Silver integrated cobalt hydroxide hybrid nanostructured materials for improved electrocatalytic oxygen evolution reaction

Gunasekaran Arunkumar,[a] Pandi Muthukumar,[b] Govindan Deviga,[c] Mariappan Mariappan,[c] Mehboobali Pannipara,[d,e] Abdullah G. Al-Sehemi[d,e] and Savarimuthu Philip Anthony[a]*

[a)]Department of Chemistry, School of Chemical & Biotechnology, SASTRA Deemed University, Thanjavur-613401, Tamil Nadu, India. E-mail: philip@biotech.sastra.edu.

[b)]Department of Chemistry, Saveetha School of Engineering, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai – 600077, Tamil Nadu, India

[c)]Department of Chemistry, SRM IST, Kattankulathur, Chennai-603203, Tamil Nadu, India.

[d)]Research center for Advanced Materials Science, King Khalid University, Abha 61413, Saudi Arabia.

[e)]Department of Chemistry, King Khalid University, Abha 61413, Saudi Arabia.

Electrochemical measurements and calculation

The polarization curve was obtained using linear sweep voltammetry at 1 mV between 0 to 0.8 vs SCE. The CV was carried at 50 mV between 0 to 0.8 to obtain a steady state of catalysts. EIS was taken at a potential where it reaches 10 mA/cm^2 current density between 1 to 10^6 HZ.

Turnover Frequency was calculated at 300mV over the potential

Stepwise calculation

Step 1. At constant potential (η=300mV) how much current density is produced by different catalysts? (Where production current is an indirect function of oxygen production).

Step 2

$$TOF = \frac{jA}{4Fm}$$

J – current density mAcm^{-2}, A- Area of working electrode n cm^2, F – Faraday constant (96485 F), m – moles of metal.

Step 3

All the catalyst loading was approximately 0.2mg on a 0.1 cm^2 surface area. Assume that only cobalt is present in the material. So, a mole of Cobalt is 3.3938 ×10^{-6}.

Step 4

By using the above formula and data we calculated TOF for all the materials.

ECSA – Electrochemical surface area:

ECSA is the indirect analysis to calculate number of active sites present in the catalytic surface. The ECSA = C_{dl}/Cs. C_{dl} (double layer capacitance) is calculated by cyclic Voltammetry

varying the scan rate at Non faradic region of the catalyst (0.1 to 0.3 vs SCE). Cs is the specific capacitance of the smooth metal surface (≈ 0.04mF cm-2 for 1M KOH solution).

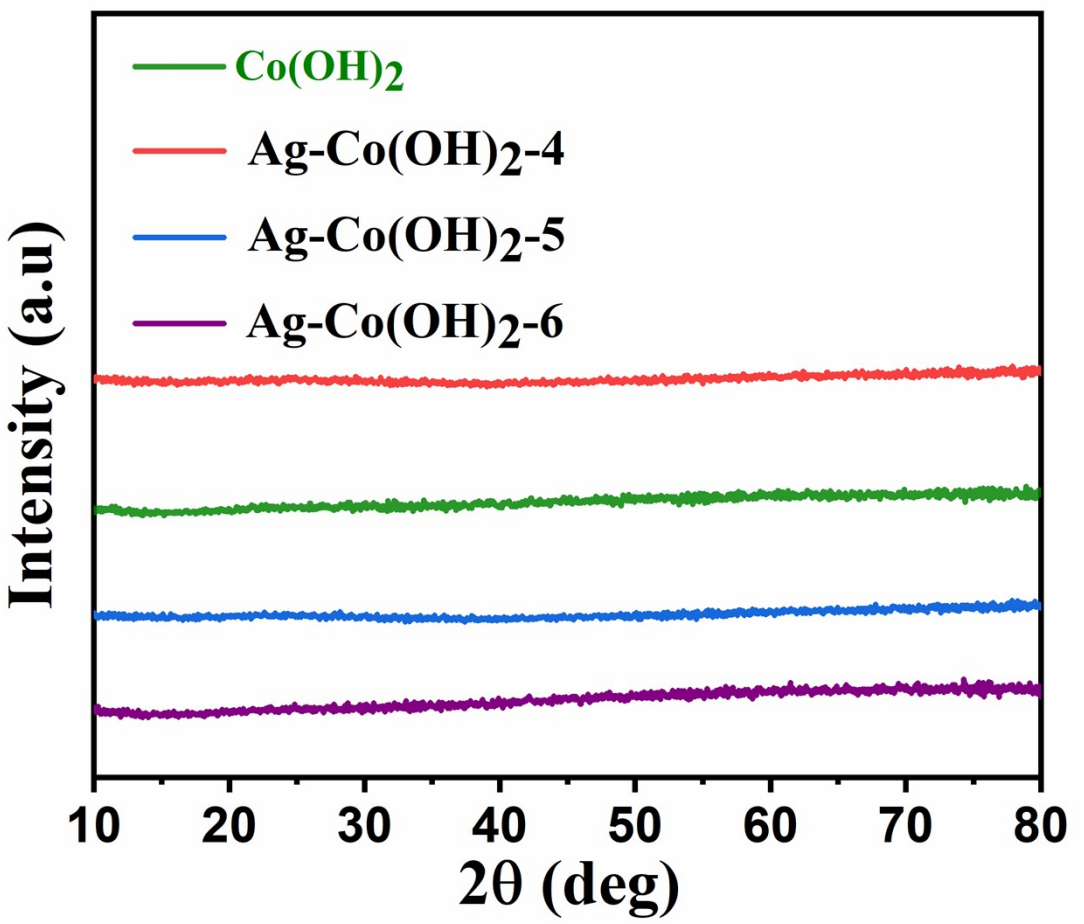

Figure S1. PXRD of $Co(OH)_2$ and AgNPs integrated $Co(OH)_2$.

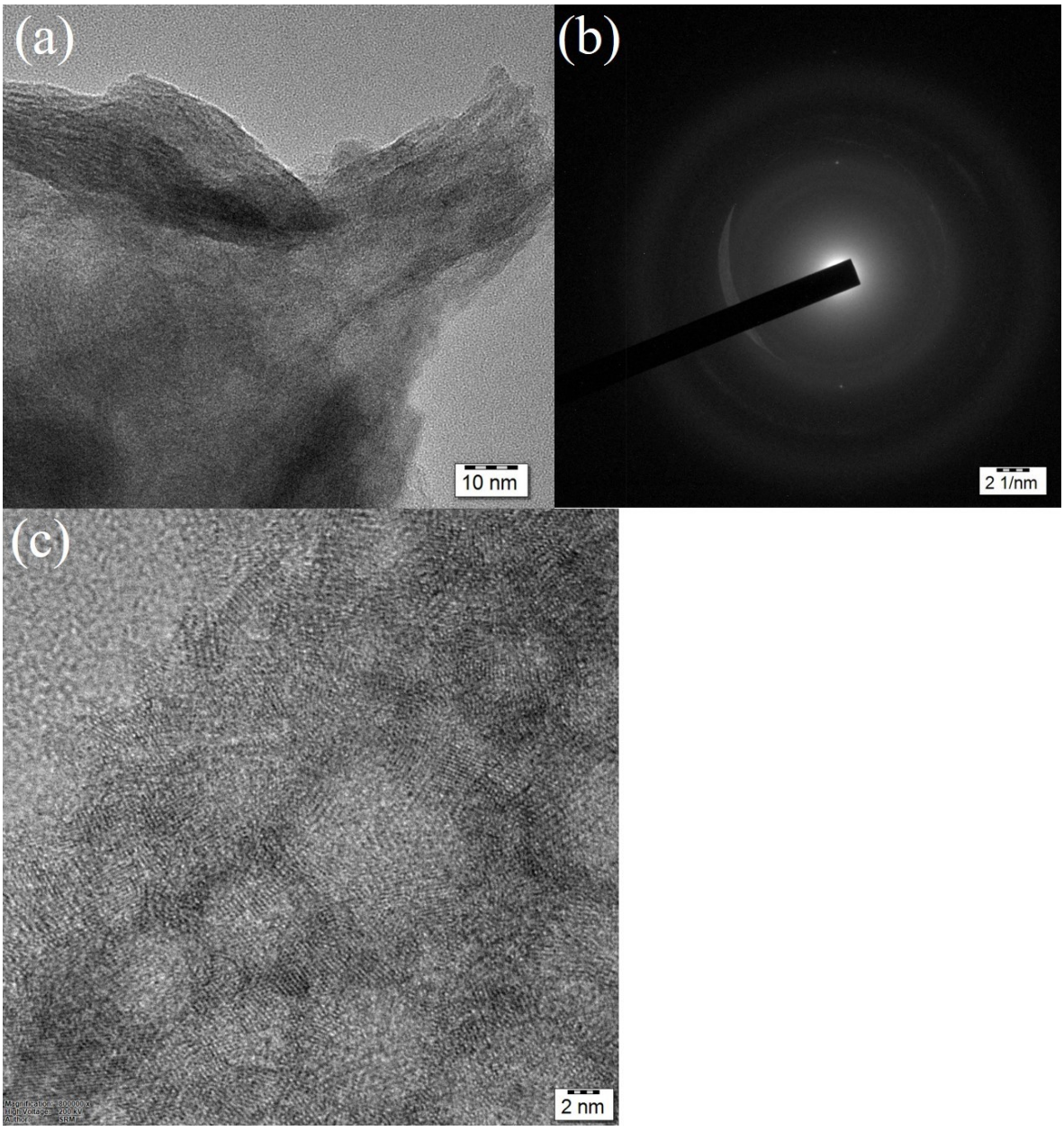

Figure S2. HRTEM images of Co-$(OH)_2$.

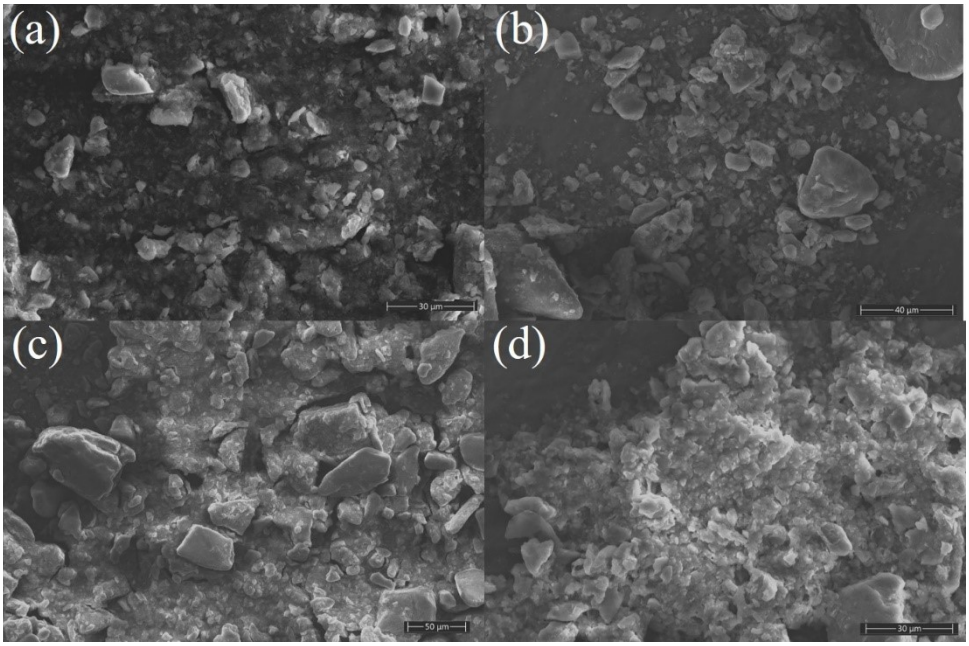

Figure S3. FESEM images of (a) Co-$(OH)_2$, (b) Ag-$Co(OH)_2$-4, (c) Ag-$Co(OH)_2$-5 and (d) Ag-$Co(OH)_2$-6.

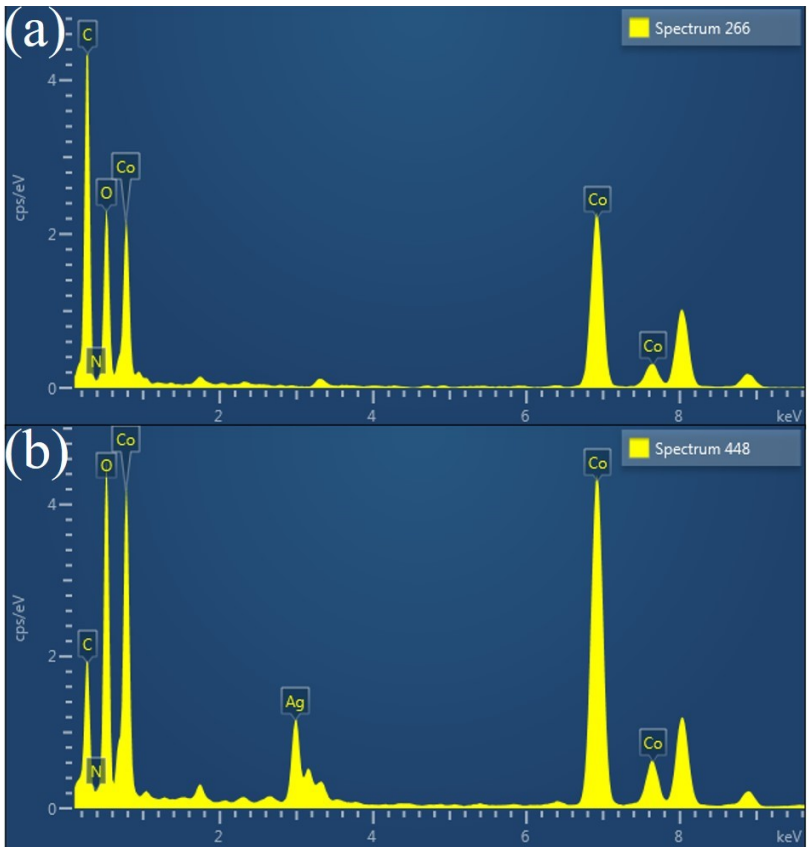

Figure S4. EDX spectra of (a) $Co(OH)_2$ and (b) Ag-$Co(OH)_2$-4.

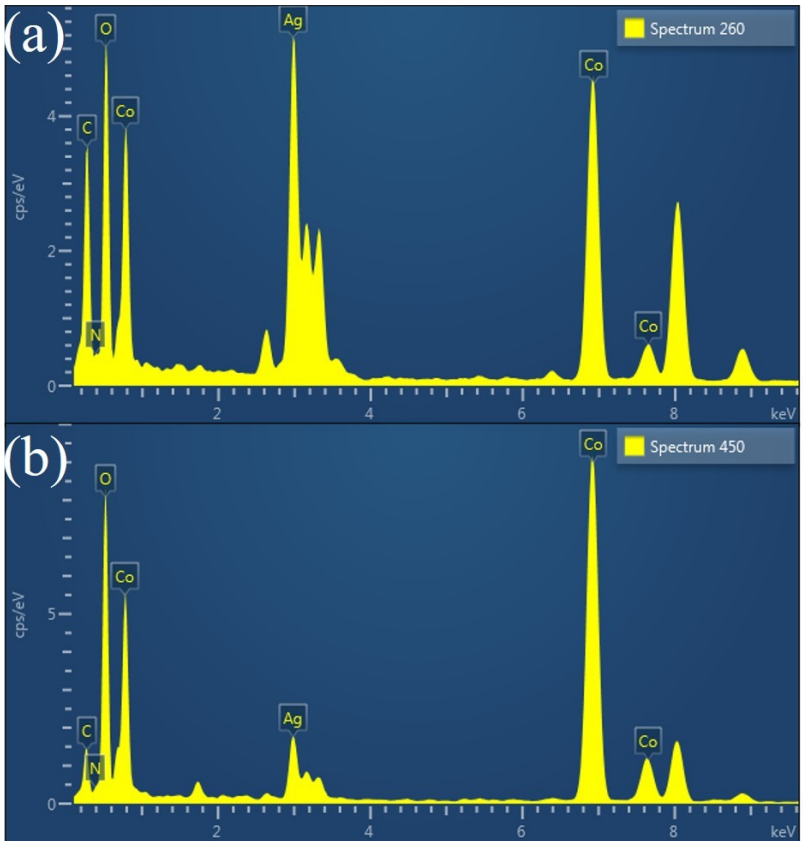

Figure S5. EDX spectra of (a) Ag-$Co(OH)_2$-5 and (b) Ag-$Co(OH)_2$-6.

Table S1. Elemental percentage obtained from EDX analysis.

Element	$Co(OH)_2$	Ag-$Co(OH)_2$-4	Ag-$Co(OH)_2$-5	Ag-$Co(OH)_2$-6
Co	8.52	18.42	13.39	25.03
O	21.23	47.91	36.9	55.84
Ag	0.00	1.95	5.74	2.15
N	0.00	1.15	5.13	2.48
C	70.25	30.58	38.84	14.5

The observed carbon is from the carbon grid used for the measurement.

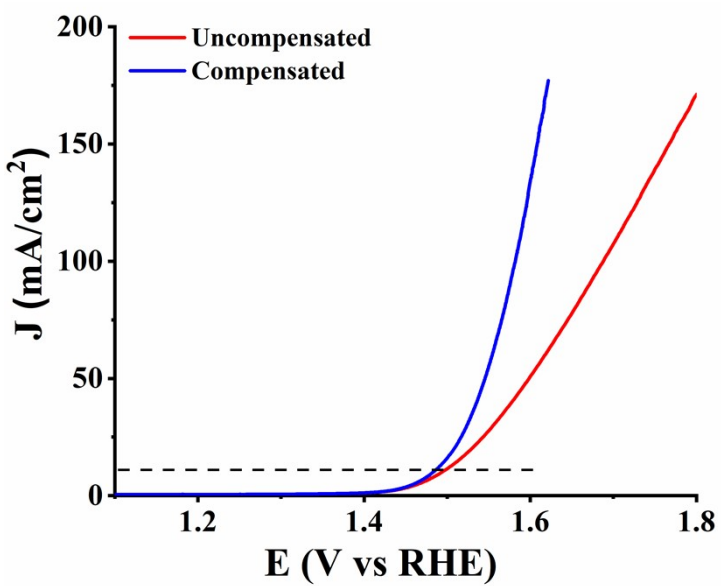

Figure S6. OER polarization curve after iR correction.

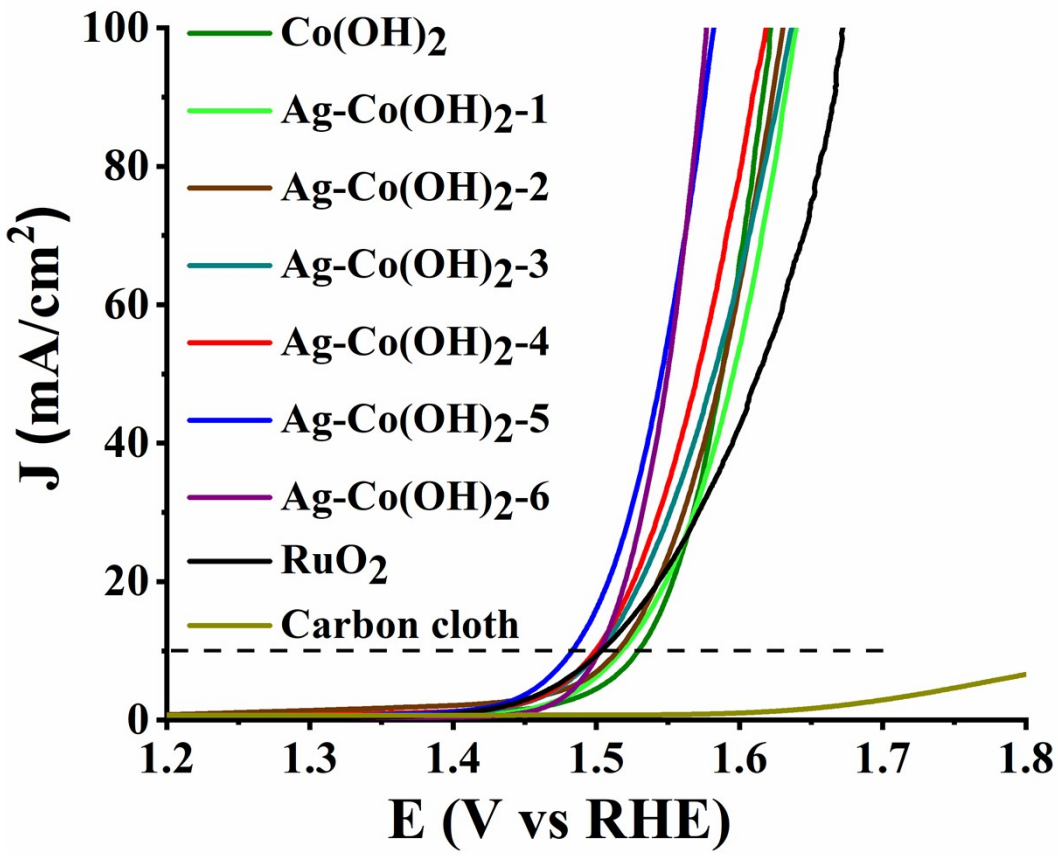

Figure S7. Linear sweep OER polarization curves of $Co(OH)_2$ and Ag-$Co(OH)_2$ samples.

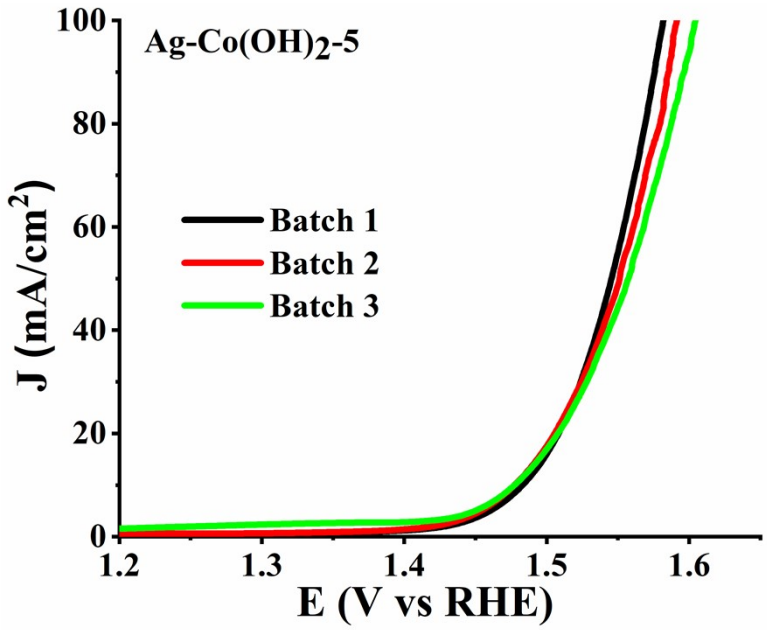

Figure S8. Linear sweep OER polarization curves of Ag-$Co(OH)_2$-5 prepared in three different batches.

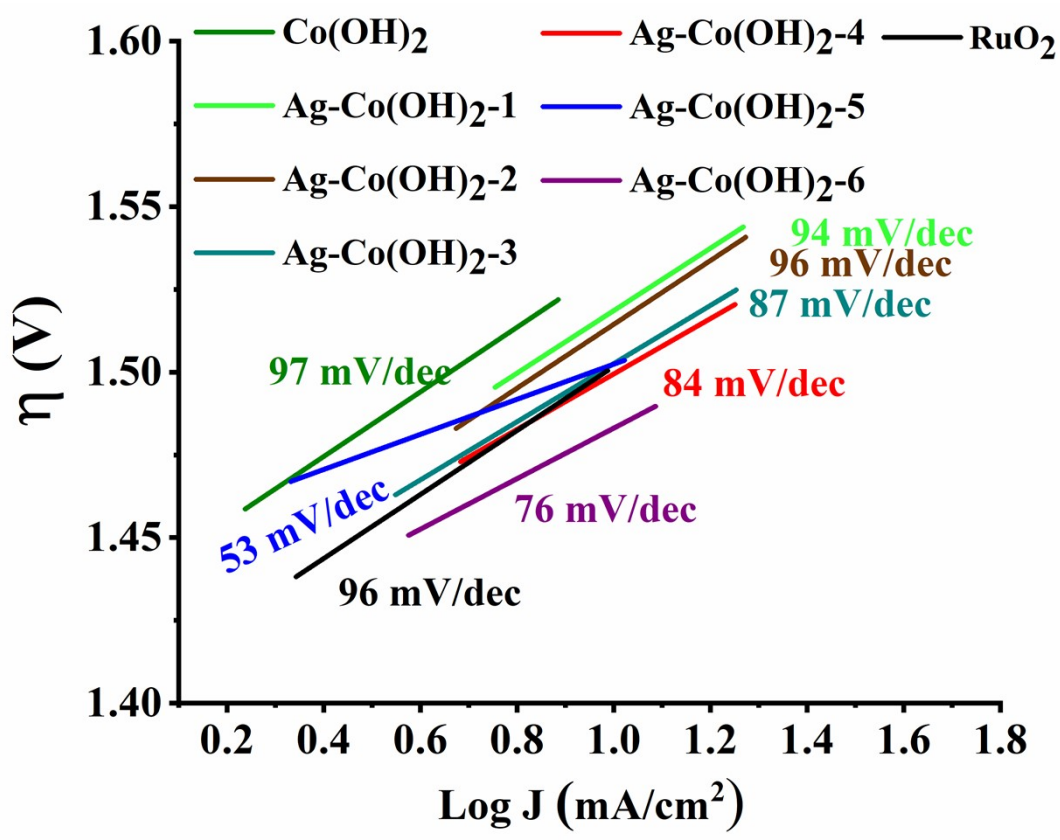

Figure S9. Tafel slope of $Co(OH)_2$ and Ag-$Co(OH)_2$ samples.

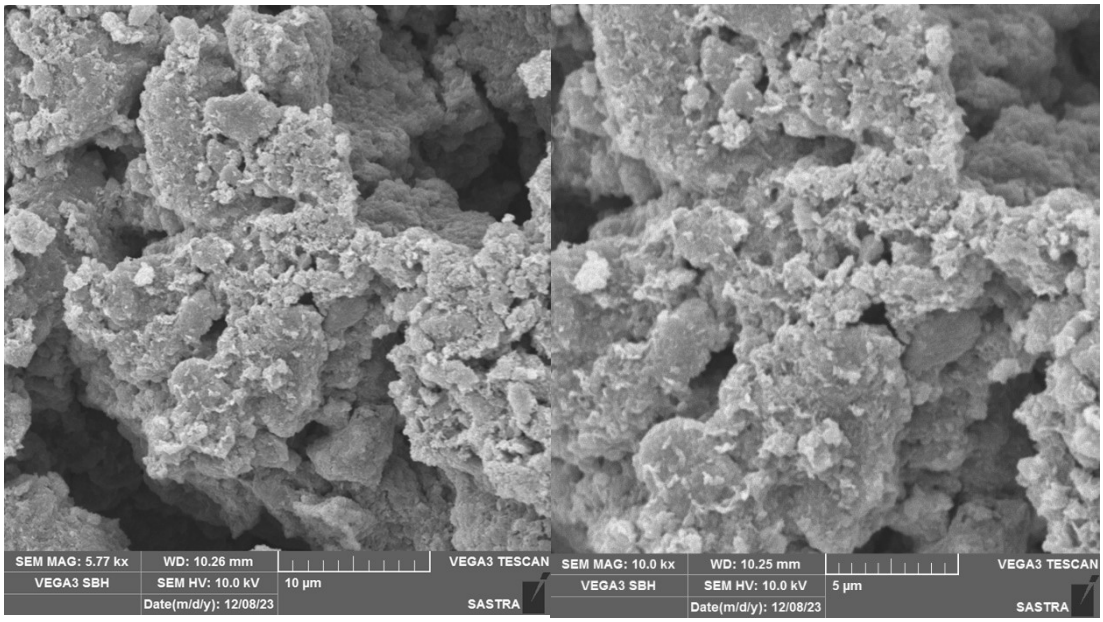
SEM MAG: 5.77 kx
WD: 10.26 mm
VEGA3 TESCAN
VEGA3 SBH
SEM HV: 10.0 kV
10 µm
Date(m/d/y): 12/08/23
SASTRA
SEM MAG: 10.0 kx
WD: 10.25 mm
VEGA3 TESCAN
VEGA3 SBH
SEM HV: 10.0 kV
5 µm
Date(m/d/y): 12/08/23
SASTRA

Figure S10. SEM image of Ag-$Co(OH)_2$-5 after catalysis.

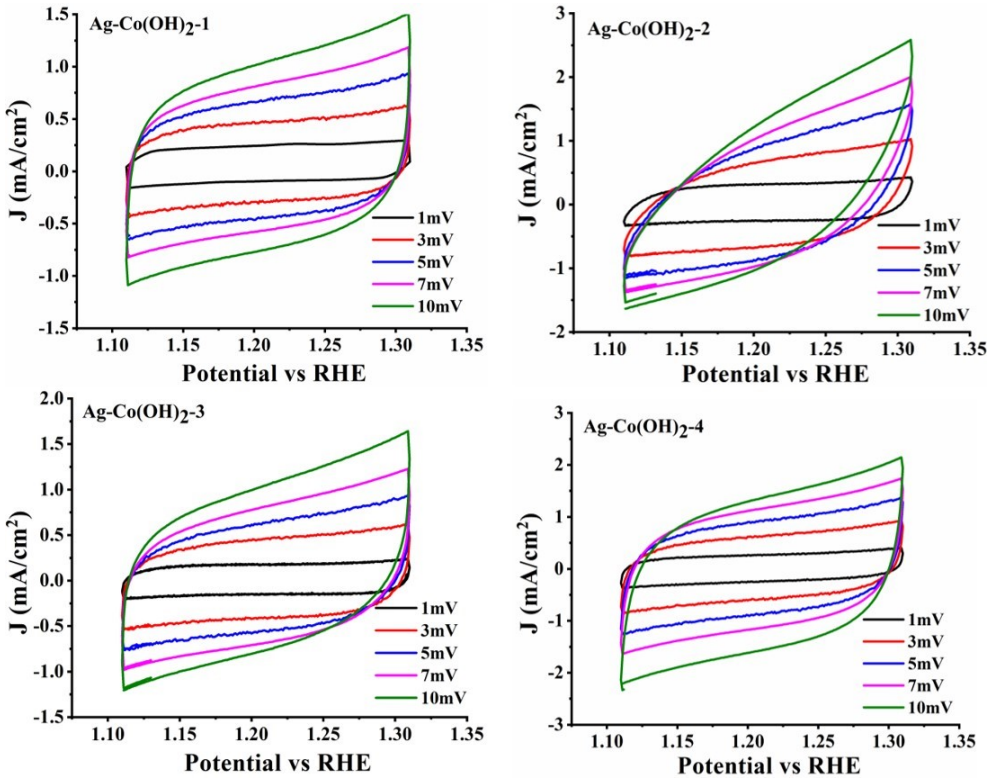

Figure S11. Double layer capacitance and capacitive currents as a functional of scan rate.