Supplemental Information for

Electrochemical Carbon Deposition from CO_2 in Molten Carbonates: Substrate-Dependent Growth

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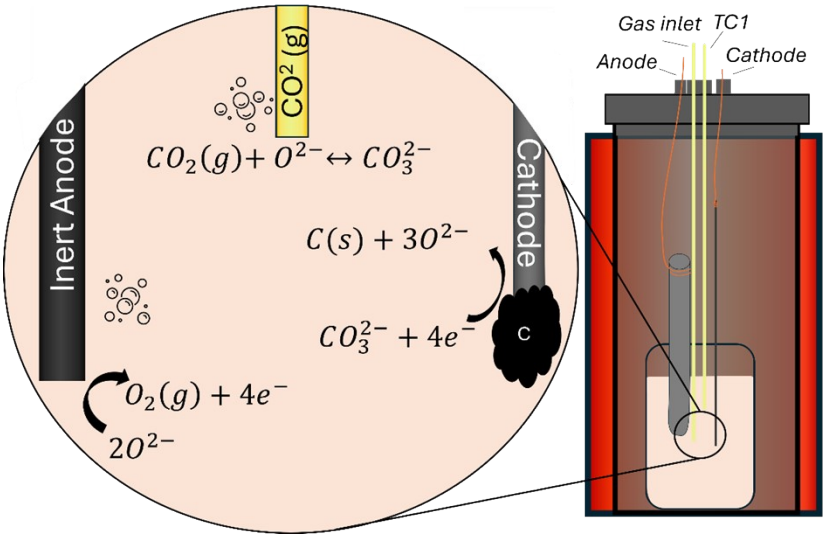
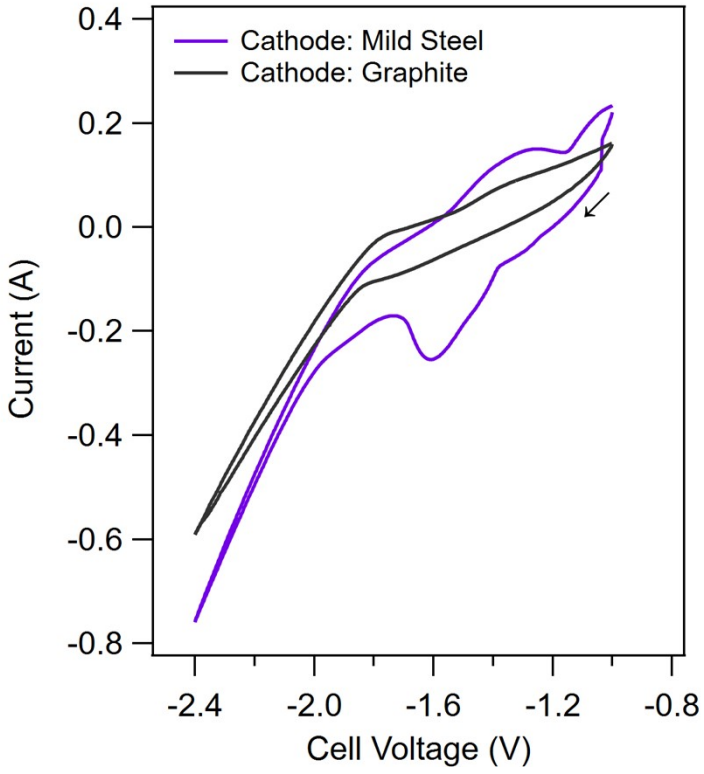
All high temperature experiments were performed with appropriate heat-resistant gloves, gas ventilation, and standard environmental health & safety protocols.



Supplementary Figure S1. Schematic of molten salt electrolytic carbon reactor



Supplementary Figure S2. Cyclic voltammetry at 10 mV/s on mild steel or graphite cathodes after >3 consecutive scans.

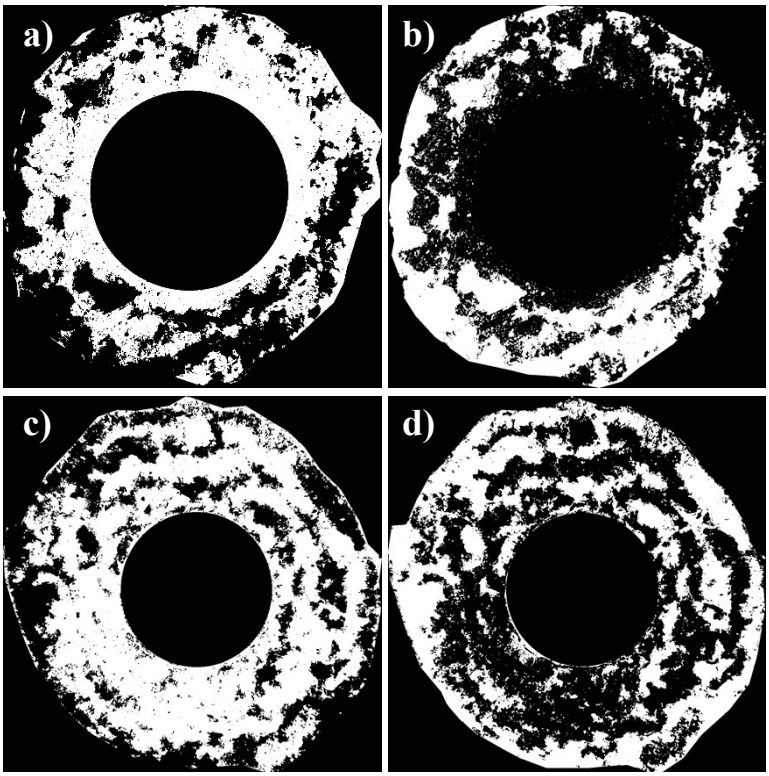
Supplementary Table S1. ICP Results of deposits on Steel and Graphite

	Steel, ppm	Graphite, ppm
Ag	BELOW LOQ	BELOW LOQ
Al	BELOW LOQ	BELOW LOQ
Ba	BELOW LOQ	BELOW LOQ
Cd	BELOW LOQ	BELOW LOQ
Co	BELOW LOQ	BELOW LOQ
Cr	BELOW LOQ	BELOW LOQ
Cu	BELOW LOQ	BELOW LOQ
Fe	**64885.48**	BELOW LOQ
Ga	BELOW LOQ	BELOW LOQ
K	**22073.63**	BELOW LOQ
Li	**17682.24**	BELOW LOQ
Mg	BELOW LOQ	BELOW LOQ
Mn	BELOW LOQ	BELOW LOQ
Na	BELOW LOQ	BELOW LOQ
Ni	BELOW LOQ	BELOW LOQ
P	BELOW LOQ	BELOW LOQ
Pb	BELOW LOQ	BELOW LOQ
Sn	BELOW LOQ	BELOW LOQ
Sr	BELOW LOQ	BELOW LOQ
Zn	BELOW LOQ	BELOW LOQ

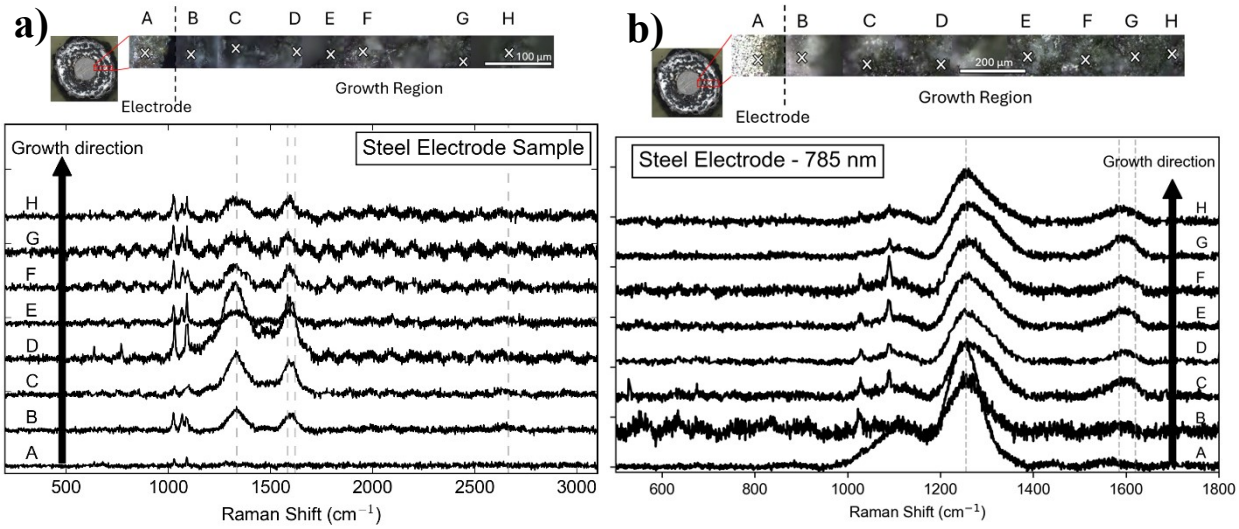
ICP-OES Parameter	**Setting**
Read time	20
RF Power (kw)	1.40
Stabilization Time (s)	15
Viewing Mode	Radial
Viewing height (mm)	8
Nebulizer flow (L/min)	0.60

Plasma flow (L/min)	13.0
Aux flow (L/min)	1.00
Make-up flow (L/min)	0.00
Internal Standard	Yttrium, Tellurium

The limit of quantification was 8333 ppm or 0.83 wt% for the carbon deposit on steel and 3846 ppm or 0.38 wt% for the carbon deposit on graphite.



Supplementary Figure S3. Thresholding of cross sectional images of a) carbon on graphite b) salt on graphite, c) carbon on steel, d) salt on steel

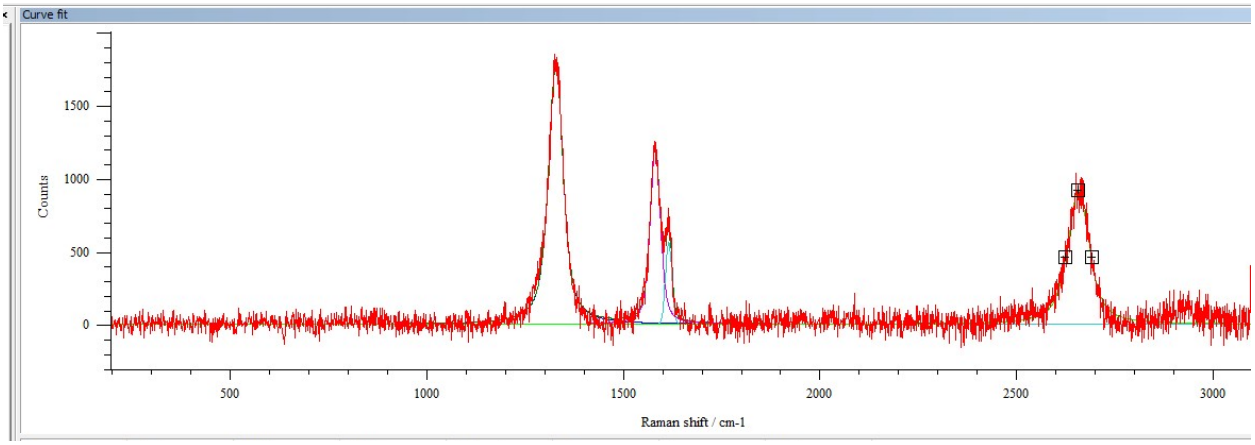


Supplementary Figure S4. Raman spectroscopy of carbon deposited on steel at a) 633 nm and b) 785 nm

Supplementary Table S2. D/G ratios calculated from Height (H) for deposit grown on graphite and steel

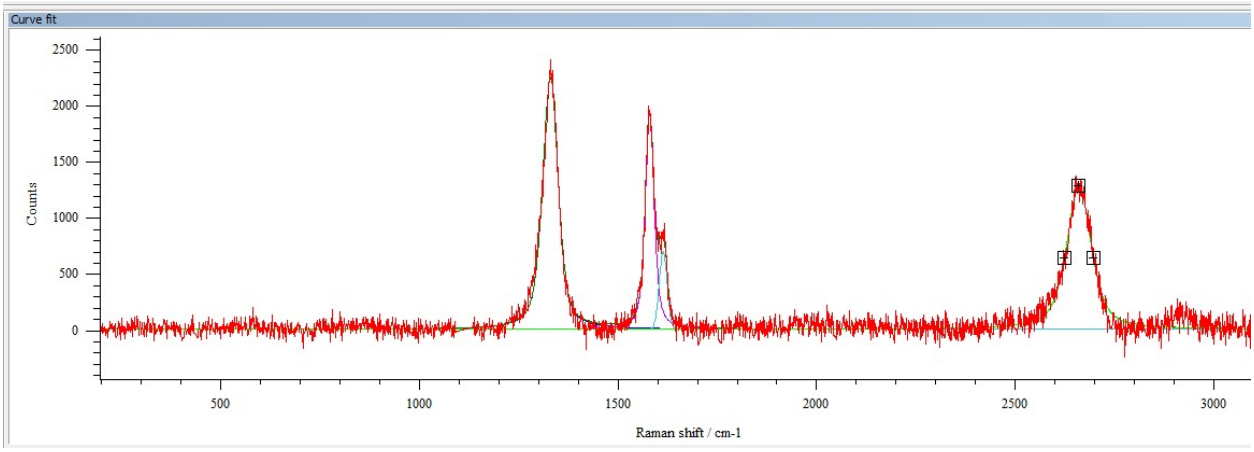
Position	Graphite D/G, H	Graphite χ^2	Steel D/G, H	Steel χ^2
A	1.48	0.94	1.49	0.81
B	1.17	1.12	1.29	1.12
C	1.59	1.09	1.25	1.15
D	1.37	1.21	1.37	1.55
E	1.48	1.10	0.85	1.14
F	1.26	1.07	1.05	1.44
G	1.41	1.21	0.84	1.42
H	1.09	1.02	0.98	1.47

Raman fits shown below

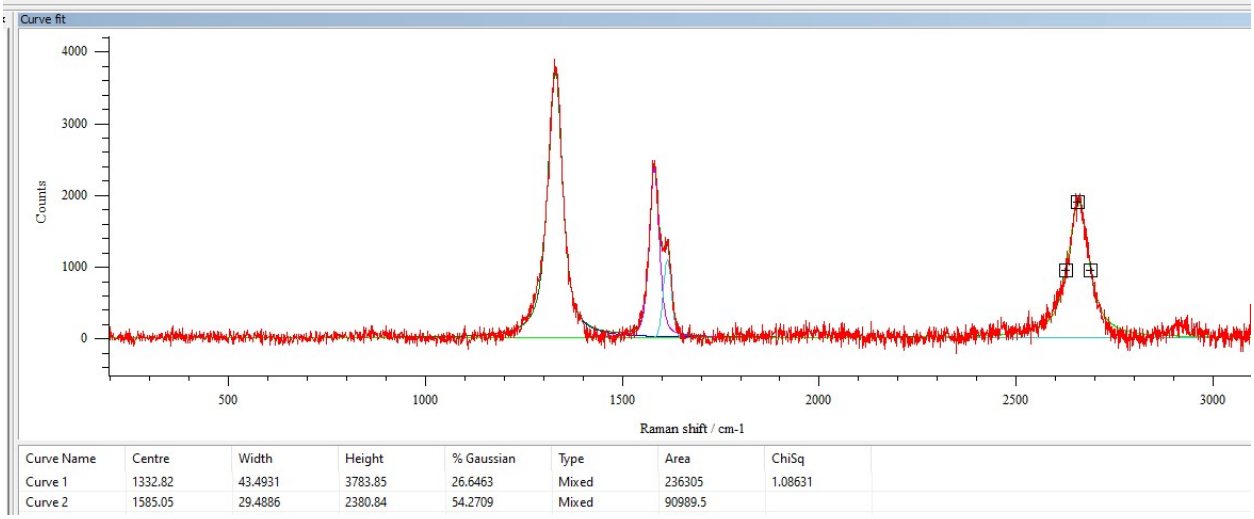


Graphite A

Graphite B

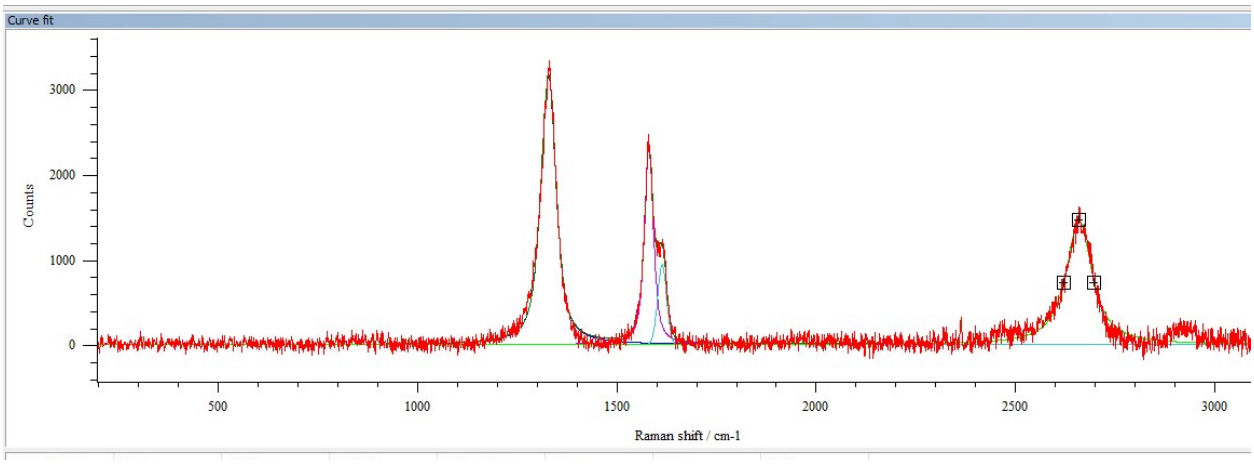


Graphite C

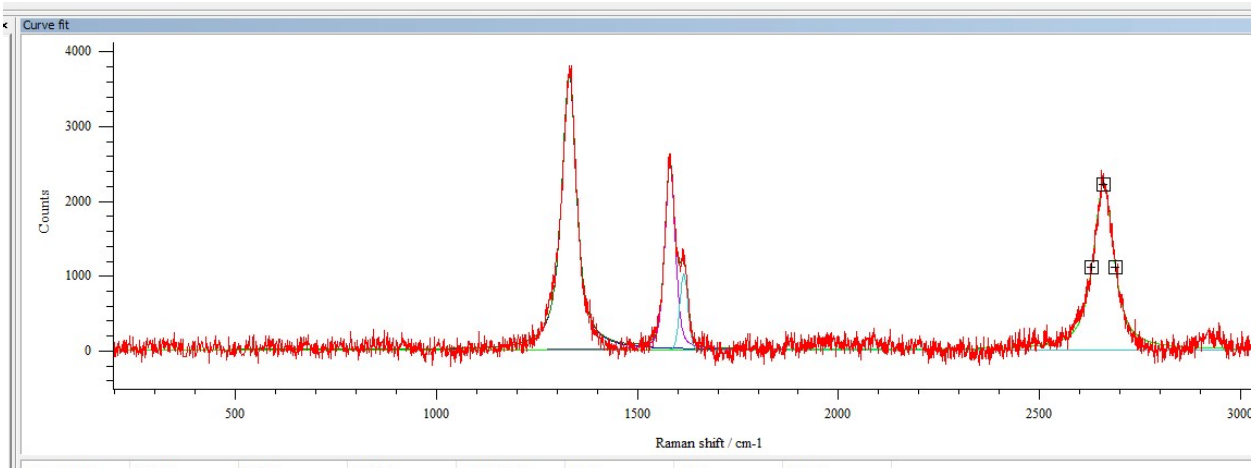


Curve Name	Centre	Width	Height	% Gaussian	Type	Area	ChiSq
Curve 1	1332.82	43.4931	3783.85	26.6463	Mixed	236305	1.08631
Curve 2	1585.05	29.4886	2380.84	54.2709	Mixed	90989.5	

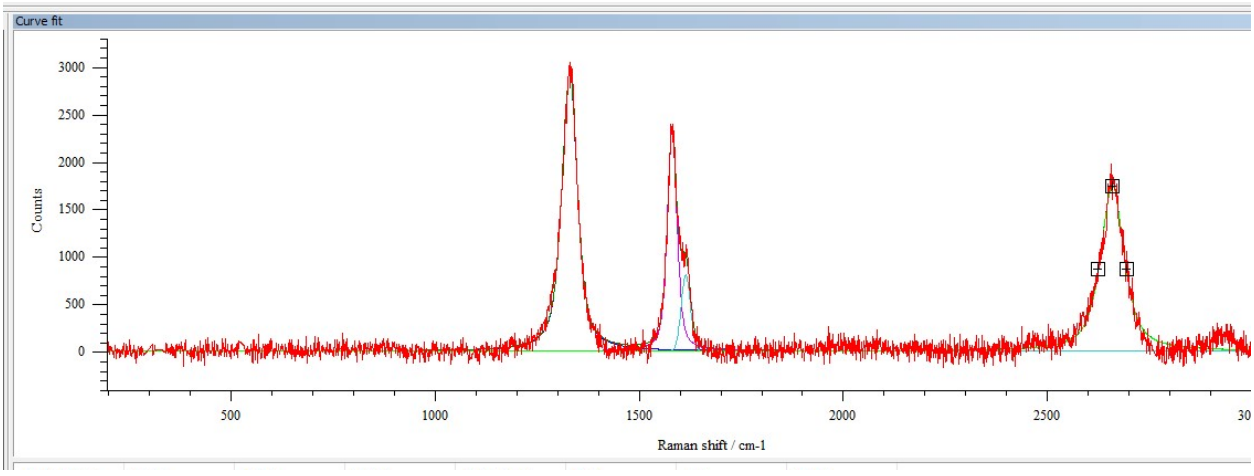
Graphite D



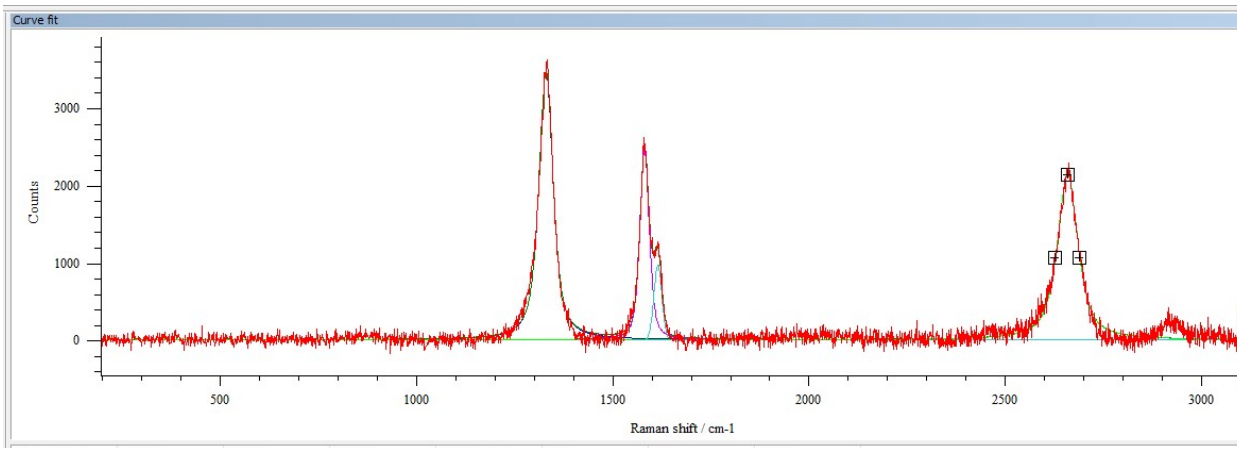
Graphite E



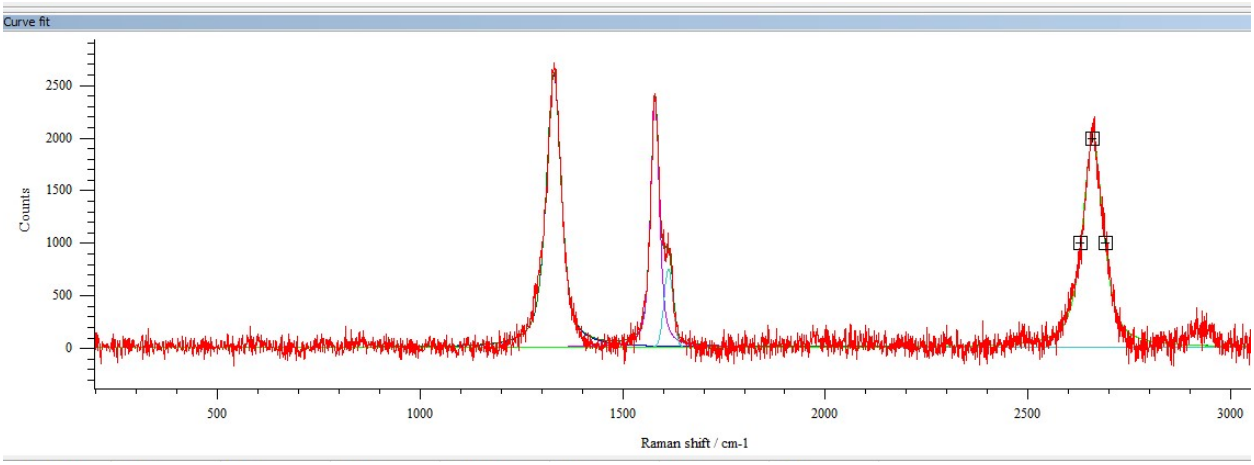
Graphite F



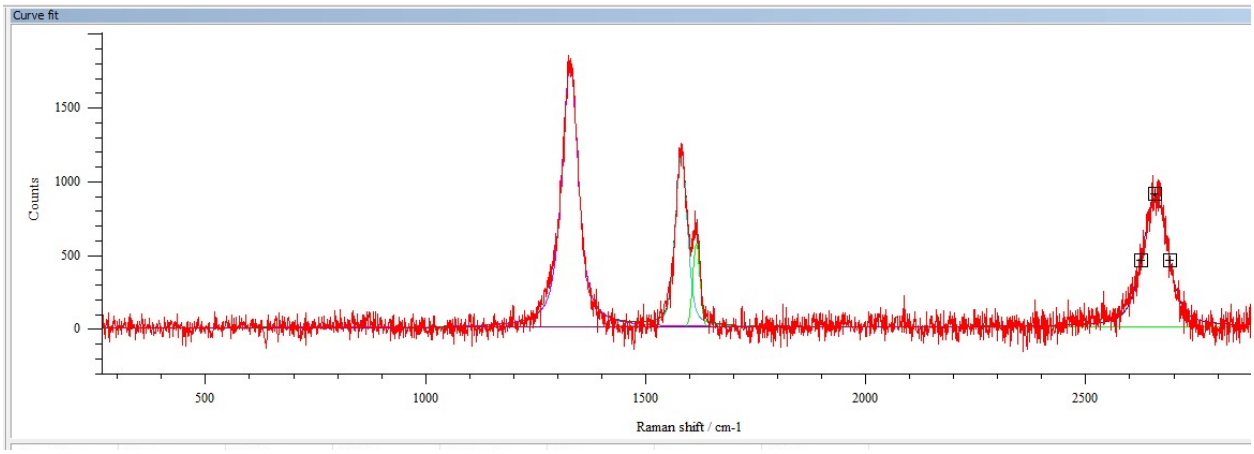
Graphite G



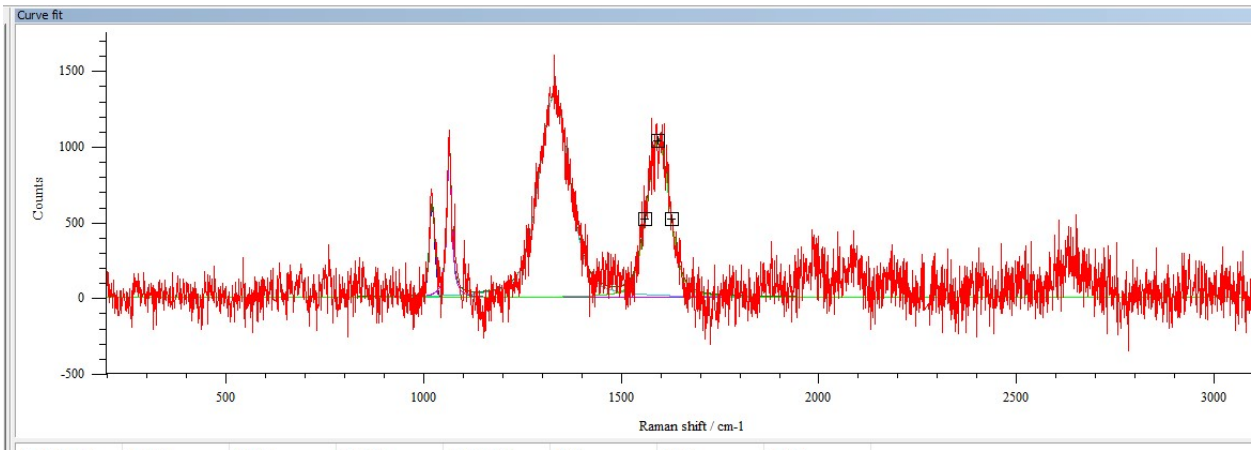
Graphite H



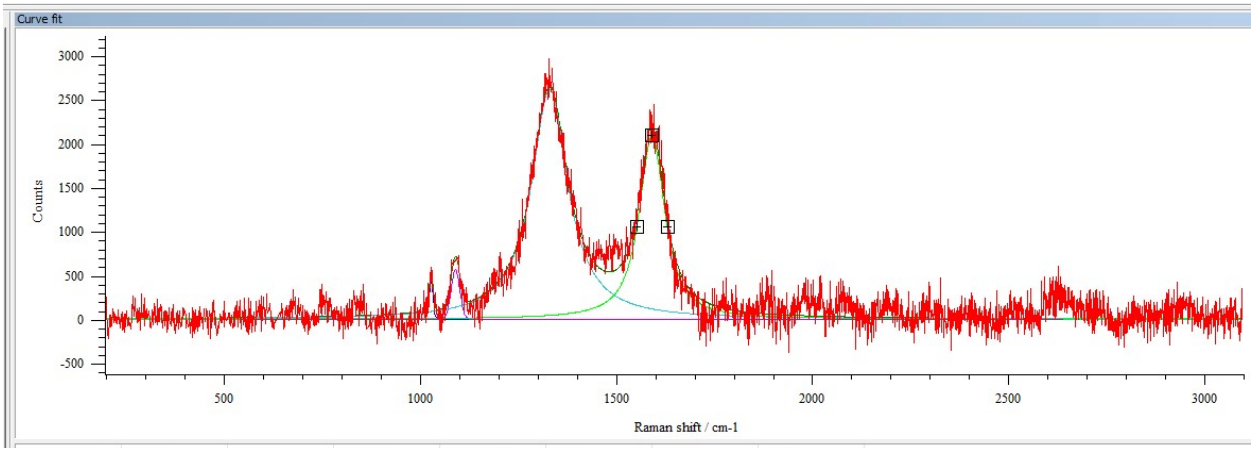
Steel A



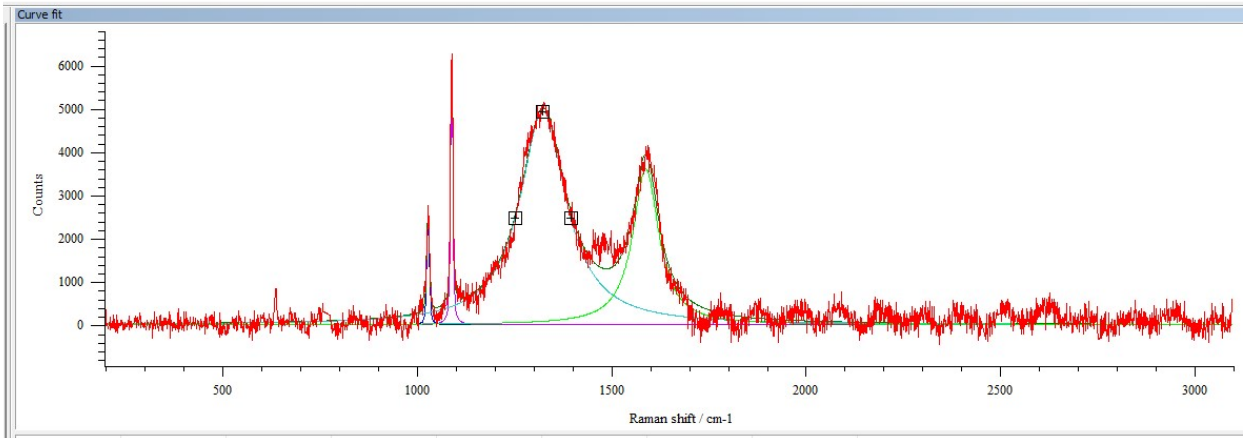
Steel B



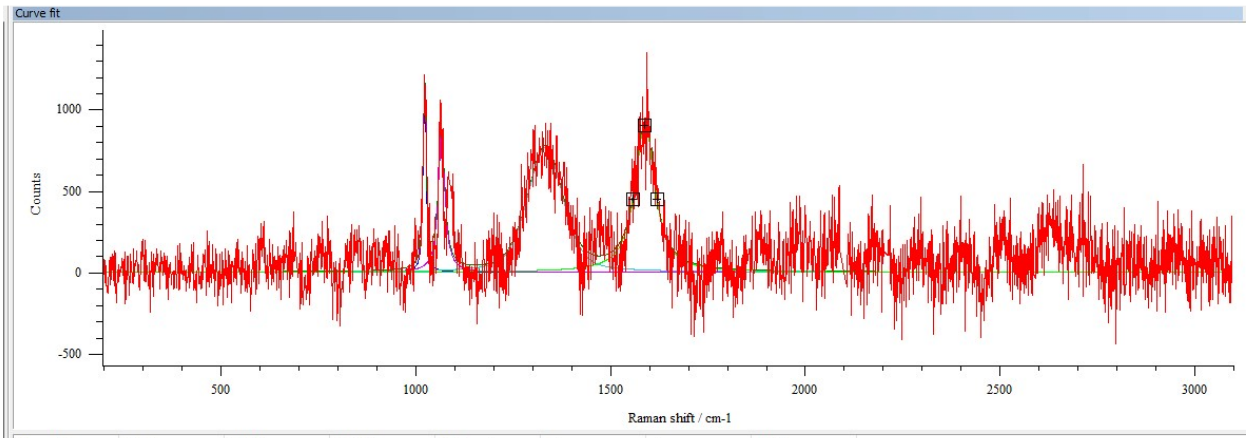
Steel C



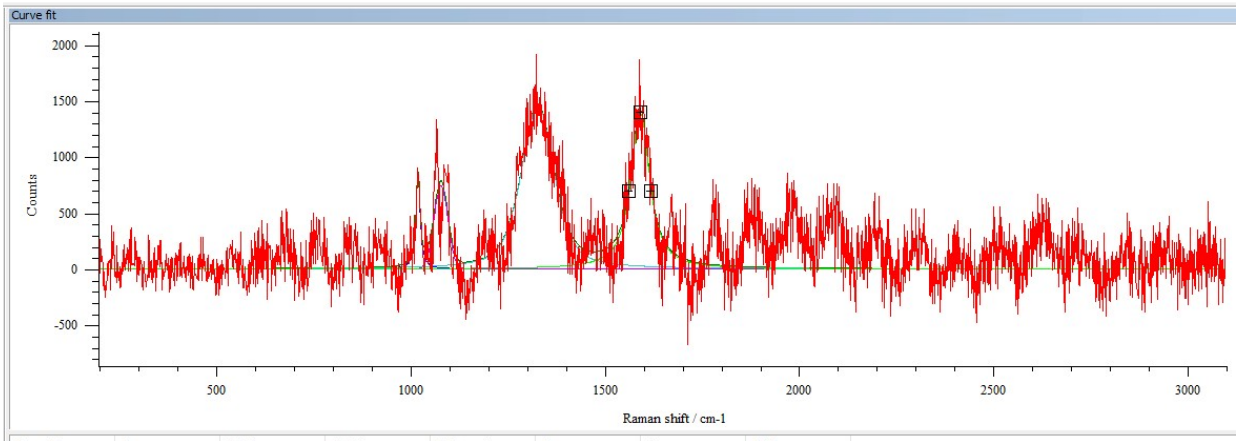
Steel D



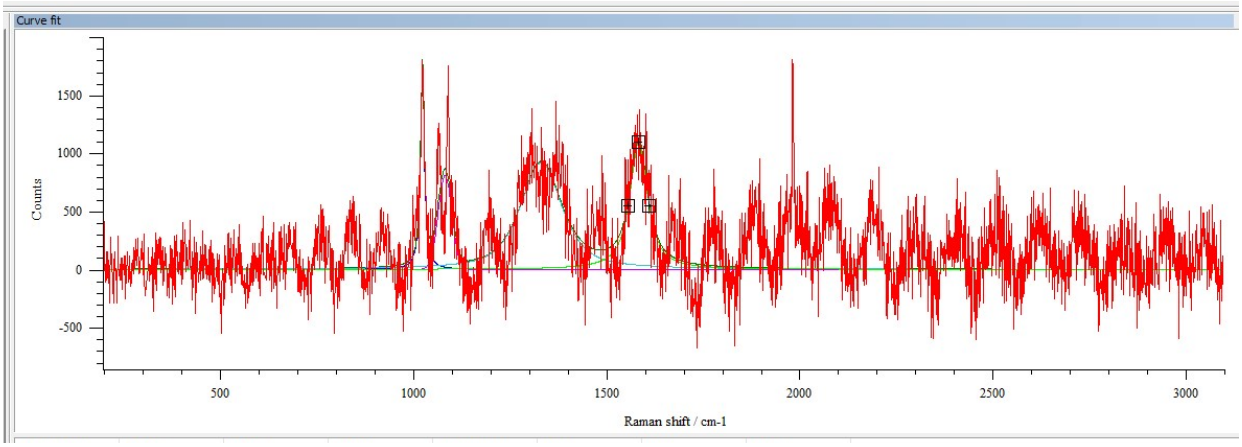
Steel E



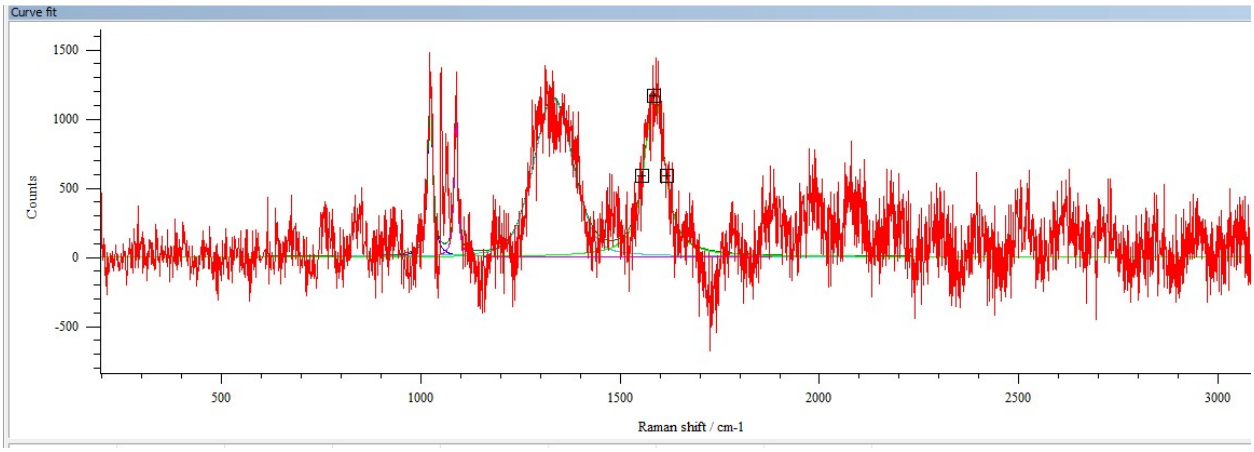
Steel F



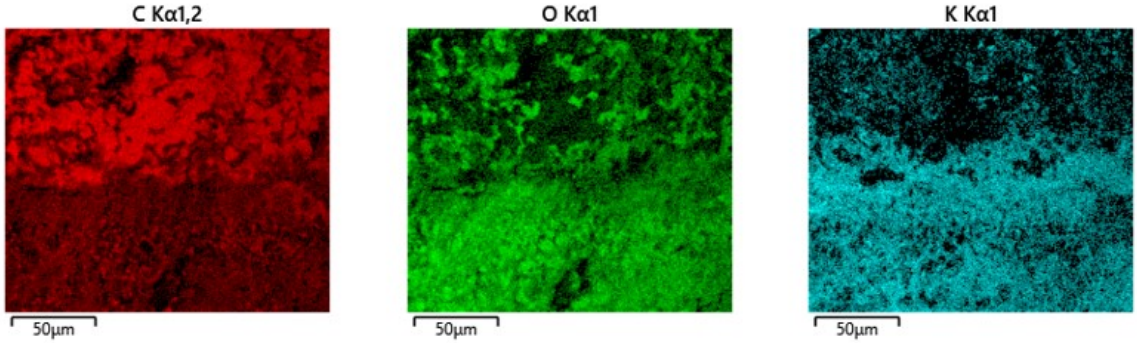
Steel G



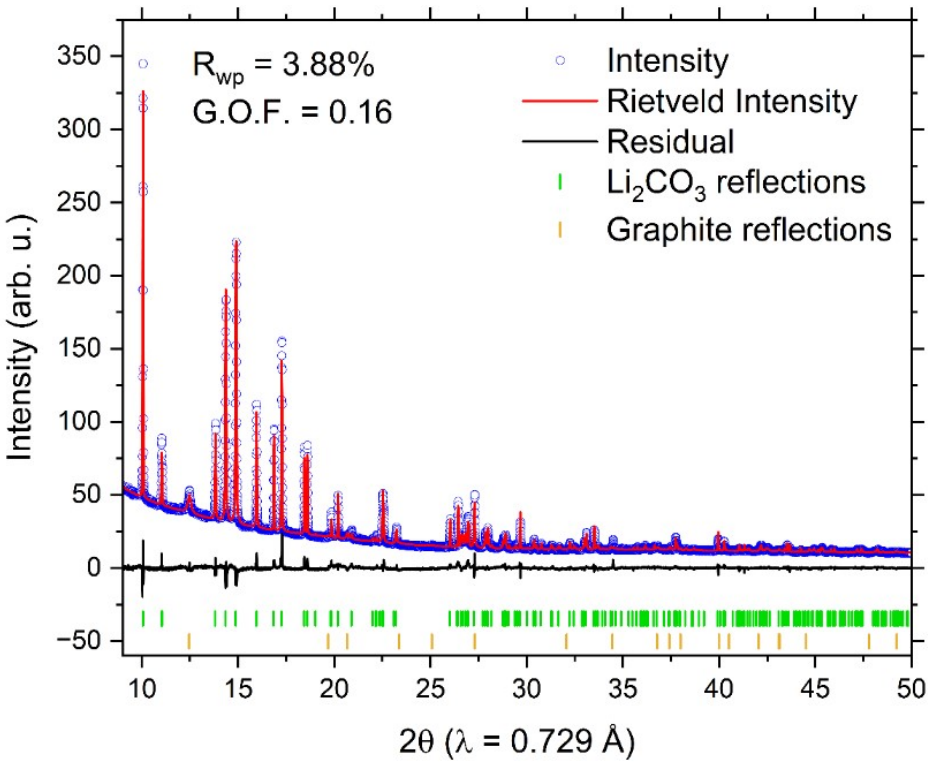
Steel H



Supplementary Figure S5.Raman fits calculated in Renishaw inVia Raman Microscope using mixed Gaussian-Lorentzian fits for each sample point.



Supplementary Figure S6. EDS mapping of graphite cathode after -2.4V chronoamperometry showing the carbon electrode (top) followed by carbon deposit with salt entrapped.



Supplemental Figure S7. Rietveld refinement of the steel electrode (unwashed) precipitates after re-measured four months later than initial measurements. GOF = Rwp/Rexp = $\sqrt{\chi^2}$. The Rexp for this dataset is 23.83.

Supplementary Table S3. Experimental Details for Rietveld Refinement of the unwashed steel electrode.

	Lithium Carbonate	**Graphite**
Crystal data		
Chemical formula	Li_2CO_3	C
M_r	295.56	24.02
Crystal system, space group	*C*2/c	$P6_3/mmc$
Temperature (K)	300	300
a, *b*, *c* (Å)	8.36933 (5), 4.98190 (2), 6.20349 (4)	2.4639 (4), 2.4639 (4), 6.7250 (12)
α, β, γ (°)	90, 114.7035 (7), 90	90, 90, 120
V (Å^3)	234.98 (1)	35.35 (1)
Z	4	2
Radiation type	Synchrotron X-ray, λ = 0.729654 Å	
Specimen shape, size (mm)	Cylinder, 1 × 0.762	
Data collection		
Diffractometer	SSRL Beamline 2-1	
Specimen mounting	Kapton Capillary	
Data collection mode	Transmission	
Scan method	Step	
2θ values (°)	$2\theta_{min}$ = 0.35, $2\theta_{max}$ = 116.62, $2\theta_{step}$ = 0.005	
Refinement		
R factors and goodness of fit	R_p = 0.027, R_{wp} = 0.039, R_{exp} = 0.238, χ^2 = 0.027, *G.O.F.* = 0.16	
No. of parameters	52	
No. of restraints	0	

Supplementary Table S4. Atomic coordinates for the refined Li_2CO_3 structure. The input for the Rietveld refinement used the structure defined in ICSD database code 28561.

Name	**Type**	**x**	**y**	**z**	**Site Occupancy**	**Site Symmetry**	**U_{iso}**
Li1	Li+1	0.699(5)	0.947(6)	0.837(8)	1.0000	1	0.14(3)
C1	C+0	0.5	0.567(6)	0.25	1.0000	2(y)	0.17(3)
O1	O-2	0.5	0.822(3)	0.25	1.0000	2(y)	0.08(2)
O2	O-2	0.150(2)	0.937(2)	0.316(3)	1.0000	1	0.08(2)

Supplementary Table S5. Atomic coordinates for the refined C (graphite) structure. The input for the Rietveld refinement used the structure defined in ICSD database code 120118.

Name	**Type**	**x**	**y**	**z**	**Site Occupancy**	**Site Symmetry**	**U_{iso}**

C1	C+0	0	0	0.25	1.0000	-6m2(100)	0.01(5)
C2	C+0	1/3	2/3	0.25	1.0000	-6m2(100)	0.01(5)