ni 2p region (Fig. S7b), compared to the position of two major Ni 2p peaks from uncharged sample (855.7 eV and 873.4 eV, in Fig. S6b), peaks from the charged sample shift to higher binding energies of 856.5 eV and 876.1 eV, corresponding to Ni $2p_{3/2}$ and Ni $2p_{1/2}$ for NiOOH[1, 2], respectively. Missing of satellite at 786 eV that is featured for Co^{2+} is observed in Co 2p region (Fig. S7c), which indicates a higher valence of Co in the charged sample.[3, 4] The two main peaks of charged Co 2p with binding energy of 780.9 and 796.2 eV, respectively, can be more possibly attached to CoO_2 according to literature.[5, 6] Four peaks can be assigned to the O 1s spectrum for charged sample (Fig. S7d). Except for two peaks at 531.6 and 532.8 eV, representing O^{2-} and adsorbed/structural H_2O, peaks at 529.8 and 533.6 eV are also obtained, which can be attached to metal-oxygen binding (M-O) from oxidation products of oxyhydroxides and dioxides and oxygen-containing adsorbates[2] generated in charging process, respectively. The reason for a higher ratio of OH^- compared to O^{2-} in O 1s spectrum might be due to the KOH electrolyte residual contribution.

Table S1. The correction values for adsorption energy (in eV) calculations. Zero-point energies (ZPE), vibrational enthalpies and entropies

	ZPE	H_{vib}	TS	ZPE+H_{vib}-TS
H_2O	0.56	0.10	0.67	-0.01
H_2	0.27	0.09	0.41	-0.05
OH*	0.22	0.05	0.08	0.19

Table S2. Bader charge table

#	X	Y	Z	CHARGE	MIN DIST	ATOMIC VOL
1	0	2.6299	25.4746	8.98	0.7952	30.2557
2	0	7.8895	25.4746	8.972	0.7948	28.9954
3	0	13.1492	25.4746	8.9799	0.7952	30.6419
4	4.1977	2.6299	25.4746	8.9796	0.7941	30.231
5	4.1977	7.8895	25.4746	8.9775	0.791	29.2181
6	4.1977	13.1492	25.4746	8.9753	0.7799	30.2044
7	8.3954	2.6299	25.4746	8.9755	0.7799	30.6735
8	8.3954	7.8895	25.4746	8.9779	0.791	27.1982
9	8.3954	13.1492	25.4746	8.9794	0.7941	30.4035
10	0	0	1.309	8.8034	0.8477	9.5824
11	0	5.2597	1.309	8.8017	0.8524	9.5242
12	0	10.5194	1.309	8.8	0.8524	9.5183
13	4.1977	0	1.309	8.8009	0.8291	9.5282
14	4.1977	5.2597	1.309	8.8023	0.8413	9.539
15	4.1977	10.5194	1.309	8.8047	0.8378	9.5804
16	8.3954	0	1.309	8.8009	0.8291	9.5311
17	8.3954	5.2597	1.309	8.804	0.8378	9.5715
18	8.3954	10.5194	1.309	8.8015	0.8413	9.538
19	0	2.6299	2.9863	8.8137	0.8534	9.6139
20	0	7.8895	2.9863	8.8135	0.8487	9.5883
21	0	13.1492	2.9863	8.8115	0.8434	9.6178
22	4.1977	2.6299	2.9863	8.8155	0.8537	9.5883
23	4.1977	7.8895	2.9863	8.8102	0.8472	9.5715
24	4.1977	13.1492	2.9863	8.8116	0.8576	9.5183
25	8.3954	2.6299	2.9863	8.8129	0.8576	9.6198
26	8.3954	7.8895	2.9863	8.8129	0.8435	9.5587

27	8.3954	13.1492	2.9863	8.8176	0.8537	9.6464
28	12.5686	0.0235	4.5748	8.8306	0.8419	9.7706
29	0.0305	5.2629	4.5962	8.8223	0.8386	9.5233
30	12.5917	10.547	4.6056	8.8126	0.8434	9.5932
31	4.2243	15.7759	4.6002	8.8223	0.8383	9.3705
32	4.1993	5.2439	4.5935	8.8247	0.8445	9.6178
33	4.2199	10.5052	4.6131	8.8253	0.8424	9.5361
34	8.4012	15.7649	4.6015	8.8123	0.8598	9.7193
35	8.4319	5.2502	4.5943	8.8264	0.846	9.6395
36	8.3794	10.4952	4.6264	8.8254	0.858	9.7302
37	12.582	2.6343	6.2851	8.8303	0.8514	9.6878
38	12.5303	7.9444	6.2569	8.8262	0.8476	9.6425
39	12.5851	13.2123	6.2845	8.8394	0.8409	9.6257
40	4.1235	2.5651	6.2496	8.8326	0.8532	9.5725
41	4.1453	7.8926	6.2645	8.8235	0.8347	9.6188
42	4.1947	13.1518	6.166	8.8809	0.821	10.6377
43	8.3925	2.6283	6.2796	8.8326	0.8486	9.5262
44	8.3062	7.8492	6.268	8.8317	0.8372	9.9351
45	8.3564	13.0919	6.2912	8.8298	0.8519	9.6651
46	12.5856	0.0534	7.7316	8.9795	0.8068	30.9612
47	0.0231	5.2978	7.6805	8.9619	0.8088	17.0453
48	12.5835	10.5841	7.6483	8.9643	0.7909	18.0523
49	4.2172	15.6907	7.6726	9.0098	0.7938	26.1833
50	4.0185	5.1839	7.678	8.9884	0.7978	20.422
51	4.2344	10.5609	7.8361	9.1908	0.8023	13.5749
52	8.3635	15.7592	7.7177	8.954	0.8115	24.7555
53	8.3465	5.1982	7.751	9.0416	0.8018	13.5296
54	8.3044	10.4549	7.8325	8.8632	0.8176	11.9708
55	7.6479	10.7503	9.7547	7.2458	0.6972	18.8751
56	4.7561	9.4448	11.2155	7.2539	0.6735	17.0975
57	7.1569	11.0582	13.3071	7.2231	0.6571	98.4625
58	2.3662	10.3416	10.6471	7.2848	0.7218	32.1455
59	5.2992	12.0301	11.6134	7.2379	0.7118	28.8732
60	3.9075	9.5734	13.9316	7.2125	0.6756	73.636
61	11.4943	7.128	9.5947	7.244	0.7216	24.862
62	8.5401	5.584	10.7505	7.2684	0.752	24.9822
63	10.595	7.4954	13.1428	7.261	0.6842	63.7166
64	5.9688	7.3387	10.2102	7.231	0.6828	19.7707
65	9.0248	8.161	10.9201	7.1988	0.7169	17.8208
66	7.3756	5.781	13.1497	7.2222	0.6464	98.2496
67	0.9743	4.2308	25.3359	7.2647	0.6964	30.3128
68	0.9743	9.4905	25.3359	7.2716	0.6967	30.3641
69	0.9743	14.7502	25.3359	7.2566	0.6976	30.7513
70	5.172	4.2308	25.3359	7.2421	0.6811	30.5552
71	5.172	9.4905	25.3359	7.2463	0.6814	28.1342
72	5.172	14.7502	25.3359	7.2659	0.726	31.1799
73	9.3697	4.2308	25.3359	7.2348	0.6683	29.8566
74	9.3697	9.4905	25.3359	7.244	0.6687	29.9295

75	9.3697	14.7502	25.3359	7.2336	0.6696	30.7809
76	0.9897	1.7126	1.3665	7.1748	0.6996	11.6851
77	0.9897	6.9723	1.3665	7.1708	0.6993	11.6624
78	0.9897	12.232	1.3665	7.1696	0.6987	11.6545
79	5.1874	1.7126	1.3665	7.1899	0.7316	11.7097
80	5.1874	6.9723	1.3665	7.185	0.7177	11.6949
81	5.1874	12.232	1.3665	7.1954	0.7171	11.7472
82	9.3851	1.7126	1.3665	7.2318	0.7507	11.895
83	9.3851	6.9723	1.3665	7.2241	0.7504	11.8408
84	9.3851	12.232	1.3665	7.2184	0.7499	11.8329
85	0.9597	4.3975	2.9697	7.1728	0.7144	11.6378
86	0.9597	9.6572	2.9697	7.1671	0.7133	11.7205
87	0.9597	14.9169	2.9697	7.166	0.7137	11.7412
88	5.1574	4.3975	2.9697	7.197	0.7471	11.8191
89	5.1574	9.6572	2.9697	7.2069	0.7461	11.7068
90	5.1574	14.9169	2.9697	7.1928	0.7465	11.6624
91	9.3551	4.3975	2.9697	7.2445	0.7799	11.9551
92	9.3551	9.6572	2.9697	7.2453	0.7788	12.0112
93	9.3551	14.9169	2.9697	7.2364	0.7792	11.9728
94	0.9541	1.7703	4.6314	7.1839	0.7196	11.7629
95	0.9511	7.0597	4.6144	7.189	0.7239	11.7196
96	0.9687	12.311	4.6298	7.1691	0.7053	11.8664
97	5.1448	1.7711	4.6228	7.2139	0.7597	11.8733
98	5.1439	7.0229	4.6317	7.2215	0.7604	11.8467
99	5.1814	12.2815	4.59	7.1756	0.7234	11.5796
100	9.3504	1.7567	4.6282	7.2492	0.7846	12.0733
101	9.338	7.0386	4.6461	7.1565	0.6986	11.7954
102	9.3199	12.2595	4.6333	7.1721	0.7169	11.827
103	1.0589	4.3414	6.2523	7.2347	0.7204	11.8733
104	1.0335	9.6356	6.2431	7.2237	0.733	11.9235
105	1.1716	14.8435	6.4461	7.2173	0.6593	12.3778
106	5.1923	4.2835	6.3129	7.2293	0.7249	11.9147
107	5.2007	9.6202	6.2244	7.1916	0.7043	11.7225
108	5.2485	14.8413	6.1802	7.219	0.7546	11.9925
109	9.485	4.3142	6.3679	7.2011	0.6666	12.1304
110	9.2699	9.5626	6.3085	7.1906	0.7282	11.9206
111	9.4056	14.8225	6.2835	7.2189	0.6886	12.0004
112	0.9336	1.7127	7.939	7.1764	0.6526	35.2188
113	0.906	6.9938	7.8979	7.2636	0.7669	20.694
114	0.7553	12.2799	8.0377	7.2428	0.7222	25.2679
115	5.1945	1.5411	7.7575	7.2148	0.6609	23.0519
116	5.0355	6.8292	7.8744	7.3002	0.729	15.4431
117	5.1409	12.0252	8.7273	7.2644	0.7622	16.3832
118	9.1321	1.6998	7.9892	7.2135	0.7074	31.239
119	9.2195	6.8543	8.0597	7.219	0.7671	13.4577
120	9.4692	12.0186	7.674	7.1736	0.6864	16.8817
121	3.2234	1.0289	25.3359	7.2334	0.6696	30.4449
122	3.2234	6.2886	25.3359	7.2446	0.6687	30.8804

123	3.2234	11.5483	25.3359	7.2347	0.6683	28.685
124	7.4211	1.0289	25.3359	7.2639	0.726	30.6843
125	7.4211	6.2886	25.3359	7.2468	0.6814	27.9332
126	7.4211	11.5483	25.3359	7.241	0.6811	28.286
127	11.6188	1.0289	25.3359	7.2563	0.6976	30.5956
128	11.6188	6.2886	25.3359	7.2716	0.6967	29.0979
129	11.6188	11.5483	25.3359	7.2651	0.6964	31.6135
130	3.208	3.5471	1.3665	7.2199	0.7499	11.824
131	3.208	8.8068	1.3665	7.2231	0.7504	11.8319
132	3.208	14.0665	1.3665	7.2314	0.7507	11.891
133	7.4057	3.5471	1.3665	7.1965	0.7171	11.7718
134	7.4057	8.8068	1.3665	7.1861	0.7177	11.7432
135	7.4057	14.0665	1.3665	7.1904	0.7316	11.7008
136	11.6034	3.5471	1.3665	7.17	0.6987	11.6585
137	11.6034	8.8068	1.3665	7.1716	0.6993	11.6703
138	11.6034	14.0665	1.3665	7.1751	0.6996	11.6939
139	3.238	0.8622	2.9697	7.24	0.7792	11.9491
140	3.238	6.1219	2.9697	7.2424	0.7788	11.9472
141	3.238	11.3816	2.9697	7.2477	0.7799	12.0043
142	7.4357	0.8622	2.9697	7.1902	0.7465	11.8437
143	7.4357	6.1219	2.9697	7.1993	0.7461	11.826
144	7.4357	11.3816	2.9697	7.1956	0.7471	11.7718
145	11.6334	0.8622	2.9697	7.2572	0.812	11.9068
146	11.6334	6.1219	2.9697	7.1664	0.7133	11.7807
147	11.6334	11.3816	2.9697	7.1657	0.7144	11.7235
148	3.2241	3.4836	4.6168	7.2342	0.7666	11.7669
149	3.2119	8.7629	4.6291	7.1667	0.6649	11.5609
150	3.2349	14.0277	4.6119	7.1495	0.6799	11.4703
151	7.462	3.5045	4.6273	7.2304	0.7745	11.9156
152	7.3942	8.7248	4.606	7.1777	0.7065	11.5392
153	7.4292	14.0063	4.6237	7.2019	0.7406	11.69
154	11.6411	3.5034	4.6447	7.1971	0.7225	11.8348
155	11.6065	8.7992	4.6191	7.1732	0.6883	11.7373
156	11.6619	14.0517	4.6299	7.2008	0.744	11.8555
157	3.157	0.77	6.1836	7.2497	0.7505	11.8772
158	3.1592	6.1265	6.1519	7.1692	0.7011	11.4742
159	3.285	11.425	6.2351	7.186	0.7283	11.9689
160	7.362	0.9092	6.2471	7.2298	0.7219	11.9413
161	7.3713	6.0354	6.1731	7.2138	0.7152	11.6516
162	7.3403	11.3369	6.2818	7.2089	0.7488	12.2546
163	11.6077	0.8564	6.1836	7.2424	0.7862	12.2497
164	11.6094	6.1223	6.1654	7.1602	0.6976	11.9817
165	11.5703	11.5201	6.1989	7.1748	0.7161	11.7787
166	3.2557	3.4766	7.9593	7.3072	0.7275	28.488
167	3.0904	8.9902	7.6604	7.21	0.6879	14.378
168	3.3198	13.9909	7.8687	7.5117	0.7967	25.2157
169	7.2256	3.6535	7.7073	7.2662	0.7201	16.934
170	7.3342	8.6399	8	7.2277	0.7438	12.8172

171	7.5554	14.0485	7.9657	7.205	0.6885	23.3268
172	11.586	3.6554	7.8394	7.2801	0.6982	21.099
173	11.4401	9.0405	7.6064	7.2165	0.6937	15.926
174	11.4796	14.2714	7.8024	7.2158	0.6419	24.9299
175	1.8276	4.3121	24.8744	0.3425	0.0632	36.6534
176	1.8276	9.5718	24.8744	0.3339	0.0426	25.4916
177	1.8276	14.8315	24.8744	0.348	0.0572	35.0809
178	6.0253	4.3121	24.8744	0.3614	0.0367	29.7551
179	6.0253	9.5718	24.8744	0.3605	0.0254	30.4498
180	6.0253	14.8315	24.8744	0.3444	0.0458	36.8958
181	10.223	4.3121	24.8744	0.3699	0.0723	31.8578
182	10.223	9.5718	24.8744	0.3637	0.0124	32.7358
183	10.223	14.8315	24.8744	0.37	0.0401	37.2368
184	1.9397	1.6262	1.1061	0.367	0.0586	1.5204
185	1.9397	6.8859	1.1061	0.3736	0.0734	1.5549
186	1.9397	12.1456	1.1061	0.3702	0.0729	1.545
187	6.1374	1.6262	1.1061	0.3499	0.0622	1.4721
188	6.1374	6.8859	1.1061	0.3508	0.0429	1.4603
189	6.1374	12.1456	1.1061	0.3458	0.0421	1.4544
190	10.3351	1.6262	1.1061	0.3141	0.0498	1.342
191	10.3351	6.8859	1.1061	0.3204	0.0212	1.3785
192	10.3351	12.1456	1.1061	0.3245	0.0196	1.3795
193	1.9353	4.313	2.9234	0.39	0.0742	1.6701
194	1.9353	9.5727	2.9234	0.3901	0.0697	1.6623
195	1.9353	14.8324	2.9234	0.3937	0.0912	1.6938
196	6.133	4.313	2.9234	0.3606	0.0475	1.5824
197	6.133	9.5727	2.9234	0.3583	0.0402	1.5499
198	6.133	14.8324	2.9234	0.3662	0.0712	1.5746
199	10.3307	4.313	2.9234	0.314	0.034	1.413
200	10.3307	9.5727	2.9234	0.3141	0.0802	1.4011
201	10.3307	14.8324	2.9234	0.3197	0.063	1.4356
202	1.9289	1.7093	4.7014	0.3812	0.0743	1.6347
203	1.9248	7.1638	4.5848	0.3791	0.0854	1.5824
204	1.9449	12.2485	4.624	0.3993	0.0914	1.7125
205	6.1151	1.6903	4.74	0.3351	0.0715	1.5046
206	6.1199	6.9793	4.6966	0.3472	0.0394	1.4819
207	6.1605	12.277	4.6137	0.394	0.089	1.6613
208	10.3289	1.7621	4.6564	0.3144	0.0869	1.4189
209	10.3154	7.0764	4.7076	0.3989	0.0941	1.7371
210	10.2829	12.138	4.7858	0.3711	0.0532	1.6228
211	1.9847	4.1517	6.5287	0.338	0.0352	1.4238
212	1.89	9.4062	6.7528	0.3227	0.0659	1.1528
213	1.9065	14.4533	6.9939	0.3548	0.059	1.4544
214	6.001	3.9772	6.8714	0.3172	0.0747	1.1223
215	6.1771	9.5777	6.1907	0.3981	0.0783	1.611
216	6.2178	14.8981	6.3259	0.3305	0.036	1.4681
217	10.2887	4.0203	6.8902	0.3492	0.0632	1.3233
218	10.183	9.4017	6.7337	0.3303	0.0671	1.1992

219	10.2386	14.567	6.7894	0.3236	0.0329	1.1923
220	1.8681	1.5494	7.6967	0.4257	0.1035	2.6299
221	1.8735	7.0107	7.7762	0.3386	0.0445	2.4111
222	1.7018	12.4463	8.213	0.367	0.0379	2.7708
223	4.9061	2.1377	8.4758	0.3658	0.0582	18.3696
224	5.9456	6.6384	7.5582	0.2988	0.0681	1.4839
225	6.094	11.8544	8.9093	0.3119	0.077	1.8308
226	10.0745	1.8455	8.1837	0.3841	0.0766	7.3595
227	10.1407	6.8492	8.4479	0.2972	0.0489	1.4622
228	9.4708	12.6053	8.4521	0.3897	0.0878	8.6483
229	2.3701	0.9476	24.8744	0.3701	0.0401	44.0129
230	2.3701	6.2073	24.8744	0.3635	0.0124	30.6567
231	2.3701	11.467	24.8744	0.37	0.0723	25.7665
232	6.5678	0.9476	24.8744	0.3445	0.0458	40.8549
233	6.5678	6.2073	24.8744	0.3605	0.0254	34.736
234	6.5678	11.467	24.8744	0.3634	0.0367	32.2283
235	10.7655	0.9476	24.8744	0.348	0.0572	45.2347
236	10.7655	6.2073	24.8744	0.3337	0.0426	34.1073
237	10.7655	11.467	24.8744	0.3422	0.0632	31.5652
238	2.258	3.6335	1.1061	0.3243	0.0196	1.3775
239	2.258	8.8932	1.1061	0.3202	0.0212	1.3765
240	2.258	14.1529	1.1061	0.3137	0.0498	1.3381
241	6.4557	3.6335	1.1061	0.3459	0.0421	1.4534
242	6.4557	8.8932	1.1061	0.3525	0.0429	1.4672
243	6.4557	14.1529	1.1061	0.3501	0.0622	1.4741
244	10.6534	3.6335	1.1061	0.3703	0.0729	1.5489
245	10.6534	8.8932	1.1061	0.3735	0.0734	1.5539
246	10.6534	14.1529	1.1061	0.3674	0.0586	1.5233
247	2.2624	0.9467	2.9234	0.3211	0.063	1.4435
248	2.2624	6.2064	2.9234	0.3164	0.0802	1.4209
249	2.2624	11.4661	2.9234	0.3152	0.034	1.4071
250	6.4601	0.9467	2.9234	0.3656	0.0712	1.5923
251	6.4601	6.2064	2.9234	0.3564	0.0402	1.5637
252	6.4601	11.4661	2.9234	0.3625	0.0475	1.5529
253	10.6578	0.9467	2.9234	0.2922	0.0708	1.345
254	10.6578	6.2064	2.9234	0.39	0.0697	1.6751
255	10.6578	11.4661	2.9234	0.3882	0.0742	1.6898
256	2.2514	3.5974	4.6475	0.3285	0.0541	1.4386
257	2.2686	8.9941	4.7865	0.3947	0.0957	1.6761
258	2.2748	14.1434	4.7841	0.3915	0.0962	1.7302
259	6.4964	3.6221	4.7548	0.3236	0.0742	1.5095
260	6.4175	8.7872	4.5612	0.3933	0.077	1.61
261	6.4581	14.131	4.6321	0.3693	0.06	1.5214
262	10.6865	3.6759	4.794	0.3615	0.0506	1.6317
263	10.6511	8.978	4.7525	0.3841	0.0757	1.7371
264	10.6946	14.1369	4.7751	0.3487	0.0451	1.611
265	2.2503	0.3566	6.1588	0.3085	0.0537	1.2031
266	2.1873	6.0203	6.0661	0.3861	0.0804	1.5726

267	2.3132	11.361	6.3499	0.3679	0.0746	1.7785
268	6.4914	1.1283	6.6746	0.3112	0.0517	1.2455
269	6.4637	5.6505	6.089	0.3514	0.0756	1.4544
270	6.3669	11.4061	6.3593	0.3655	0.0767	1.8643
271	10.6442	0.6746	6.2539	0.2996	0.064	1.4396
272	10.6598	5.8734	6.2309	0.3762	0.0855	1.679
273	10.6942	11.6397	6.693	0.339	0.0967	1.2494
274	2.3716	3.2913	8.3347	0.3037	0.039	16.8078
275	2.8364	8.6512	8.5375	0.3629	0.0327	4.437
276	3.8176	13.442	8.5147	0.0899	0.0389	1.4406
277	7.2711	3.0261	8.4511	0.3042	0.0393	8.8582
278	6.3577	8.7096	7.9333	0.3721	0.05	2.1037
279	6.6243	13.9447	8.2353	0.3995	0.0683	4.1098
280	11.8825	3.1429	8.6144	0.3134	0.031	25.7497
281	11.3321	8.518	8.4379	0.3549	0.0651	1.9086
282	11.7392	13.6242	8.4872	0.3677	0.0679	21.2192
283	7.1505	9.9028	9.7159	0.3425	0.0615	2.1362
284	5.1782	8.598	10.8622	0.3052	0.0406	1.5312
285	7.8403	10.4865	13.6974	0.3488	0.0735	125.1926
286	1.5492	10.8575	10.5272	0.2917	0.0435	19.3106
287	5.1494	12.9425	11.9218	0.36	0.057	99.031
288	3.536	10.01	14.7158	0.3557	0.0507	206.9024
289	12.4429	7.1713	9.3012	0.3482	0.0685	2.753
290	8.7037	4.6361	10.5877	0.3229	0.0528	31.1868
291	11.1961	6.9951	13.7187	0.3141	0.0226	198.1014
292	5.4461	7.0793	9.3645	0.3359	0.0703	1.7076
293	8.8117	9.1062	11.0684	0.3763	0.0542	3.9798
294	6.877	6.1415	13.9028	0.3653	0.0306	174.1332
295	4.1179	11.0849	10.1232	8.0334	0.8259	17.1359
296	3.0464	9.6686	12.2588	8.1809	0.7968	62.682
297	5.3697	10.3511	12.8875	7.9933	0.8089	25.5862
298	7.8734	7.1859	9.4748	7.9317	0.8177	11.4328
299	6.7042	6.1251	11.4011	8.172	0.7658	46.0654
300	8.9735	6.7251	12.4054	8.0057	0.8191	28.4023
301	7.2222	11.4375	11.4441	8.1327	0.7999	48.4341
302	10.9384	7.5683	11.2688	8.1051	0.778	40.9672

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VAC	UUM CHARGE	:	0			
VAC	UUM VOLUME	:	0			
NUM	BER OF ELE	CTRONS:	1452			

Bader charge analysis:

					CHARGE		
Co	295	4.1179	11.0849	10.1232	8.0334	0.8259	17.1359

	296	3.0464	9.6686	12.2588	8.1809	0.7968	62.682
	297	5.3697	10.3511	12.8875	7.9933	0.8089	25.5862
	298	7.8734	7.1859	9.4748	7.9317	0.8177	11.4328
	299	6.7042	6.1251	11.4011	8.172	0.7658	46.0654
	300	8.9735	6.7251	12.4054	8.0057	0.8191	28.4023
	301	7.2222	11.4375	11.4441	8.1327	0.7999	48.4341
	302	10.9384	7.5683	11.2688	8.1051	0.778	40.9672
					64.5548		
					72		
O	55	7.6479	10.7503	9.7547	7.2458	0.6972	18.8751
	56	4.7561	9.4448	11.2155	7.2539	0.6735	17.0975
	57	7.1569	11.0582	13.3071	7.2231	0.6571	98.4625
	58	2.3662	10.3416	10.6471	7.2848	0.7218	32.1455
	59	5.2992	12.0301	11.6134	7.2379	0.7118	28.8732
	60	3.9075	9.5734	13.9316	7.2125	0.6756	73.636
	61	11.4943	7.128	9.5947	7.244	0.7216	24.862
	62	8.5401	5.584	10.7505	7.2684	0.752	24.9822
	63	10.595	7.4954	13.1428	7.261	0.6842	63.7166
	64	5.9688	7.3387	10.2102	7.231	0.6828	19.7707
	65	9.0248	8.161	10.9201	7.1988	0.7169	17.8208
	66	7.3756	5.781	13.1497	7.2222	0.6464	98.2496
					86.8834		
					72		
H	283	7.1505	9.9028	9.7159	0.3425	0.0615	2.1362
	284	5.1782	8.598	10.8622	0.3052	0.0406	1.5312
	285	7.8403	10.4865	13.6974	0.3488	0.0735	125.1926
	286	1.5492	10.8575	10.5272	0.2917	0.0435	19.3106
	287	5.1494	12.9425	11.9218	0.36	0.057	99.031
	288	3.536	10.01	14.7158	0.3557	0.0507	206.9024
	289	12.4429	7.1713	9.3012	0.3482	0.0685	2.753
	290	8.7037	4.6361	10.5877	0.3229	0.0528	31.1868
	291	11.1961	6.9951	13.7187	0.3141	0.0226	198.1014
	292	5.4461	7.0793	9.3645	0.3359	0.0703	1.7076
	293	8.8117	9.1062	11.0684	0.3763	0.0542	3.9798
	294	6.877	6.1415	13.9028	0.3653	0.0306	174.1332
					4.0666		
					12		
		64.5548	86.8834	4.0666		72	72	12
					-0.4952		

64.5548+86.8834+4.0666-(72+72+12) = -0.4952

Experimental Section

***Materials synthesis*:**

Chemicals with analytical grade were used without further purification. $Ni(OH)_2$ on Ni Foam (NF) was prepared by a similar method as reported previously[7]. 526 mg $NiSO_4 \cdot 6H_2O$ was added to 35 ml deionized water (DI water). The solution was magnetically stirred for 15 min and then transferred to a 45 mL teflon-lined stainless steel auto clave. A 2 cm × 2 cm NF, pretreated sonication in acetone, ethanol and DI water sequentially, was immersed into the Teflon liner and used as substrate. Then the autoclave was sealed and transferred to oven for 5 h of hydrothermal process at 140 ℃. After hydrothermal, the substrate was collected, rinsed with DI water for several times and dried at 60 ℃ for 12 h. The as fabricated $Ni(OH)_2$/NF with mass loading of $Ni(OH)_2$ to be approximately 1.2 mg cm^{-2} was cut into four 1 cm × 1 cm pieces, leaving two pieces to be used directly as $Ni(OH)_2$ electrode and two others to be further decorated by CoQDs.

CoQDs was synthesized using the method reported by Liu et al.[8] with modification. Briefly, 1 mmol of $CoCl_2 \cdot 6H_2O$ and 3 mmol NH_4HCO_3 were added into 30 mL of ethanol, the solution of which was magnetically stirred for 5 hours. Ultrafine particles were then found being formed and suspended in the solution, which were identified (see the results session) to be $Co(OH)_2$ QDs. Such a solution containing CoQDs is named CoSol-5 for further reference. $Ni(OH)_2$-CoQD was fabricated by immersing the as-prepared 1 cm × 1 cm $Ni(OH)_2$/NF into CoSol-8 for 1 min under ultrasonication, dried in the oven at 60℃ for 4 h, washed with DI water and ethanol to eliminate NH_4Cl and extra NH_4HCO_3 and dried in the oven for another 4 h. The $Co(OH)_2$ powder was collected by centrifuging of the as-prepared CoSol-5, washed several times with distilled water and dried in the oven at 60℃ for 8 h. The mass loading of $Ni(OH)_2$ and $Ni(OH)_2$-CoQD on NF is 1.25 mg cm^{-2} and 1.45 mg cm^{-2}, respectively.

Materials characterizations:

The morphology and structure of the sample were examined by using SEM (Zeiss SUPRA40) and TEM (JEOL 2000FX), which was also used for acquiring the SAED patterns and EDS elemental mappings. The crystal structure was examined by XRD pattern obtained with BRUKER AXS (D8 ADVANCE, Cu, K = 0.154060 nm) at 40 kV and 40 mA. Raman spectroscopy was performed with a Horiba Scientific LabRAM HR Evolution system using an Ar laser (l=514 nm).

Electrochemical measurements:

In the three-electrode configuration, the electrochemical performance of the samples was tested by electrochemical workstation (PARSTAT MC), using a three-electrode mode with the as-fabricated $Ni(OH)_2$ and $Ni(OH)_2$-CoQD as working electrode, Pt wire as counter electrode and saturated calomel electrode (SCE) as reference electrode. 2M KOH was used as electrolyte. Electrochemical impedance spectroscopy (EIS) was performed by applying an AC voltage with a perturbation amplitude of 5 mV versus the open circuit in the frequency range from 0.01 Hz to 100 kHz.

In the two-electrode configuration, $Ni(OH)_2$-CoQD was used as a positive electrode and reduced graphene oxide (RGO) as a negative electrode with 2M KOH as an electrolyte solution. The RGO anode was prepared by mixing 80 wt% RGO (Graphene Supermarket), 10 wt% carbon black and 10 wt% PTFE and spreading the mixture on to a 2 cm × 2 cm NF. The mass loading of the RGO electrode was adjusted based on the principle of $Q_+ = Q_-$, where Q_+ is the charge stored in positive electrode and Q_- is the charge stored in negative electrode. Q_- was calculated according to the gravimetric capacitance of the negative electrode measured in the three-electrode configuration.

Calculation or computation:

All calculations were carried out using the density functional theory (DFT) with the generalized Perdew-Burke-Ernzerhof (PBE)[9], and the projector augmented-wave (PAW) pseudopotential planewave method as implemented in the VASP code50[10, 11]. For the PAW pseudopotential, we included $3d^8 4s^2$, $3d^7 4s^2$, $2s^2 2p4$ and $1s^1$ were treated as valence electrons for Ni, Co, O and H atoms, respectively. A 12×12×10 Monkhorst-Pack (MP) k-point grid was used for $Ni(OH)_2$ and $Co(OH)_2$ unitcell geometry optimization calculations. Good convergence was obtained with these parameters, and the total energy was converged to 1×10^{-6} eV per atom. Energy convergence with respect to the plane wave cutoff was tested by varying this setting between 300 and 600 eV considering the electron spin polarization. Convergence to within 10 meV was achieved with a cutoff energy of 500 eV for both unitcells. For $Ni(OH)_2$ (110) surface calculations, we created a surface model using 110 slabs with a vacuum thickness of 25 Å. To study the CoQDs attached surface, we select 8-Co atoms with 12-OH pairs as a CoQDs to explore its effect on electrical properties of $Ni(OH)_2$ (110) surface. The Bader method[12] was used to analyze the electronic structure and the charge transfer between CoQDs and $Ni(OH)_2$ (110) surface. The optimized CoQDs attached $Ni(OH)_2$ (110) surface are shown in Figure S6.

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