NORMAN B. KEEVIL INSTITUTE OF MINING ENGINEERING
THE UNIVERSITY OF BRITISH COLUMBIA

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FPX Nickel Corp.
TSX-V:FPX

The flotation of awaruite – electrochemical characterization and surface composition under flotation-related conditions

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FLOTATION '21
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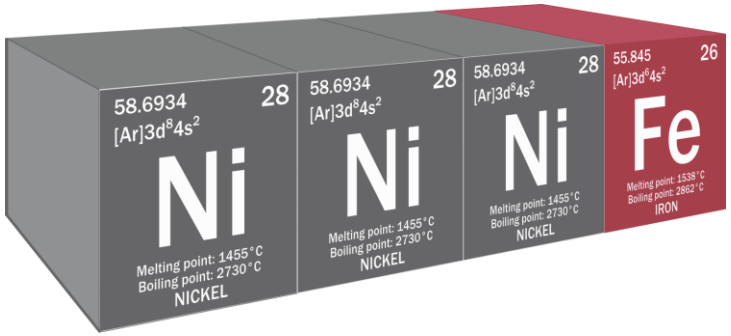
MEI Conferences

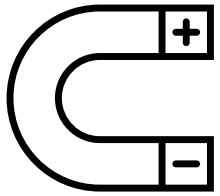
Naturally occurring nickel-iron alloy: **AWARUITE**

Chemical formula: Ni_3Fe

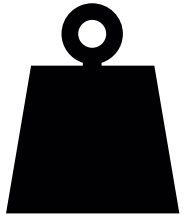


Properties:

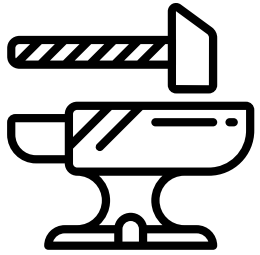
Ferromagnetic



High density ≈ 8 g/cm^3



Malleable



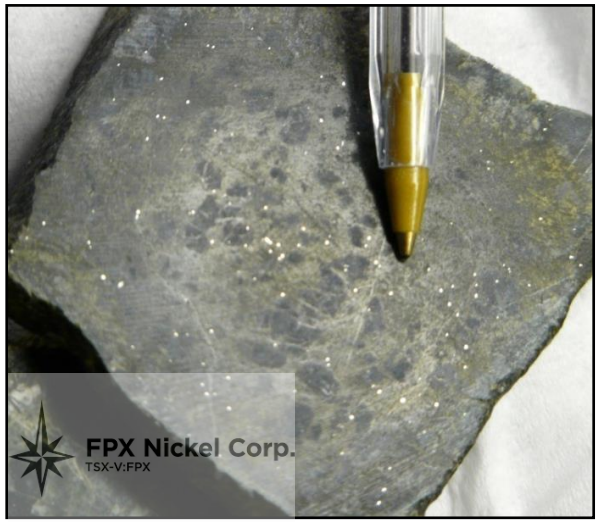
Chemical composition:

77% nickel, 22% iron, and minor concentration cobalt and copper

Awaruite occurrences

- Reported occurrences in many countries: New Zealand, Canada, Switzerland, US, Finland
- These occurrences are generally associated with serpentinized ultramafic rocks

Decar Nickel District



- Large resource of broadly disseminated awaruite mineralization
- Located in British Columbia, Canada
- Baptiste Deposit is the main target of the district, this research is based on this deposit

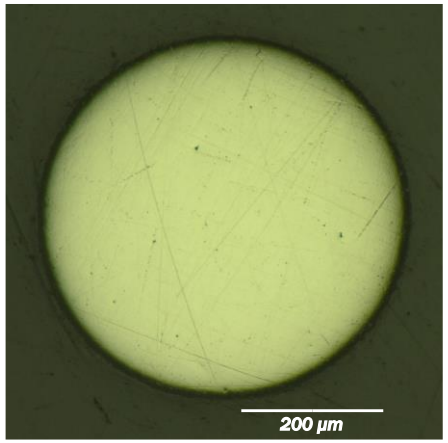
Awaruite concentration methods

- Limited information available regarding awaruite concentration
- Technical reports have shown that awaruite floats in acidic solution with xanthate

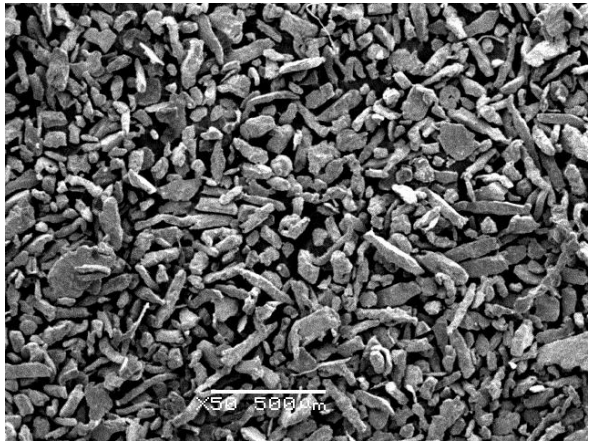
Why does awaruite float only in acidic condition?

Which is the mechanism that enables the interaction between awaruite and xanthate?

Awaruite samples



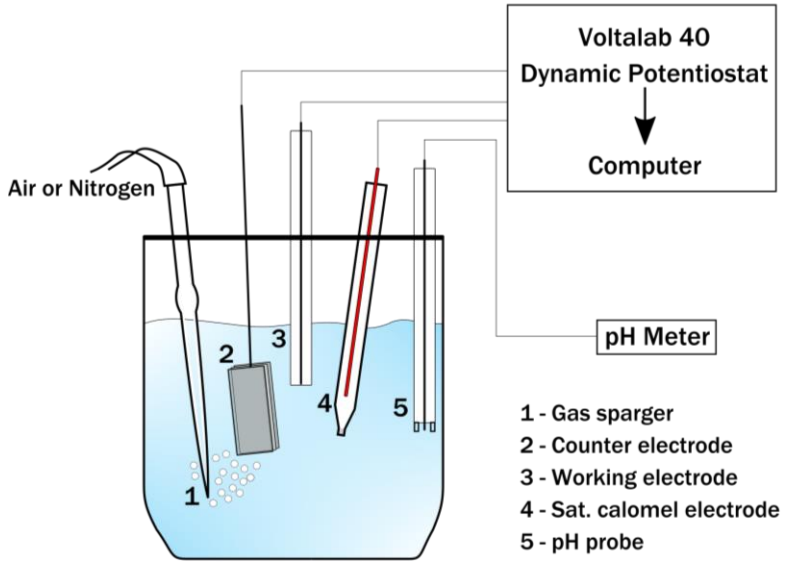
- Electrochemical characterization:
  - synthetic awaruite sample
  - wire: 500 µm in diameter, 80% nickel, 20% iron



- Microflotation experiments:
  - Native awaruite sample
  - Obtained by physical concentration, 86% awaruite based on XRD results, 120-38 µm size fraction

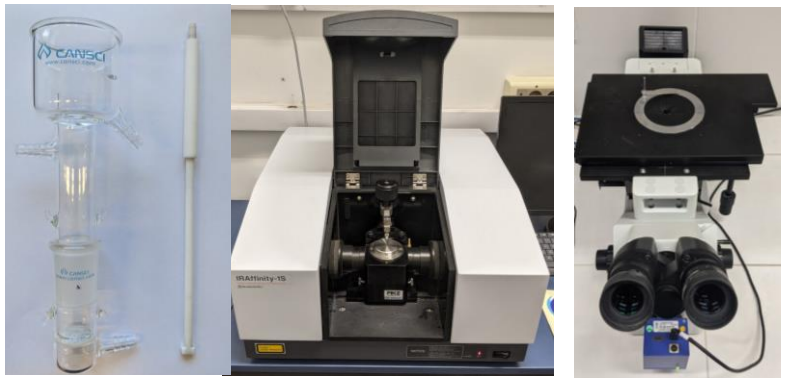
Electrochemical characterization

- Three-electrode compartment electrochemical cell



Microflotation

- Partridge-Smith cell
- 0.5 g in each flotation test
- Potassium amyl xanthate (PAX)



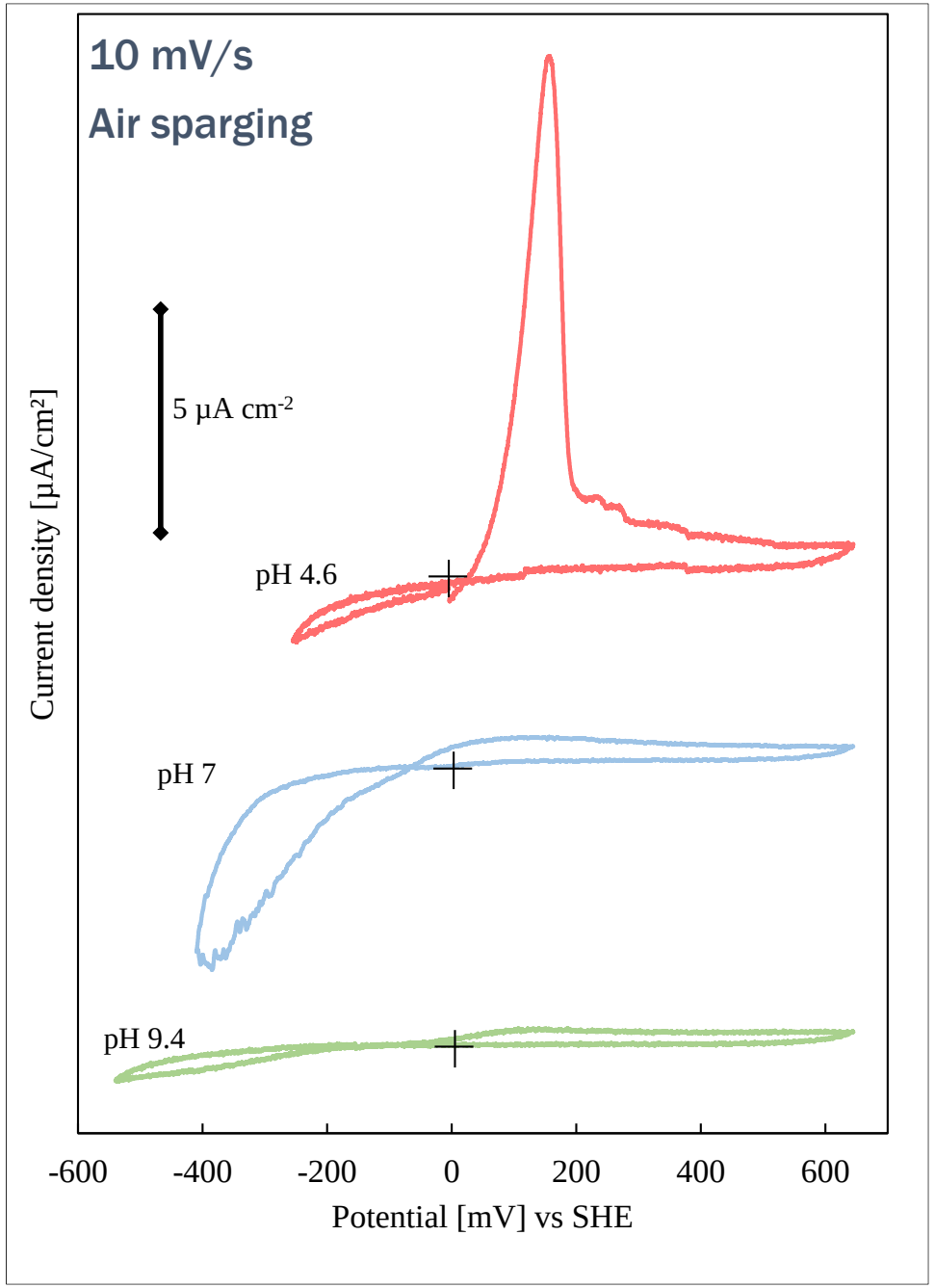
Surface characterization

- Infrared surface analysis
- Optical inspection

Effect of solution pH

Cyclic voltammogram profiles without xanthate

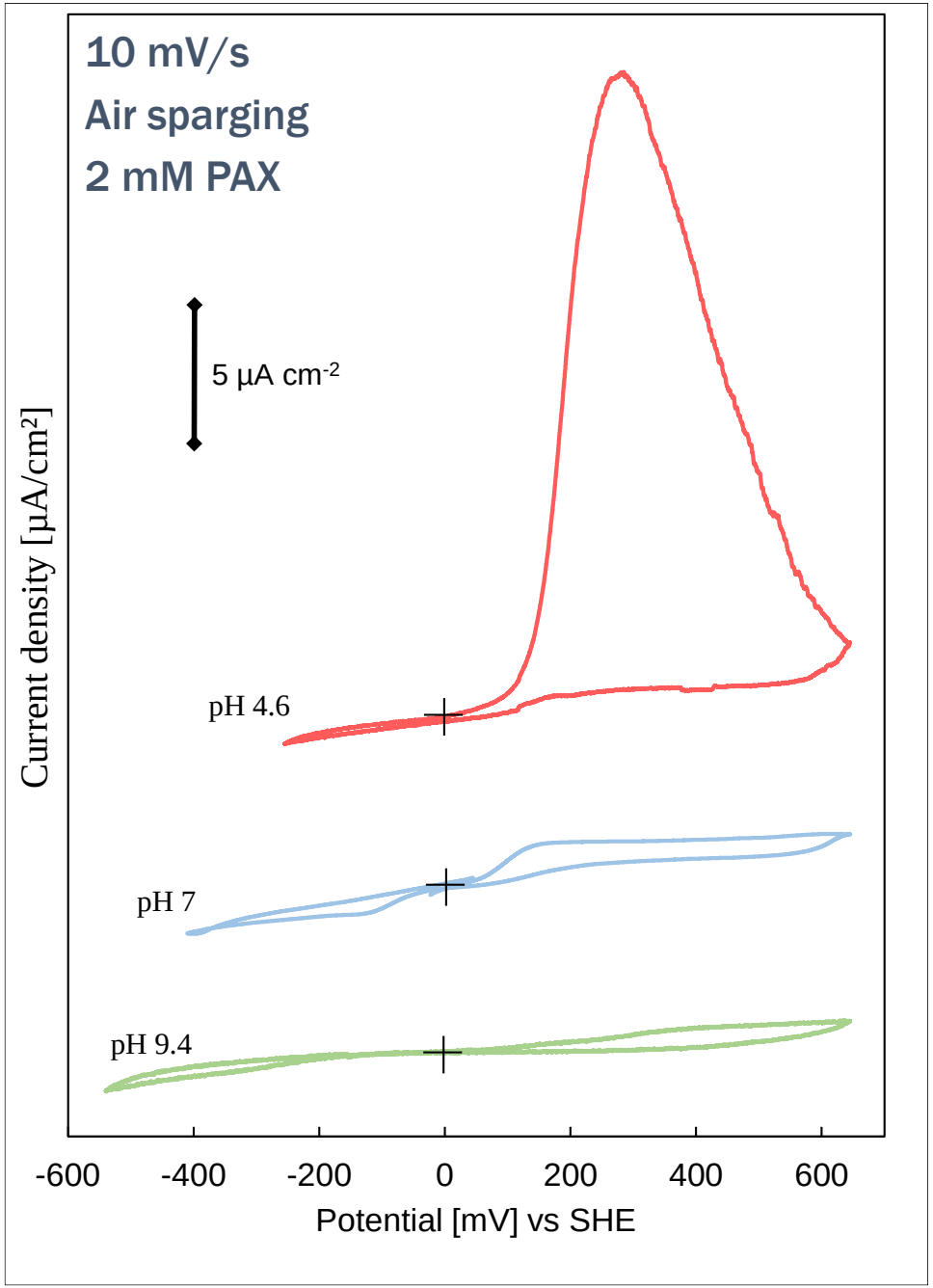
- acidic solution:
  - Anodic peak at 120 mV
  - Oxidation of metallic nickel
  - Active-passive transition behaviour
- neutral and alkaline solution:
  - Passive behaviour



Effect of solution pH

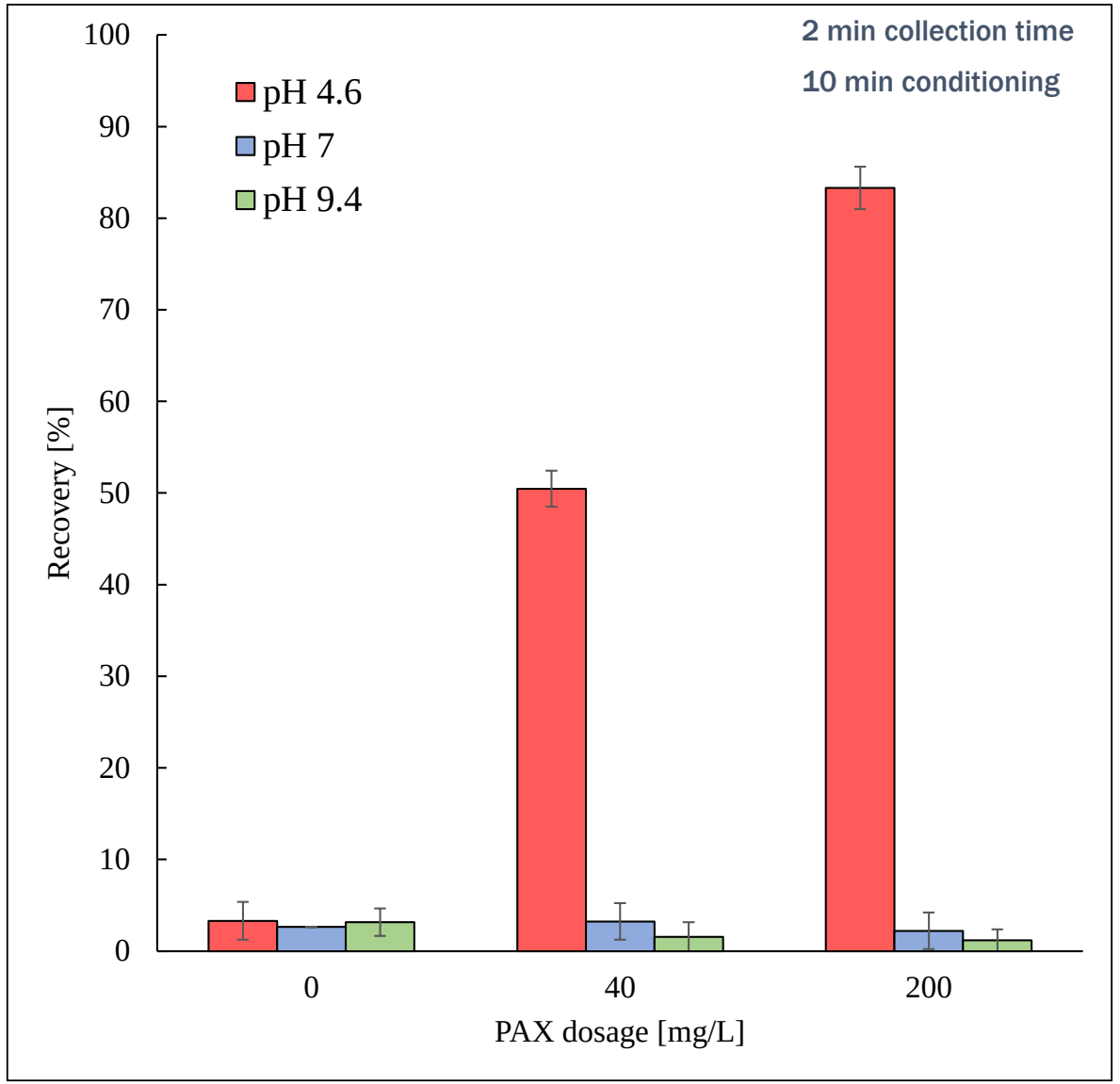
Cyclic voltammogram profiles with xanthate

- acidic solution:
  - Similar behaviour to free xanthate solution
  - Broader anodic peak shifted towards anodic values - xanthate oxidation
- neutral and alkaline solution:
  - Passive layer does not allow xanthate to interact with awaruite surface



Effect of solution pH

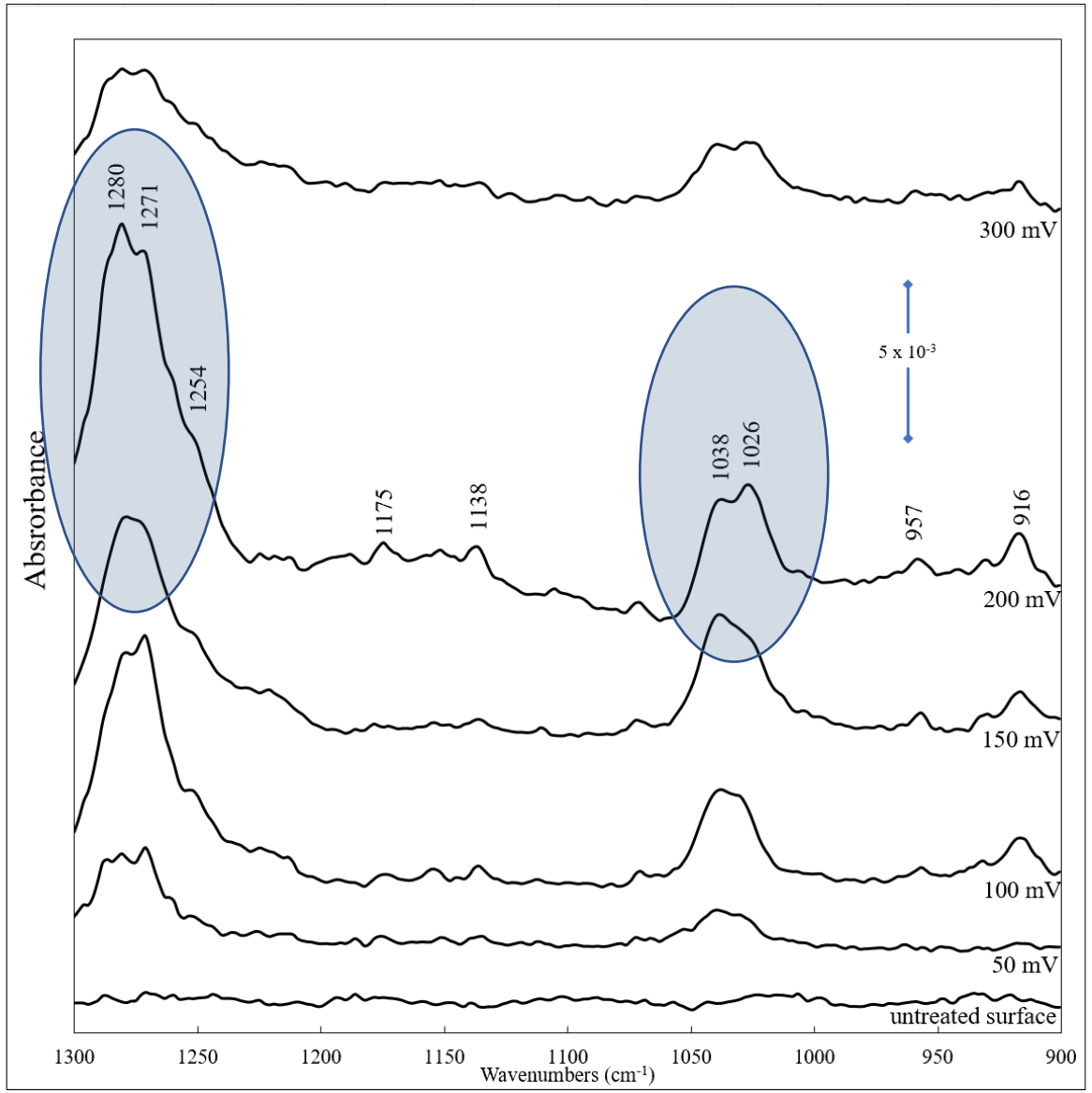
- Natural awaruite only floats in acidic condition with xanthate in solution
- Microflotation results match with electrochemical characterization
- In acidic solution awaruite surface is activated and reacts with xanthate



Surface characterization

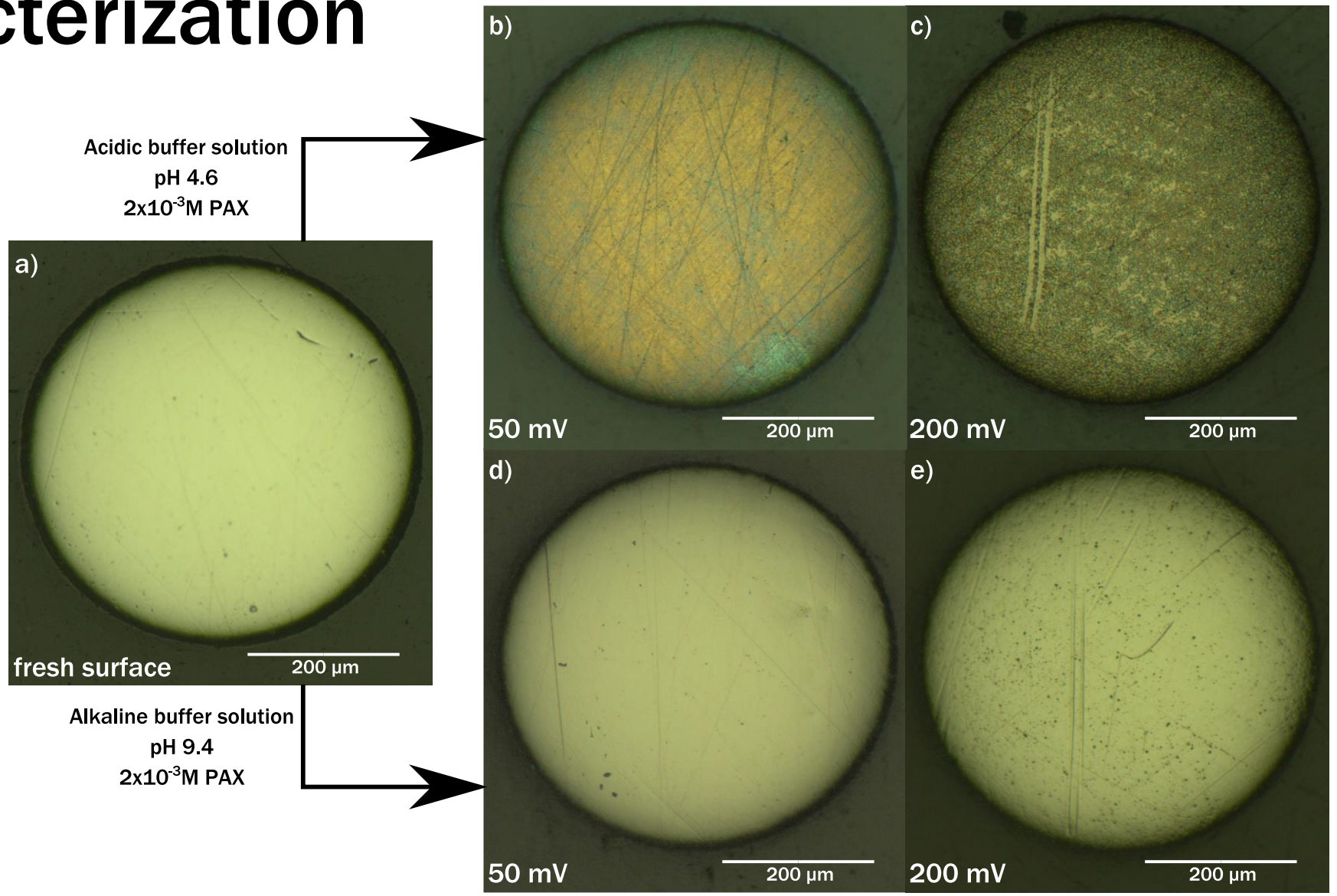
FTIR results of synthetic awaruite electrode surface in acidic solution with PAX:

- one strong absorption peak at 1280 cm^{-1} with a doublet at 1271 cm^{-1} associated to the C-O-C stretching band
- one medium absorption peak at 1026 cm^{-1} with a doublet at 1038 cm^{-1} associated to the C=S stretching band



Surface characterization

When treated in acidic solution with xanthate, the electrode is covered with a yellowish layer, not observed in alkaline solution



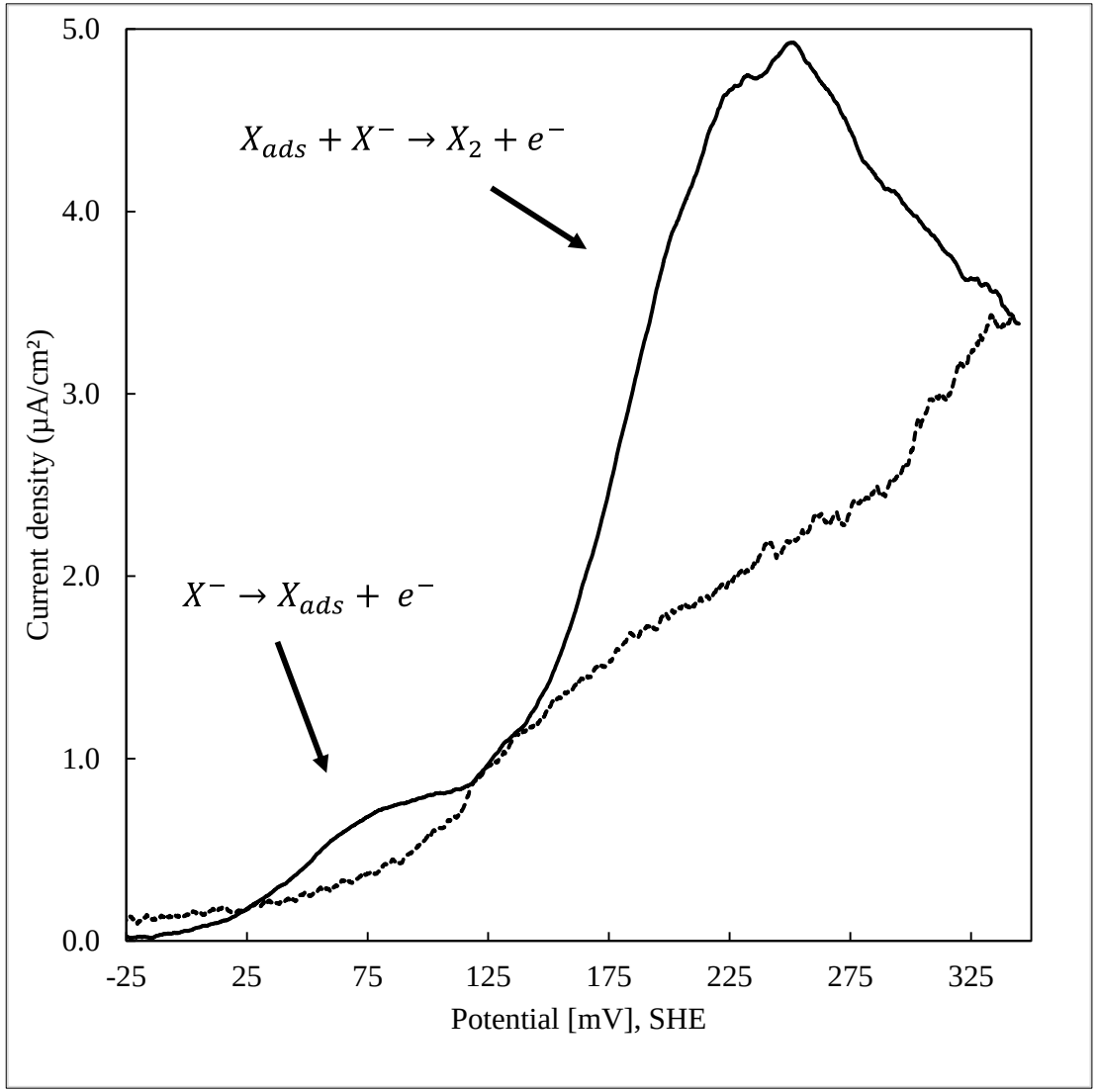
Mechanism of interaction in acidic solution

Cyclic voltammogram at lower sweep rate (1 mV/s):

- Two steps reaction

$$X^- \rightarrow X_{ads} + e^-$$

$$X_{ads} + X^- \rightarrow X_2(l) + e^-$$



Mechanism of interaction in acidic solution

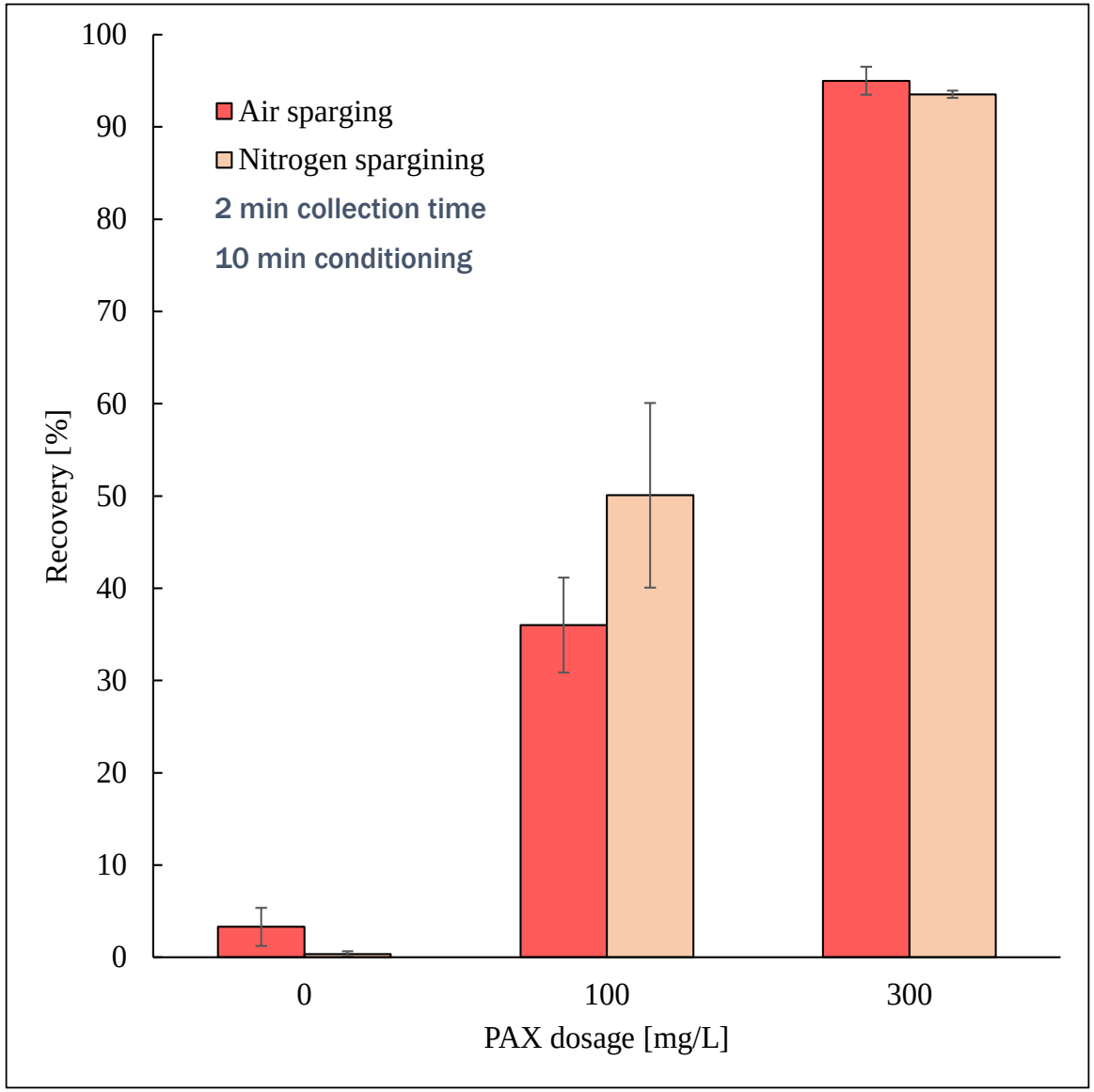
Awaruite floats in the presence and absence of dissolved oxygen:

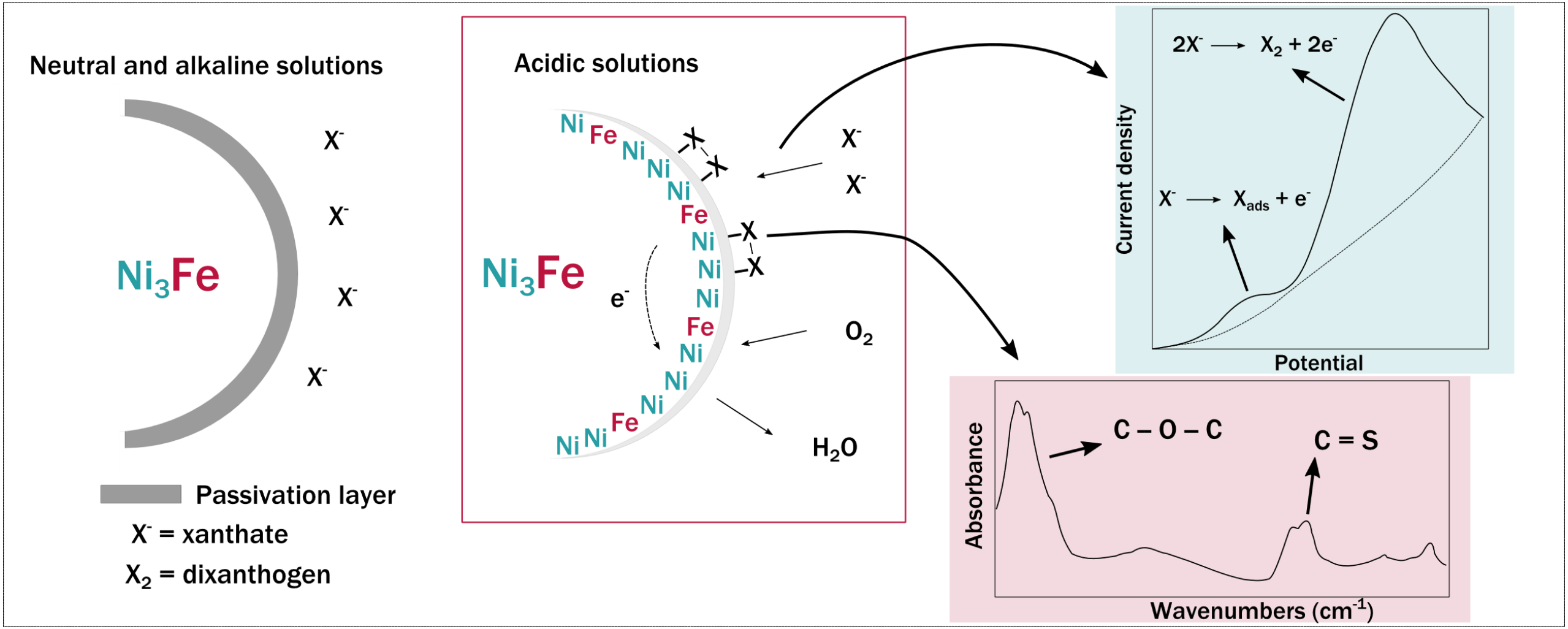
- Xanthate oxidation may be coupled with oxygen and/or iron reduction

$$O_2 + 4H^+ + 4e^- \rightarrow 4H_2O$$

or

$$Fe^{3+} + e^- \rightarrow Fe^{2+}$$




Neutral and alkaline solutions
Ni3Fe
X-
X-
X-
X-
Passivation layer
X- = xanthate
X2 = dixanthogen
Acidic solutions
Ni3Fe
e-
X-
X-
O2
H2O
2X- → X2 + 2e-
X- → Xads + e-
Current density
Potential
Absorbance
C – O – C
C = S
Wavenumbers (cm-1)

Summary

Thanks for attending!

Feel free to contact me if you have any further question:

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Mitacs

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