Hydrometallurgical process to recycle spent Lithium-ion batteries

Metal extraction of LFP-NMC blackmass

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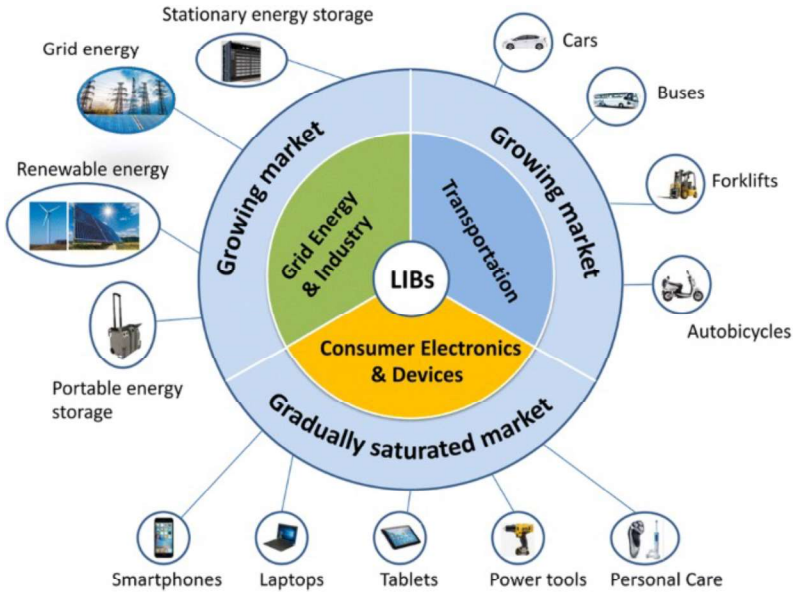
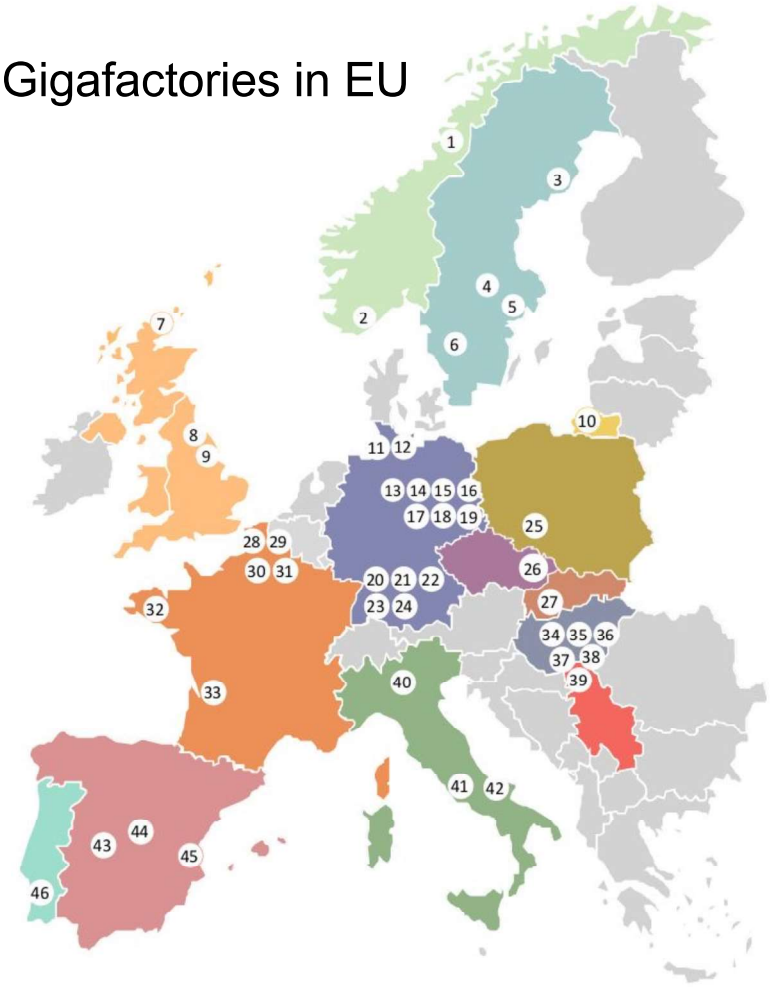
Li-ion battery is at the center of the energy transition and the electric mobility

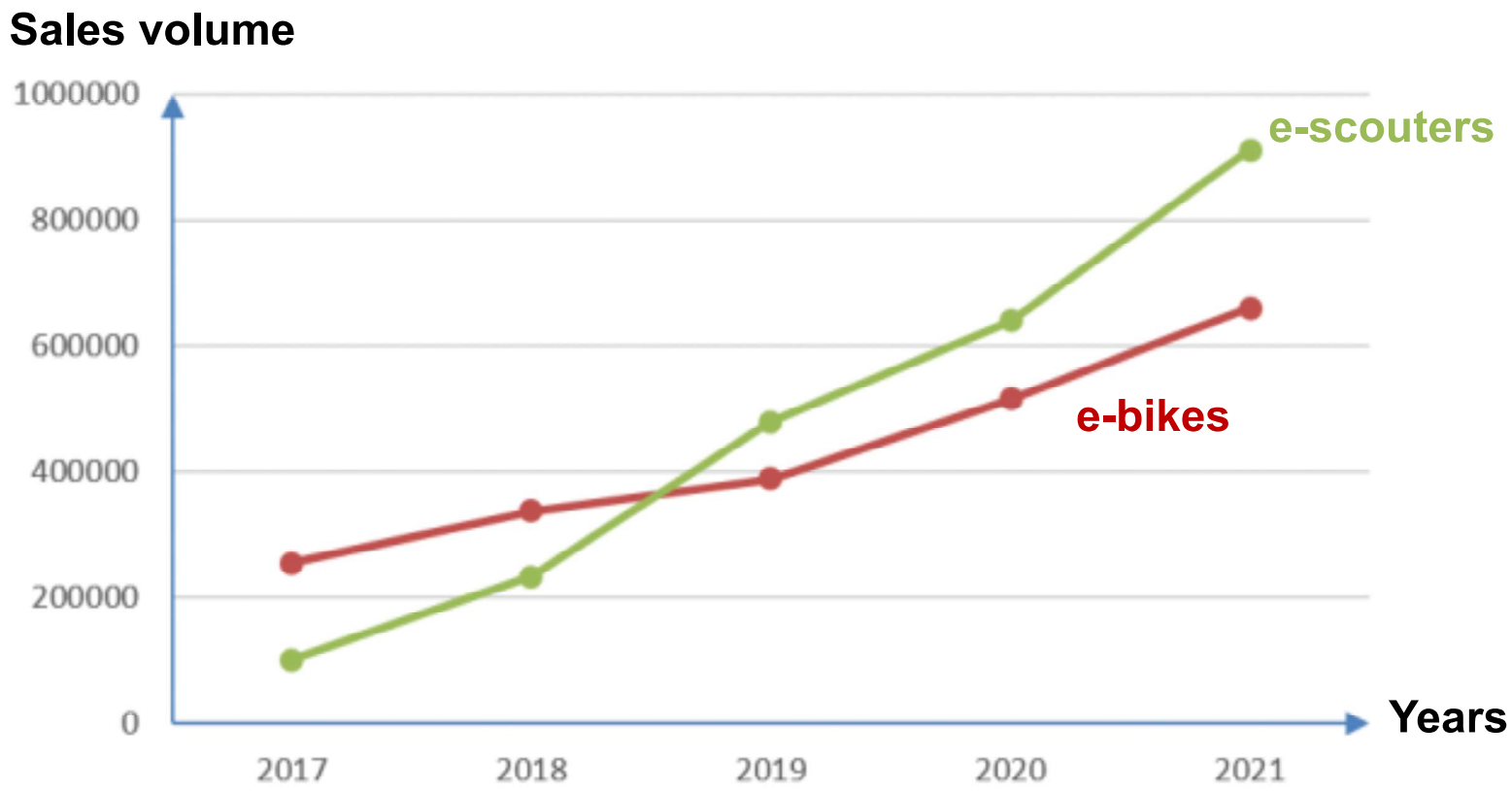


Gigafactories in EU



Ding, Y., Cano, Z.P., Yu, A. *et al.* E*lectrochem. Energ. Rev.* **2,** 1–28 (2019); https://knowhow.distrelec.com

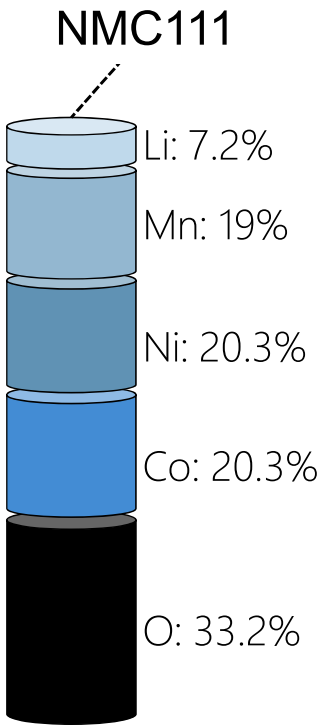
The market of e-bikes, e-scouters is a growing market

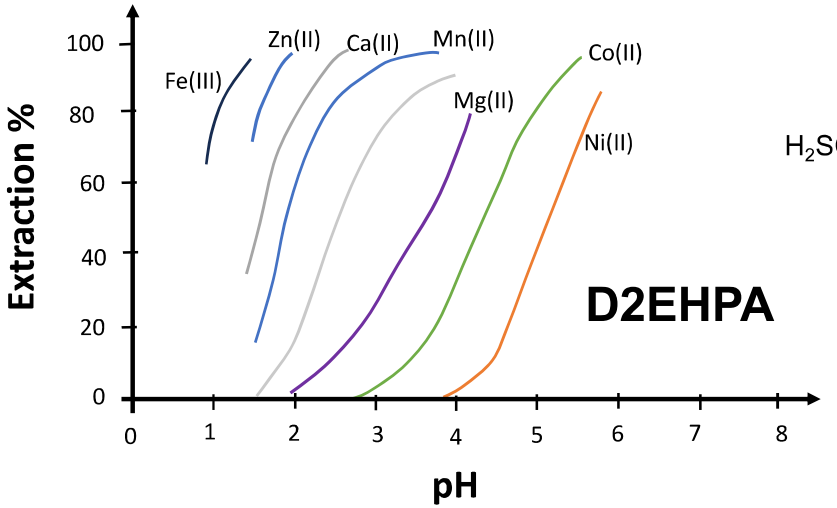


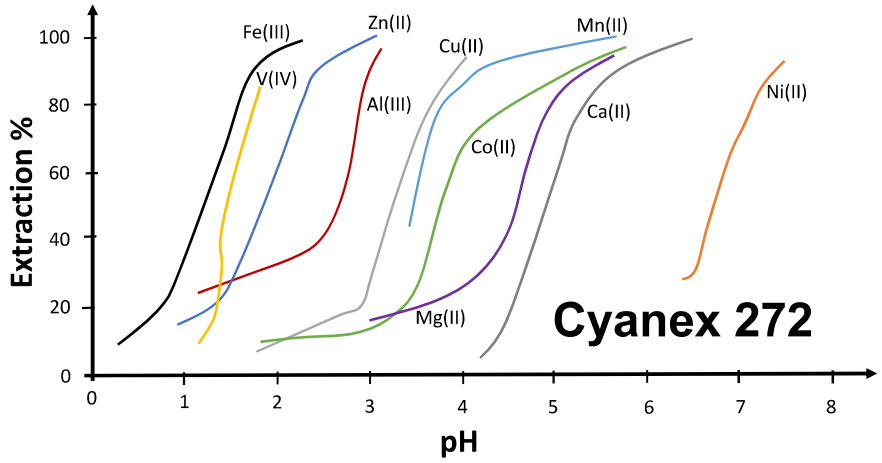
60% increase of e-bike sales between 2017 and 2019 in Europe !

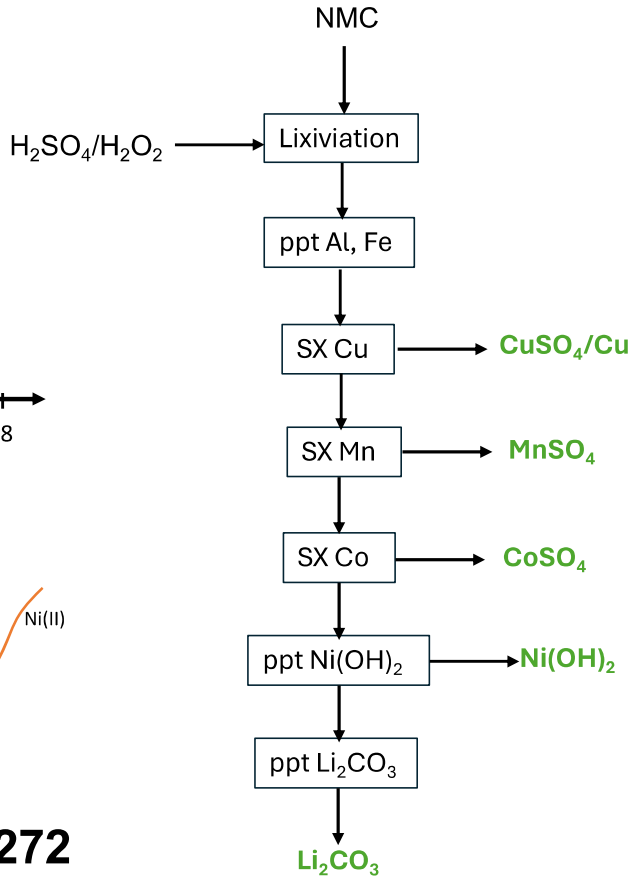
https://fpmm.fr/nos-activites/etudes-prospectives/

Two battery technologies for e-bikes and e-scouters

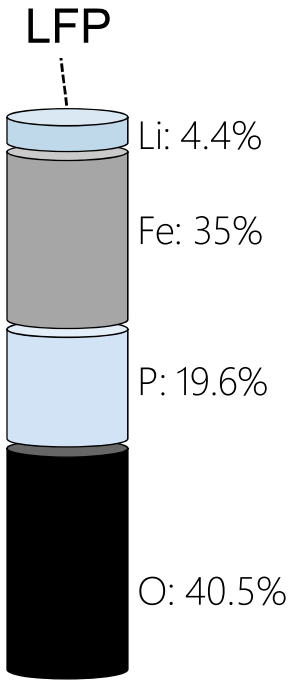


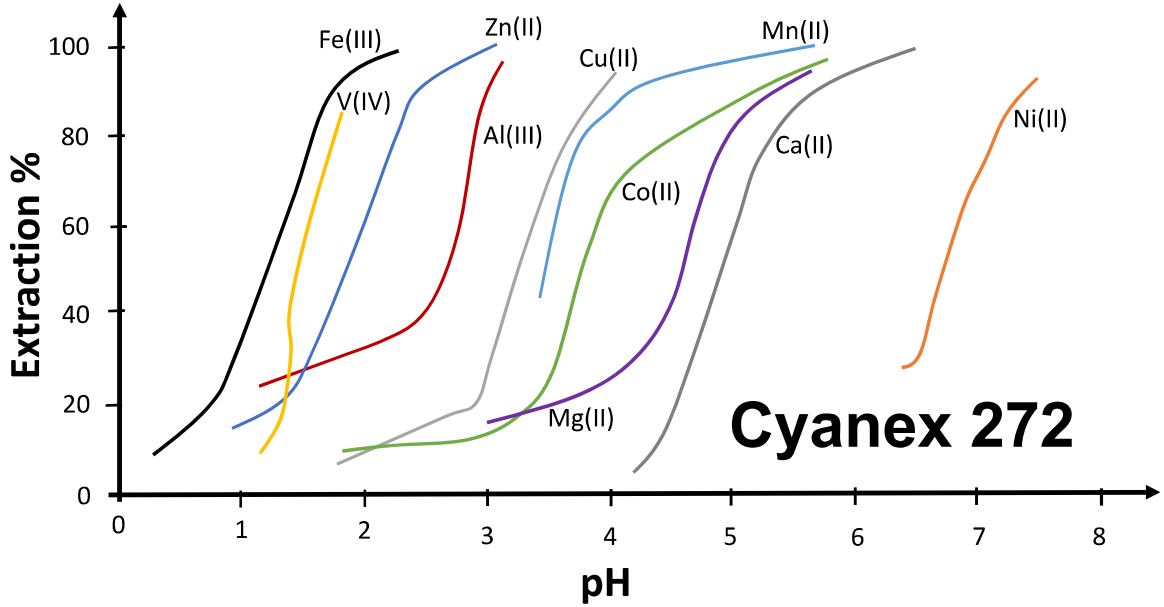






Two battery technologies for e-bikes and e-scouters



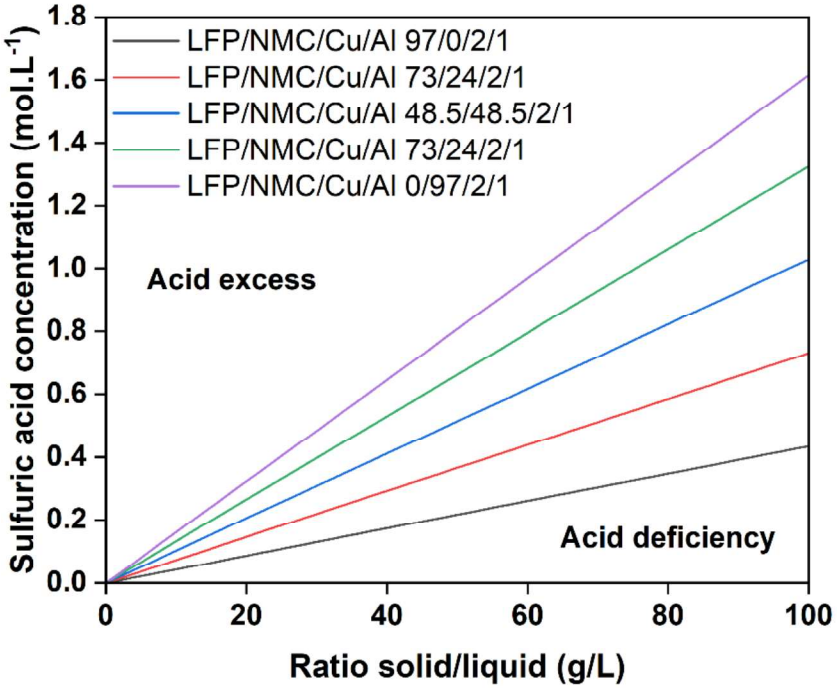


How to manage the presence of iron and what is the impact of the presence of phosphate on the process to recycle mixtures of NMC and LFP in the blackmass?

Leaching of NMC-LFP mixtures

Can we play on precipitation-dissolution phenomena to perform selective dissolution of Li, Ni, Mn, Co without iron dissolution ?

Definition of acid excess and acid deficiency zones as a function of sulfuric acid concentration and solid/liquid ratio.

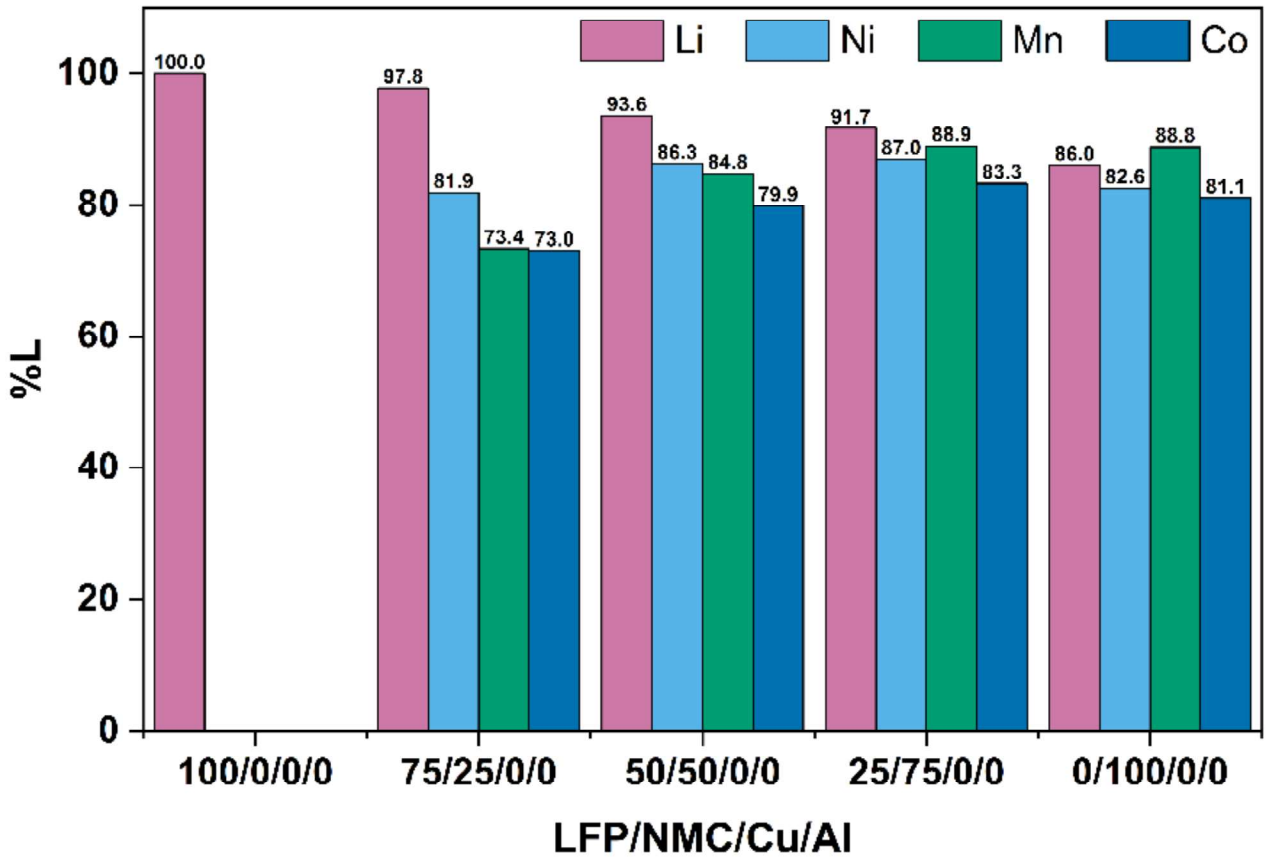


$2LiFePO_4+H_2SO_4+H_2O_2 \leftrightharpoons Li_2SO_4+2FePO_4+2H_2O$

$2LiMO_2+3H_2SO_4+H_2O_2 \leftrightharpoons 2MSO_4+Li_2SO_4+4H_2O+O_{2(g)}$

$Cu+H_2SO_4+H_2O_2 \leftrightharpoons CuSO_4+2H_2O$

$2Al+3H_2SO_4 \leftrightharpoons Al_2(SO_4)_3+3H_{2(g)}$

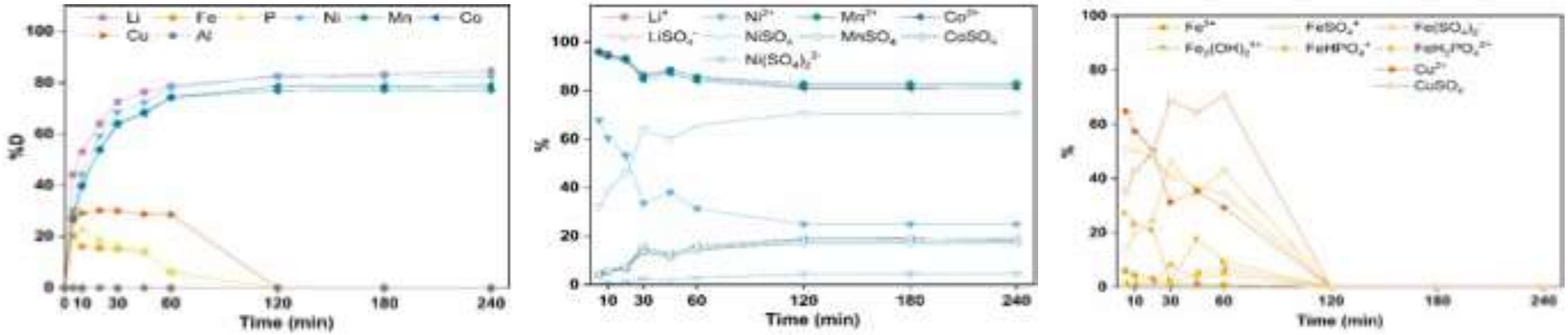


Dissolution yields of Ni, Mn, Co and Li during the leaching of LFP/NMC mixtures by H_2SO_4+3% (v/v) H_2O_2 in the absence of copper and aluminium under acid deficiency conditions (temp=30 °C).

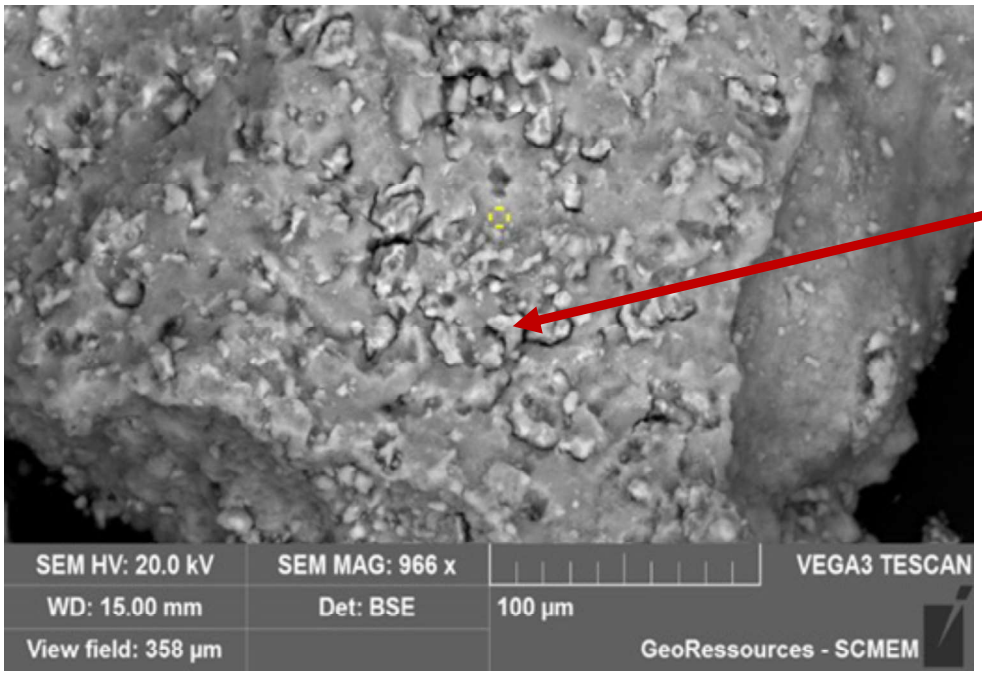
NMC-LFP mixture leaching

Acid deficiency leaching conditions

LFP/NMC/Cu/Al = 48.5/48.5/1/2 (lot 6, Table 3) by 0.45 mol L^{-1} H_2SO_4+ 3% (v/v) H_2O_2 (temperature = 30 °C, S/L = 50 g/L).

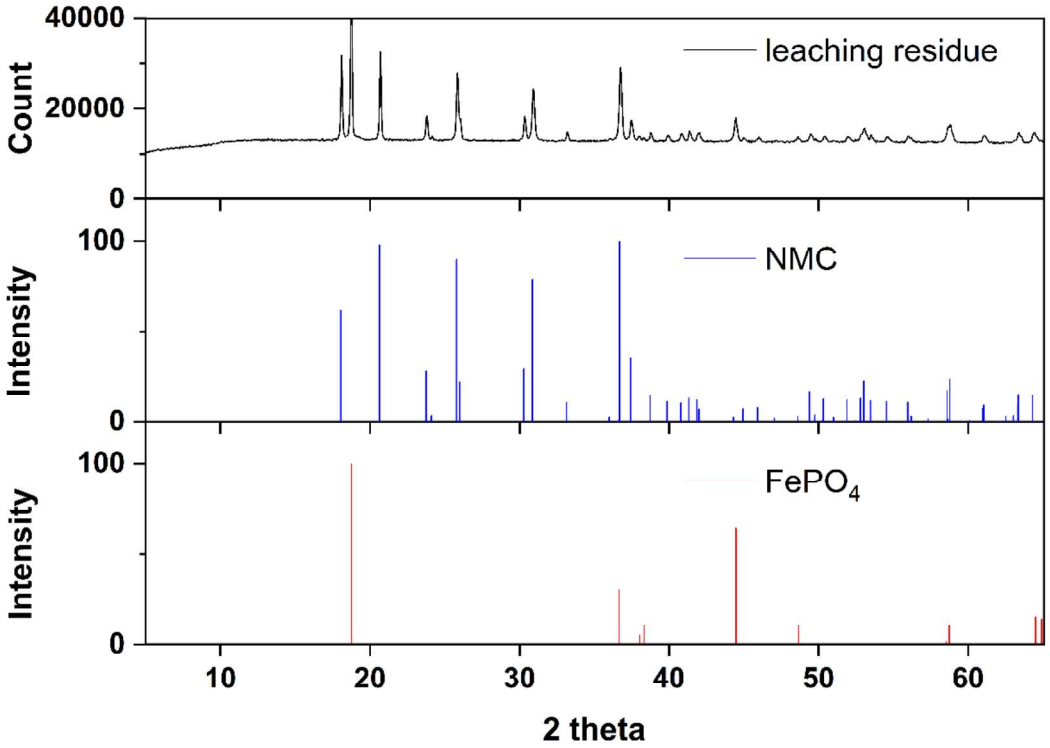


NMC-LFP mixture leaching



Cu cementation on iron particles

SEM picture of an iron particle remaining in the leaching residue of LFP/NMC/Cu/Al = 48.5/48.5/1/2



XRD patterns of LFP/NMC = 50/50 leaching residue after 240 min (Leaching reagent: 0.45 mol L^{-1} H_2SO_4 + 3% (v/v) H_2O_2 (temperature = 30 °C; S/L = 50 g/L).

Flexible flowsheet to recover metals from LFP/NMC blackmass mixtures