

Electronic Supplementary Information (ESI)

Self-assembly of cobalt hexacyanoferrate crystals in 1-D array using ion exchange transformation route for enhanced electrocatalytic oxidation of alkaline and neutral water

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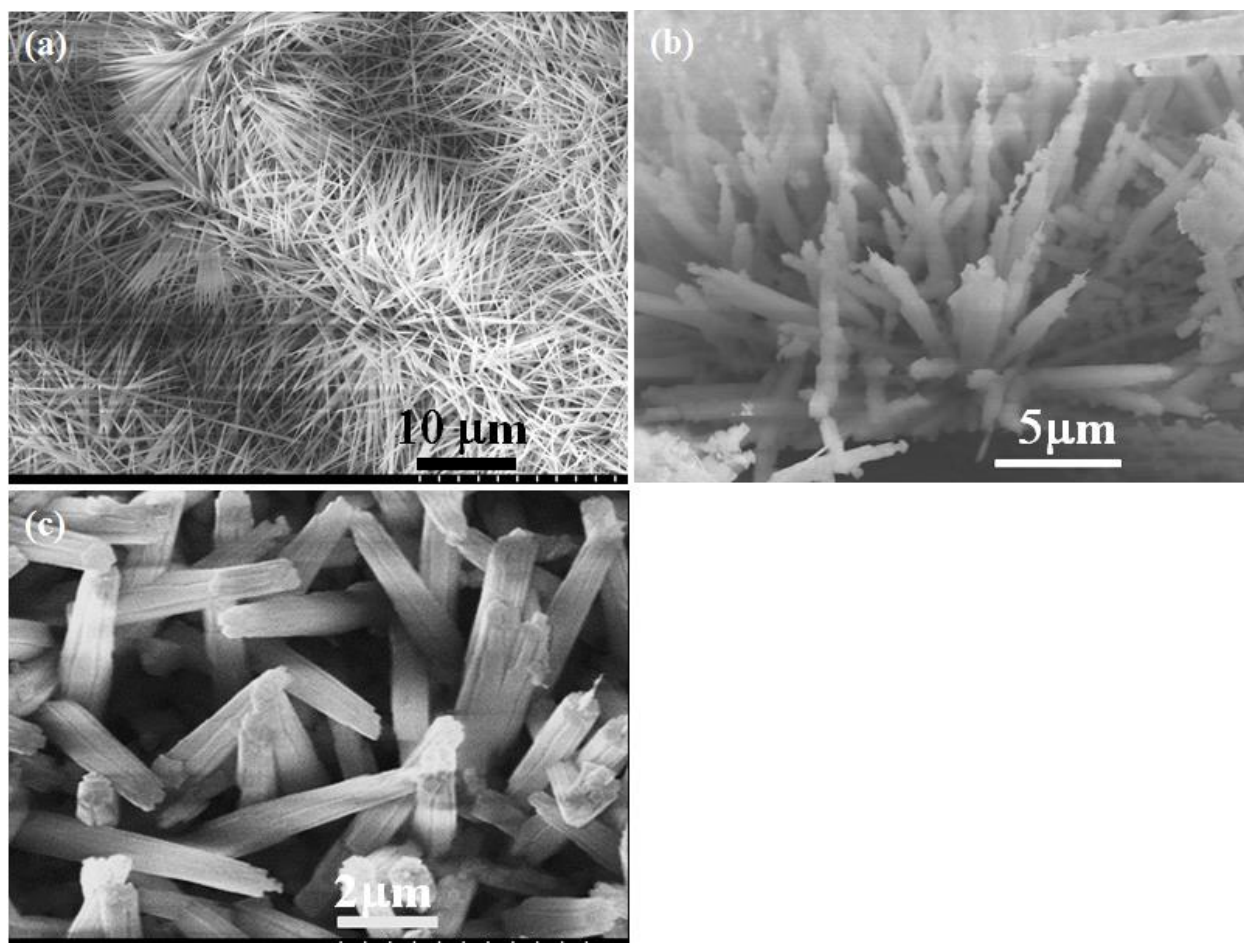


Fig. S1. SEM images of 1-D structured film on a carbon paper substrate. (a) Cobalt hydroxycarbonate, and cobalt hexacyanoferrate obtained by ion exchange reaction for (b) 60 min, and (c) 90 min.

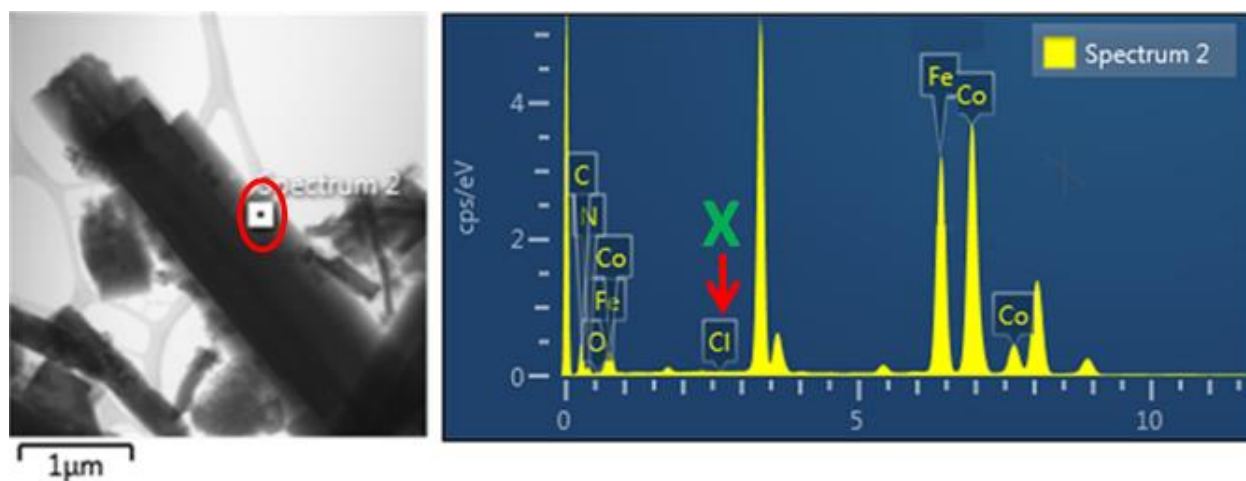


Fig. S2. TEM image and the EDX profile of the area shown by red circle in the TEM image of 1-D cobalt hexacyanoferrate structure obtained by ion exchange reaction for 90 min.

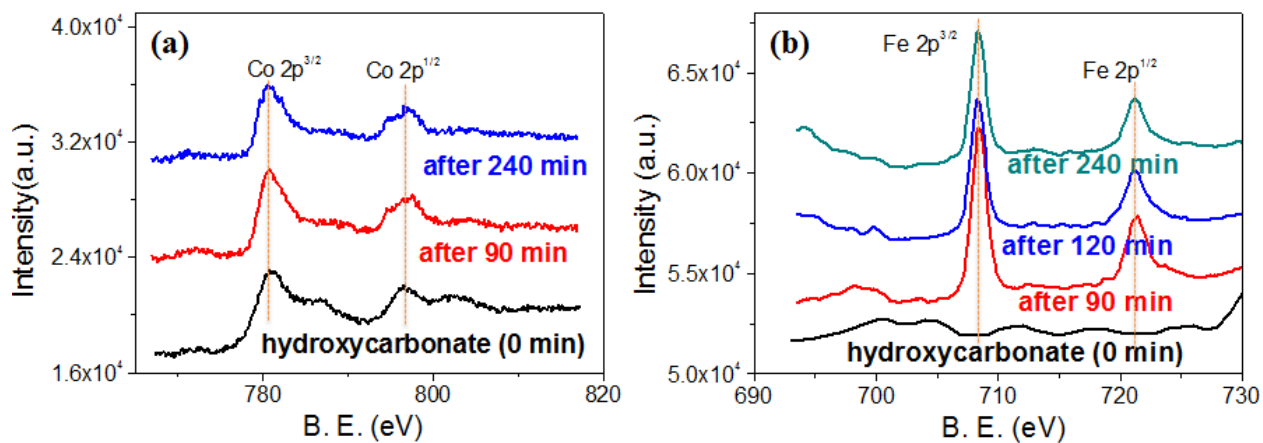


Fig. S3. XPS spectra of cobalt hydroxycarbonate film (0 min), and cobalt hexacyanoferrate film obtained by ion exchange reaction for 90, 120, and 240 min.

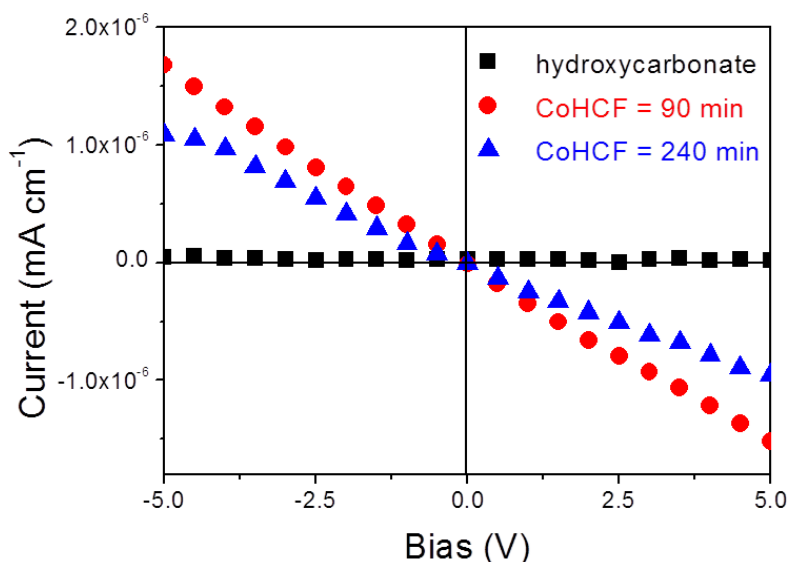


Fig. S4. Polarization of of cobalt hydroxycarbonate, and cobalt hexacyanoferrate film on a non-conducting glass substrate obtained by ion exchange reaction for 90, and 240 min, showing the degree of their electrical conductivity.

Table S1: Comparison of catalytic OER activity of various earth abundant catalysts

(Ir(20% wt)/C and RuO₂ catalysts have also been included as benchmark references)

Catalyst	Film* /Powder**	Electrolyte	pH	Catalyst loading (mgcm ⁻²)	Overpotential (V)		Reference
					1mA cm ⁻²	10mAcm ⁻²	
1-D CoHCF /CFP	Film	PBS	7	0.7	0.47	0.88	This work
Ir(20% wt)/C	Powder	PBS	7	0.04	0.57	0.98	
CoHCF	Powder	Kpi buffer	7	–	~ 0.58	–	<i>J. Am. Chem. Soc.</i> , 2013, 135 , 13270
α -MnO ₂ -Py ...	Powder	Na ₂ SO ₄	7.5	~1600 nmol	0.66	–	<i>Nat. Commun.</i> 2014, 5 , 4256
Mn ₃ (PO ₄) ₂	Powder	PBS	7	611 nmol	0.68	–	<i>J. Am. Chem. Soc.</i> 2014, 136 , 7435
LiMnP ₂ O ₇	Film	PBS	7	1059 nmol	0.59	–	<i>J. Am. Chem. Soc.</i> 2014, 136 , 4201

MnOx	Film	PBS	7	1800 nm	0.45	–	<i>J. Phys. Chem. C</i> , 2014, 118 , 14073
Co-based	Film	PBS	7	100 nmol	0.55	–	<i>Angew. Chem. Int. Ed.</i> 2015, 54 , 4870
Fe-based	Film	PBS	7	10.2 nmol	0.48	–	
NiOx-en	Film	NaBi buffer	9.2	270 nmol	0.51	–	
NiOx-aqua	Film	NaBi buffer	9.2	280 nmol	0.57	–	<i>Energy Environ. Sci.</i> 2013, 6 , 579
NiOx-NH ₃	Film	NaBi buffer	9.2	290 nmol	0.60	–	
1-D CoHCF /CFP	Film	1M KOH	14	0.7	0.34	0.42	
Ir(20% wt)/C	Powder	1M KOH	14	0.04	0.29	0.40	<i>Nat Commun.</i> , 2015, 6 , 6616
RuO ₂	Powder	0.1 M KOH	13	–	–	0.37	<i>ACS Nano</i> ,2014, 8 , 3970
Co ₃ O ₄ /N-rmGO/NF	Powder	1M KOH		1	~ 0.28	0.31	<i>Nat.Mater.</i> ,2011, 10 , 780
α -Ni(OH) ₂ spheres	Powder	0.1 M KOH	13	–	–	0.33	<i>J.Am. Chem. Soc.</i> , 2014, 136 , 7077
NiS _{1.3}	Film	1M KOH	14	–	–	0.35	<i>Adv.Funct.Mater.</i> ,2015, 25 , 5739
Co ₃ O ₄ -CuCo ₂ O ₄	Powder	0.1 M KOH	13	0.12	0.32	0.50	<i>Chem.Mater.</i> 2013 , 25 , 4926
Fe-Co ₃ O ₄	Powder	0.1 M KOH	13	0.12	0.35	0.49	<i>Chem. Mater.</i> 2014 , 26 , 3162
Zn _x Co _{3-x} O ₄	Film	1M KOH	14	1	–	0.32	<i>Chem. Mater.</i> 2014 , 26 , 1889
LiCoO ₂	Film	0.1M KOH	13	0.25	–		<i>Nat. Commun.</i> 2014 , 5 , 3949
PNG-NiCo ₂ O ₄	Film	0.1M KOH	13	–	–	0.35	<i>ACS Nano</i> 2013 , 7 , 10190
Co ₃ O ₄ /NiCo ₂ O ₄	Powder	1M KOH	14	1	–	0.34	<i>J. Am. Chem. Soc.</i> 2015 , 137 , 5590
CoO _x @CN	Powder	1M KOH	14	1	–	0.26	<i>J. Am. Chem. Soc.</i> , 2015, 137 , 2688
NiFe-LDH/CNT	Powder	1M KOH	14	0.2	–	0.25	<i>J. Am. Chem. Soc.</i> 2013, 135 , 8452
Zn-Co-LDH/CNT	Powder	0.1M KOH	13	0.28	–	0.55	<i>J. Am. Chem. Soc.</i> 2013, 135 , 17242
Zn-Co-LDH nanosheets	Powder	0.1M KOH	13	0.212	–	0.48	<i>J. Mater. Chem. A.</i> 2015, 3 , 6878
CoMn LDH	Powder	1M KOH	14	0.142	–	0.33	<i>J. Am. Chem. Soc.</i> 2014, 136 , 16481
CoCo-NS	Powder	1M KOH	14	0.07	0.31	0.35	<i>Nat. Commun.</i> 2014, 5 , 4477
NiCo-NS	Powder	1M KOH	14	0.07	0.29	0.33	
NiFe-NS	Powder	1M KOH	14	0.07	0.26	0.30	
NiCo LDHs	Powder	1M KOH	14	0.17	0.30	0.37	<i>Nano Lett.</i> 2015, 15 , 1421
NNCNTAs	Powder	0.1M KOH	13	–	0.37	0.46	<i>Adv. Funct. Mater.</i> 2014, 24 , 4698
NiCo ₂ S ₄ @N/S-rGO	Powder	0.1M KOH	13	0.283	–	0.47	<i>ACS Appl. Mater. Interfaces</i> , 2013, 5 , 5002
NG-CoSe ₂	Powder	0.1M KOH	13	0.2	–	0.37	<i>Nano.</i> , 2014, 8 , 3970
CeO ₂ /CoSe ₂	Powder	0.1M KOH	13	0.2	–	0.29	<i>Small.</i> , 2015, 11 , 182
Co(PO ₃) ₄	Powder	PBS	6.4	1.1	0.33	0.41	<i>Adv. Funct. Mater.</i> , 2013, 23 , 227
Co-P	Film	1M KOH	14	1	–	0.35	<i>Angew. Chem. Int. Ed.</i> , 2015, 54 , 6251
De-LNiFeP/rGO	Powder	0.1M KOH	13	0.5	–	0.27	<i>Energy Environ. Sci.</i> , 2015, 8 , 1719
PCPTF	Film	1M KOH	14	0.1	–	0.30	<i>Adv. Mater.</i> , 2015, 27 , 3175
NiCo	Film	1M KOH	14	–	–	0.42	<i>J. Am. Chem. Soc.</i> , 2015, 137 , 4347
Co/P	Film	1M KOH	14	–	–	0.38	
Co/B	Film	1M KOH	14	–	–	> 0.4	

Ni/B	Film	1M KOH	14	–	–	> 0.4	
N-G-CoO	Powder	1M KOH	14	0.7	–	0.34	<i>Energy Environ. Sci.</i> , 2014, 7 , 609
Co-P/NC	Powder	1M KOH	14	0.283	–	0.35	<i>Chem. Mater.</i> , 2015, 27 , 7636
FeO _x	Powder	0.1M KOH	13	–	–	0.40	<i>Adv. Energy Mater.</i> , 2016, 6 , 1502095
Ni _{2.5} Co _{0.5} Fe/NF	Powder	0.1M KOH	13	–	–	0.28	<i>J. Mater. Chem. A</i> , 2016, 4 , 7245
Ni ₂ CoFe/NF	Powder	0.1M KOH	13	–	–	0.31	
Ni ₃ Fe/NF	Powder	0.1M KOH	13	–	–	0.31	
Ni _{2.5} Co _{0.5} Fe/NF	Powder	1M KOH	14	0.3	–	0.39	
CQD/NiFe-LDH	Powder	0.1M KOH	13	–	–	0.31	<i>ACS Appl. Mater. Interfaces</i> , 2014, 6 , 7918
n-NiFe LDH/NGF	Powder	0.1M KOH	13	–	–	0.34	<i>Adv. Mater.</i> , 2015, 27 , 4516
NiFe LDH/oGSH	Powder	0.1M KOH	13	–	–	0.35	<i>J. Mater. Chem. A</i> , 2015, 3 , 24540
m-NiFe/CN _x	Powder	0.1M KOH	13	–	–	0.36	<i>J. Mater. Chem. A</i> , 2015, 3 , 7986
3-D NiFe-LDH	Powder	0.1M KOH	13	–	–	0.25	<i>Chem. Commun.</i> , 2014, 50 , 6479
O-NiCoFe-LDH	Powder	0.1M KOH	13	–	–	0.42	<i>Adv. Energy Mater.</i> , 2015, 5 , 1500245.
a-Fe ₄₀ Ni ₆₀ O _x	Powder	0.1M KOH	13	–	~ 0.25		<i>J. Am. Chem. Soc.</i> , 2013, 135 , 11580
Ni-Fe [40% Fe]	Film	0.1M KOH	13	–	–	0.42	<i>J. Am. Chem. Soc.</i> , 2013, 135 , 12329
NiFe LDH/NF	Powder	1M KOH	14	–	–	0.47	<i>Science</i> , 2014, 345 , 1593
Ni(OH) ₂ /NF	Powder	1M KOH	14	–	–	0.59	
NiFeO _x /CFP	Powder	1M KOH	14	1.6	–	0.32	<i>Nat. Commun.</i> , 2015, 6 , 7261.
Ni ₂ P/NF	Powder	1M KOH	14	5	–	0.40	<i>Energy Environ. Sci.</i> , 2015, 8 , 2347
Ni ₅ P ₄ /Ni foil	Film	1M KOH	14	3.5	–	0.47	<i>Angew. Chem. Int. Ed.</i> , 2015, 54 , 12361
Ni-P/Cu foam	Film	1M KOH	14	5	–	0.45	<i>J. Power Sources</i> , 2015, 299 , 342
NiSe/NF	Powder	1M KOH	14	2.8	–	0.40	<i>Angew. Chem. Int. Ed.</i> , 2015, 54 , 9351
Ni ₃ Se ₂ /Cu foam	Film	1M KOH	14	3	–	0.42	<i>Catal. Sci. Technol.</i> , 2015, 5 , 4954
CoMnO@CN/NF	Powder	1M KOH	14	2	–	0.27	<i>J. Am. Chem. Soc.</i> , 2015, 137 , 14305
Co ₃ O ₄ NCs/CFP	Powder	1M KOH	14	0.35	–	0.68	<i>Chem. Commun.</i> , 2015, 51 , 8066

* As deposited catalyst film on various conducting substrates

**Powder catalyst on GC electrode with

Nafion

PBS : Phosphate Buffer
Solution

NF = Ni foam

n: nanometer-
sized

m: mesoporous

a: amorphous

PNG: Porous Nitrogen-Doped Graphene

NNCNTAs : Ni@[Ni(2+/3+)Co₂(OH)₆₋₇]_x nanotube arrays

oGSH: oxidized graphene/ single-walled CNT
hybrids

PCPTF : Porous Co phosphide/phosphate thin film

De-LNiFeP/rGO : delithiated Li(Ni,Fe)PO₄/rGO composite

NS = nano sheet

CFP: carbon fiber paper

CQD: Carbon quantum dot

_ : Data not available in the respective references