NTNU

SisAL Slag

High-purity Alumina from Industrial Slag; Material Processing and its Use in Secondary Li-ion Batteries

Camilla Lian[1], *Matthias Heuer*[2], *Oliver Schüßler*[3], *Andreas Gronbach*[3], *Uwe Guntow*[3], *Andreas Flegler*[3], *Gabriella Tranell*[1] *and Ann Mari Svensson*[1]

[1] NTNU Gløshaugen, Sem Sælands vei 12, 7034 Trondheim, Norway
[2] SiQAl UG, Bosestraße 40, 12103 Berlin, Germany
[3] Fraunhofer ISC, Neunerplatz 2, 97082 Würzburg, Germany

Introduction

High-purity alumina (HPA) is currently the most widely used choice for separator coatings in Li-ion batteries. It is commercially produced by reacting aluminium with alcohol to form alkoxide that is further hydrolysed to obtain the final product, a process which is both highly energy demanding and expensive.[1-3] Here, a possible pathway to obtain HPA from a Si/Al industrial slag mix is presented. Acid leaching and calcination of the alumina by-product aims to produce HPA for use in Li-ion batteries, ultimately maximising the utilisation of the slag while also presenting a potentially less expensive and energy intensive pathway to obtain HPA.

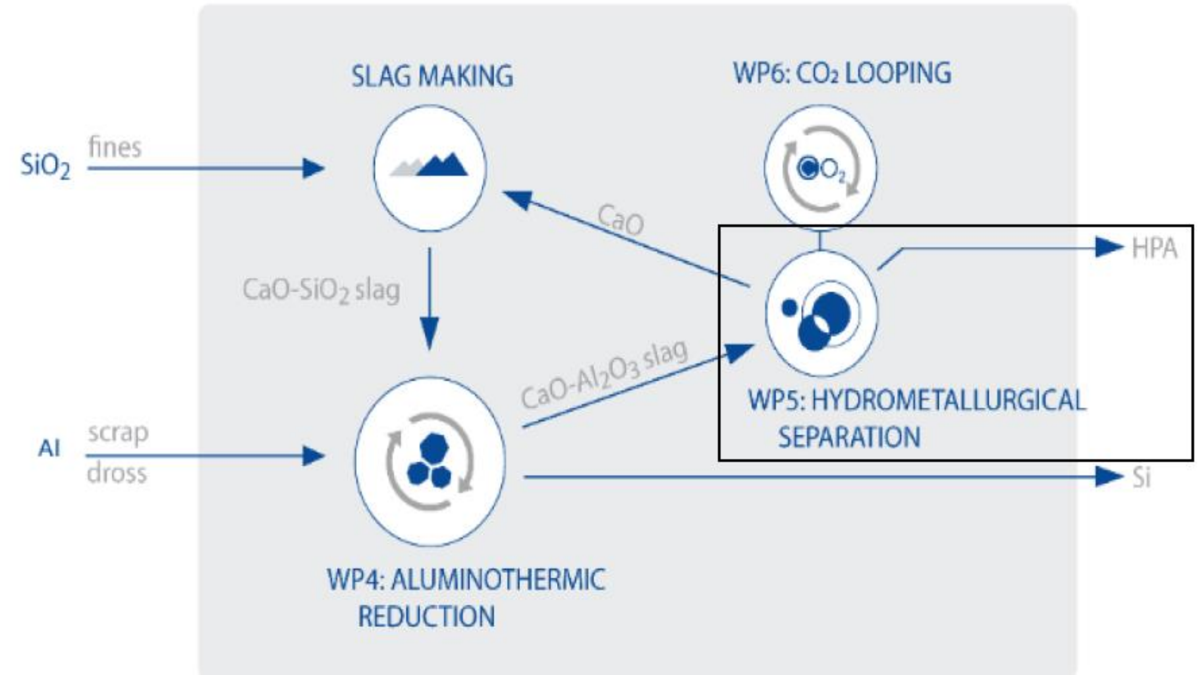

Fig. 1: Schematic representation of the industrial Si/Al slag project, resulting in Si and HPA

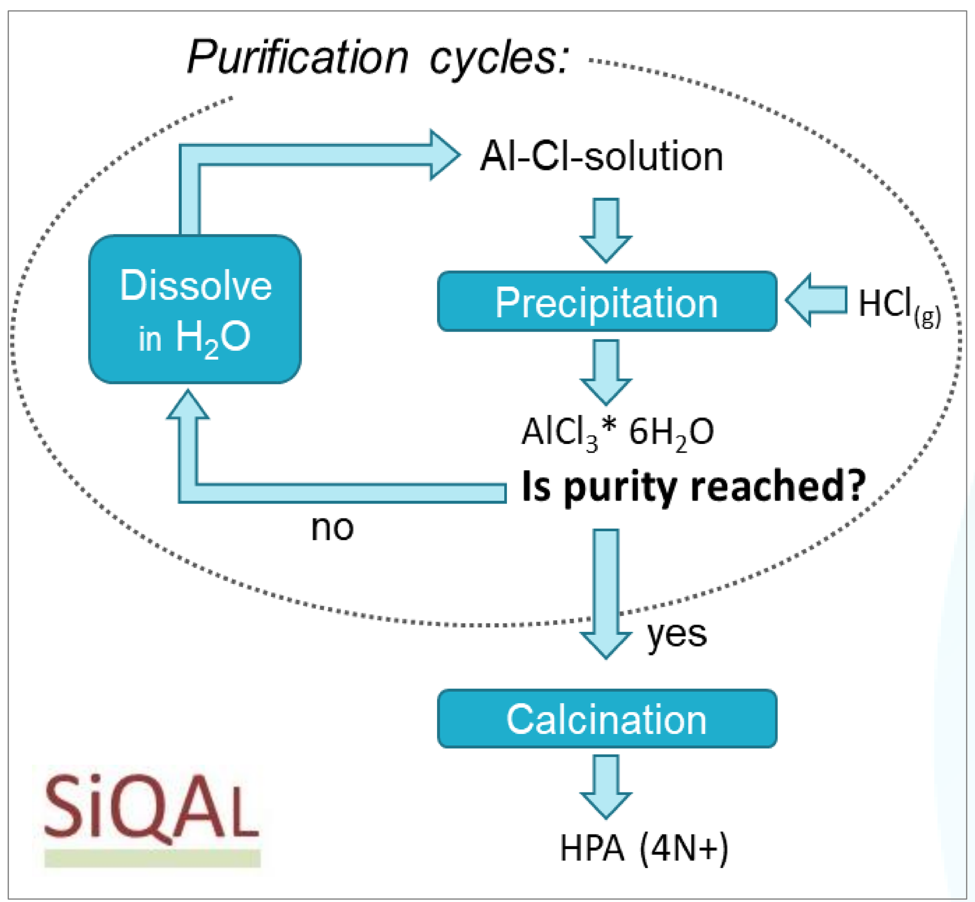

Fig. 2: Purification process(es) to achieve HPA from the Si/Al industrial slag

Methodology

- Slag product from the process in Fig. 1 is purified by several acid leaching steps as shown in Fig. 2
- The purified precursor was calcinated to reach alpha-phase HPA
- The HPA was mixed in an aqueous solution with CMC binder, and coated directly onto a polypropylene separator membrane
- Pouch cells were tested with a 2.0 mAh/cm² NMC622 cathode and graphite anode (Fig. 4)

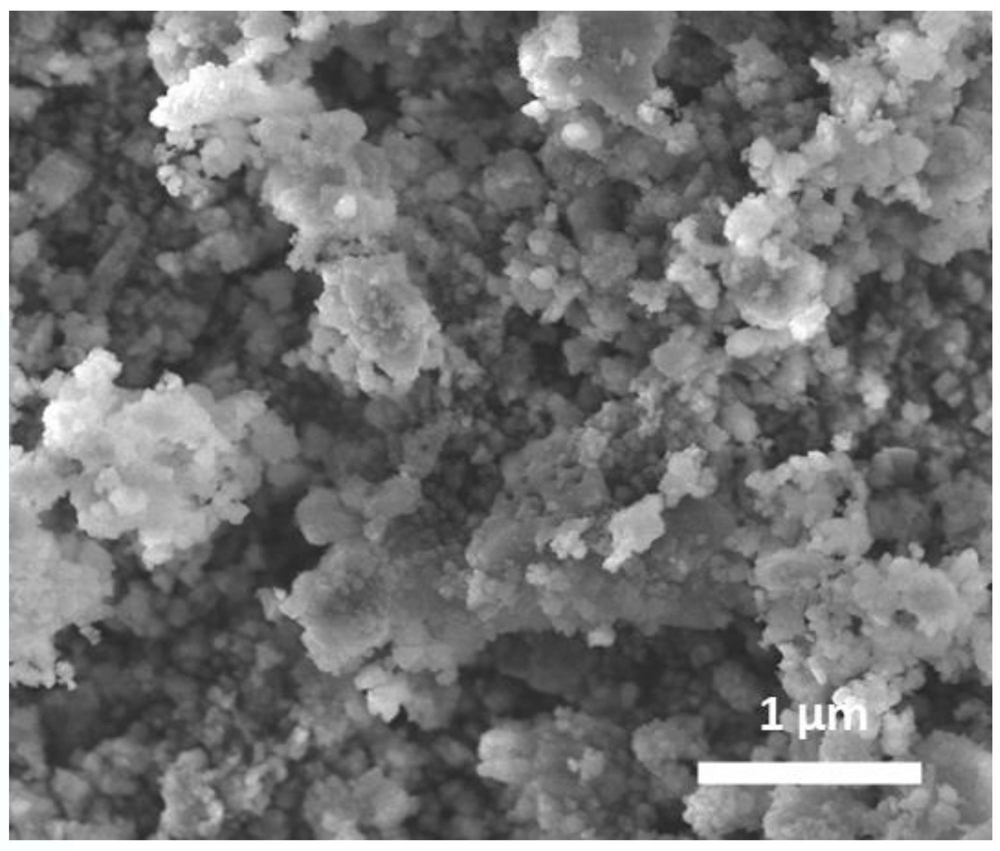

Fig. 3: SEM image of milled alpha-HPA from the SiQAL process in Fig. 2

Results and Discussion

- So far, the purified and calcinated slag product has yielded nanometer-sized grains of HPA (Fig. 3)
- Porosity and grain sizes affect the coating behaviour, and will most likely influence the separator performance
- Well-performing coatings were made with commercial HPA and tested against commercially coated separators (Fig. 4), where the slight difference in discharge capacity is likely due to the thicker coatings obtained with the gamma-phase HPA

Future Work

- Purified HPA from the SiSAL slag process (Fig. 1) will be coated and tested on separator membranes
- Control of the HPA grain morphology and dimensions will be investigated by altering the purification and calcination steps
- Impurity levels will be further investigated and studied for their potentially detrimental effects in Li-ion batteries
- Contact with relevant industry will be required to achieve commercialisation of the SiSAL product and process

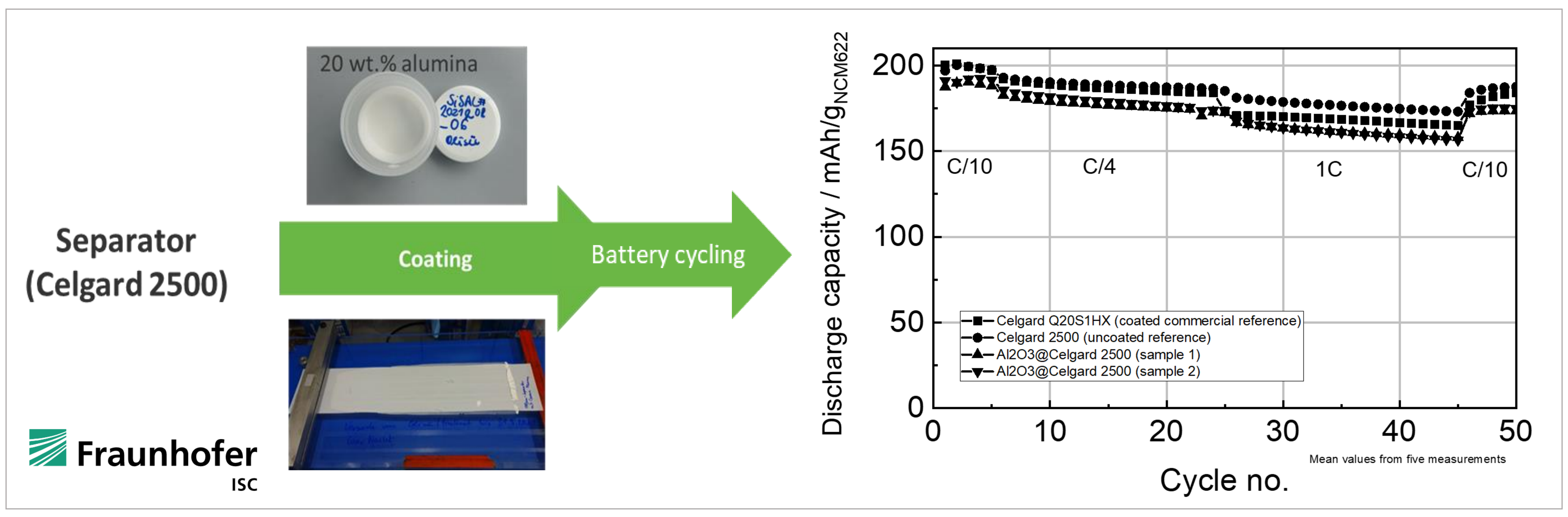

Fig. 4: Coating procedure and cycle data comparing a Celgard coated separator, uncoated separator, and two samples of separators coated in-house with commercial gamma-alumina

References

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[3] P. Smith & G. Power, *Mineral Processing and Extractive Metallurgy Review*, **43** (2021) 747-756.

Acknowledgements

SisAL Slag Valorisation

Kava Reference 20255, D2.2 Upscaling

https://sisalslag.eu/

This activity has received funding from the European Institute of Innovation and Technology (EIT), a body of the European Union, under the Horizon 2020, the EU Framework Programme for Research and Innovation

NordBatt Oct 26-28th 2022
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European Institute of Innovation & Technology

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