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Supporting Information

Oxygen Evolution Catalysts under Proton Exchange Membrane Conditions in a Conventional Three Electrode Cell vs. Electrolyser Device: A Comparison Study and a 3D-Printed Electrolyser for Academic Labs

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Keywords: OER; Electrolysers; Conventional three-electrode cell; Transition metal oxides; 3D-printing.

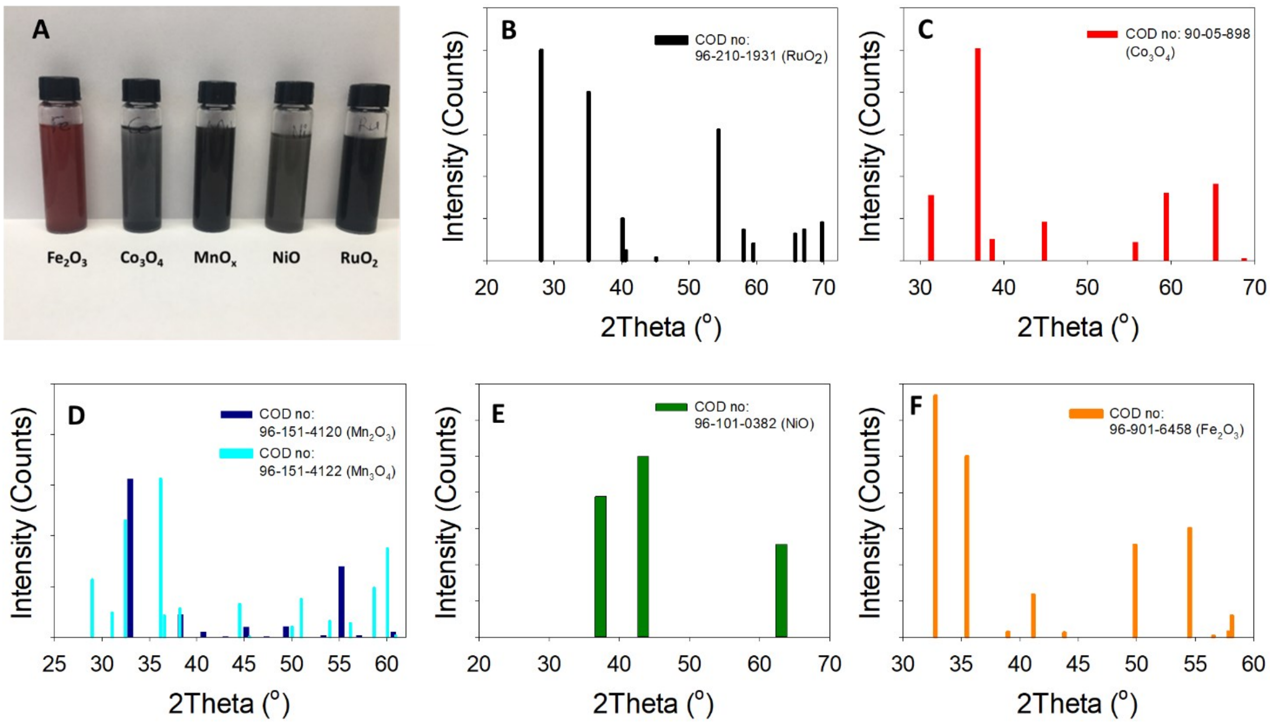

Figure S1. A. Adams metal oxide powder suspensions **and B-F.** Crystallography open database XRD references used to help assign crystal structure to materials in Figure 1.

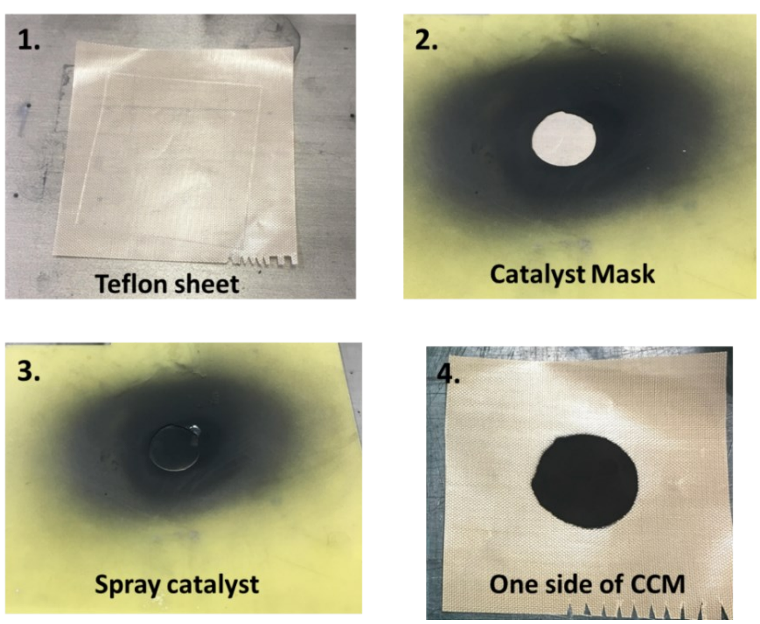

Figure S2. Typical CCM preparation for device studies

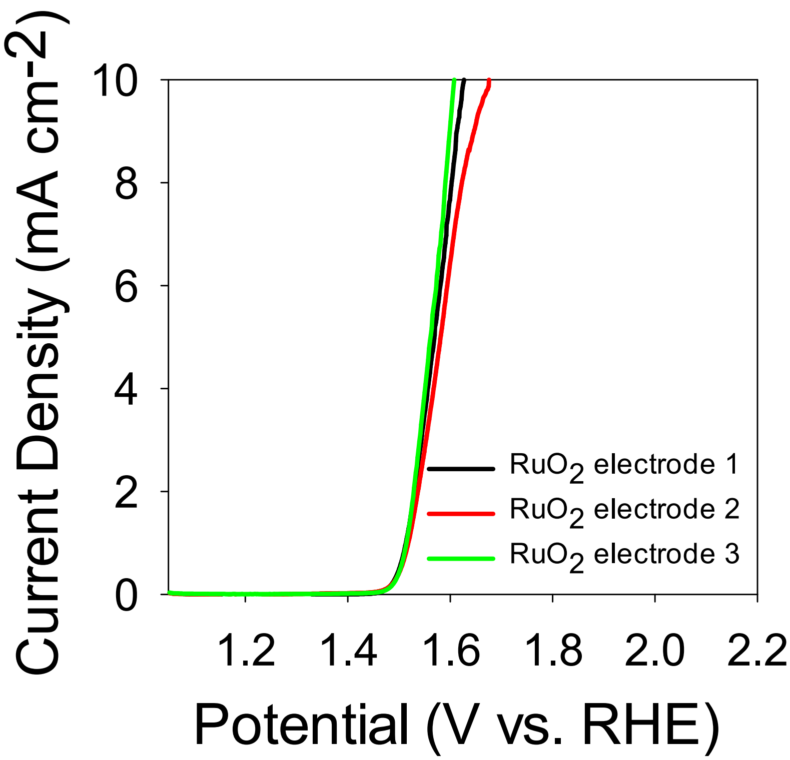

Figure S3. LSV of RuO_2 on GC repeats in a conventional three electrode cell

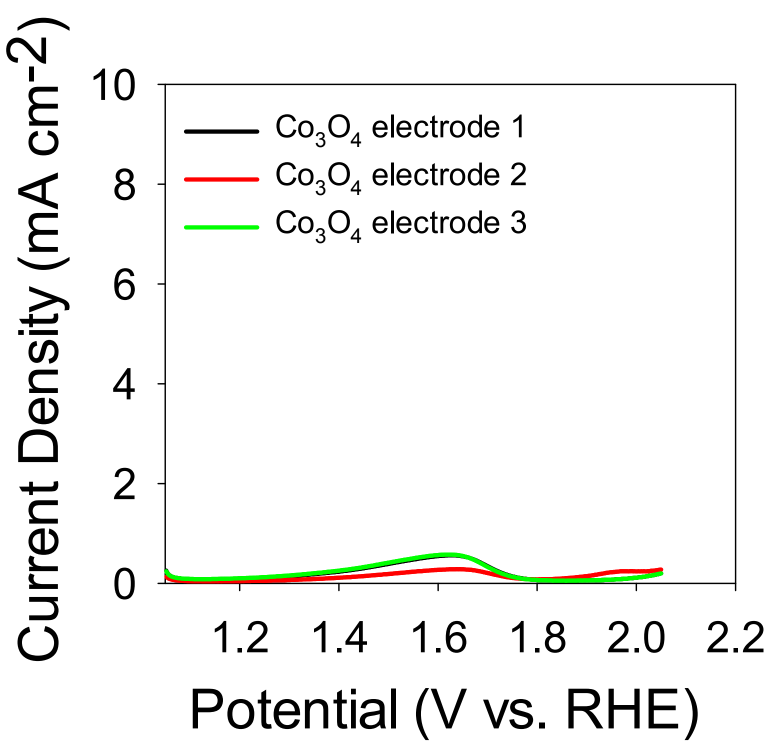

Figure S4. LSV of Co_3O_4 on GC repeats in a conventional three electrode cell

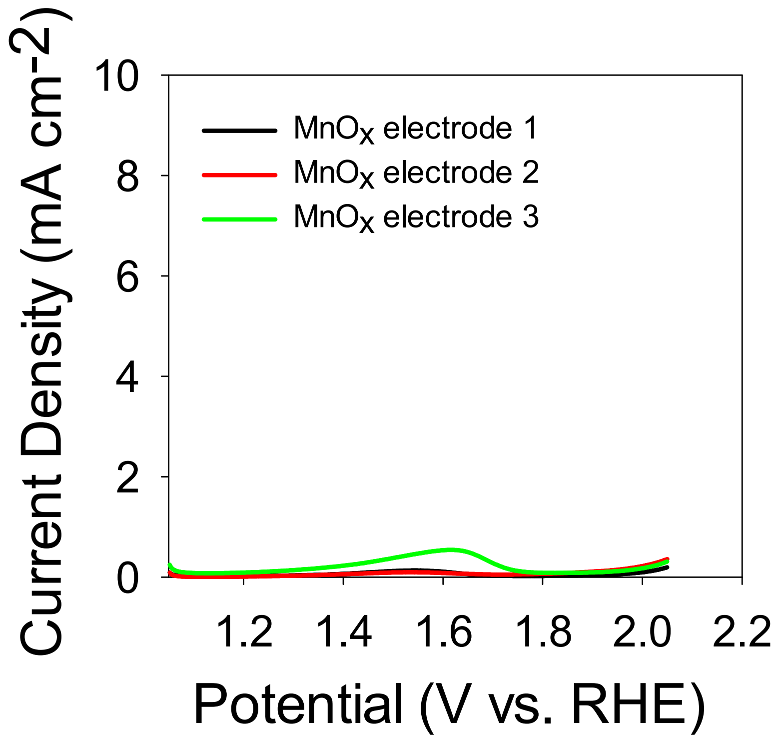

Figure S5. LSV of MnO_x on GC repeats in a conventional three electrode cell

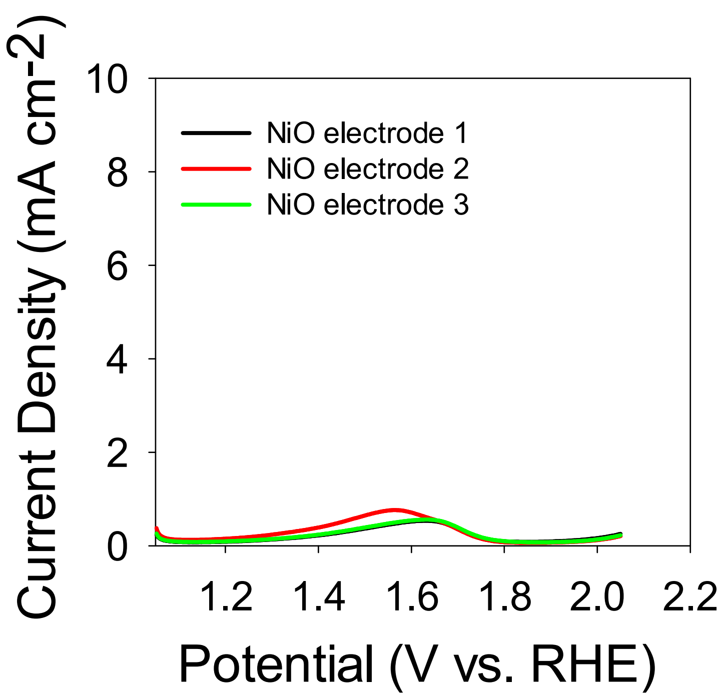

Figure S6. LSV of NiO on GC repeats in a conventional three electrode cell

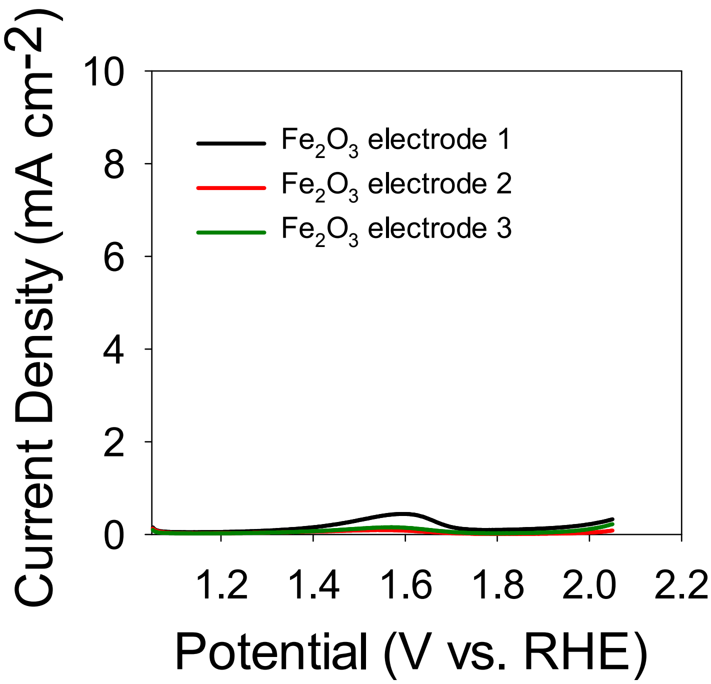

Figure S7. LSV of Fe_2O_3 on GC repeats in a conventional three electrode cell

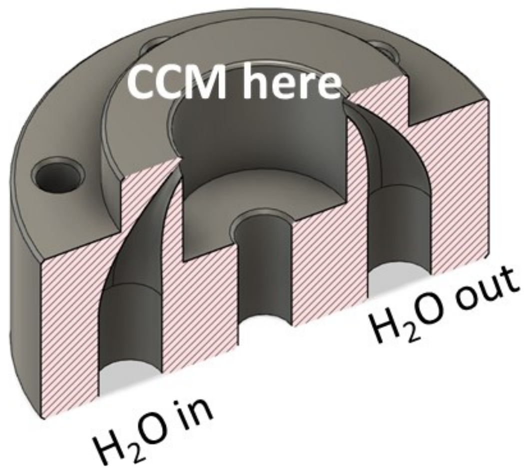

Figure S8. Cell design of the 3D-printed compartment which is half of the overall PEM device.

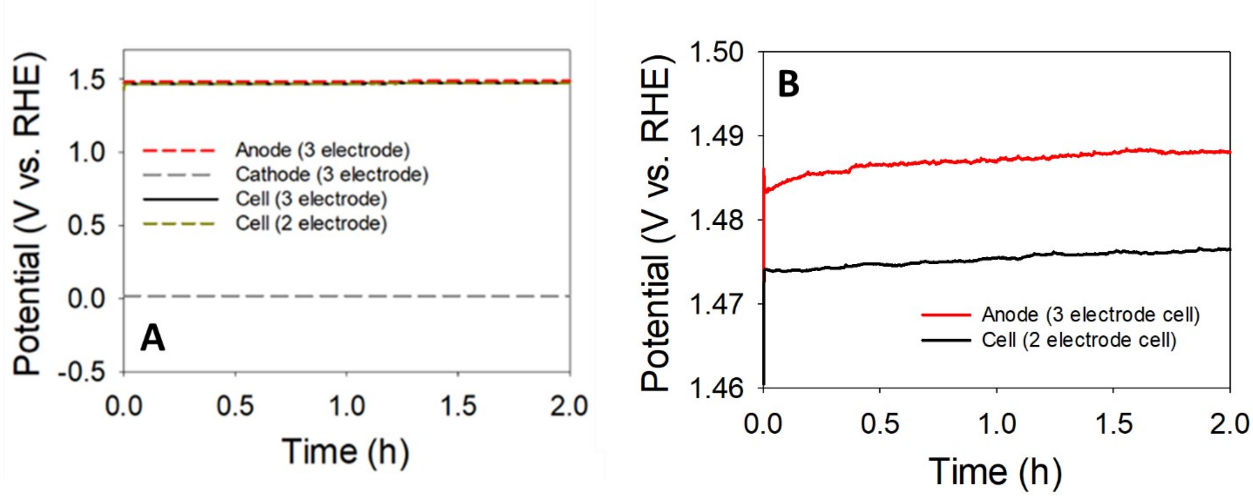

Figure S9. Chronopotentiometry tests for the three- and two-electrode devices at a current density of 10 mA cm^{-2} using a IrO_2/Pt CCM.

To experimentally confirm that the response recorded from a two-electrode electrolyser device can be used to evaluate catalysts for the OER similar to the integrated three electrode electrolyser device, a IrO_2/Pt CCM was tested in a PEEK two- and three-electrode electrolyser device at a current density of 10 mA cm^{-2} for 2 hours.

In **Figure S9**, the silver and red lines represent the potential (V vs. RHE) response of the cathode and anode reactions, respectively, and the black line is representative of the overall cell response in a three-electrode cell electrolyser device. This indicates that at a current density of 10 mA cm^{-2}, the anodic reaction contributes all of the overall cell voltage. Furthermore, in a two-electrode electrolyser cell the overall cell potential is equal to that in the three-electrode cell device at the same current density. Thus, the overall potential in a two-electrode cell (with Pt/C cathode) can also be rationalised as the potential associated with the anodic reaction in a three-electrode cell, i.e. the OER. To this end, the utilisation of the 3D-printed electrolysers manufactured in this study are capable of evaluating OER catalysts at low current densities (i.e. 10 mA cm^{-2}) and, thus, would be a cheap alternative to purchasing expensive and more complex electrolyser devices from commercial sources, **See SI Table 2**.[1]

Note: The cell resistance must be checked before conducting water splitting measurements to ensure the cell has been assembled correctly.

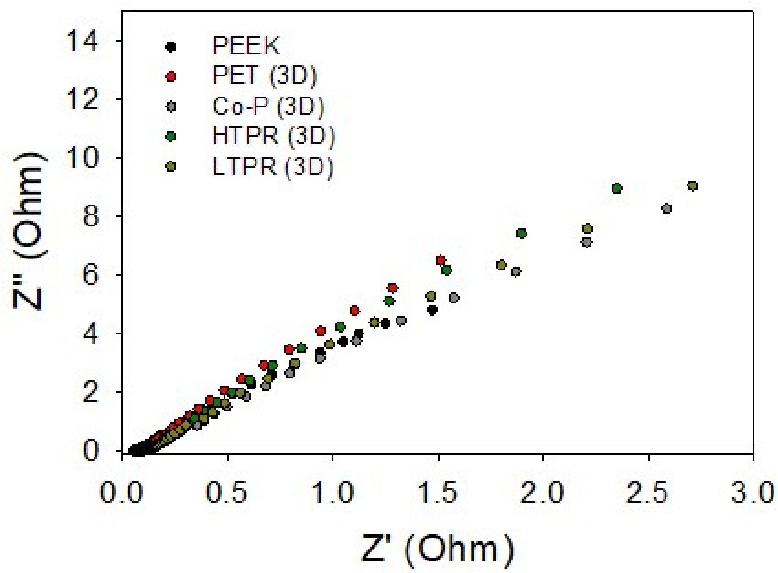

Figure S10. Nyquist plot of PEEK and 3D-printed cells conducted using an IrO_2/Pt CCM.

Table S1: Cost of additional electrolyser parts for the PEEK and 3D-printed electrodes

Additional electrolyser parts	Estimated cost (£)
Piston	83
Mesh	3
Sinter	17

Table S2: Cost comparison of commercial, PEEK and 3D-printed electrolysers

Electrolyser	Active area	Manufactured	Cost of electrolyser (£)	Reference
Commercial	5 cm^2	Machined	3640.35	[1]
PEEK	5 cm^2	Machined	274	This study
PET	5 cm^2	3D-printed	0.83	This study
Co-P	5 cm^2	3D-printed	1.66	This study
LTPR	5 cm^2	3D-printed	19.62	This study
HTPR	5 cm^2	3D-printed	26.28	This study

1. F. C. Store, Electrolyzer Hardware - Square, https://www.fuelcellstore.com/hydrogen-equipment/hydrogen-production-electrolyzers/electrolyzer-hardware-test-cell-square).