Electronic Supplementary Material (ESI) for Dalton Transactions.

Supporting Information

Cobalt Coordination Controlled Carbon Nanospheres Formation and Inclusion of Amorphous Co_3O_4 and AuNPs: Strongly Enhanced Oxygen Evolution Reaction with Excellent Mass Activity

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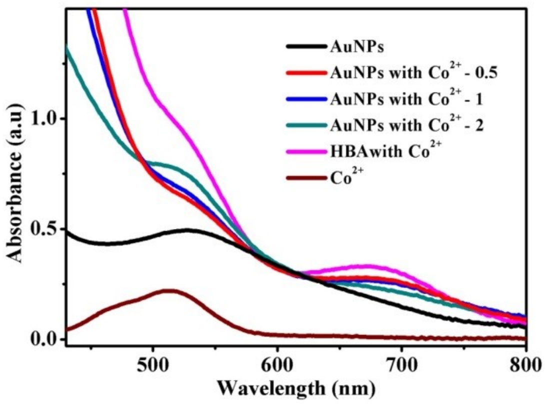

Figure S1. Absorption spectra of HBA, HBA@AuNPs, Co^{2+} ions and coordination with HBA ligand.

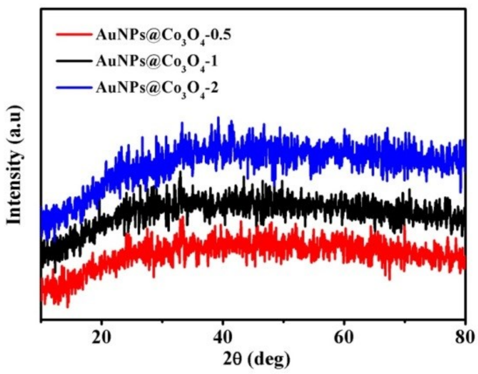

Figure S2. PXRD pattern of 1, 2 and 3.

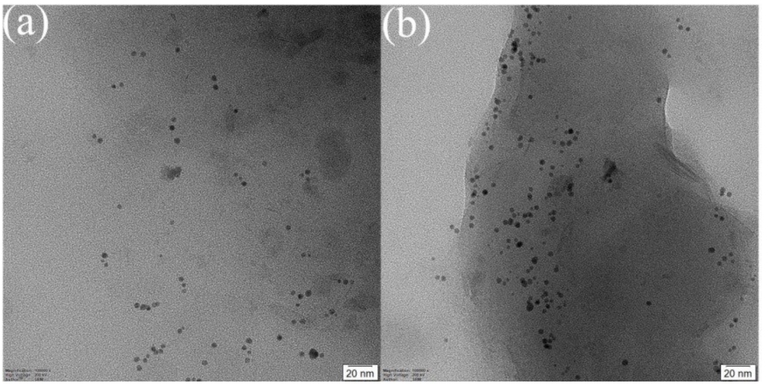

Figure S3. HR-TEM images of AuNPs synthesised using HBA.

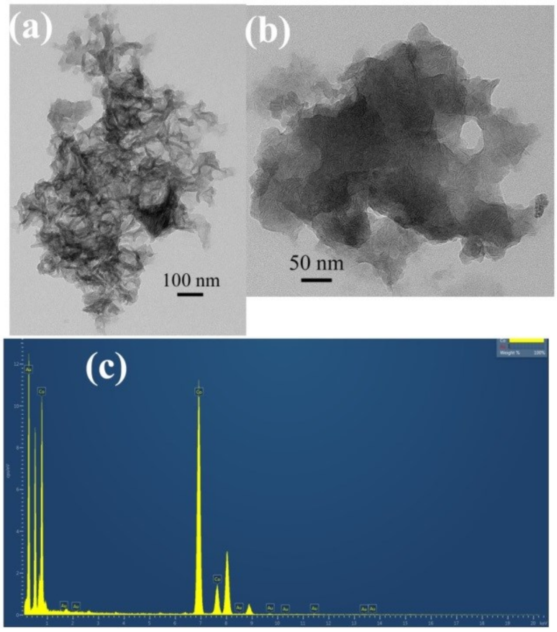

Figure S4. HR-TEM images (a, b) and EDX spectra (c) of **1**.

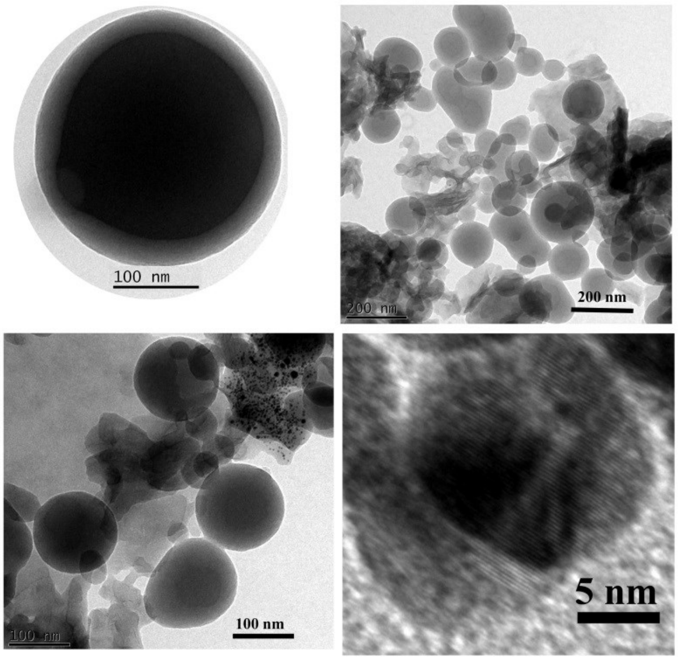

Figure S5. HR-TEM images of **2**.

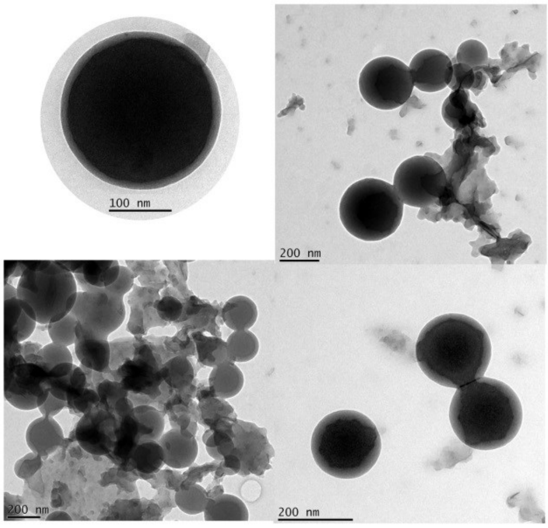

Figure S6. HR-TEM images of **3**.

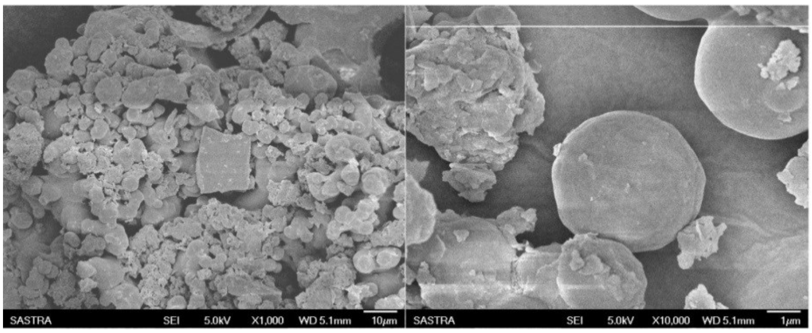

Figure S7. FE-SEM images of **2**.

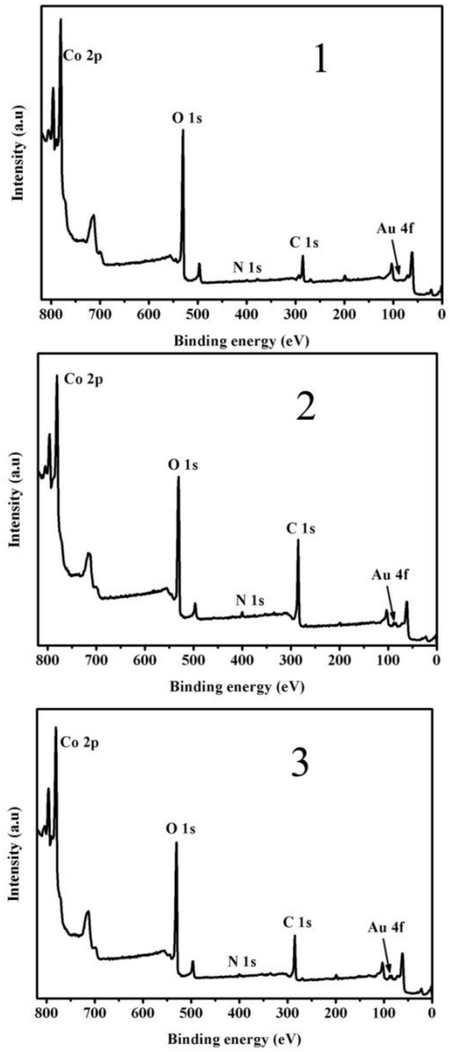

Figure S8. XPS survey spectra of **1**- **3**.

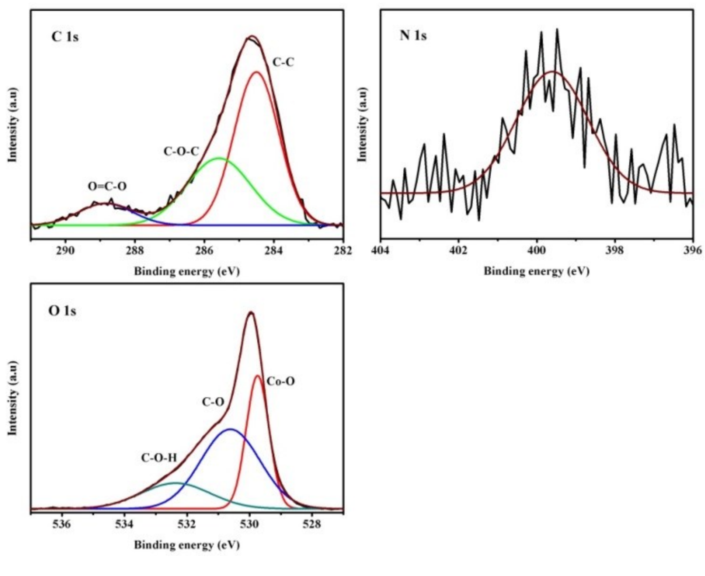

Figure S9. High resolution XPS spectra of C, N and O of **1**.

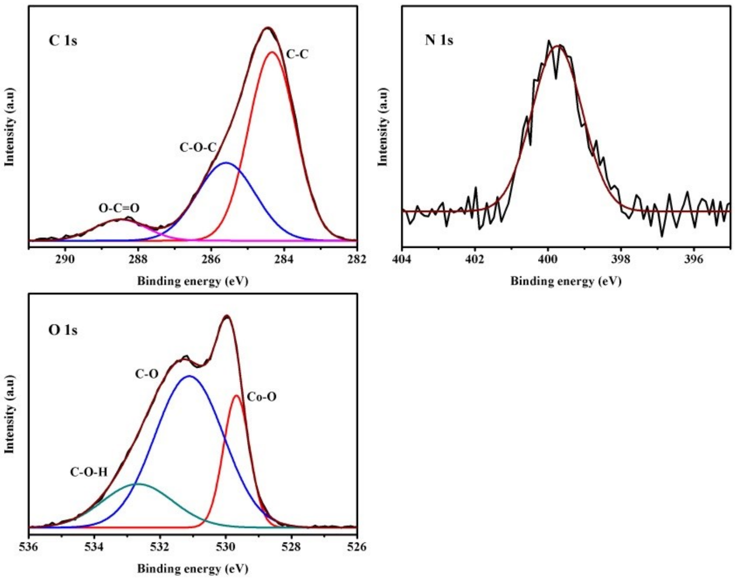

Figure S10. High resolution XPS spectra of C, N and O of **2**.

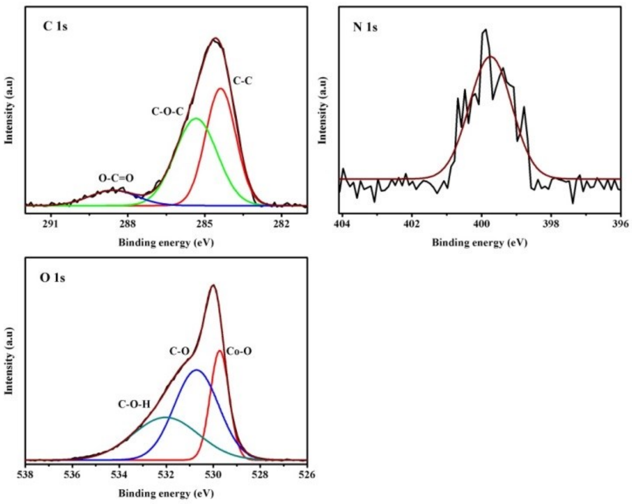

Figure S11. High resolution XPS spectra of C, N and O of **3**.

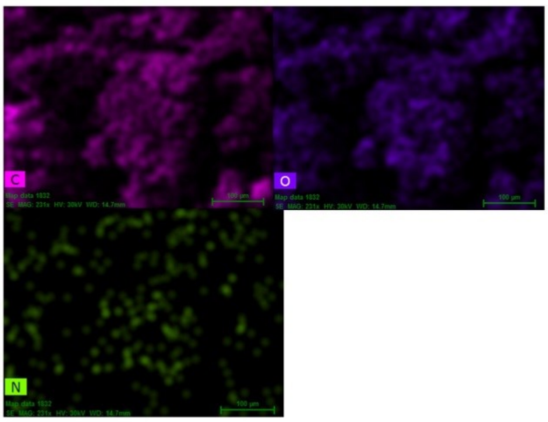

Figure S12. Elemental mapping of **1**.

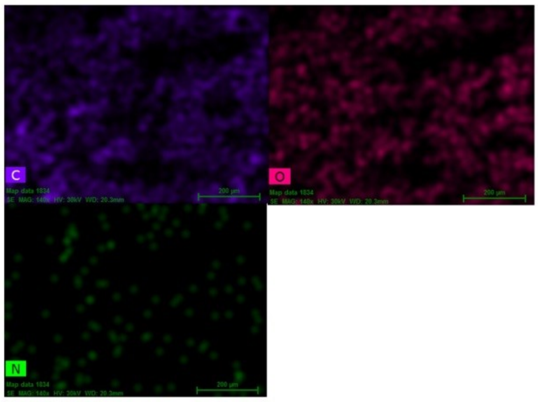

Figure S13. Elemental mapping of **2**.

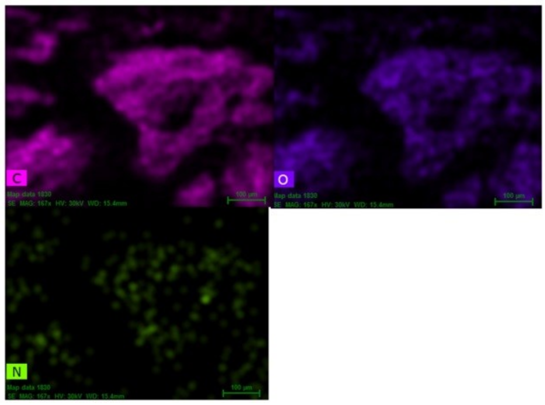

Figure S14. Elemental mapping of **3**.

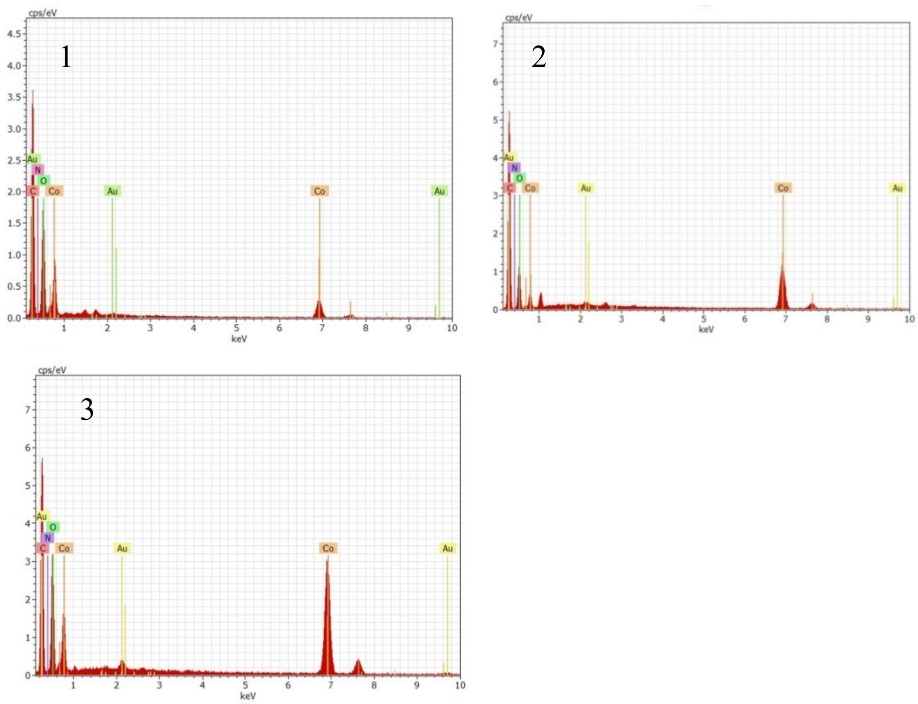

Figure S15. EDX spectra of (a) 1, (b) 2 and (c) **3**.

Table S1. Au and Co percentage in **1-3**.

Catalyst	Element	wt% by EDAX
1	Au Co	0.01 0.46
2	Au Co	0.04 1.74
3	Au Co	0.05 2.86

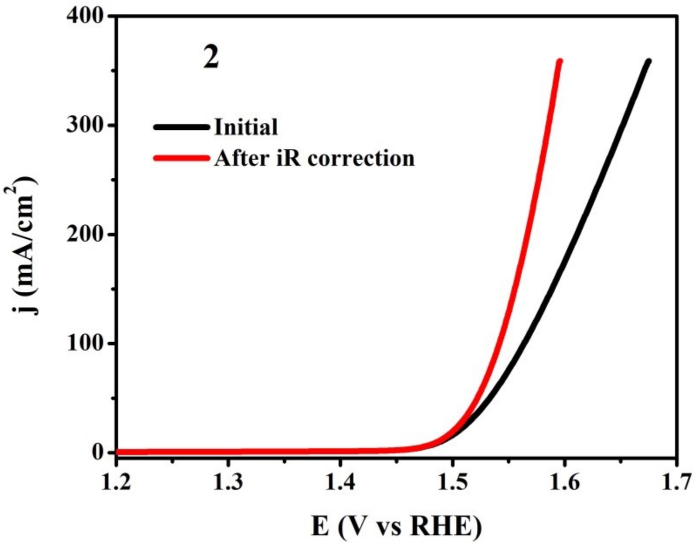

Figure S16. Linear sweep OER polarization curve of 2 before and after iR correction.

Table S2. OER data of different catalysts.

Catalyst	Overpotential (mV)	Tafel slope (mV/dec)	Stability	Reference
2	**256**	**52.4**	**1000 cycle & 48 h**	**Present work**
Au/$NiCo_2O_4$	360	63	1000 cycle & 120 min	1
Au/m Co_3O_4	440	46	2000 cycle	2
MnO_2/ AuNP-4.4	390	~200	NA	3
CNTs-Au@Co_3O_4	350	68	1000 cycle & 25 h	4
AuNCs@$Ni(OH)_2$	375	73	600 cycle & 2 h	5
AuNCs@$Co(OH)_2$	350	72	600 cycle	6
AuNDs@LDH/GCE	530	53	2000 seconds	7
NiCeOOH/Au	259		NA	8
NiFeOOH/Au	267			8
$ZnCo_2O_4$/Au/CNTs	440	46.2	10 h	9
AuCuCo	596	160	4 h	10
$Au_{0.89}Fe_{0.11}$ NPs	800	163	NA	11
Au@NiO_x	394	117	2 h	12

Au/FeO_x	439	43	2 h	12
Au@$CoFeO_x$	328	58	2 h	12
Au-$Ni_{12}P_5$	340	49	2.78 h	13
Au-$Co(OH)_2$	320	119	6 h	14
Au25/$CoSe_2$	430	NA	1000 cycle	15
Au-Ru NPs	220	62	NA	16
AuNPs@LDH	510	61	1.5 h	17
Au/NiFe LDH	237	36	2000 cycle & 20 h	18
AuNi-Cu_2O (after 2nd OER test)	532	NA	10 h	19
AuNi HDs	350	45.9	2 h	20
Au−Fe_xO_y 12	450	132	5 h	21
$Au_{0.10}Ir_{0.90}O_y$-50	241	55.2	5000 cycle	22
Au/Ir NCs	300	52.94	36 h	23
Au-$CoFe_2O_4$	312	35	8 h	24
3DG-Au-Ni3S2	370 (91.15 j)	106	NA	25
Au-vanadate nanoflute	310	127	NA	26
GMN@Co_xS_y	345	138	6000 seconds	27

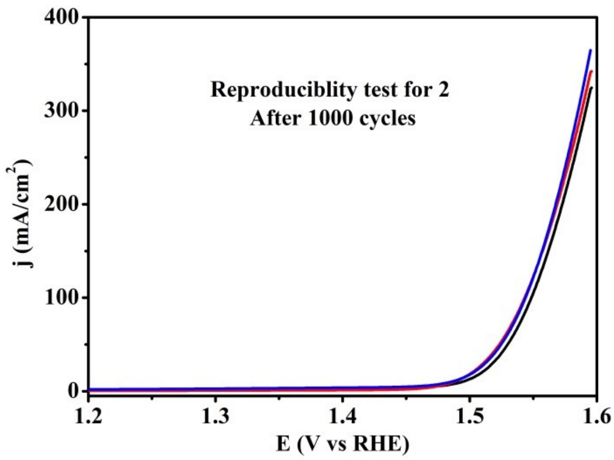

Figure S17. Comparison of linear sweep OER polarization curves of **2** synthesised at three different batches.

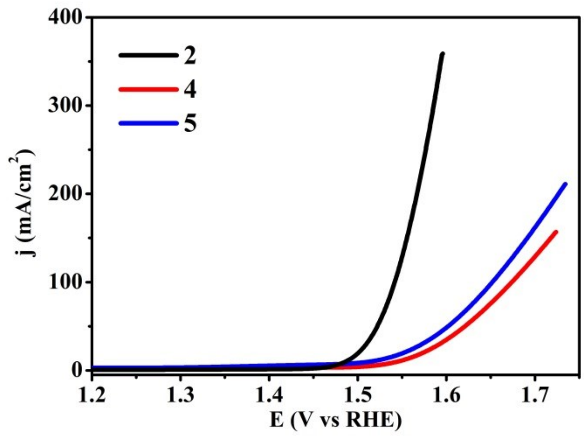

Figure S18. Comparison of linear sweep OER polarization curves of **2**,**4** and **5**.

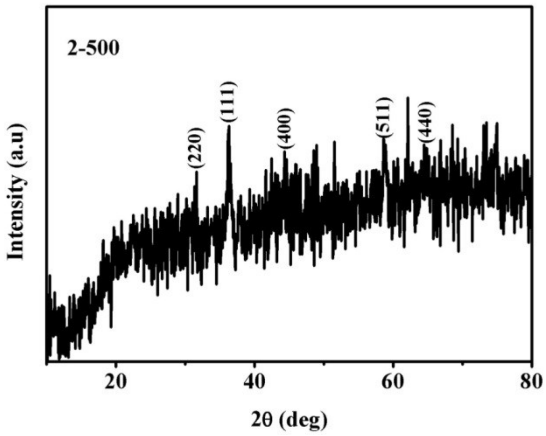

Figure S19. PXRD of **2** after heating at 500 °C.

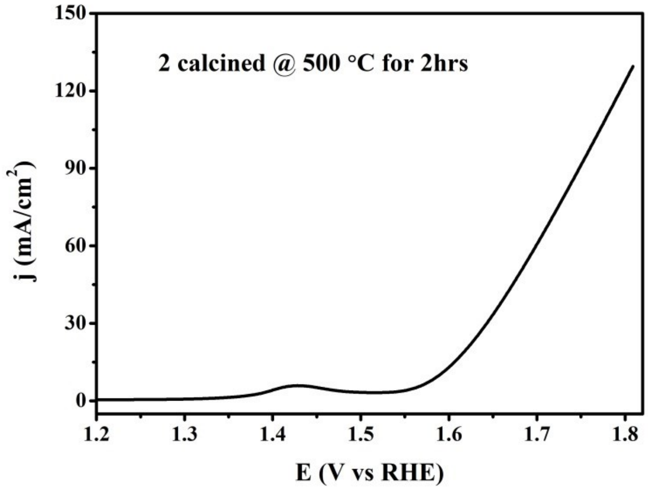

Figure S20. Linear sweep OER polarization curve of **2** after heating at 500 °C.

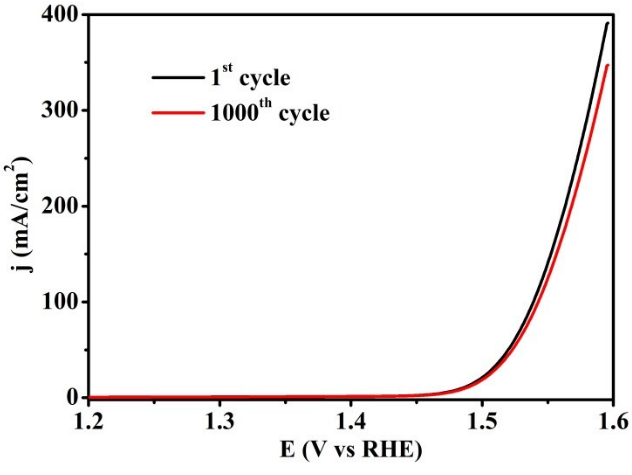

Figure S21. Linear sweep OER polarization curve of **2.**

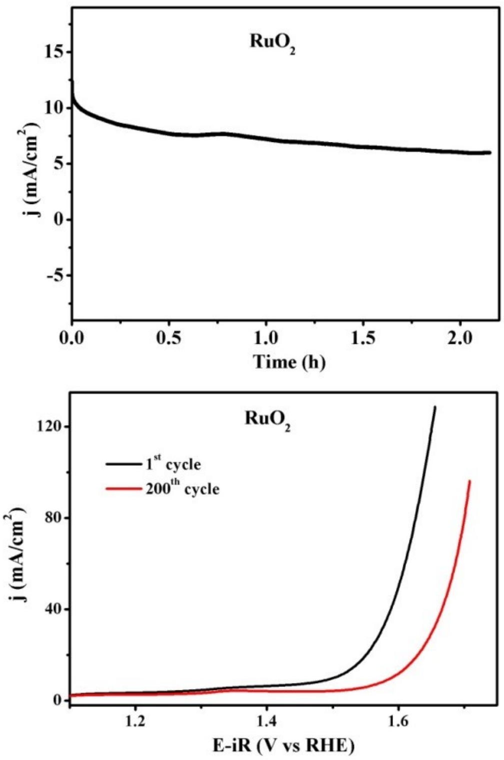

Figure S22. (a) Chronopotentiometric response and (b) OER polarization curve of RuO_2.

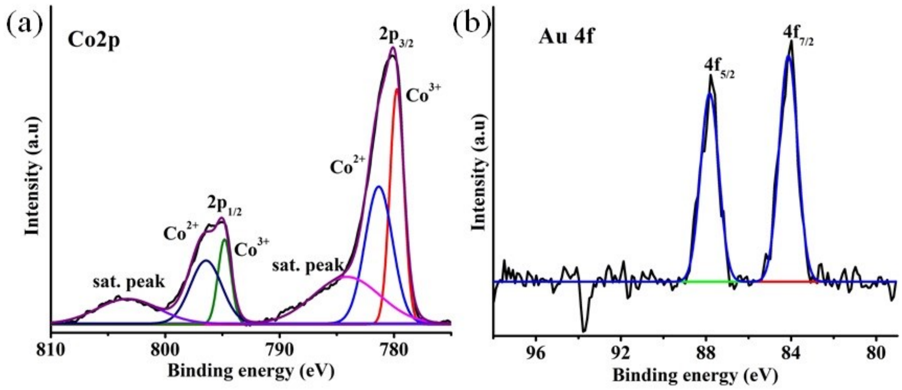

Figure S23. High resolution XPS spectra of (a) Co and (b) Au of **2** after catalytic studies.

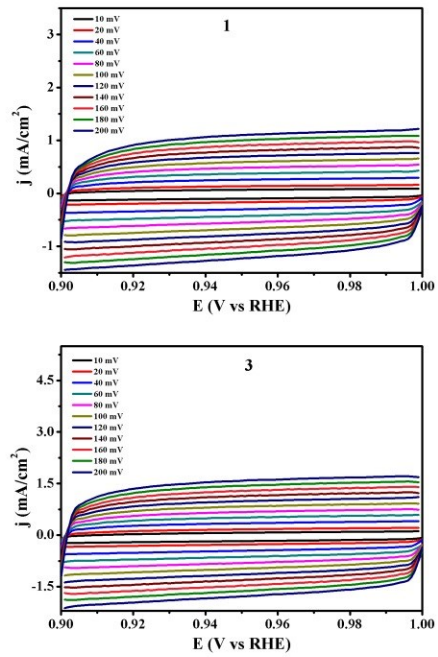

Figure S24. (a) CV of **1**, **2** and **3**.

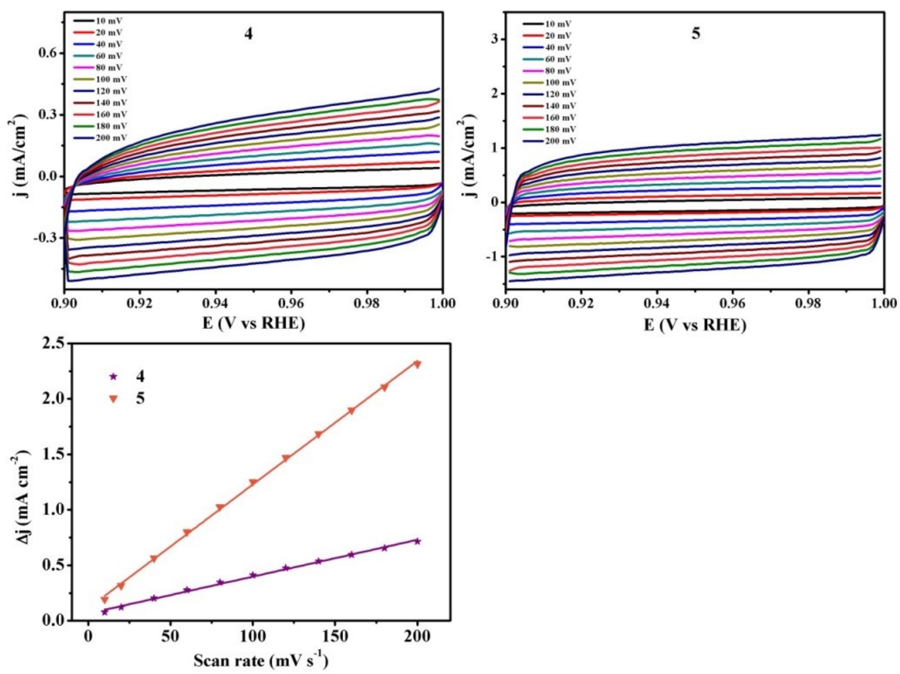

Figure S25. (a) CV of **4** and **5** and capacitive currents as a function of the scan rate for **2** and **4**.

Table S3. Comparison of mass activities of different catalysts.

Catalyst	Loading (mg)	Overpotential (mV)	Current density (mA/cm^2)	Mass activity ($mA\ mg^{-1}$)	Ref
2	**0.05**	**300**	**67.62**	**1352.5**	**This work**
α-$Ni(OH)_2$	0.2	350	30.02	150.1	28
γ-CoOOH	0.15	300	10	66.6	29
$CuCo_2S_4$	0.7	310	10	14.29	30
NiFe-LDH/CuO NRs/CF	0.70	300	~105	150	31
$Ba_2CoMo_{0.5}Nb_{0.5}O_{6-\delta}$	0.232	440	~10	~43	32
$LaCo_{0.8}Fe_{0.2}O_{3-\delta}$-700	0.245	293	10	40.80	33
Electrochemically activated $Co_xNi_{1-x}S_2$	0.285	340	60	217	*34*
CeO_2/Co_3O_4	0.35	340	~45	128.6	35
Au/NiFe LDH	2	280	129.8	64.9	18
Co-S-130	0.17	350	~13	76	36
CoOOH-NS	2	320	~45	~22.5	37

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