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Development of a robust resynthesis process for cathode active material (NCM-type) from the leachate of the COOL-process

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Agenda

1. Motivation
2. Hydrometallurgical Recycling
   - COOL-Process
   - Direct co-precipitation
3. Results
   - Analysis of synthesised Cathode Active Materials (CAM)
   - Selective Precipitation
4. Conclusions and Further Research

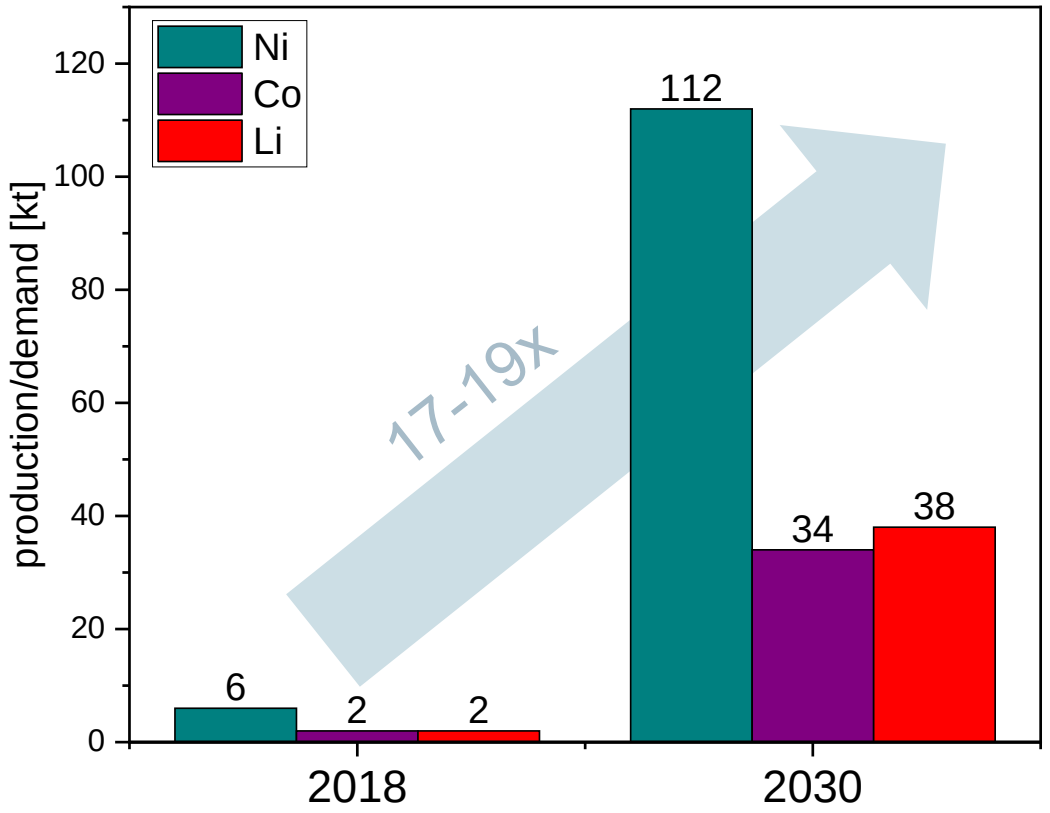
1. Motivation

Importance of Lithium-Ion Batteries (LIB) recycling

Challenges for LIB technology:

- Increasing demand for critical ressources
- Market availability and cost dynamics
- Accumulation of waste from spent batteries

Recycling of LIB essential



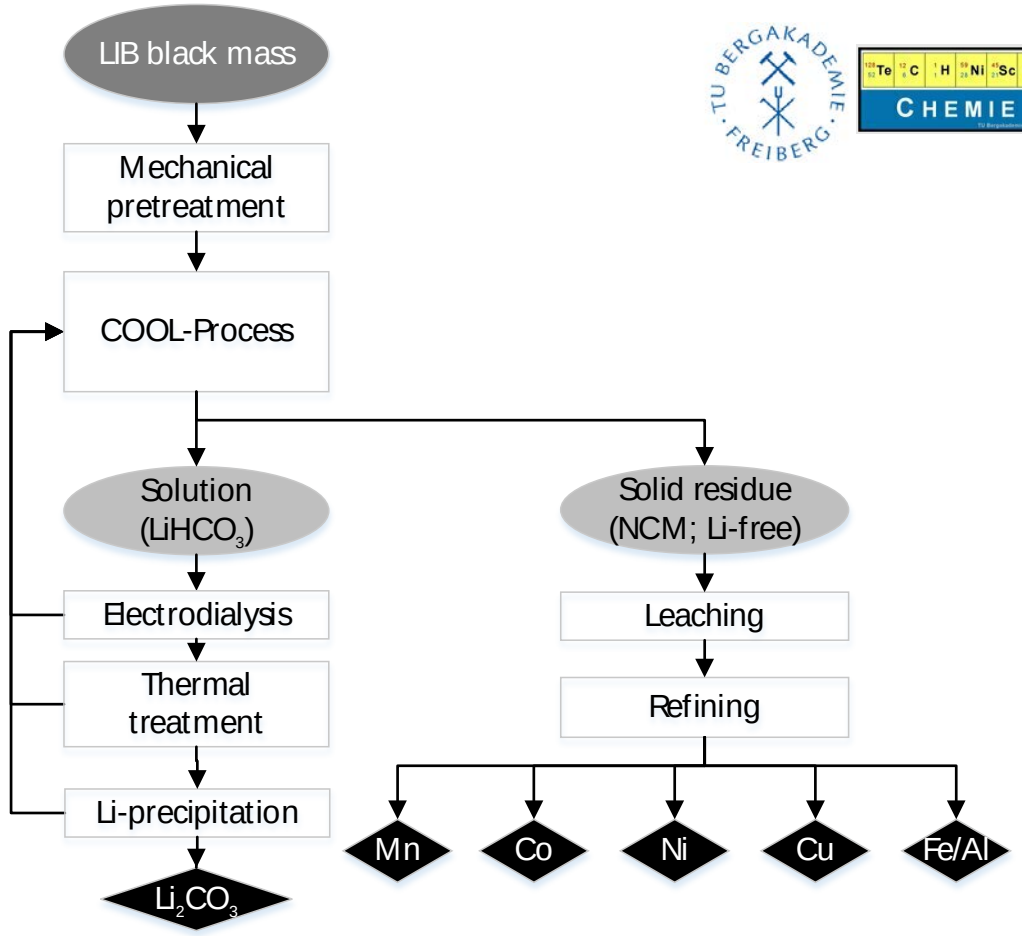
Production (2018) and approximate demand (2030) for Ni, Co and Li (EU-wide) [1]

[1] European Commission, Joint Research Centre, C. Pavel, D. Blagoeva, P. Alves Dias, N. Arvanitidis, *Cobalt : demand-supply balances in the transition to electric mobility*, Publications Office, **2018**.

2. Hydrometallurgical Recycling

COOL-Process [2]

- Leaching with *sc*-CO_2
- Li-Extraction from primary and secondary raw materials
  - lepidolite, zinnwaldite, spodumene
  - **Lithium-Ion-Batteries**
- **Scale-up at IKTS**: from lab scale to pilot scale (15 -200 L)
- Purification/concentration: Solvent extraction, Membrane technology, Precipitation
- Primary Li-product: ***bg*-Li_2CO_3**



[2] Pavón, S.; Kaiser, D.; Mende, R.; Bertau, M. The COOL-Process—A Selective Approach for Recycling Lithium Batteries. *Metals* **2021**, *11*, 259.

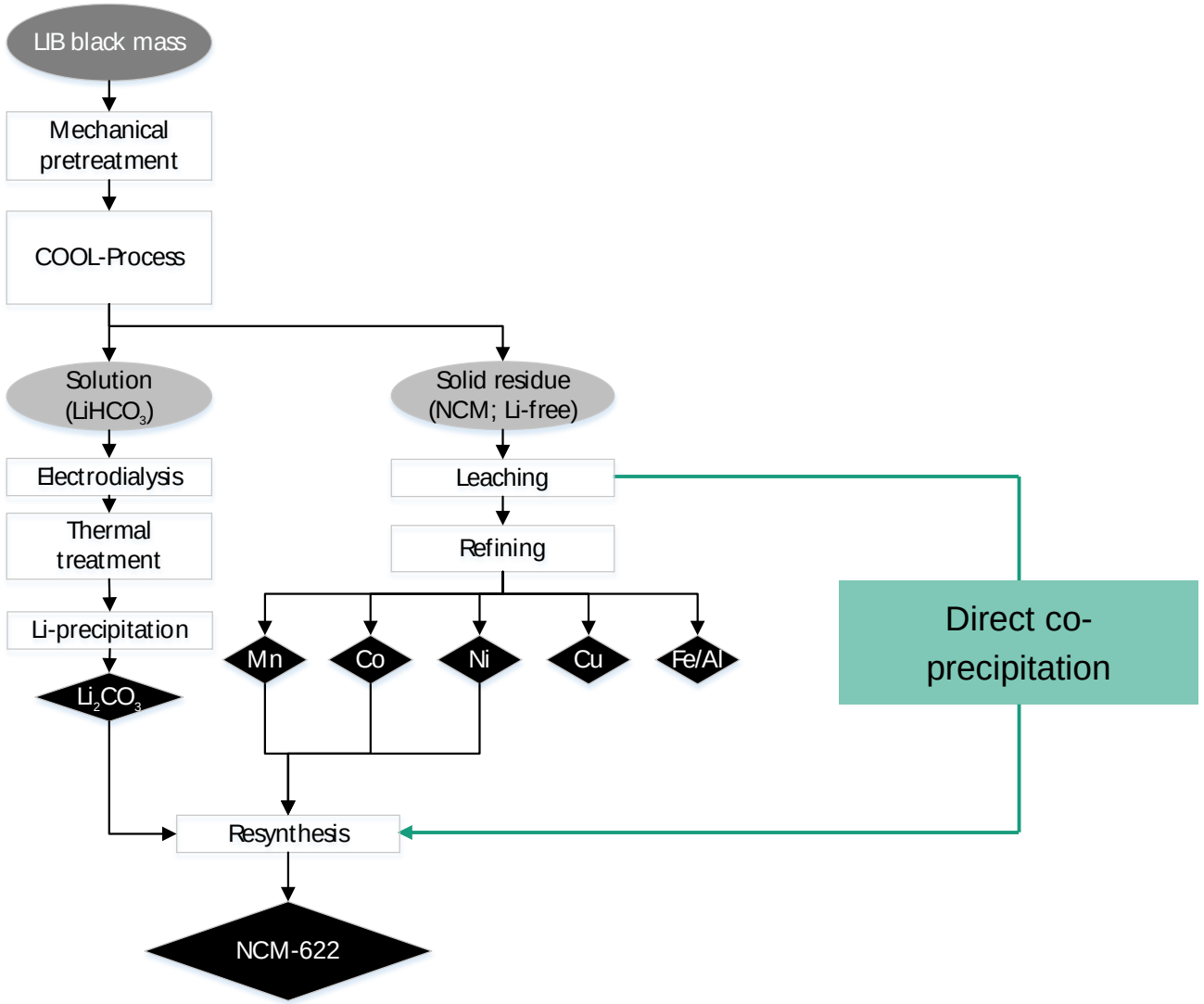
2. Hydrometallurgical Recycling

Closing the loop

Establishment and validation of a robust and flexible resynthesis process of NCM

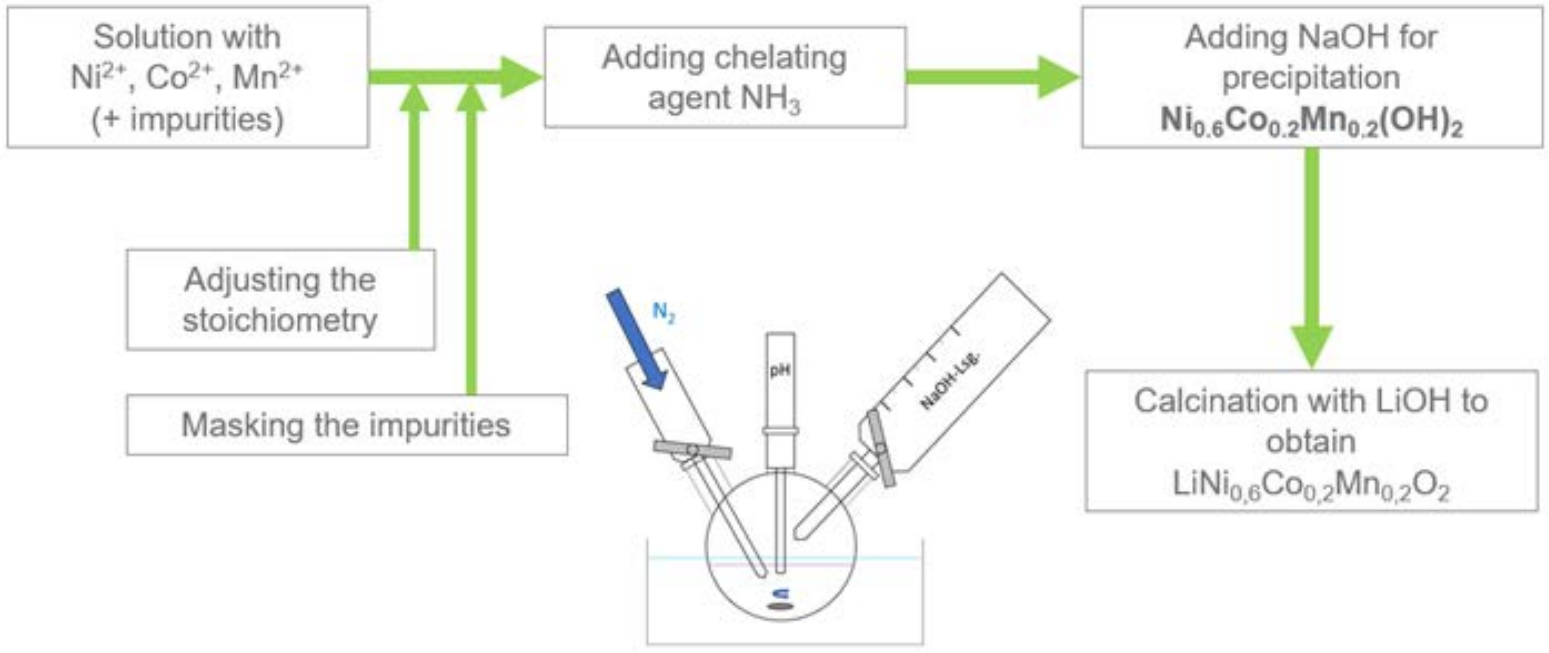
- **Precipitation and calcination of NCM**
- Evaluation of masking strategies
- Selective precipitation

- Avoid refining processes
- Economise the resynthesis process



2. Hydrometallurgical Recycling

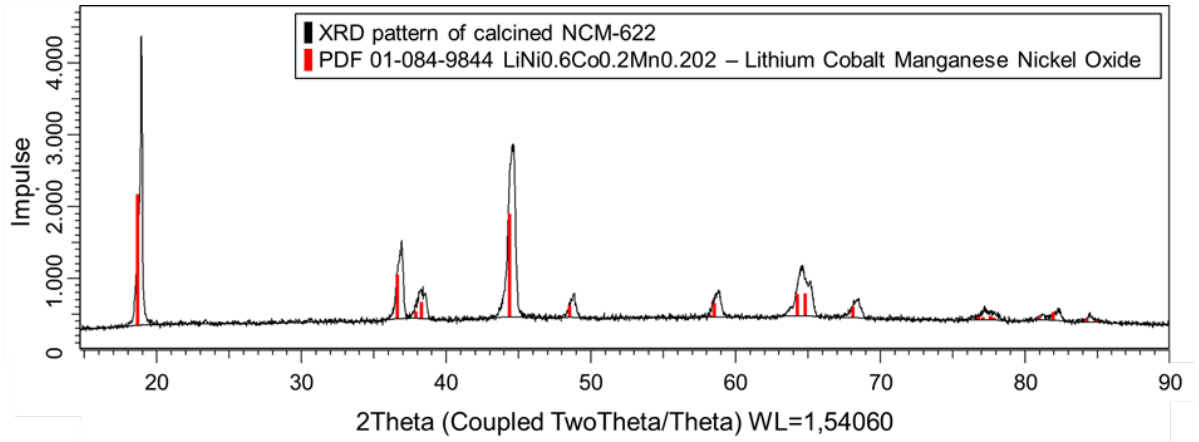
Direct co-precipitation



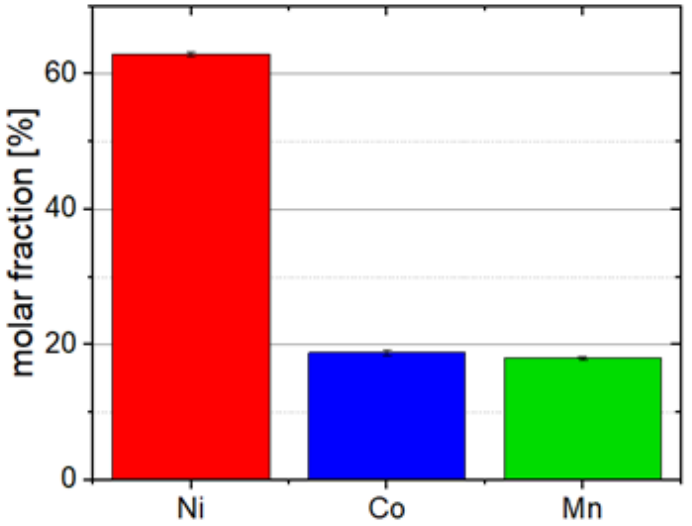
3. Results

Analysis of synthesised Cathode Active Materieal (CAM)

Cristallinity of active materials

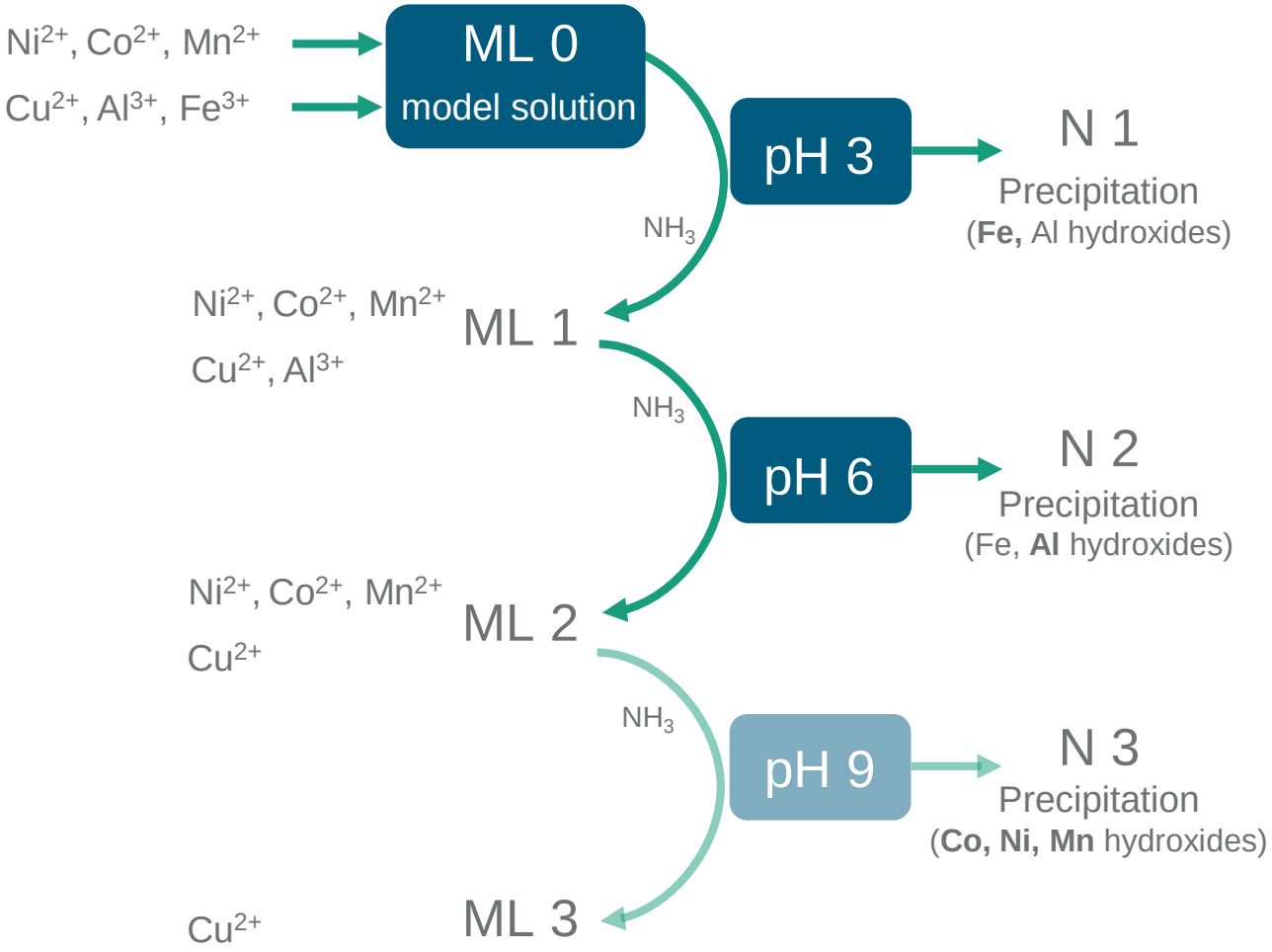


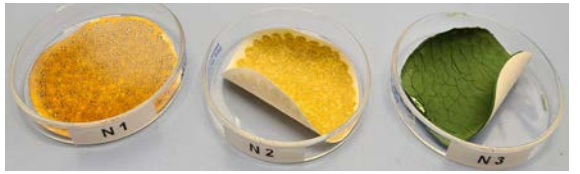
Ratio of Ni:Co:Mn in the precipitated precursors



3. Results

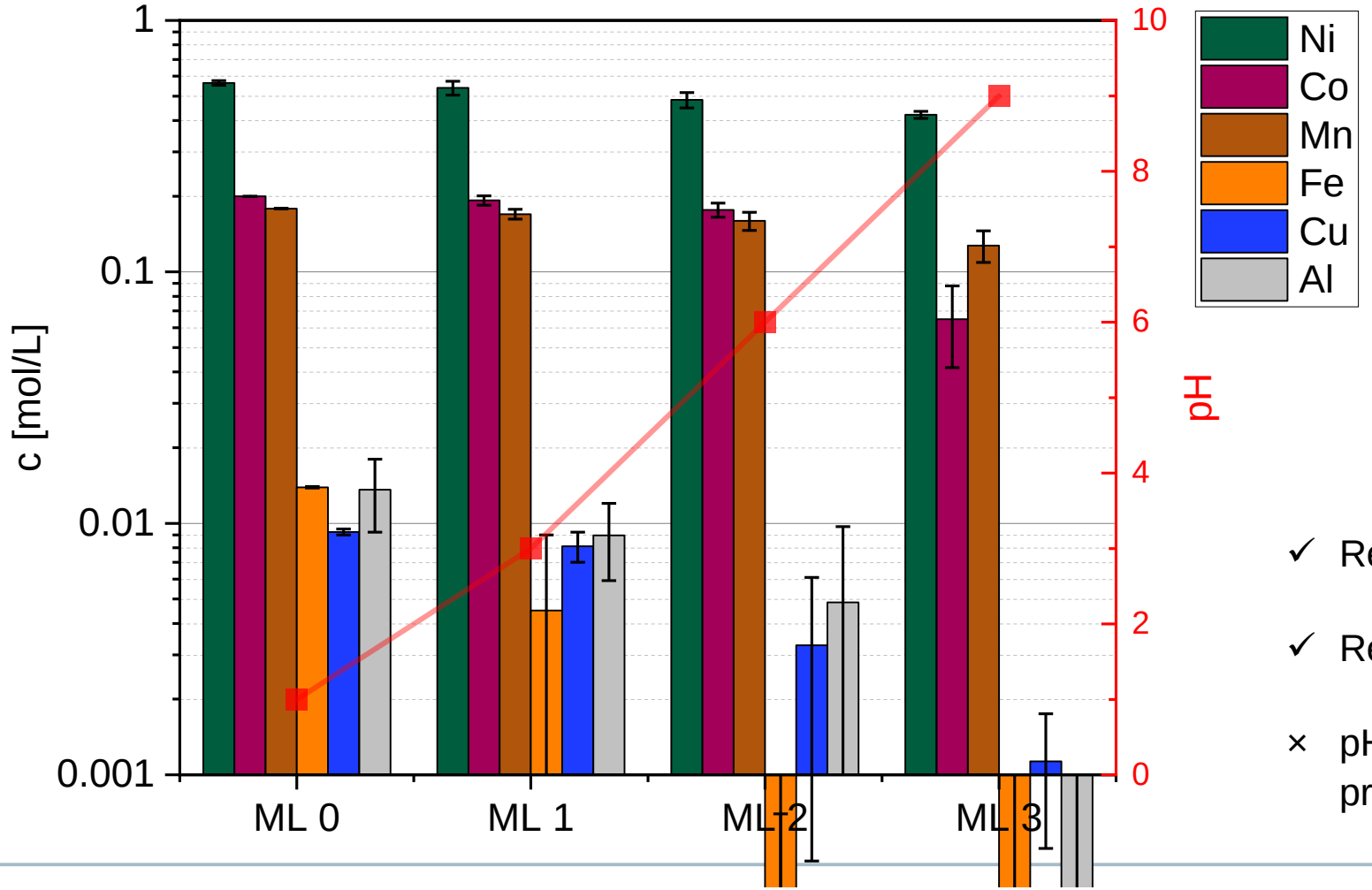
Selective precipitation





3. Results

Selective precipitation



- ✓ Removal of Fe at pH ≥ 3
- ✓ Reducing of Cu and Al content
- × pH > 6: undesirable Co, Ni, Mn precipitation

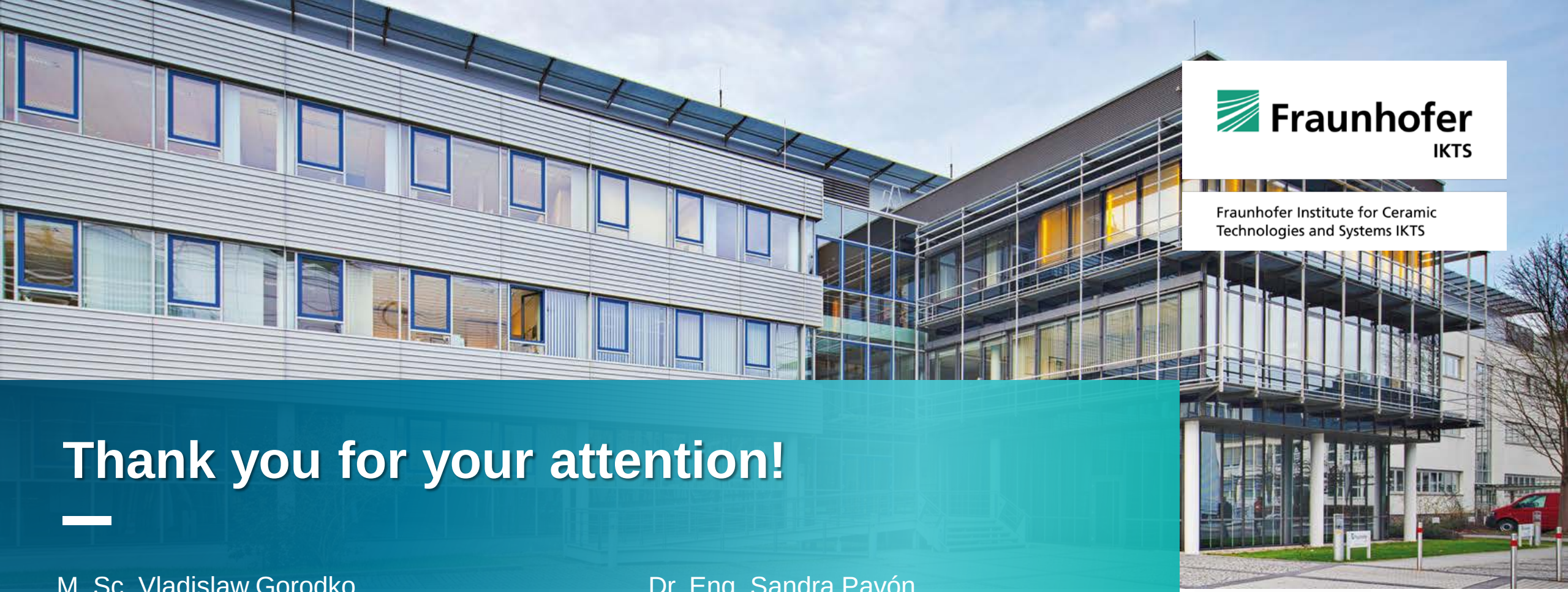
4. Conclusion and Further Research

Conclusions

- ✓ Promising alternative route for closing the recycling loop by direct co-precipitation
  - Selective precipitation of Fe, Al

Further Research

- Cu-Removal: electrochemical processes or complexation
- Evaluation of masking strategies →Tolerable limit of impurities



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Thank you for your attention!

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