Battery Recycling meets Electrodialysis: Lithium Recovery from CRMs-rich Matrices

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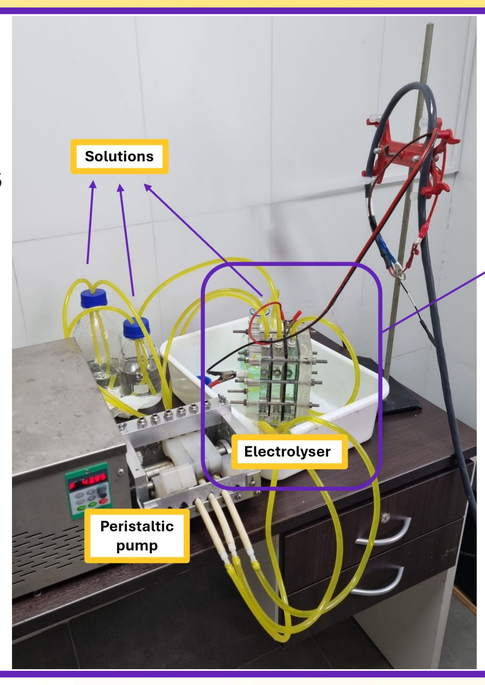
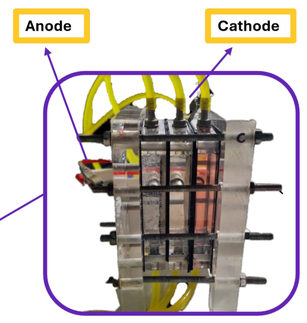
Electrodialysis is a well-known technology to separate different ions in solutions. [1] It is here applied to the **lithium-ion batteries recycling** field, to selectively recover lithium and various transition metals (TMs), significative in this area, as characteristics components in cathodic materials. This avoids the post leaching selective separation steps in the hydrometallurgical recycling process.

Feed solutions are here artificial aqueous solutions whose composition simulates a cathode leachate, with Li^+ and TMs (Ni^{2+}, Mn^{2+}, Co^{2+}).



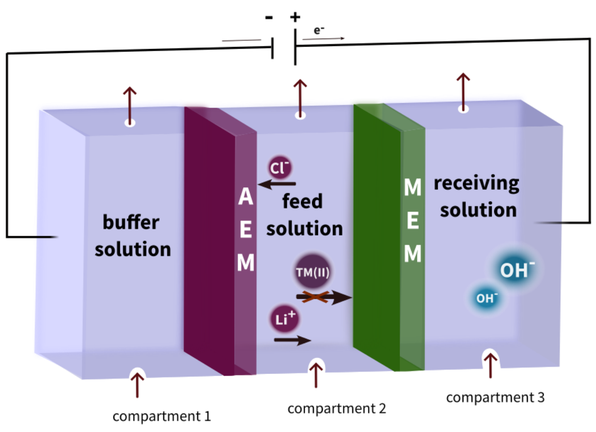


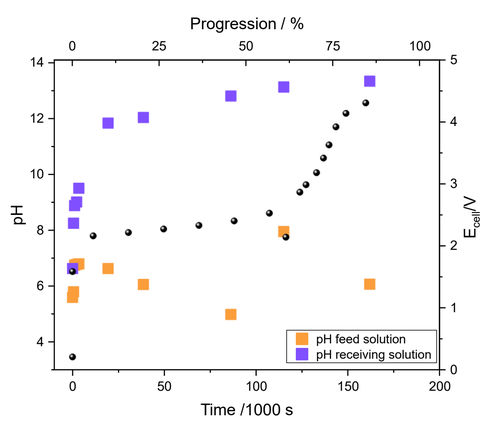
Experimental parameters:
- Pump rate
- Current
- Feed solution compositions (Li, Ni, Mn, Co)

SETUP 1

Li^+ separation

Li^+ is separated from the feed solution through a Monovalent Exchange Membrane (MEM).





anode:

$$2\,H_2O \rightarrow O_2 + 4\,H^+ + e^-$$

cathode:

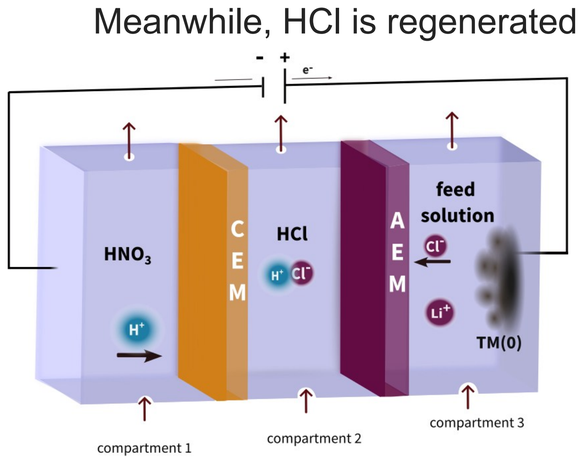
$$2\,H_2O + 2\,e^- \rightarrow H_2 + 2\,OH^-$$

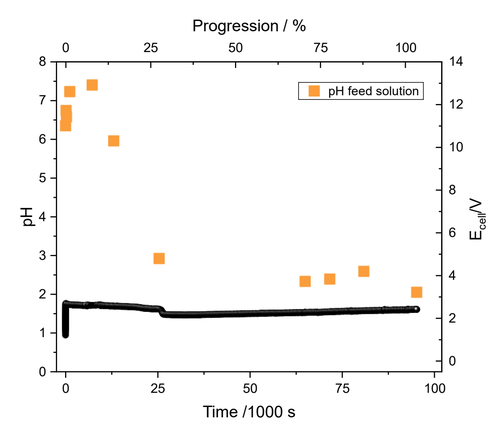
I = 0.025 A
Pump rate : 45 L/h
[Li] = [Ni] = 0.1 M
V_{sol}= 500 mL

SETUP 2

TM deposition HCl regeneration

TM^{2+} is reduced and deposited on the cathode, while Li^+ remains in the feed solution.
Meanwhile, HCl is regenerated in the middle compartment.





anode:

$$2\,H_2O \rightarrow O_2 + 4\,H^+ + e^-$$

cathode:

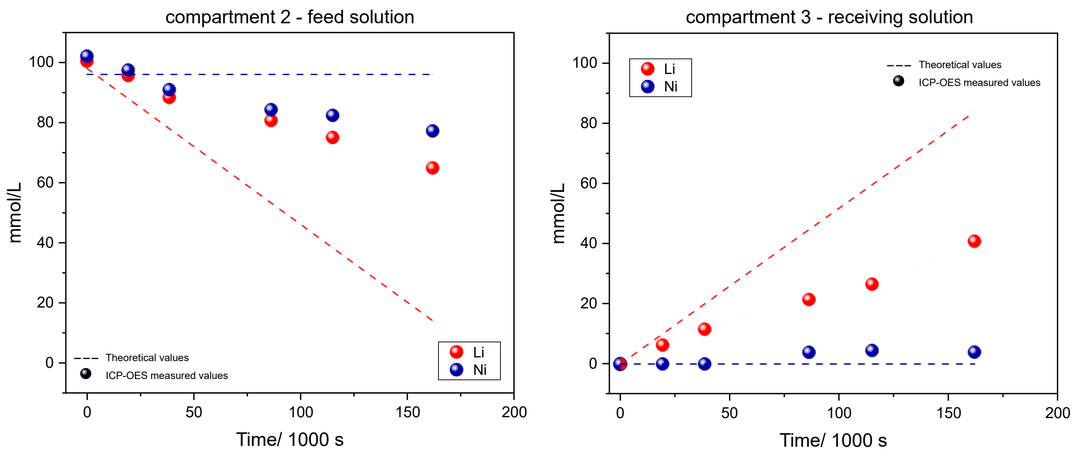
$$2\,H_2O + 2\,e^- \rightarrow H_2 + 2\,OH^-$$

$$TM^{2+} + 2e^- \rightarrow TM^0$$

I = 0.100 A
Pump rate : 45 L/h
[Li] = [Ni] = 0.1 M
V_{sol}= 500 mL

SETUP 1

Li^+ migrates to the compartment 3, enriching the receiving solution.

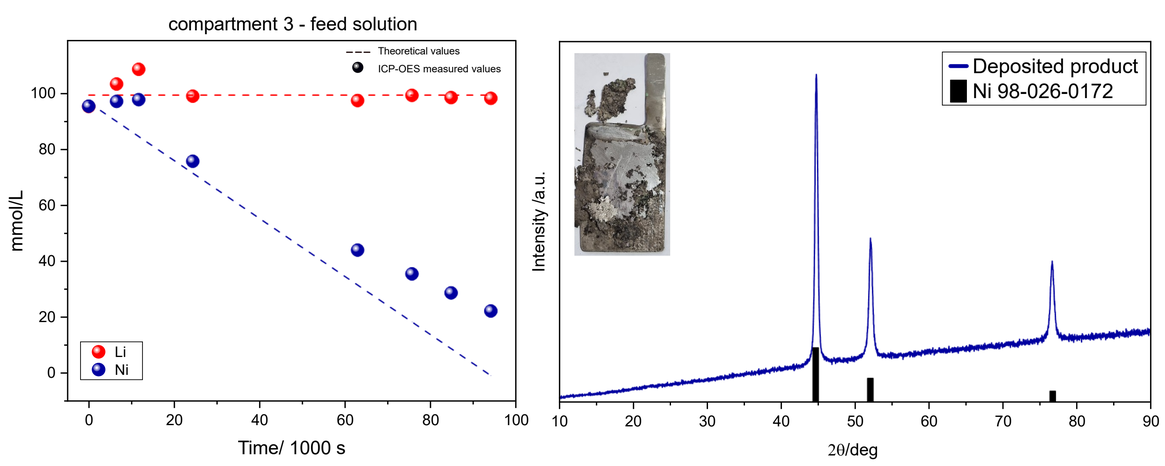


- The setup has been optimized in terms of **pump rate** and **intensity of current**

✓ Li^+ migrates from the compartment 2 to the compartment 3
× Due to **poor membrane selectivity**, part of Ni^{2+} migrates to the compartment 3
✓ Ni^{2+} in compartment 3 can still be recovered as $Ni(OH)_2$

SETUP 2

Ni^{2+} is recovered as metallic Ni, deposited on the cathode foil.



✓ Li^+ remains in solution, while Ni^{2+} is collected as Ni^0_s, with a 75% process efficiency.

- The same system has been applied with feed solution based on Li-Co and Li-Mn, and in more complex mixture (Li-Co-Ni-Mn 0.1M)

References:
[1] Nieto, C., Flexer, V. *Current Opinion in Electrochemistry*, 35, 101087 (2022)

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