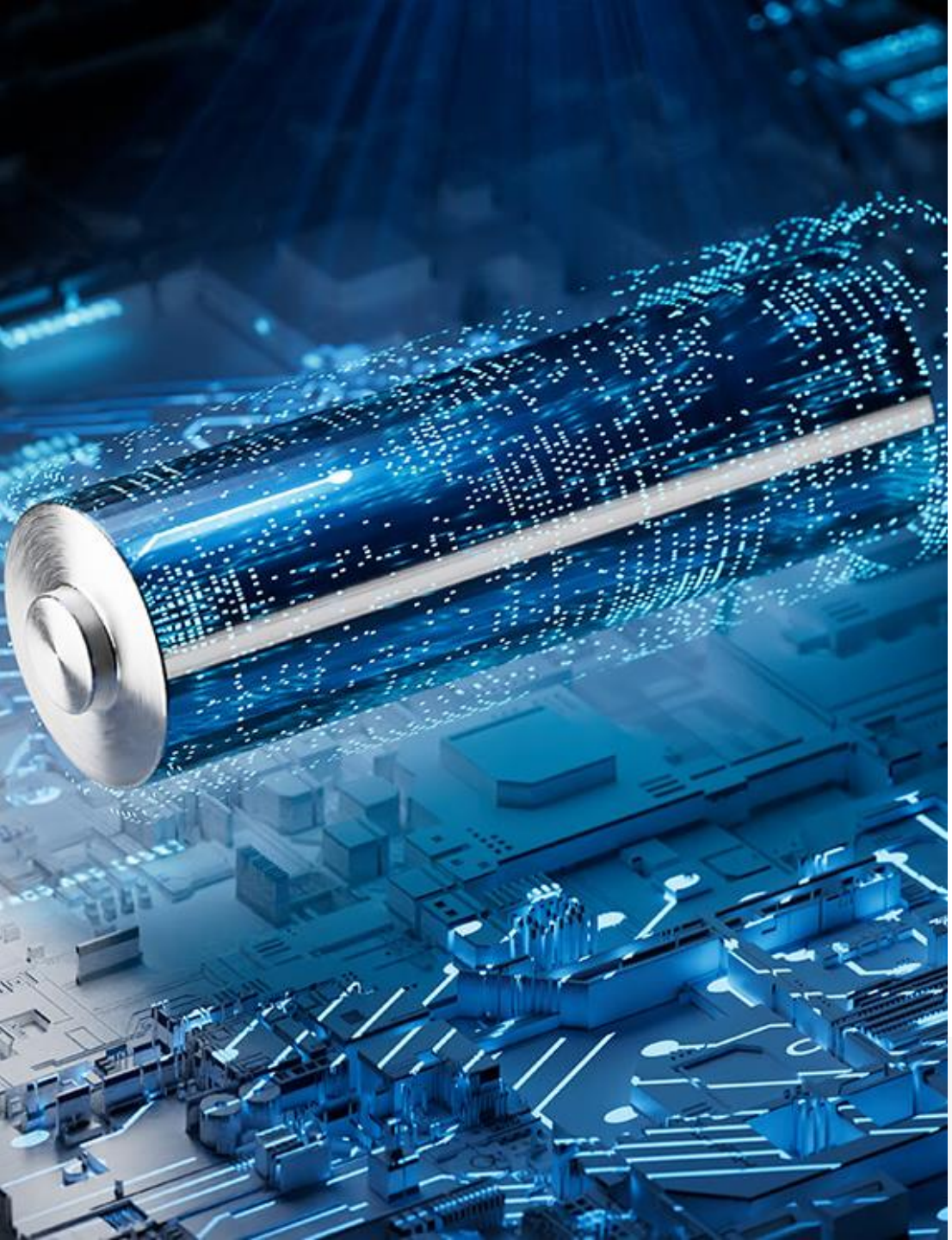

Electrochemical Li recovery strategy from Li-ion battery black mass

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Brussels

12th December 2024

RHINOCEROS

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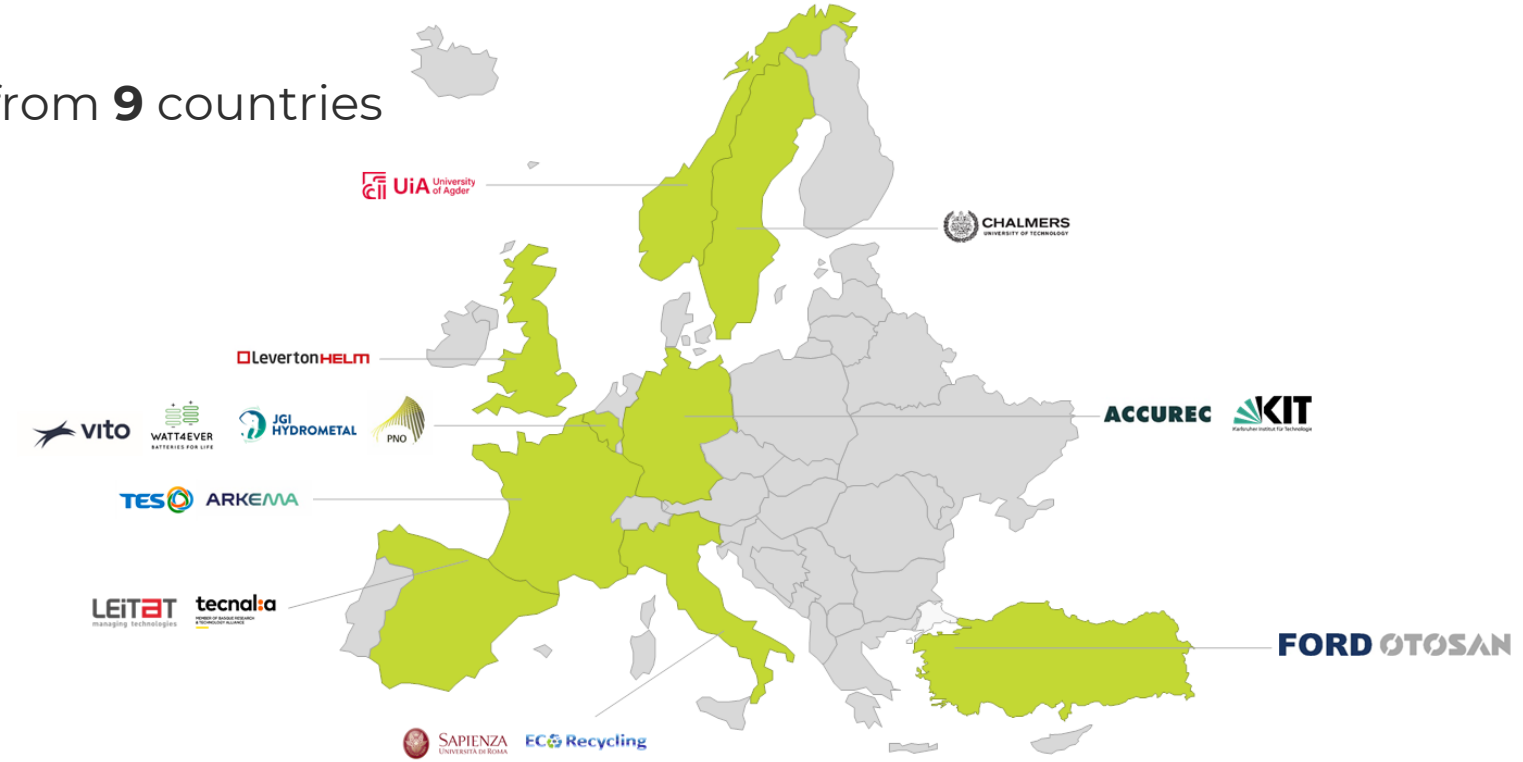
RHINOCEROS Objective

- The objective of Rhinoceros is to develop, improve, and demonstrate, in an industrially relevant environment, an economically and environmentally viable route for re-using, and recycling End-of-Life (EoL) Electric Vehicles (EV) and stationary energy storage Lithium-Ion Batteries (LIBs).

🌎 **16** partners from **9** countries



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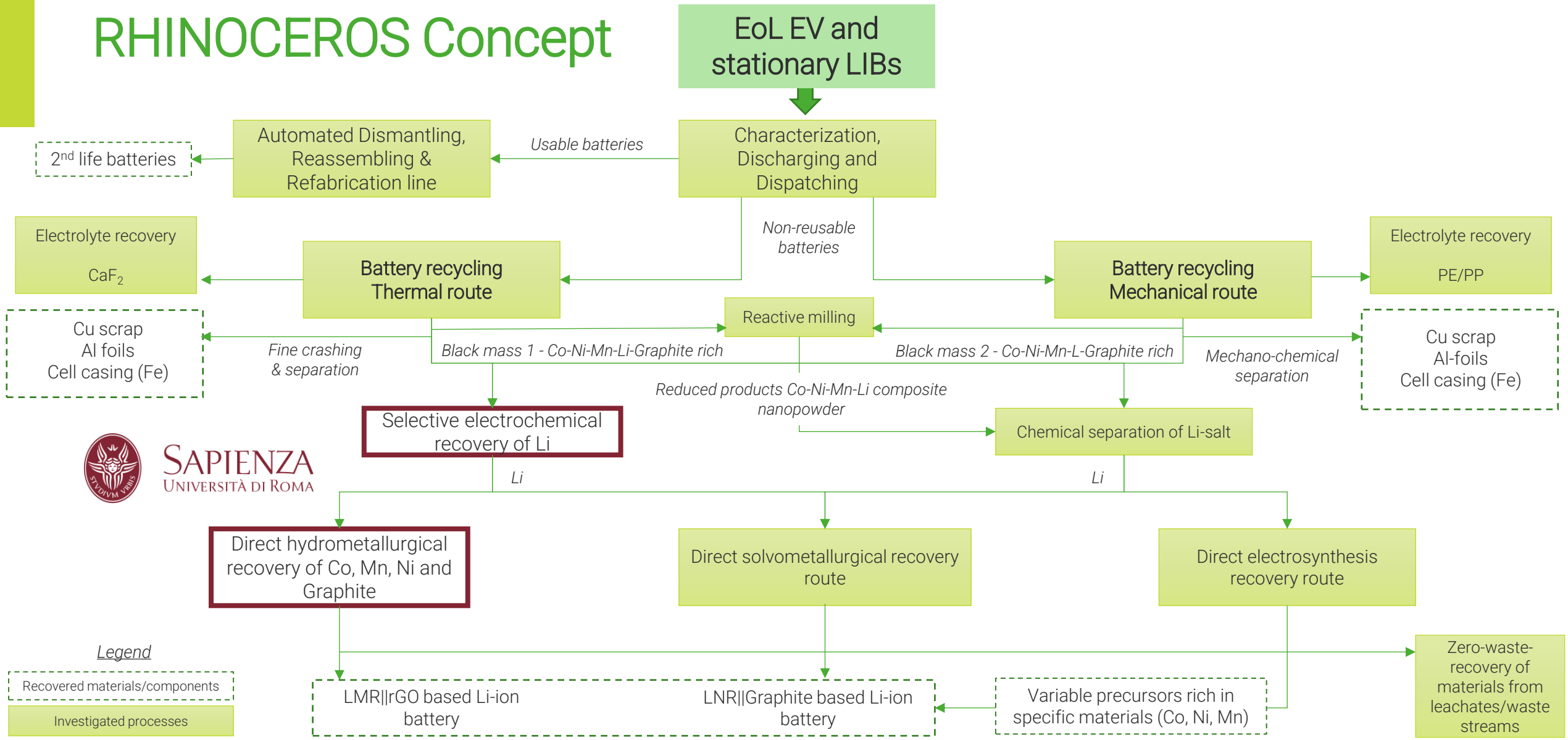
RHINOCEROS Concept



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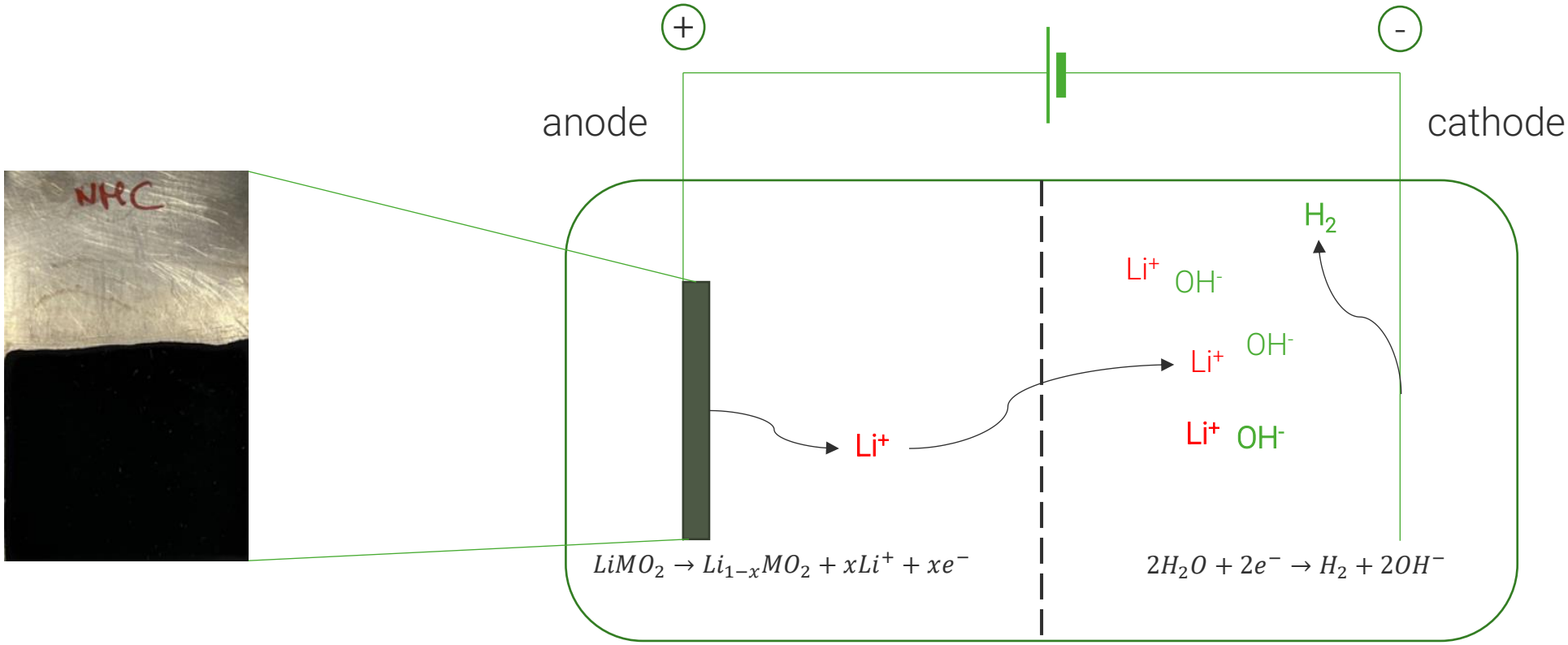
Electrochemical recovery of Lithium: concept

- This activity aims to develop an electrochemical process for selective extraction of Li from the EoL LIB black mass, mimicking the charging process of a standard LIB.



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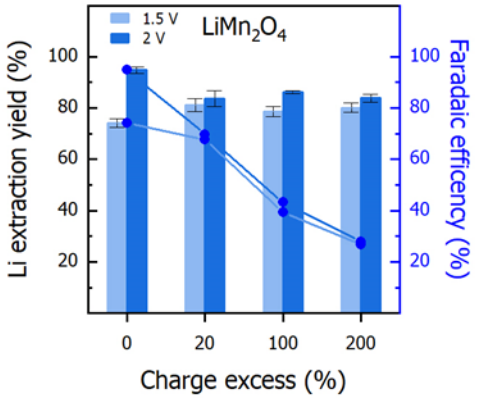
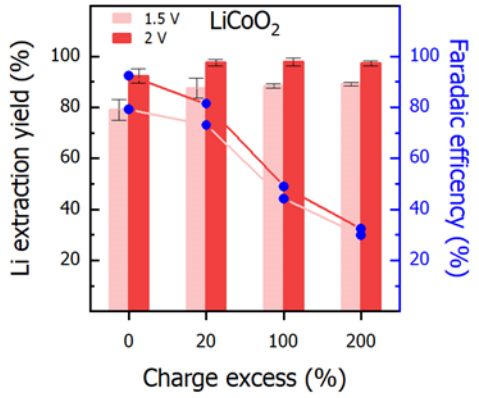
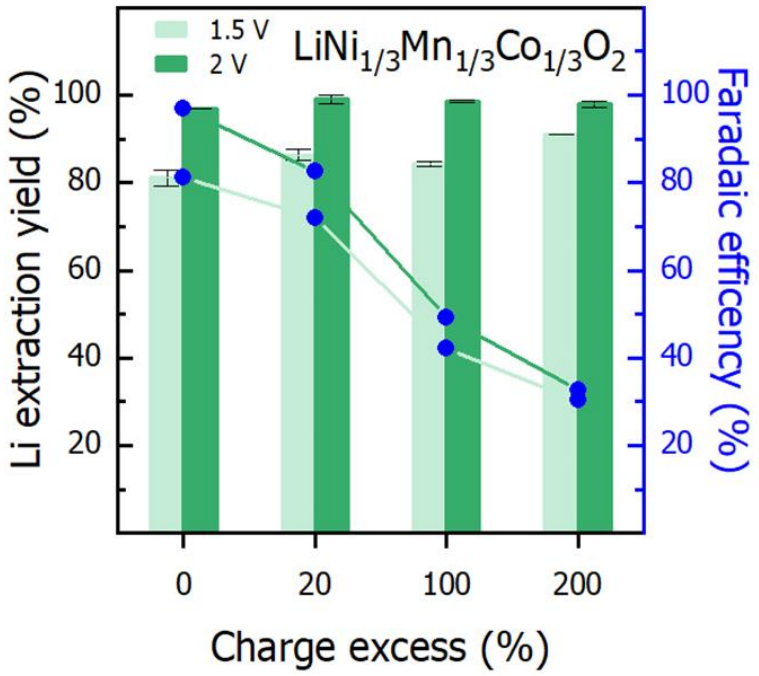
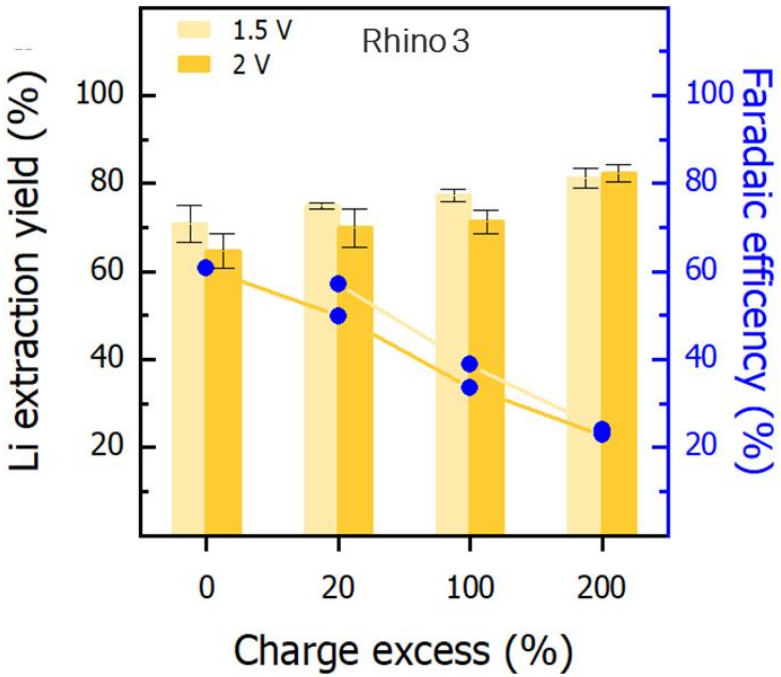
Potentiostatic delithiation

- Li extraction yields of up to 82% were achieved with electrodic powders from EoL LIBs, while commercial electrodic powders reached 99%.









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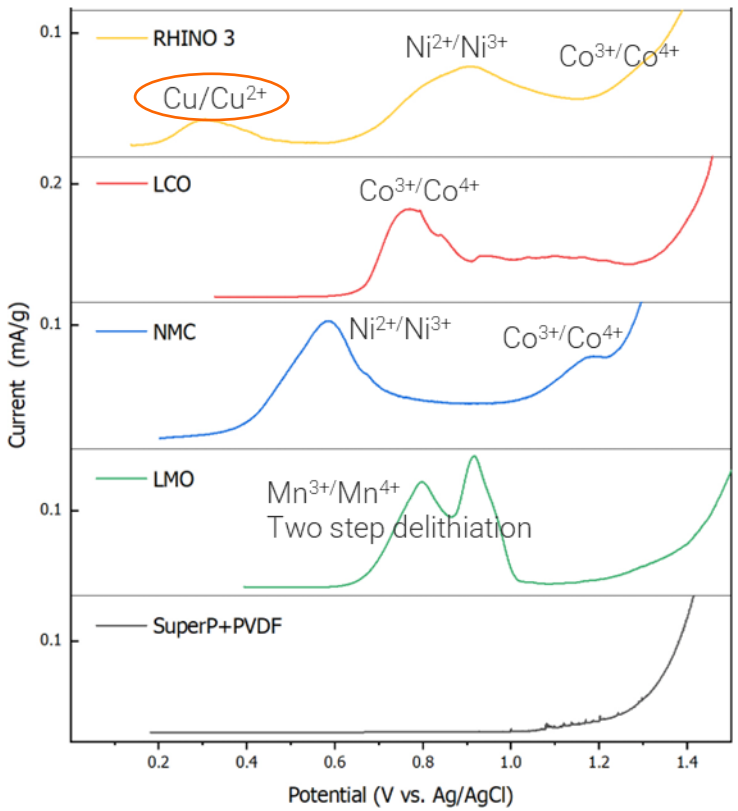
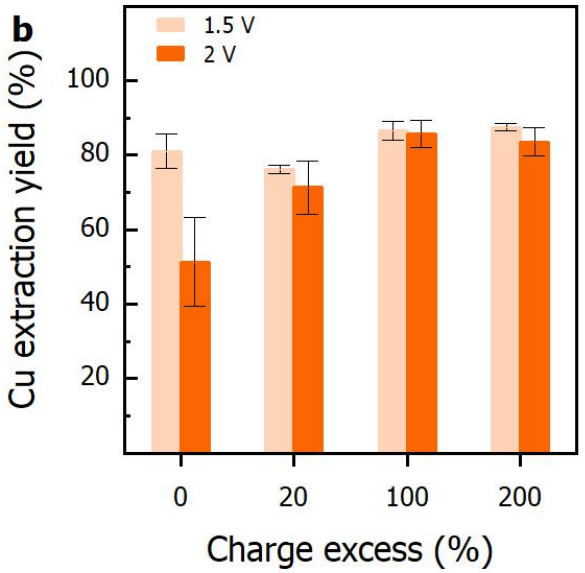
Role of impurities: Cu





RHINO-3 – Black mass		
	average [mg/g]	st.dev [mg/g]
Co	75	3
Ni	92	1
Mn	88	6
Li	31	1
Al	6	5
Cu	13	1
Fe	1	0

Theorethical charge for the complete oxidation of Cu ~ 40 C/g

- corresponding to ~ 9 % of theoretical charge imposed for the oxidation of NMC in R3 (493 C/g)
- corresponding to ~ 3% of total charge in the case of 200% charge excess respect theoretical charge for NMC oxidation (1480 C/g)

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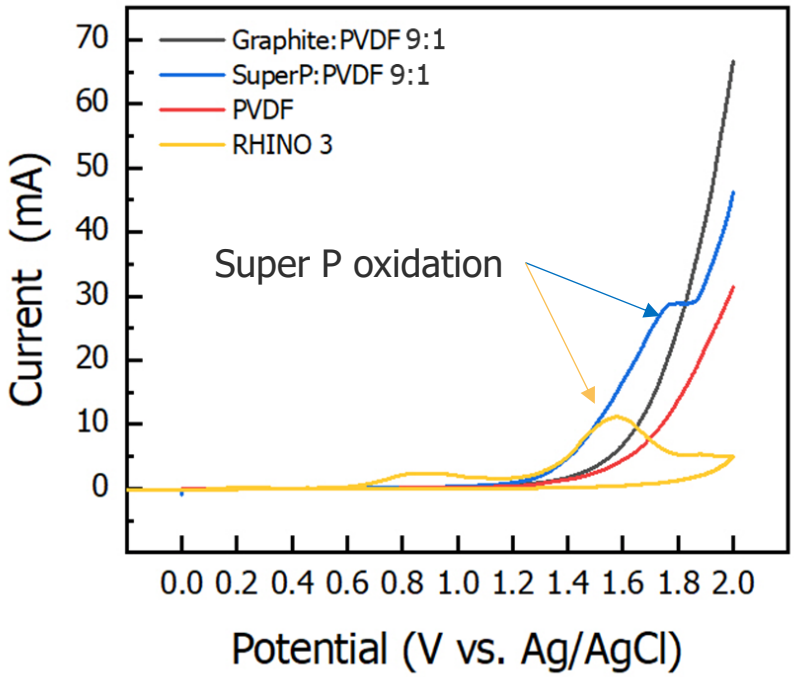
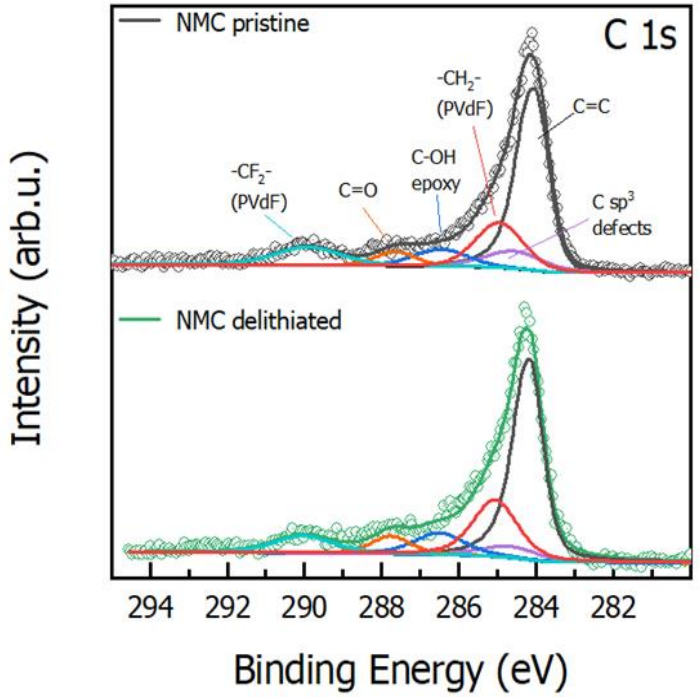
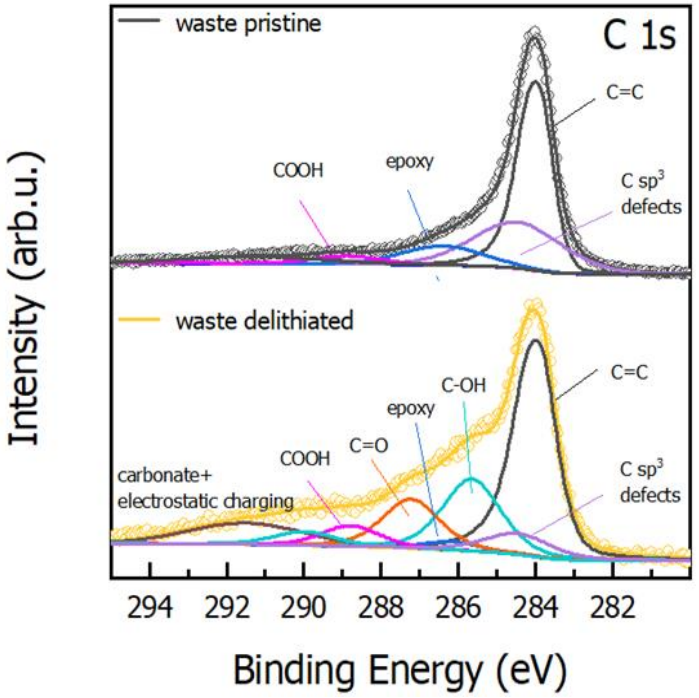
Role of impurities: graphite and super P conductive carbon







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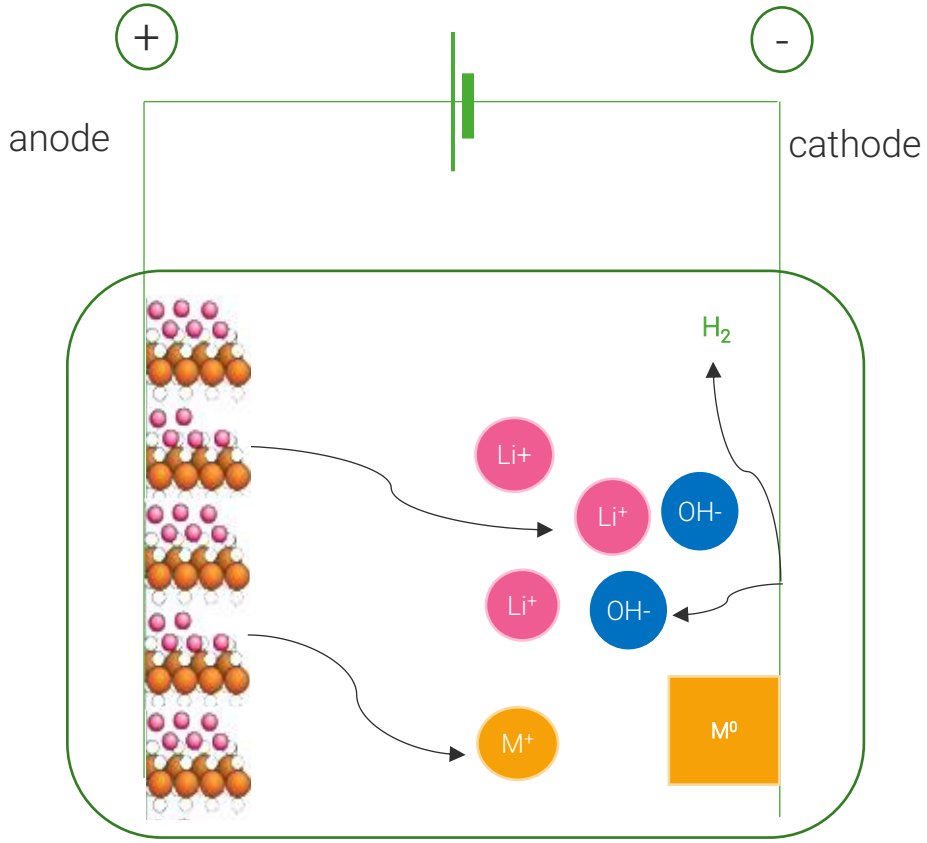
Li selectivity towards Ni, Mn and Co



Metal	Extraction %
Co	0.04±0.005
Ni	0.07±0.009
Mn	0.02±0.002

Experimental Procedure:

- Delithiation of Rhino 3 at 2V with a 200% charge excess (6 replicates).
- ICP-OES analysis of the electrolytes (no metals detected).
- Digestion of counter electrodes used during delithiation, followed by analysis with ICP-OES

$$LiMO_2 \rightarrow Li_{1-x}MO_2 + xLi^+ + xe^-$$

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

$$M^{x+} + x\,e^- \rightarrow M^0$$

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Conclusions

- **Efficiency:** Rhino 3 displays lower extraction yields (82%) and faradaic efficiency to respect commercial cathode materials (close to 100%). Super P oxidation could explain the lower Li extraction

- **Selectivity:** Ni, Mn and Co are not extracted

- **Scaling up:** evaluating an alternative approach that enables the treatment of larger quantities of powder **without replicating the manufacturing process of LIB electrodes!**

Slurry electrolysis

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Thanks for your attention!

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