Supplementary Information

A comprehensive activity-stability correlation study of tantalum doped tin oxide as support for iridium oxide in low loading water electrolysis cell anodes

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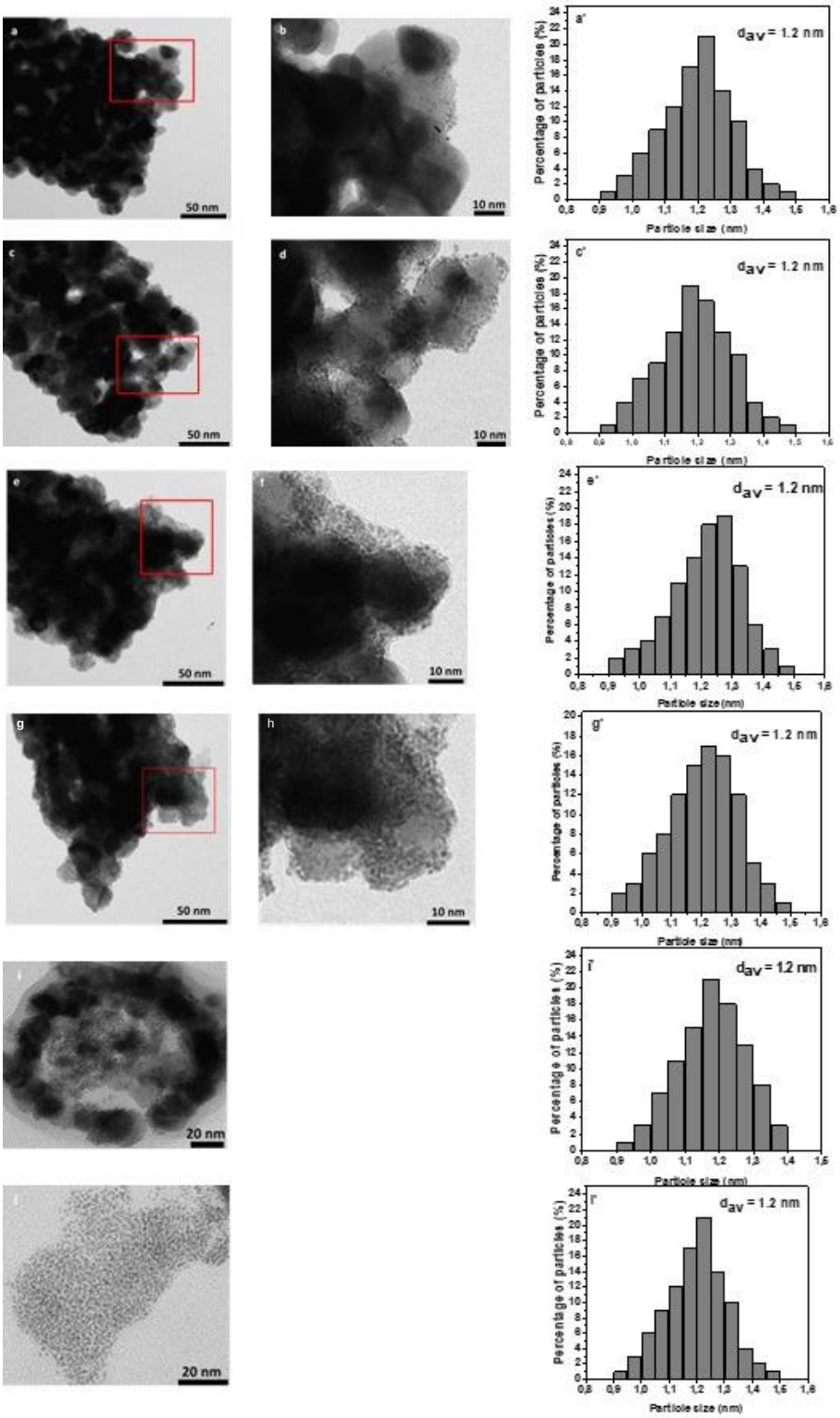
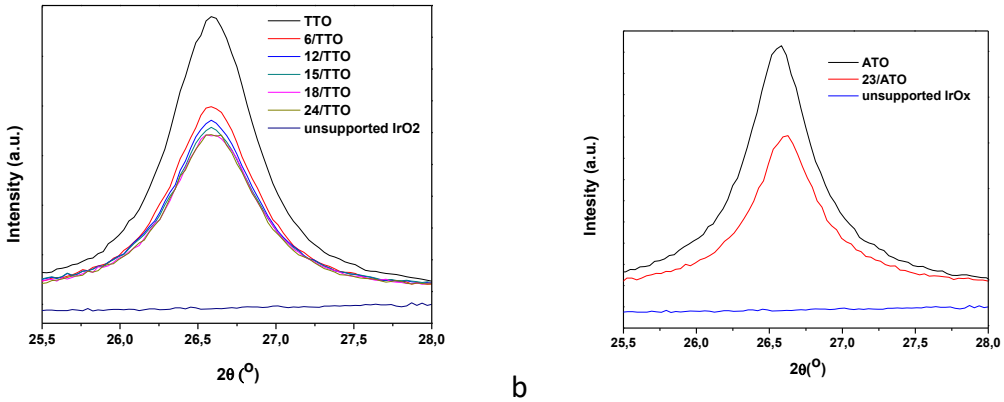


Figure S1. TEM micrographs of 6/TTO (a,b), 12/TTO (c, d), 19/TTO (e,f), 24/TTO (g,h), ultramicrotome section of 23/ATO (i) and unsupported IrO_x (l) and their corresponding particle size distribution histograms (a', c', e', g', i', l').



a b

Figure S2. Details of XRD patterns (25.5-28 °) of supports before and after the deposition of IrO_x nanoparticles in a range of loadings (a) 6-24 wt.% for TTO and b) and 23 wt.% ATO).

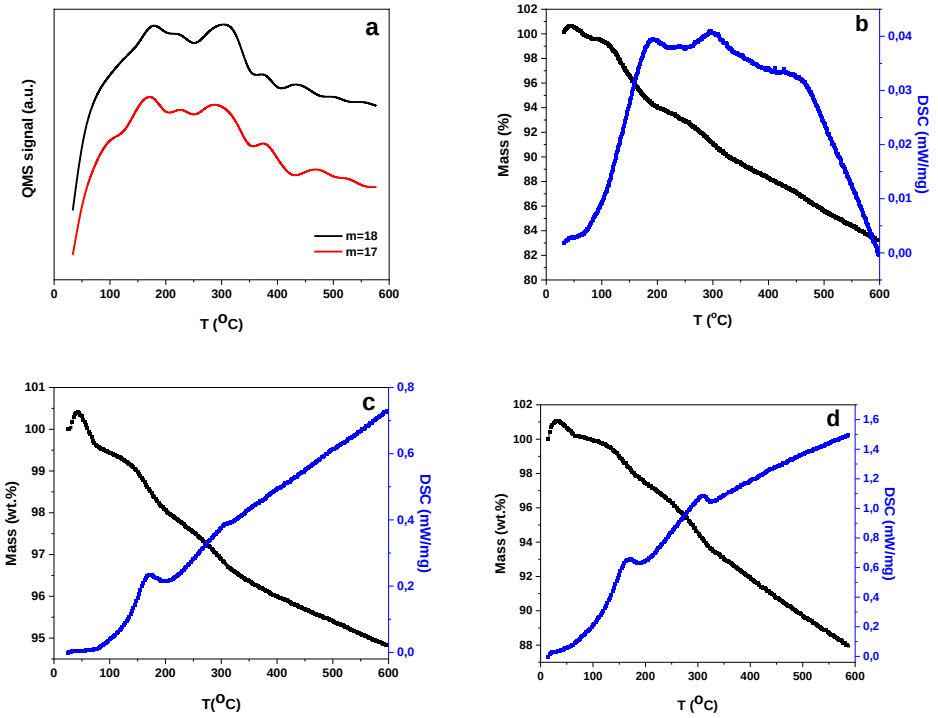


Figure S3. Thermogravimetry, quadrupole mass spectrometry and differential scanning calorimetry (TG-QMS-DSC) of a) unsupported IrO_x nanoparticles and TG-DSC analysis of b) unsupported IrO_x nanoparticles, c) 16/TTO and d) 23/ATO.

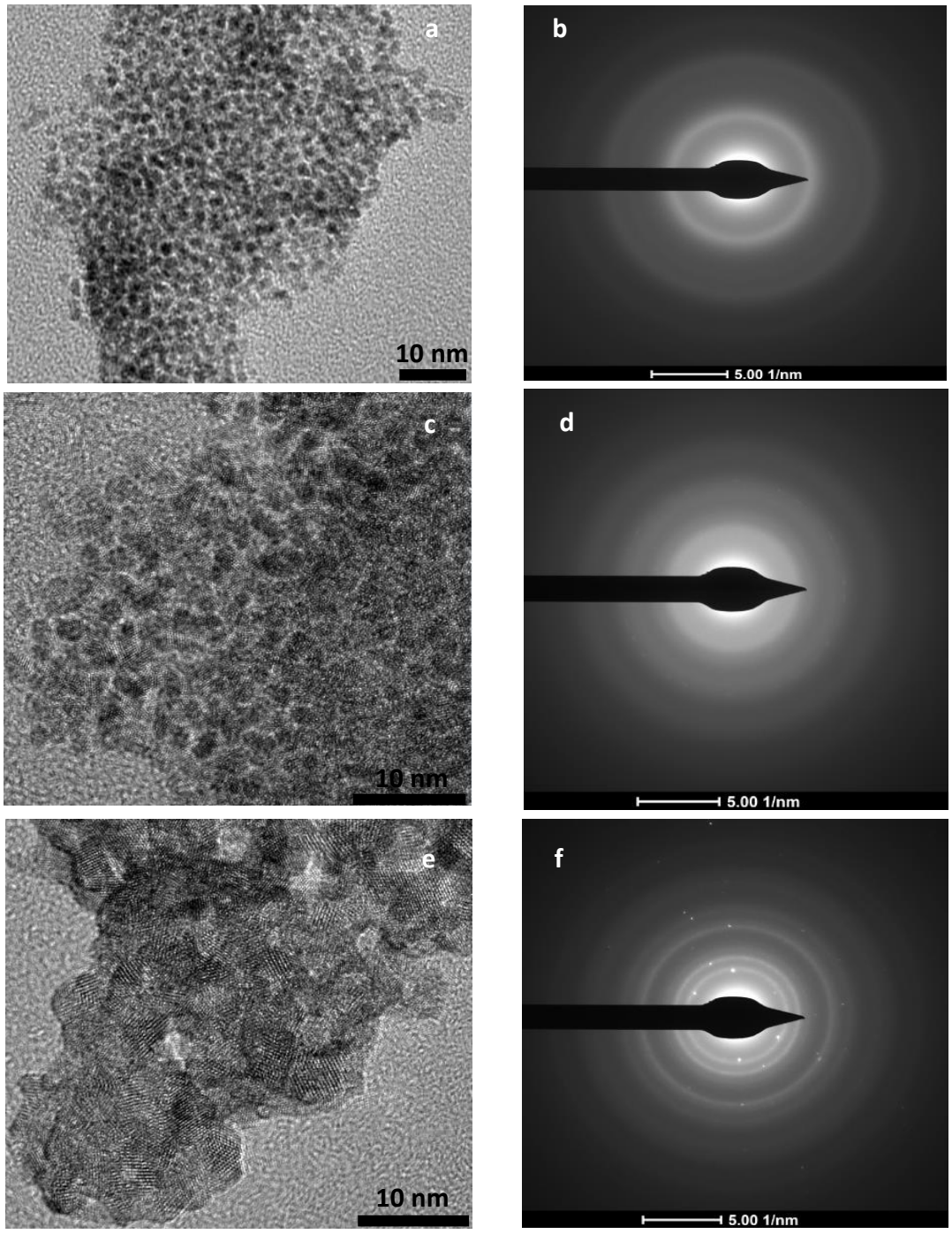


Figure S4. HRTEM micrographs and their corresponding SAED for unsupported IrO_x (a, b) as prepared, treated at 300 °C (c, d) and treated at 325 °C (e, f).

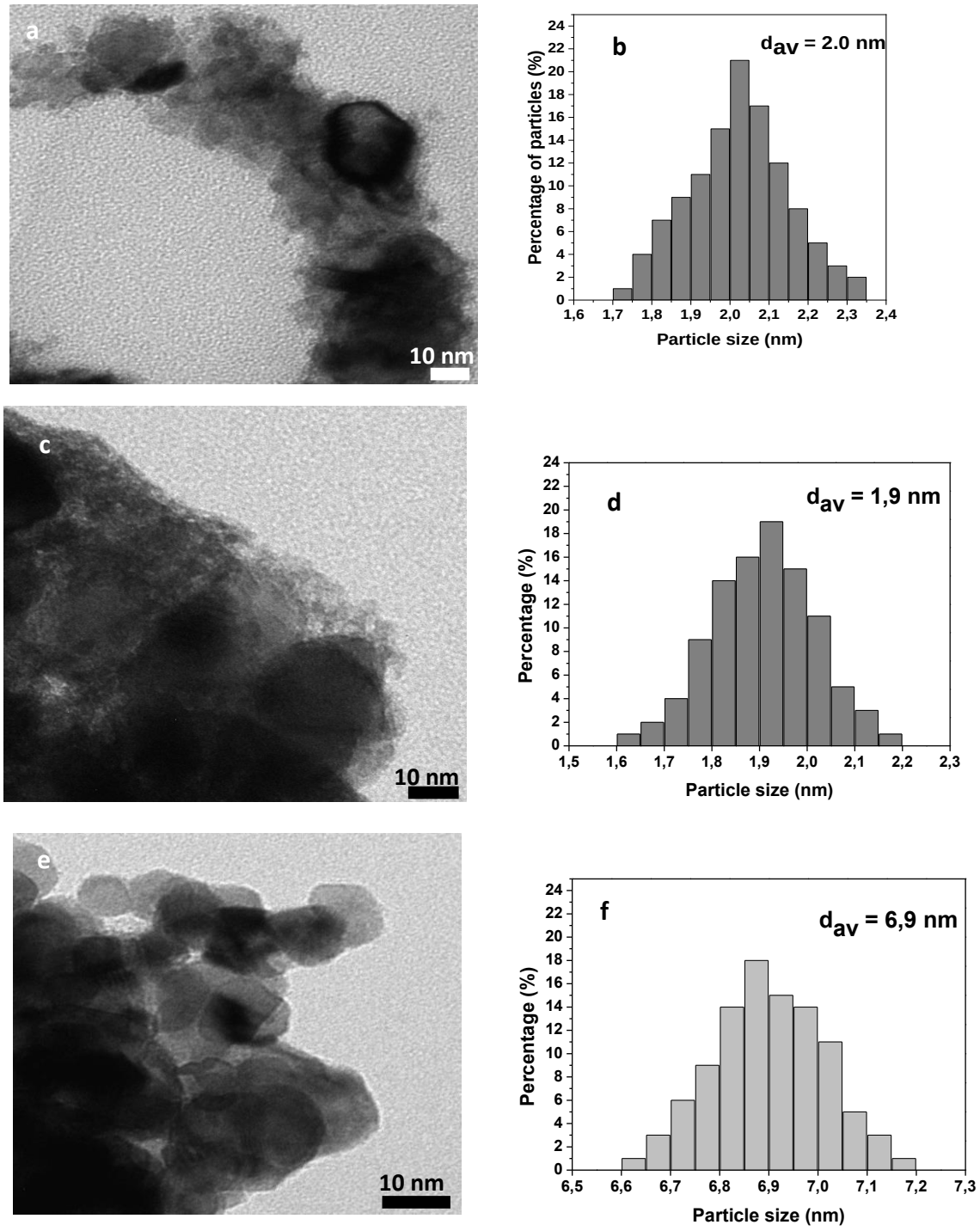


Figure S5. TEM micrographs of ultramicrotome sections of a) 23/ATO/300 and its corresponding particle size distribution histogram (b) and TEM micrographs of c) 16/TTO/300 and e) 24/TTO/300 and their corresponding particle size distribution histograms (d, f, respectively).

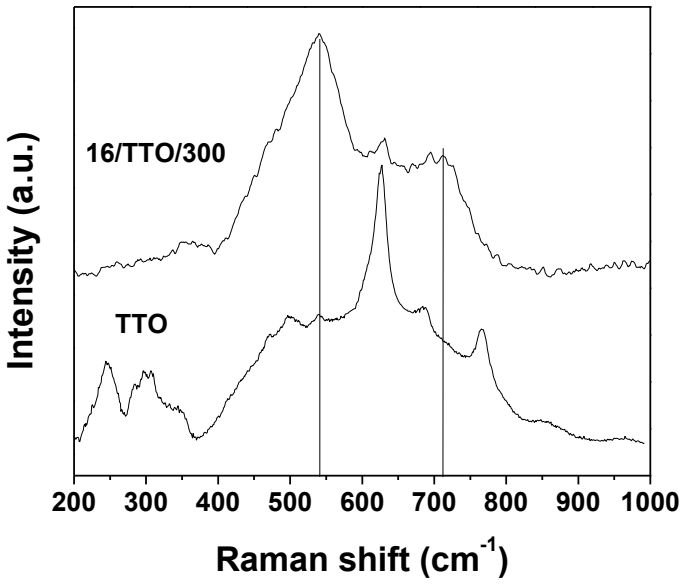


Figure S6. Raman spectra of electrocatalyst support material (TTO) and thermally treated catalysed support (16/TTO/300).

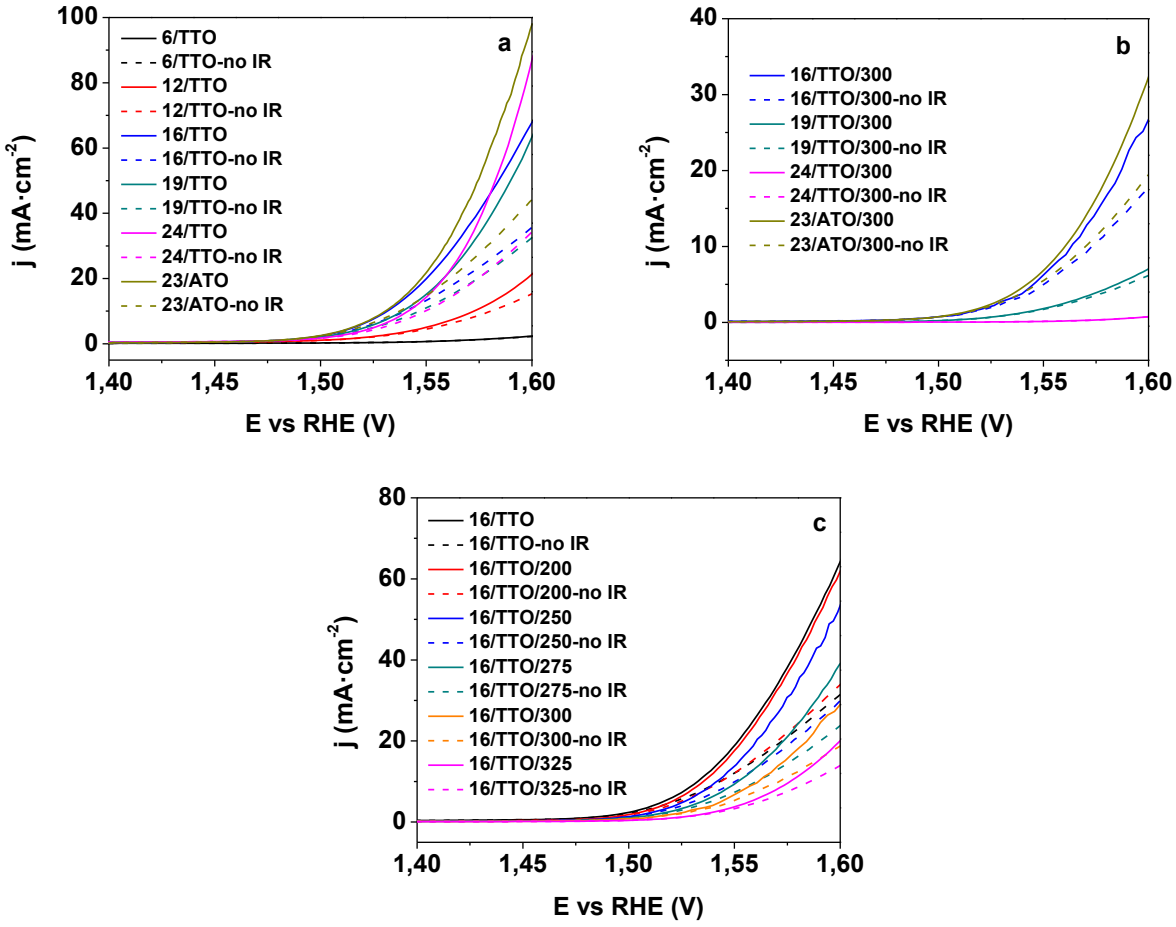


Figure S7. OER polarisation curves with and without iR correction normalised to the geometric area for a) non-treated, b) thermally treated at 300 °C and c) thermal treated at various temperatures electrocatalysts.

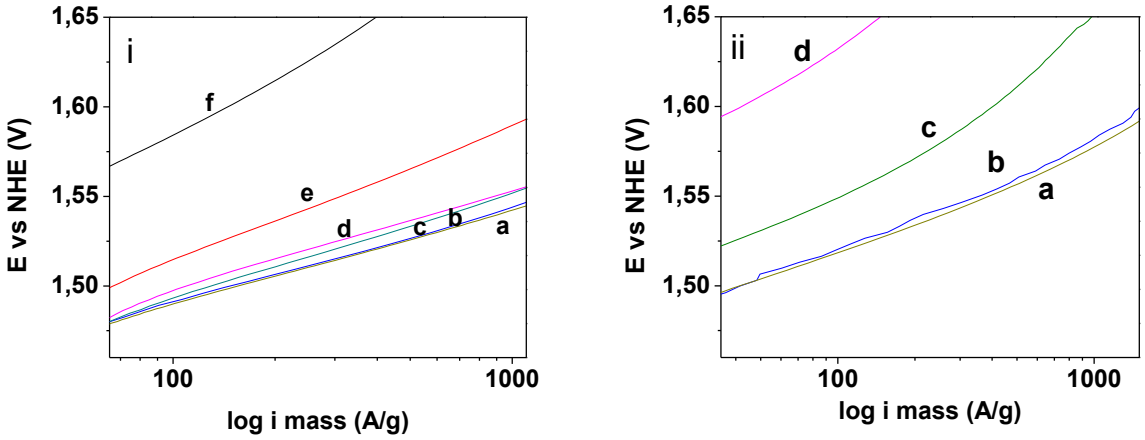


Figure S8. OER Tafel slopes for i) non-treated and ii) thermally treated electrocatalysts: a) 23/ATO (300), b) 16/TTO(300), c) 19/TTO(300), d) 24/TTO(300), e) 12/TTO and f) 6/TTO.

Table S1. Double layer capacitance (C_{dl}) and electrochemical surface area (ECSA) for all catalysed materials.

Electrocatalyst	C_{dl} ($mF \cdot cm^{-2}$)	ECSA ($m^2 \cdot g^{-1}$)
6/TTO	1.9	31
12/TTO	3.4	54
16/TTO	5.7	91
16/TTO/300	2.2	35
19/TTO	5.3	85
24/TTO	4.8	78
23/ATO	6.4	104

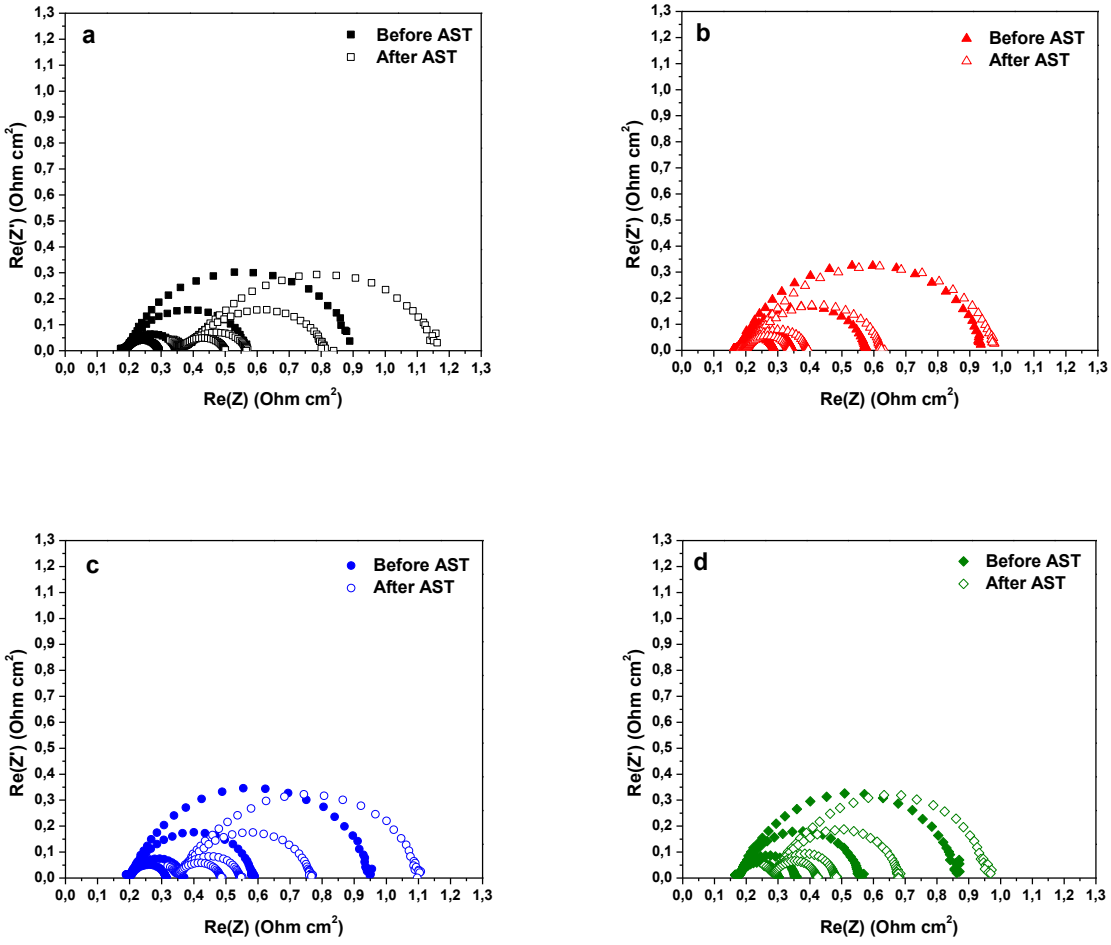


Figure S9. Nyquist plots acquired in the 30 kHz- 10 mHz frequency range at 0.025, 0.05, 0.125 and 0.2 A cm^{-2} of MEAs comprising at the anode side a) 16/TTO/275, b) 16/TTO/300, c) 16/TTO/325 and d) 23/ATO/300, before (solid symbols) and after AST (open symbols).

Table S2. Ohmic and charge transfer resistances at different current densities by fitting EIS spectra for supported catalysts treated at different temperatures before and after stability test.

Anode catalyst	**j (mA cm^{-2})**							
	0.025		0.05		0.125		0.2	
	R_{ohm} (Ω cm^2)	R_{CT} (Ω cm^2)	R_{ohm} (Ω cm^2)	R_{CT} (Ω cm^2)	R_{ohm} (Ω cm^2)	R_{CT} (Ω cm^2)	R_{ohm} (Ω cm^2)	R_{CT} (Ω cm^2)
16/TTO/ 275 (AST)	0.175 (0.340)	0.890 (1.163)	0.175 (0.339)	0.566 (0.800)	0.173 (0.332)	0.347 (0.566)	0.174 (0.327)	0.292 (0.500)
16/TTO/ 300 (AST)	0.162 (0.186)	0.934 (0.970)	0.162 (0.187)	0.576 (0.624)	0.163 (0.186)	0.356 (0.395)	0.163 (0.184)	0.301 (0.336)
16/TTO/ 325 (AST)	0.182 (0.323)	0.961 (1.097)	0.179 (0.327)	0.584 (0.767)	0.180 (0.322)	0.366 (0.548)	0.182 (0.319)	0.315 (0.486)
23/ATO/ 300 (AST)	0.165 (0.257)	0.871 (0.968)	0.166 (0.258)	0.564 (0.679)	0.166 (0.258)	0.358 (0.484)	0.165 (0.256)	0.302 (0.425)

Table S3. EDX analysis of catalysed materials MEAs before and after stability test.

MEA	**EDX analysis**					
	IrO_x (wt. %)		Ta/Sn		Sb/Sn	
	Before AST	After AST	Before AST	After AST	Before AST	After AST
16/TTO/275	16.1	10.9 - 11.6	0.95	1.04	-	-
16/TTO/300	16.1	13.0 -13.6	0.97	1.01	-	-
16/TTO/325	16.1	14.0 - 19.5	0.93	1.02	-	-
23/ATO/300	23.2	17.2	-	-	10.2	7.1

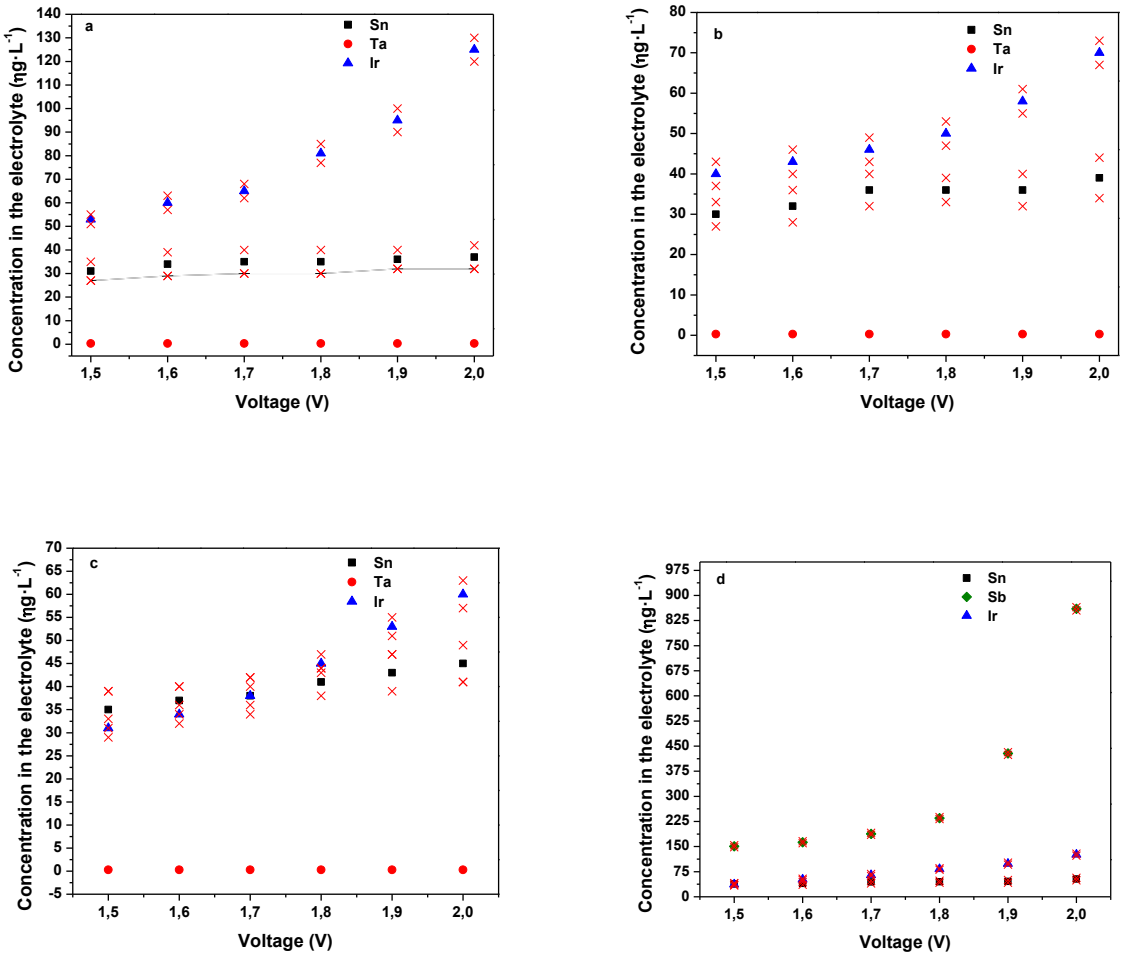


Figure S10. Amount of leached Sn, Ta, Ir as a function of applied potential obtained by ICP-MS analysis of anode exhaust water after chronoamperometry measurements from 1.5 to 2.0 V every 4 h step for a) 16/TTO/275, b) 16/TTO/300, c) 16/TTO/325 and d) 23/ATO/300.

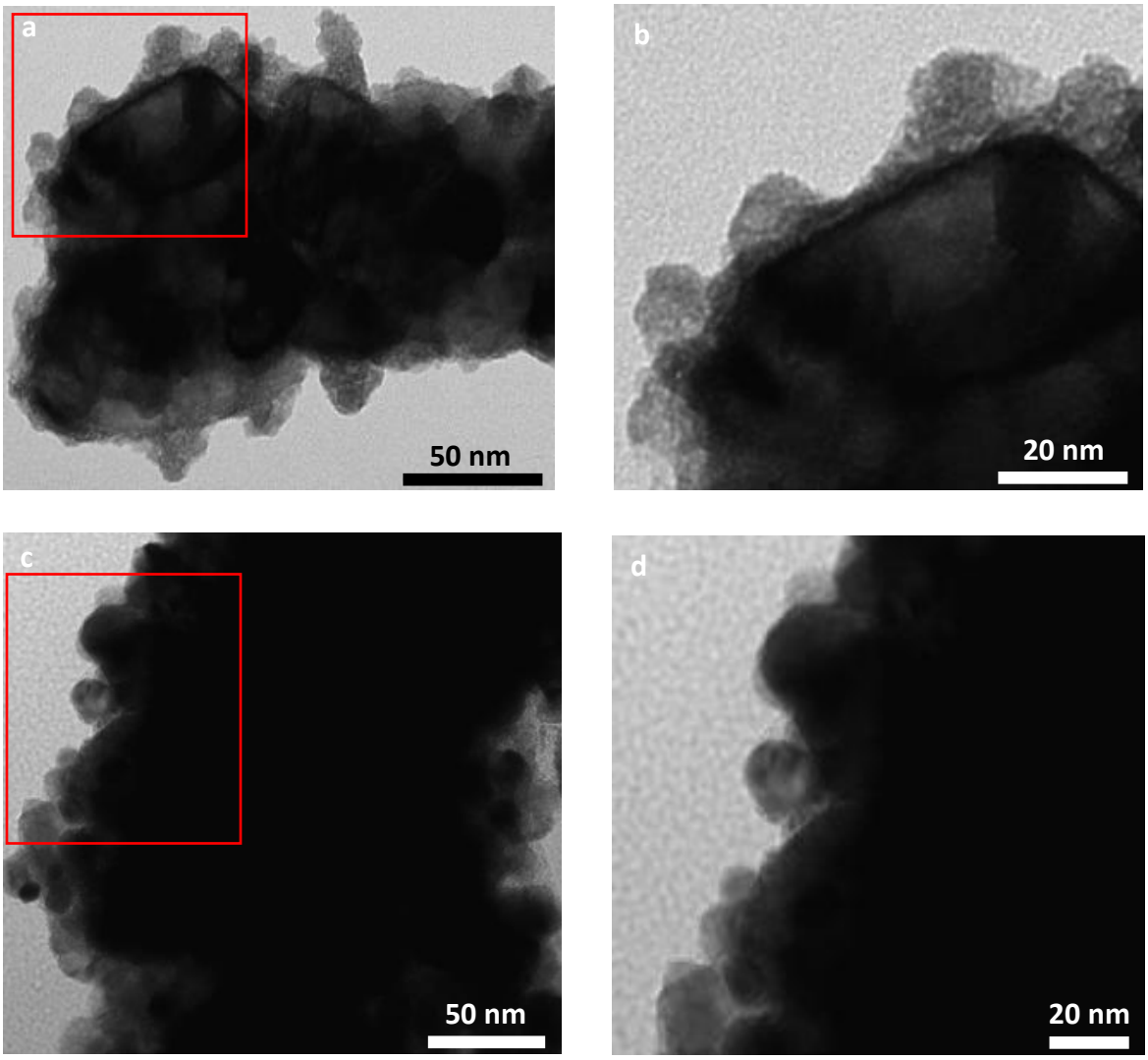


Figure S11. TEM micrographs of a) 16/TTO/325 before and c) after AST with the corresponding magnified images (b and d, respectively).