Graphite Electrode Behaviors and its Application for Salt Purification

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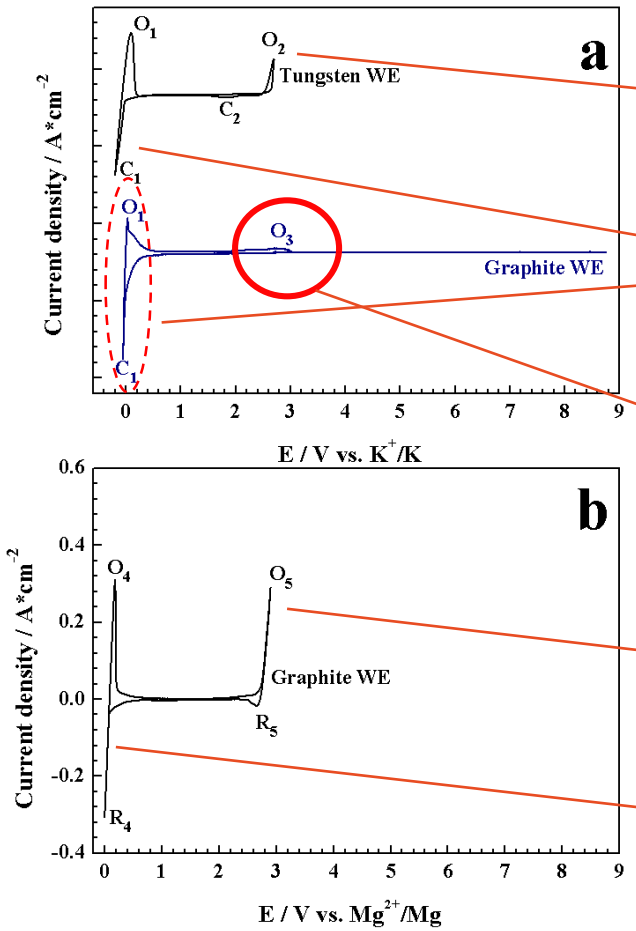
Outline

- Anodic Effects
- Non-metal element separation
- Metal element separation
- Galvanic Corrosion by graphite

Anode effect on graphite electrode in molten FLiNaK



Redox couple (C_2/O_2): $WF_x + e \rightleftharpoons W + xF^-$

Redox couple (C_1/O_1): $K^+ + e \rightleftharpoons K(l)$

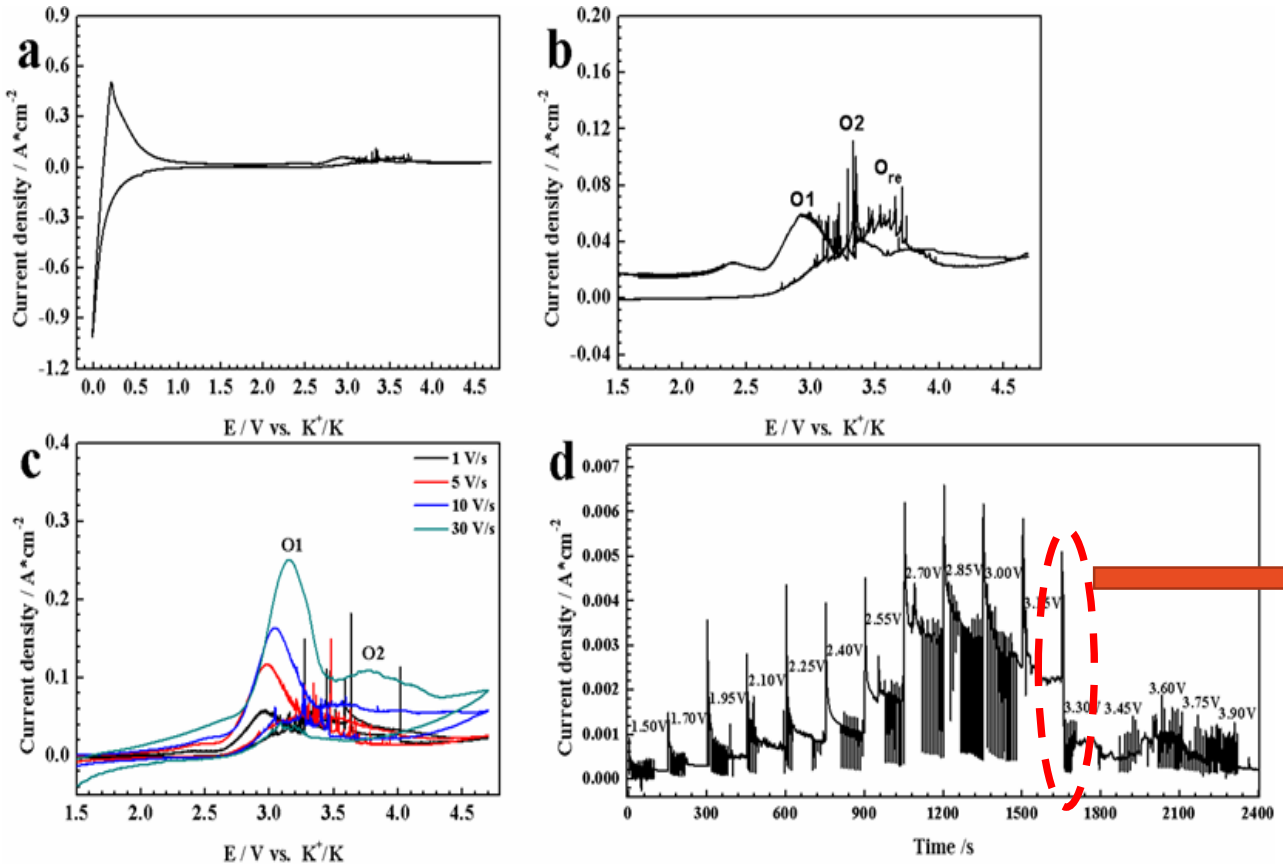
Reaction O_3-anode effect: $C + xF^- - xe = CF_x$

Redox couple (C_5/O_5): $Cl_2 + 2e \rightleftharpoons 2Cl^-$

Redox couple (C_4/O_4): $Mg^{2+} + 2e \rightleftharpoons Mg$

(a) CV tests recorded from W and graphite WE in FLiNaK at 1023 K; (b) CV test recorded from graphite electrode in $MgCl_2$-NaCl-KCl at 1023 K. Scan rate: 500 mV/s.

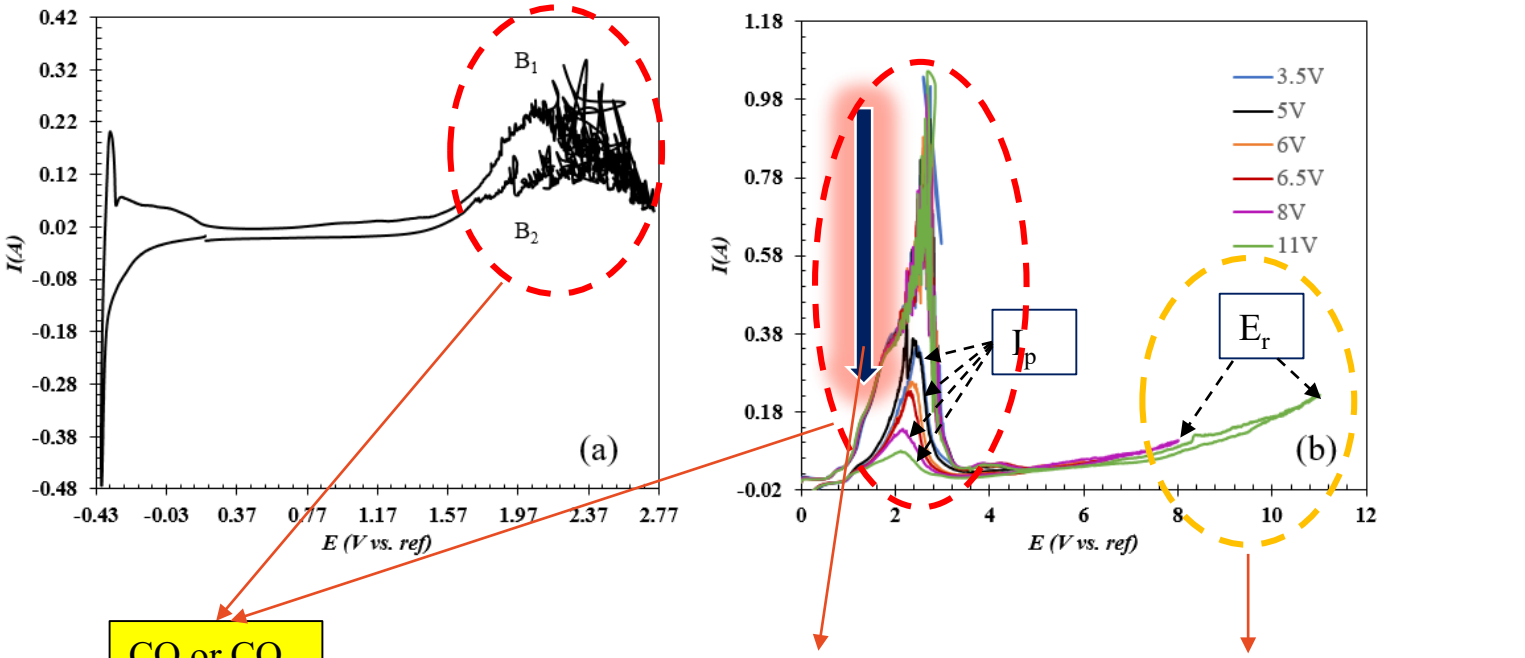
Anode effect on graphite electrode in molten FLiNaK



A suddenly drop shows the anodic effects

(a) CV curve recorded from a graphite WE (area: 0.21 cm^2) in FLiNaK melt at 973 K under argon atmosphere; (b) the enlargement of the curve in Figure 2a. Scan rate: 500 mV/s. CE and RE: Graphite and Pt; (c) CV curves recorded from graphite WE at various scan rates; (d) CA tests recorded in FLiNaK at 973 K. Electrolysis time interval: 150s. OCP interval: 300 s. OCP curves are not shown here.

$FLiNaK\text{-}La_2O_3$: Separation of Oxygen



CO or CO_2

I_p decreases with Er increasing, which shows the anodic effects can limit the current, therefore, can influence the separation of oxygen

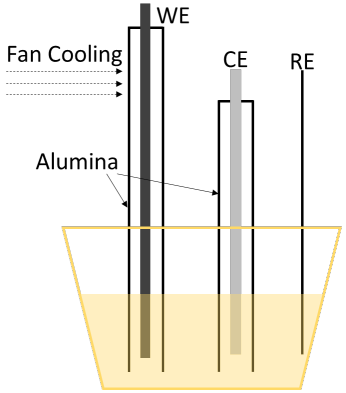
CF_4 Or other C-F compounds

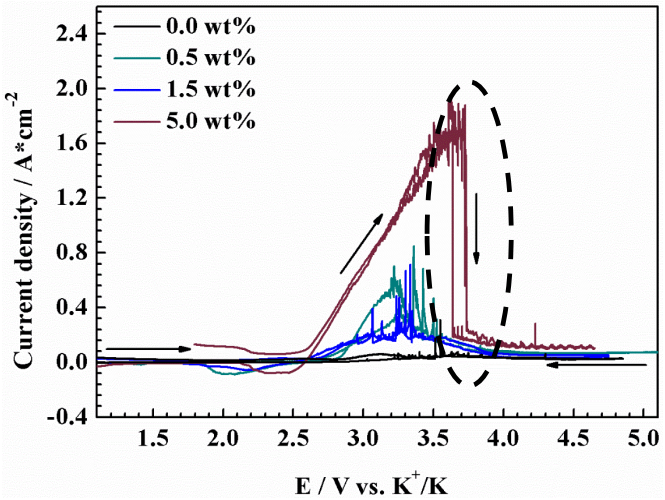
WE: graphite, CE: graphite, RE: tungsten

(a) CV scan in FLiNaK-La_2O_3 at 700°C, scan rate 100mV/s, electrode surface area: 0.9381cm^2

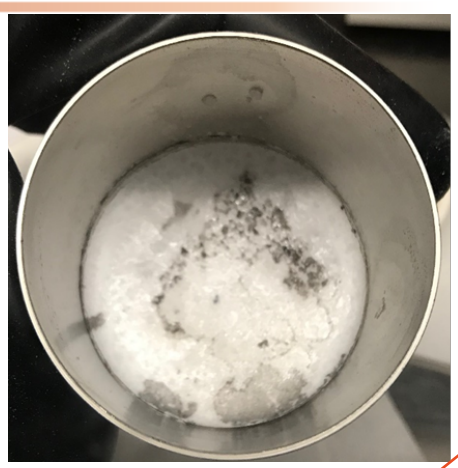
(b) CV scan in FLiNaK-La_2O_3 at 700°C, scan rate 1000mV/s, electrode surface area: 0.8514cm^2

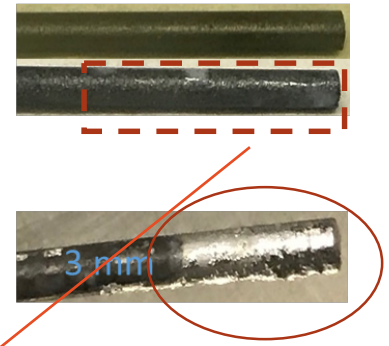
Graphite electrode in molten FLiNaK with NaI-Iodine Separation





CV curves recorded from a graphite WE (area: 0.21 cm^2) in FLiNaK melt with various NaI concentration at 973 K under argon atmosphere; Scan rate: 500 mV/s. CE and RE: Graphite and Pt;





Potassium

I_2 in ethonal (left) and in starch solution (right)

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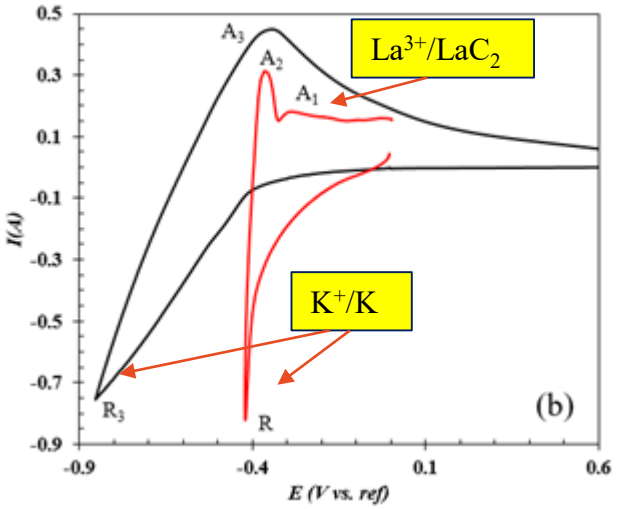
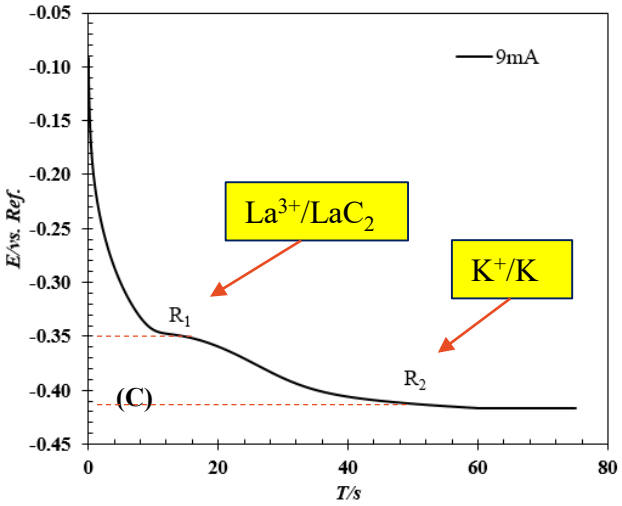
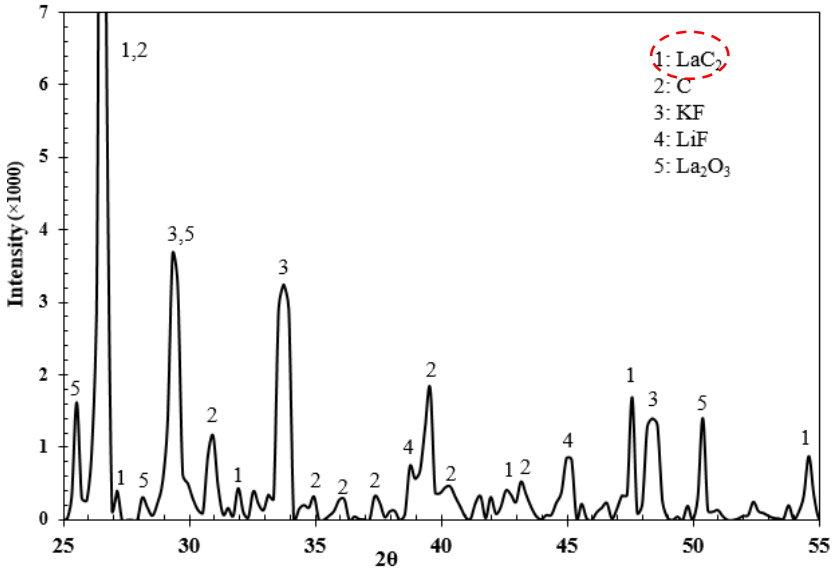
FLiNaK-La_2O_3-Separation





(b) Black curve: CV scan in FLiNaK-La_2O_3 at 700°C, scan rate 200mV/s, electrode surface area: 1.2346cm^2; Red curve: CV scan in FLiNaK at 700°C, scan rate: 200mv/s, electrode surface area:1.2574cm^2;
(c) CP scan in FLiNaK-La_2O_3 at 700°C, applied constant current 9mA, electrode surface area:1.0236cm^2;

WE: graphite, CE: graphite, RE: tungsten



XRD analysis of graphite cathode surface powder sample

Overall Reaction:
$xLa_2O_3 + (3+4x)C = 3CO_x + 2xLaC_2$, where x=1 or 2

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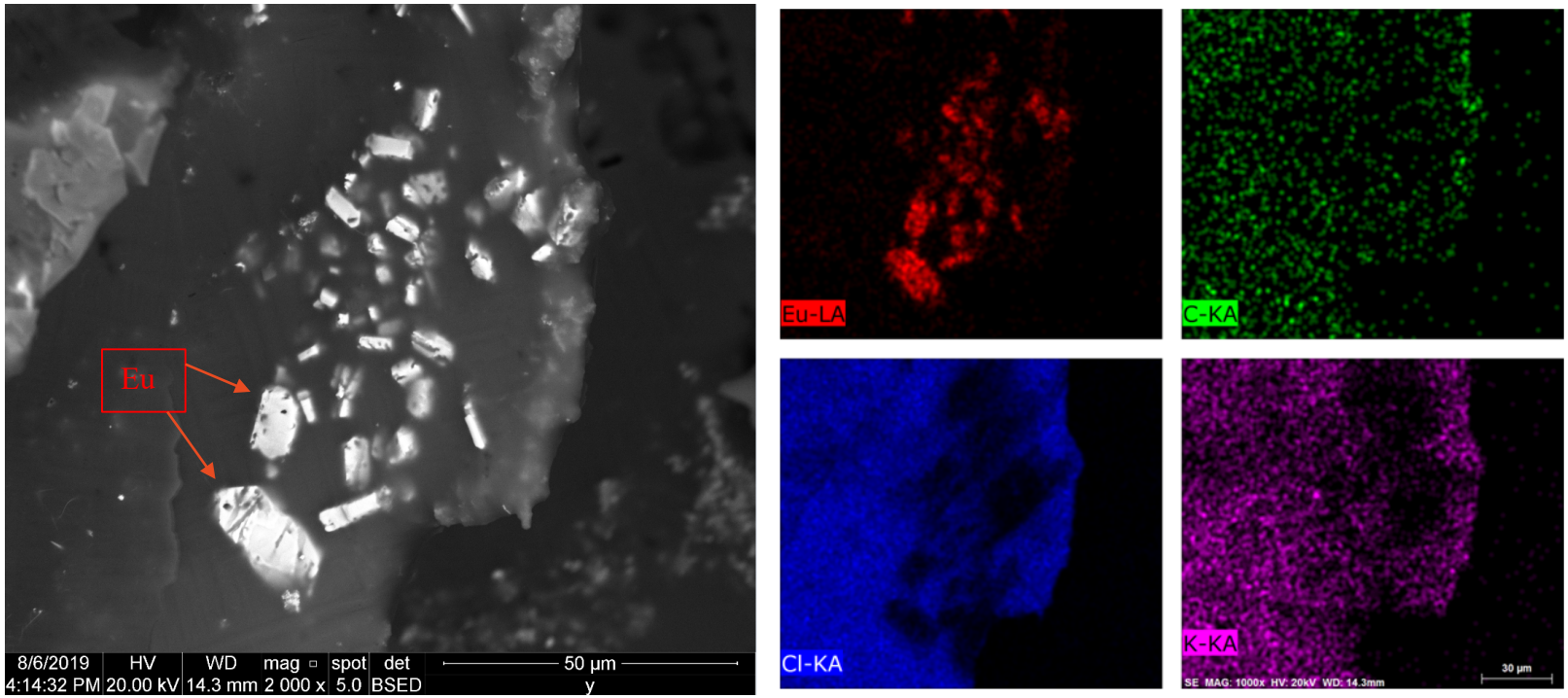
$LiCl\text{-}KCl\text{-}EuCl_3$-Separation Eu metal

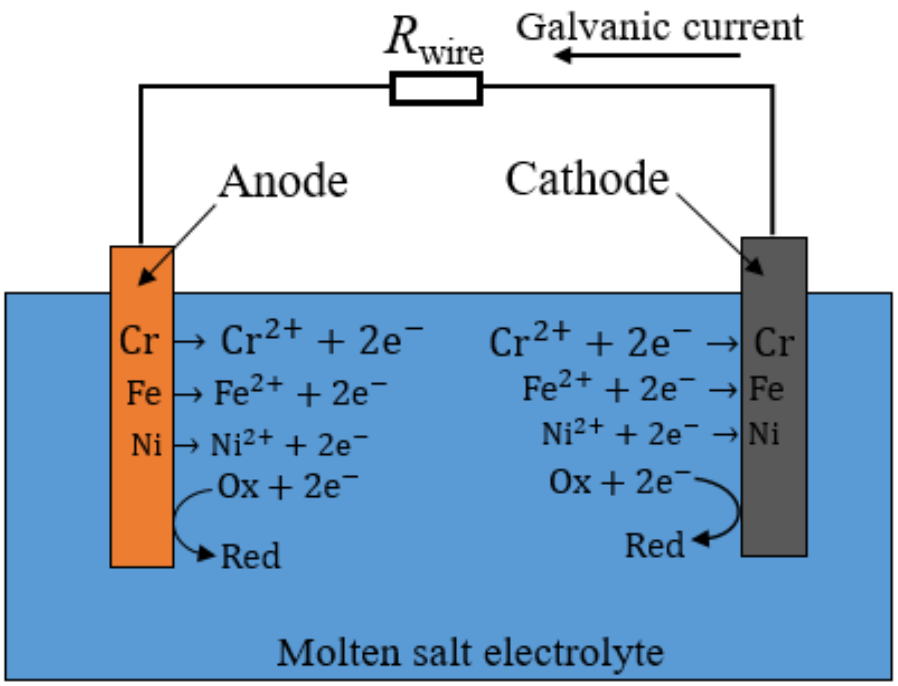


(a) SEM results of Eu deposition on graphite in $LiCl\text{-}KCl\text{-}EuCl_3$ at 550°

Eu Deposition Test:

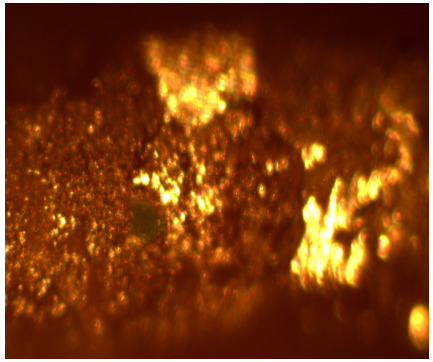
- CP scan, applied current I = -40mA, t = 2h
- WE: graphite, CE: graphite, RE: Ag/AgCl
- WE surface area: 1.0342 cm^2

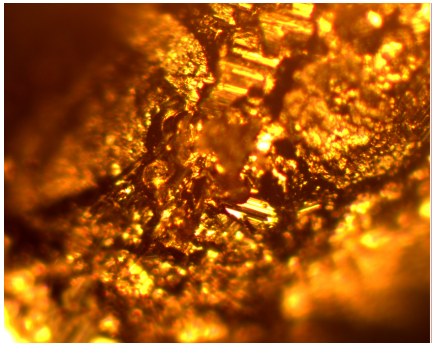
Galvanic Corrosion by Graphite

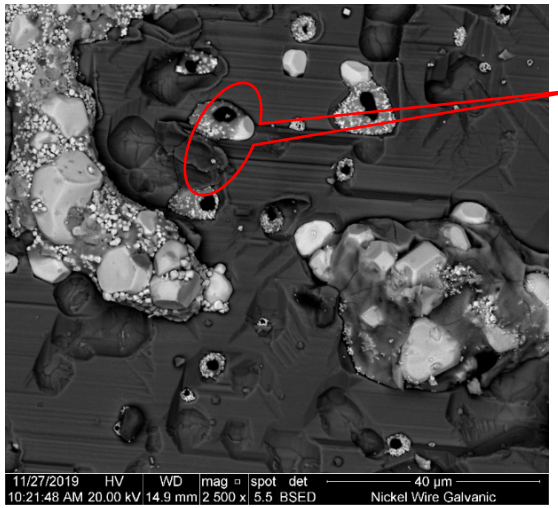


$$E^{\text{cathode}}_{\text{Cr/Cr}^{2+}} - E^{\text{anode}}_{\text{Cr/Cr}^{2+}} = \frac{RT}{nF} \ln \frac{a^{\text{anode}}_{\text{Cr}}}{a^{\text{cathode}}_{\text{Cr}}}$$

Galvanic Corrosion-Ni Corrosion by Graphite







Deep cavities were observed on the surface. Salt were embedded into these cavities.

Nickel deposits along with the salt on the graphite specimen surface, the Ni deposits also showed presence of S. These were introduced from the nickel wire degradation due to galvanic corrosion.

Acknowledgement

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