How Acid Washing Nickel Foam Substrates Improves the Efficiency of the Alkaline Hydrogen Evolution Reaction - Supplementary Information

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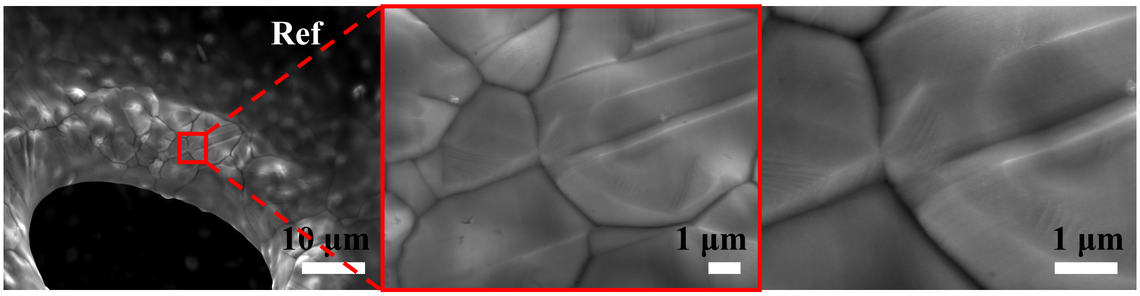
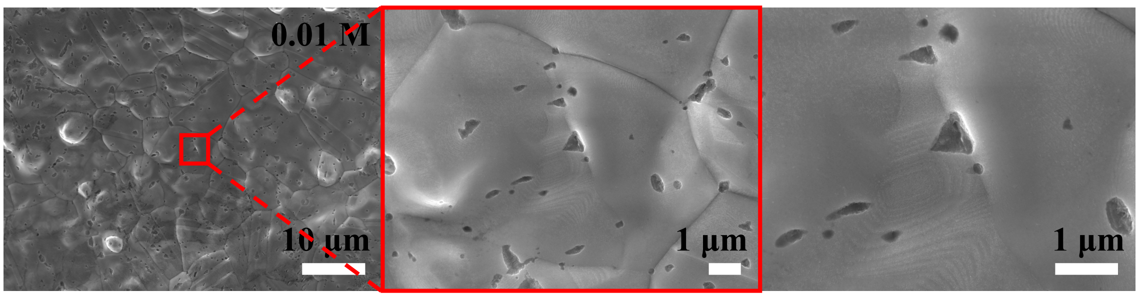
This document contains supplementary information to the paper entitled "How Acid Washing Nickel Foam Substrates Improves the Efficiency of the Alkaline Hydrogen Evolution Reaction".

Additional spectroscopic data



(a)



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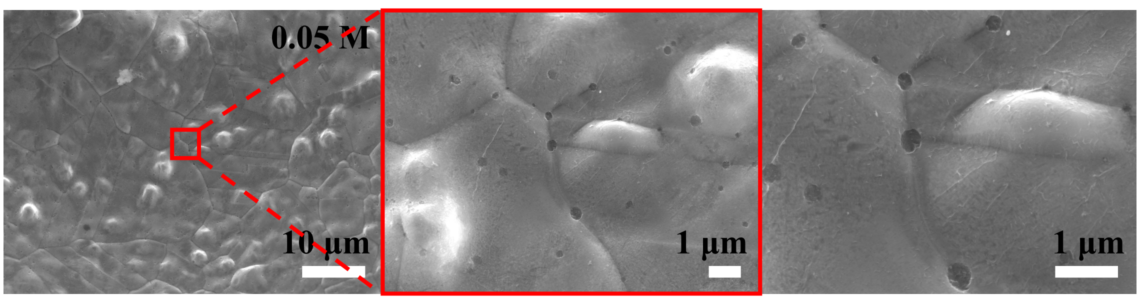
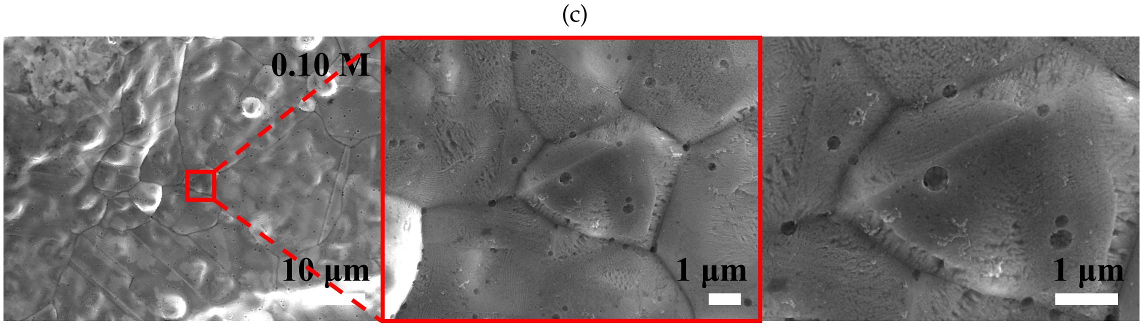
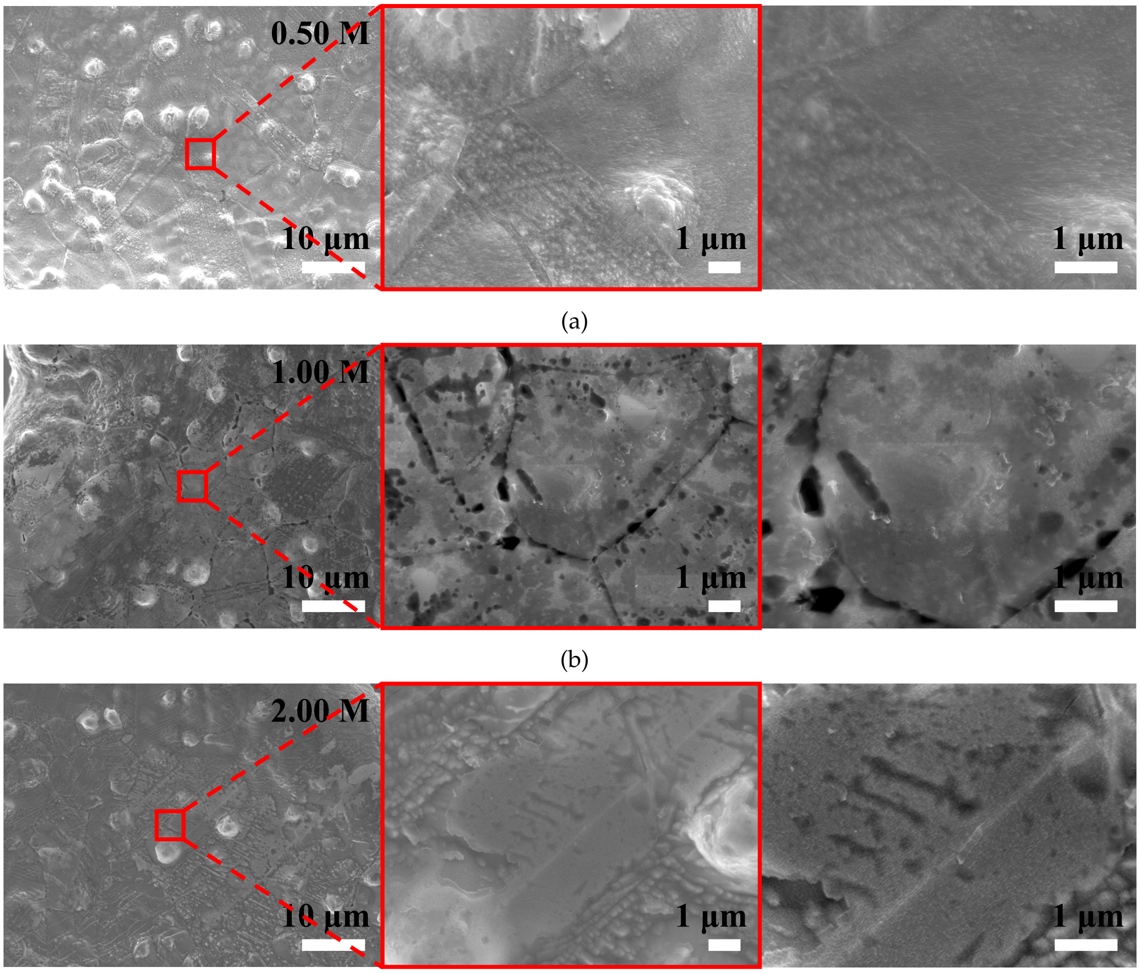


(c)



(d)

Figure S1: Additional SEM figures for the various acid treated nickel foam electrodes.

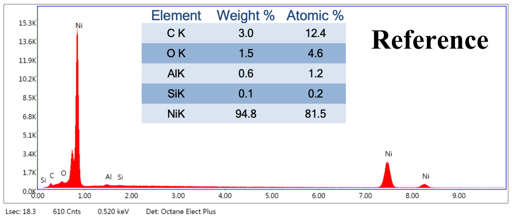


(a)

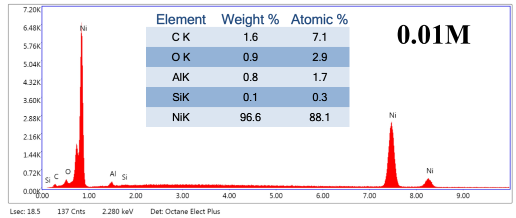
(b)

(c)

Figure S2: Additional SEM figures for the various acid treated nickel foam electrodes.



(a)



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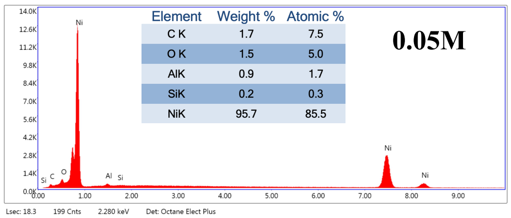

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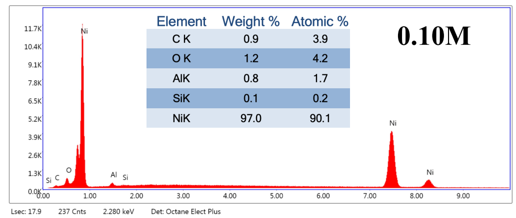

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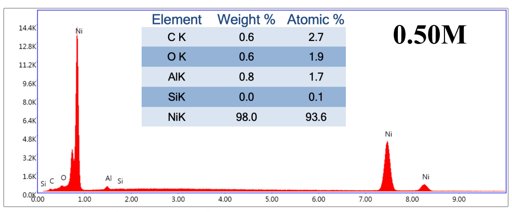

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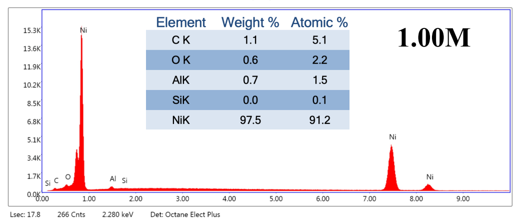

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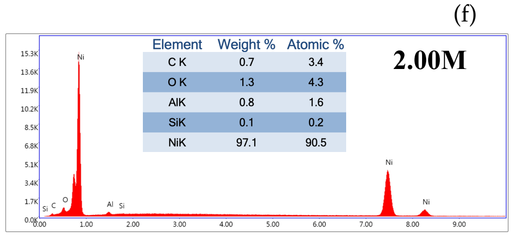


(g)

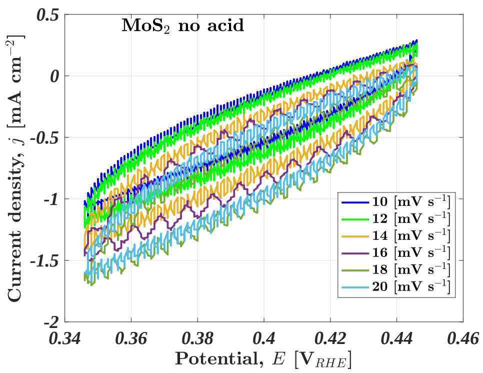
Figure S3: Complete EDS scan with quantification for the various acid treated nickel foam electrodes.

Additional electrochemical data

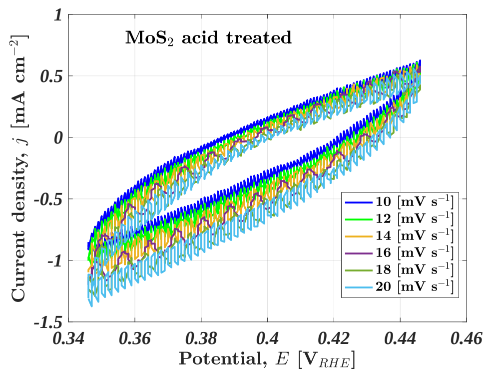
The cyclic voltammograms (CV) utilised to determine the double layer capacitance are displayed in Fig. S4 below. There are clear oscillations present at all scan rates, where these are due to instrumentation from the Iviumstat electrochemical workstation. This is very clear when evaluating the scan at 16 mV s^{-1}, which appears almost sinusoidal based on the wave shape. All scans were repeated multiple times until the voltammograms were repeatedly overlapping, resulting in the CVs shown below. Moreover, the width of the CVs was found to vary linearly with sweep rate at the centre point at 0.40 V_{RHE}.

The electrochemically active surface area (ECSA) was determined through Eq.S1, where C_{dl} is the double layer capacitance determined through the CV scans in Fig. S4, and C_s is the specific capacitance for an ideal smooth electrode, which is usually defined as 40 μF cm^{-2} [1–3].

$$ECSA = \frac{C_{dl}}{C_s} \tag{S1}$$



(a)



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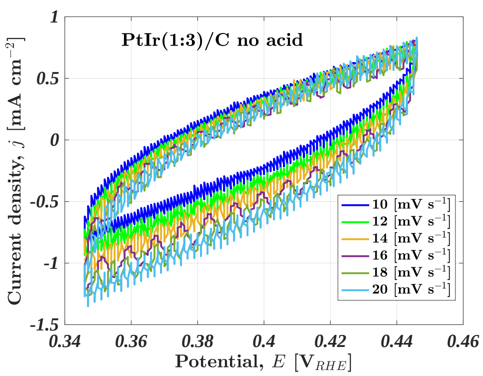

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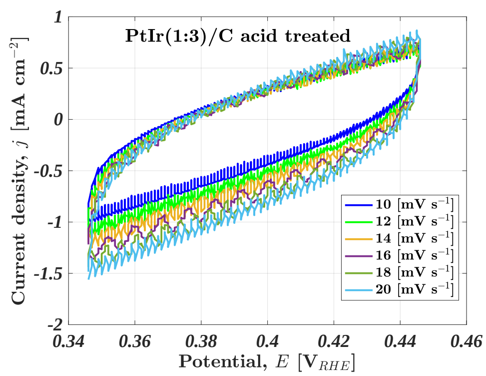

(d)

Figure S4: Cyclic voltammetry scans performed in a non-faradaic region. These were utilised to determine the double layer capacitance for catalyst-coated, acid treated nickel foam electrodes.

Normalising the current by the electrochemical active surface area (ECSA) displays the intrinsic activity of the catalyst layer. This result is displayed in Fig. S5a.

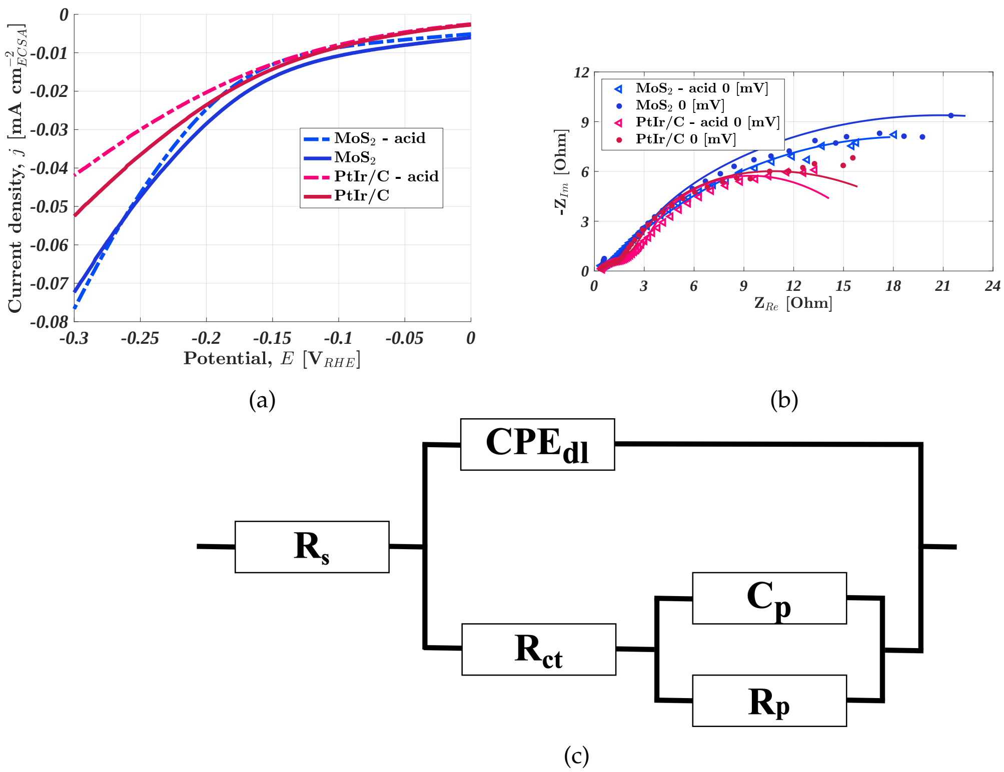

Figure S5: The performance of the untreated and acid treated electrodes quantified through **(a)** linear sweep voltammograms measured in pseudo-steady state (10 mV s^{-1}) [4] normalised for the ECSA determined by cyclic voltammetry. **(b)** Fitted open circuit EIS spectra. **(c)** The equivalent circuit employed to fit the EIS spectra.

Table S1 displays the values from the EIS fitting. The EIS spectra were fitted utilising Iviumsoft.

Table S1: Values from the fitting of EIS spectra to the equivalent circuit displayed in Figure S5c.

	R_s [Ω]	R_{ct} [Ω]	R_p [Ω]	C_p [F]	Q_{dl} [S s^n]	n_{dl} [-]
0 [mV]						
MoS_2 - acid	0.3903	7.219	29.82	1.013×10^{-6}	0.03805	0.5247
MoS_2	0.2597	8.204	34.90	2.602×10^{-3}	0.02710	0.5000
PtIr - acid	0.2231	3.996	14.72	2.319×10^{-2}	0.02073	0.5000
PtIr	0.2239	4.633	18.72	9.546×10^{-3}	0.02675	0.5000
200 [mV]						
MoS_2 - acid	0.2558	3.168	2.790	5.498×10^{-3}	0.02489	0.5273
MoS_2	0.3075	3.987	2.782	5.420×10^{-3}	0.01392	0.5842
PtIr - acid	0.3164	2.505	2.104	2.216×10^{-2}	0.01073	0.5945
PtIr	0.2555	2.559	2.354	1.129×10^{-2}	0.01511	0.5526

References

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