Supplementary Information (SI) for RSC Sustainability.

Critical metal recovery from e-waste in concentrated ionic media using ultrasound.

Christopher E. Elgar*, Kelsey Hall, Andrew P. Abbott

Centre for Sustainable Materials Processing, School of Chemistry, University of Leicester, Leicester, LE1 7RH

* *Corresponding author. Email address: cee17@leicester.ac.uk*

Additional tables and figures

Table S1 - *Physicochemical properties of the different brine solutions and ChCl:2EG used in this study, and recorded at 25 °C. Uncertainties in the last digit are in brackets. Data from Zante et al[1].*

Brine	$[Cl^-]$ / mol kg^{-1}	Viscosity / mPa s	Conductivity / mS cm^{-1}
1:3	5.17	14.08(6)	43.3(3)
1:5	4.36	6.24(9)	67.6(5)
1:10	3.13	4.56(2)	96.3(2)
1:20	2.00	1.79(2)	92(2)
ChCl:2EG			
ChCl:2EG	3.79	37	7.61

Table S2 - *Redox couples for $M^{II/0}$ couples in the different solvents used in this study, recorded at 25 °C vs $[Fe(CN)_6]^{3-/4-}$ couple at 10 mV s^{-1} in 100 mmol solutions.*

Solvent	$[Cl^-]$ / mol kg^{-1}	$Sn^{II/0}$ redox potential / V	$Pb^{II/0}$ redox potential / V
1:3	5.17	-0.549	-0.436
1:5	4.36	-0.472	-0.492
1:10	3.13	-0.485	-0.483
1:20	2.00	-0.476	-0.500
ChCl:2EG	3.79	-0.712	-0.624

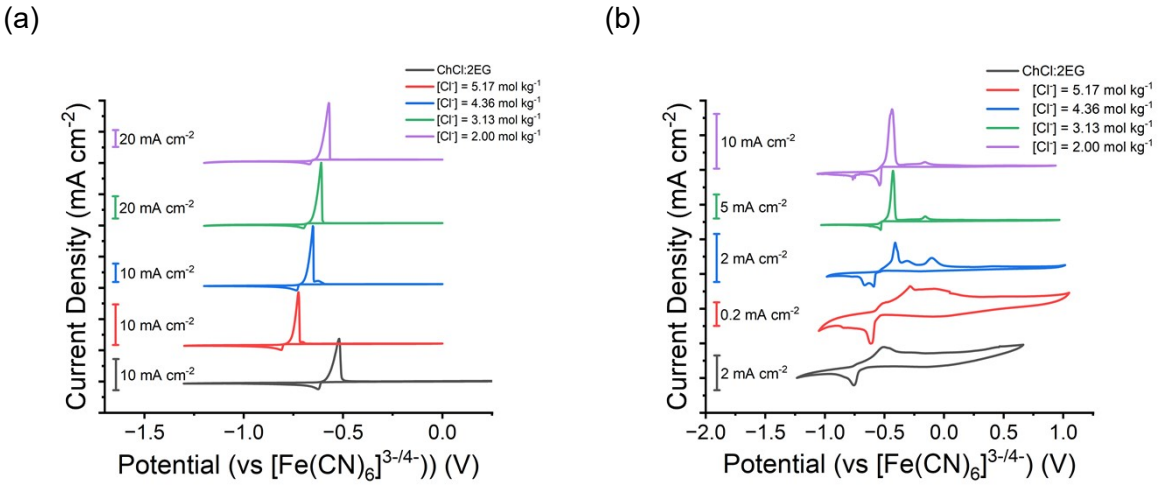


***Figure S1**: Cyclic voltammograms for 100 mmol (a) $SnCl_2$ and (b) $PbCl_2$ dissolved in different solvents. Scans started at OCP and run at 10 mV s^{-1}, recorded on a platinum disc electrode, and referenced too $[Fe(CN)_6]^{3-/4-}$.*

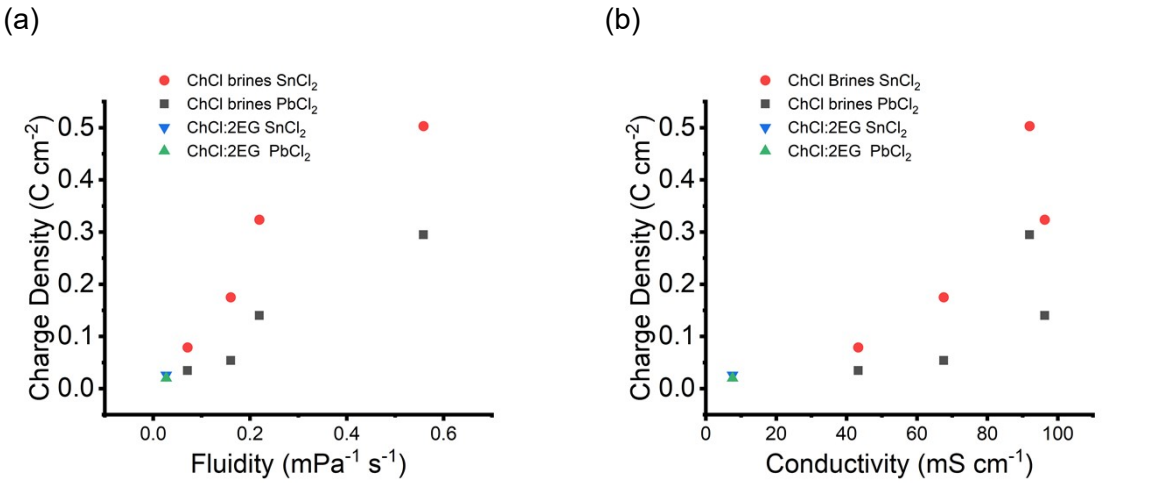


***Figure S2**: Charge density from cyclic voltammogram measurements in Figure S1 plotted vs (a) solvent fluidity and (b) solvent conductivity.*

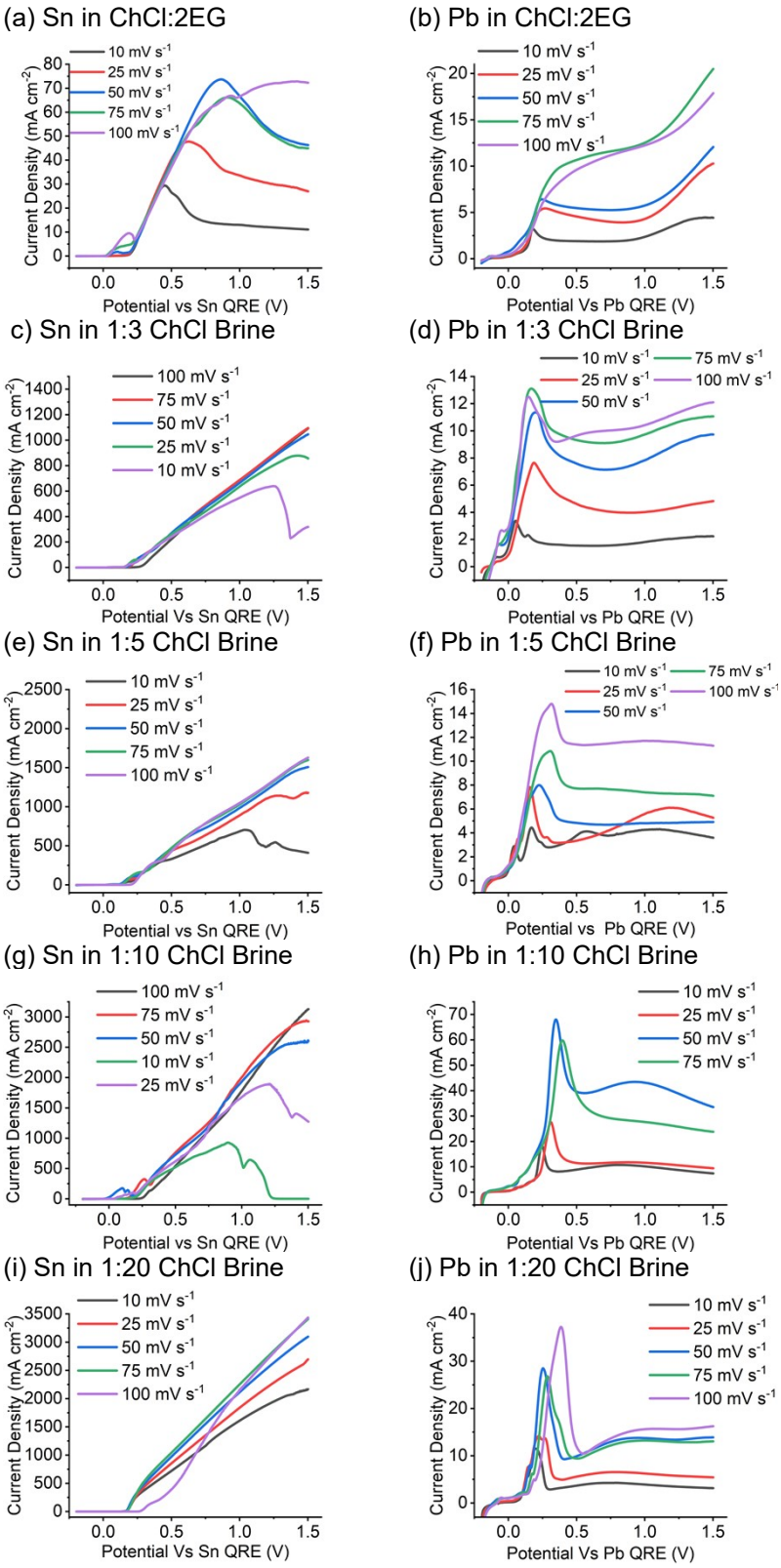


Figure S3: *Silent LSVs for metallic disc working electrodes, recorded at different scan speed vs a quasi-reference electrode. Solvents and metals indicated above each voltammogram.*

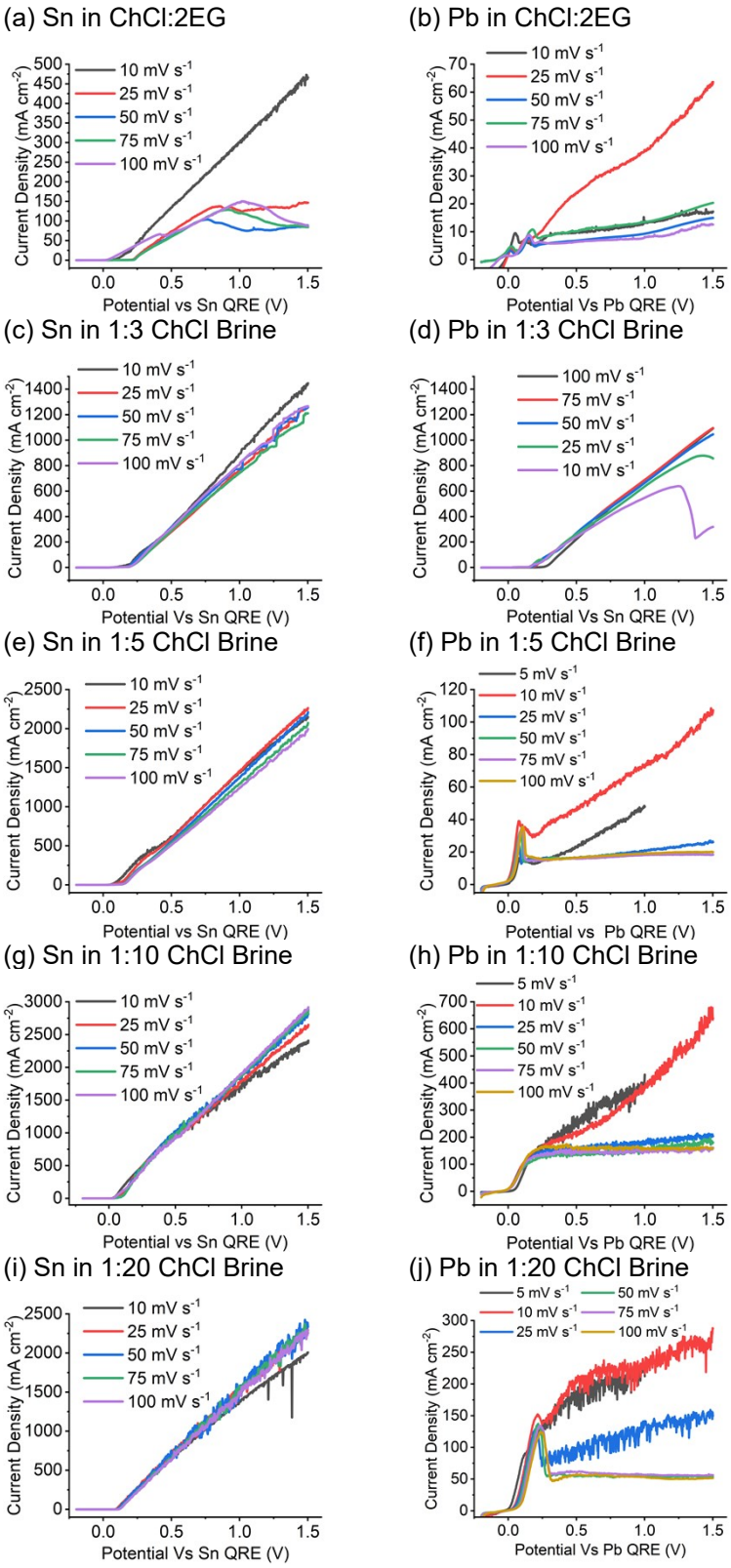


Figure S4: *Insonated LSVs for metallic disc working electrodes recorded 4 mm under sonic horn (20 kHz, 130 W cm^{-2}), recorded at different scan speed vs a quasi-reference electrode. Solvents and metals indicated above each voltammogram.*

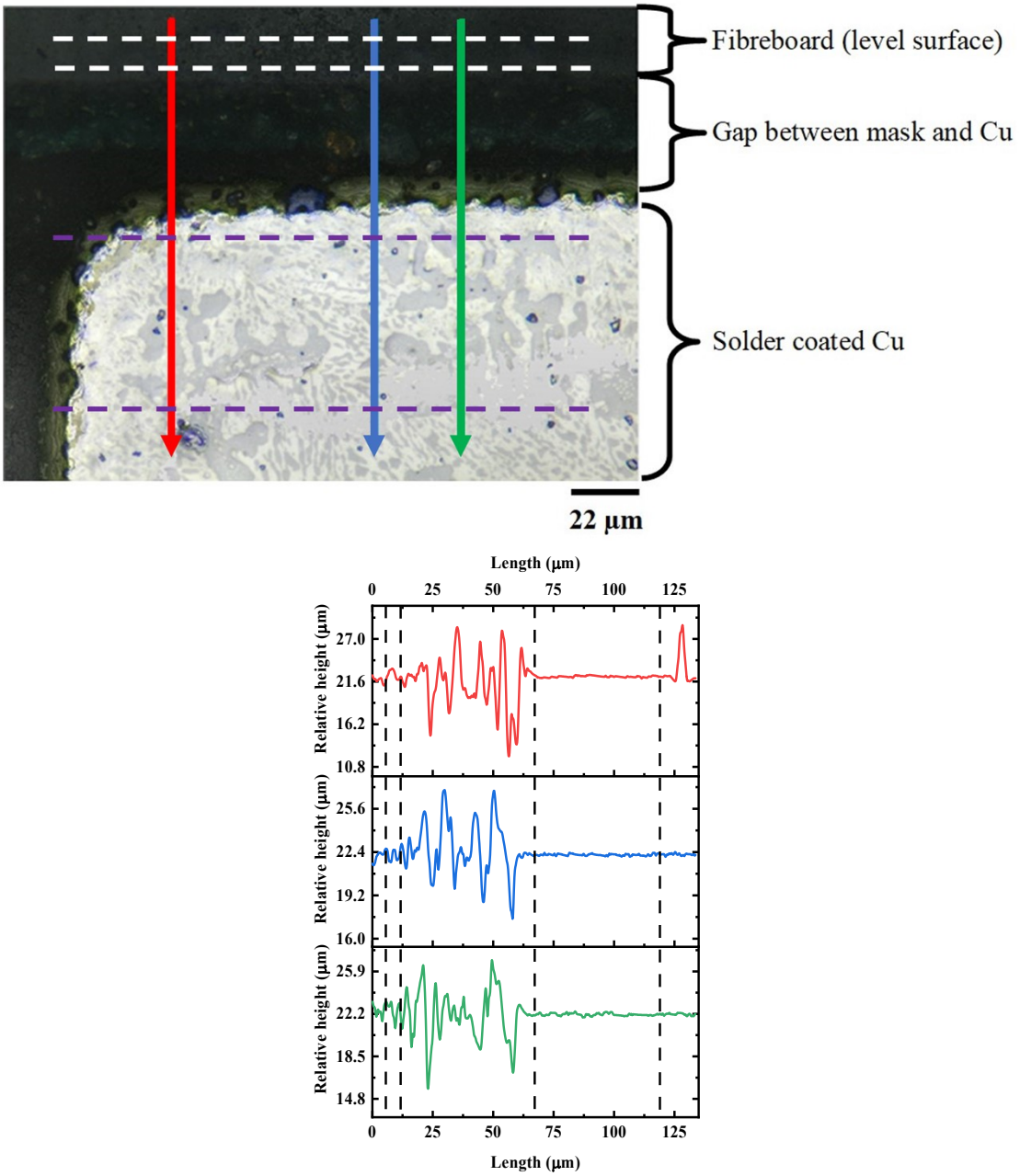
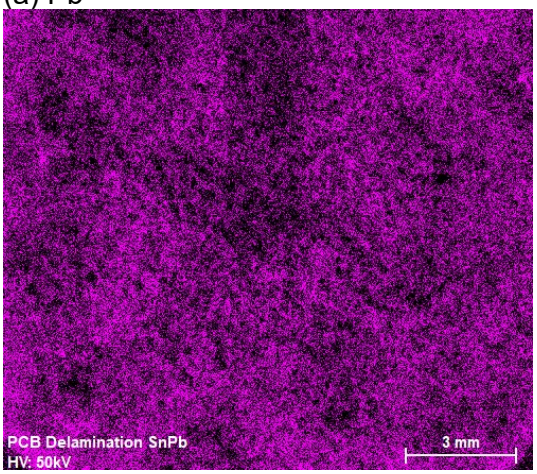
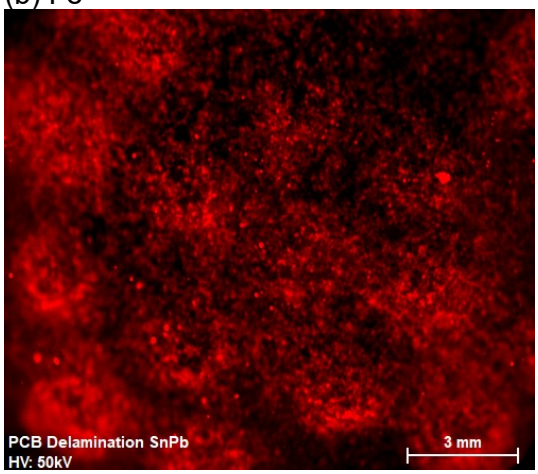


Figure S5 *– An example of calculating etch depth using 3D optical surface topography measurements. Lines are drawn using Zeta3D software across the surface and relative heights are measured between the dotted lines. The difference between the reference surface and the metal level is calculated and gives the final measurement.*

(a) Pb



(b) Fe



(c) Sn

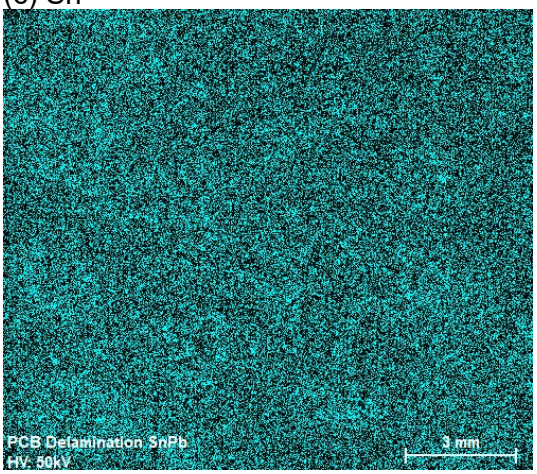


Figure S6 – Additional X-ray fluorescent maps for the 1:10 brine filter paper post processing. (a) Pb, (b) Fe, and (c) Sn.

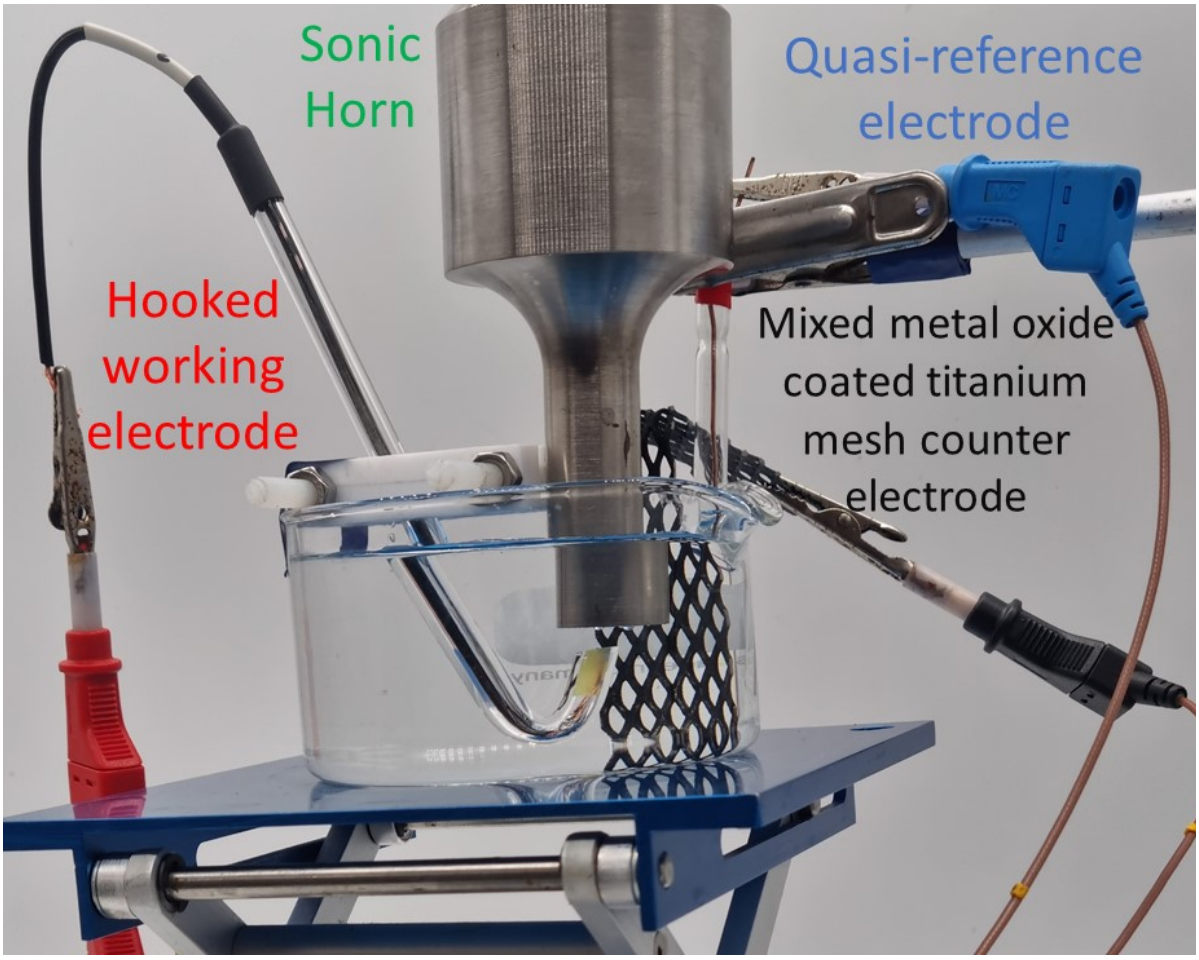


Figure S7 – Sonoelectrochemical set up for LSV experiments.

Economic Analysis

The power draw of the Fisherbrand FB15055 ultrasonic bath was measured using a RS Pro Energy Meter plug. Energy consumption for 30 minutes of run time was 0.067 kWh. The bath has a maximum volume of 5.5 litres. Operating the process at a 1:5 solid-liquid ratio would allow the processing of 1 kg of e-waste in 5 litres of lixiviant, allowing an operating energy of 0.067 $kWh.kg^{-1}$.

References:

1 G. Zante, C. E. Elgar, K. George, A. P. Abbott and J. M. Hartley, *Angew. Chem. Int. Ed.*, 2023, **62**, e202311140.