

Recycling and Life Cycle Analysis of Aluminium Ion Batteries

Clive Shaw, University of Southampton

Supervisors: Dr. Richard Wills and Prof. Andrew Cruden

Introduction

- The Al-ion battery is relatively new type of battery in the early development stage with very little literature about it.
- The ALION project is a Horizon 2020 EU funded project aiming to develop the Al-ion battery with improved energy density, cost and safety compared to Li-ion batteries.
- Similar to the Li-ion battery, the Al-ion battery works through the concept of the “rocking chair” mechanism, in which Al ions are reversibly intercalated inside the anode and cathode, migrating between the electrodes during charging and discharging [1].
- The aim of this project is to review the literature on battery recycling and LCA and apply it to the Al-ion battery.

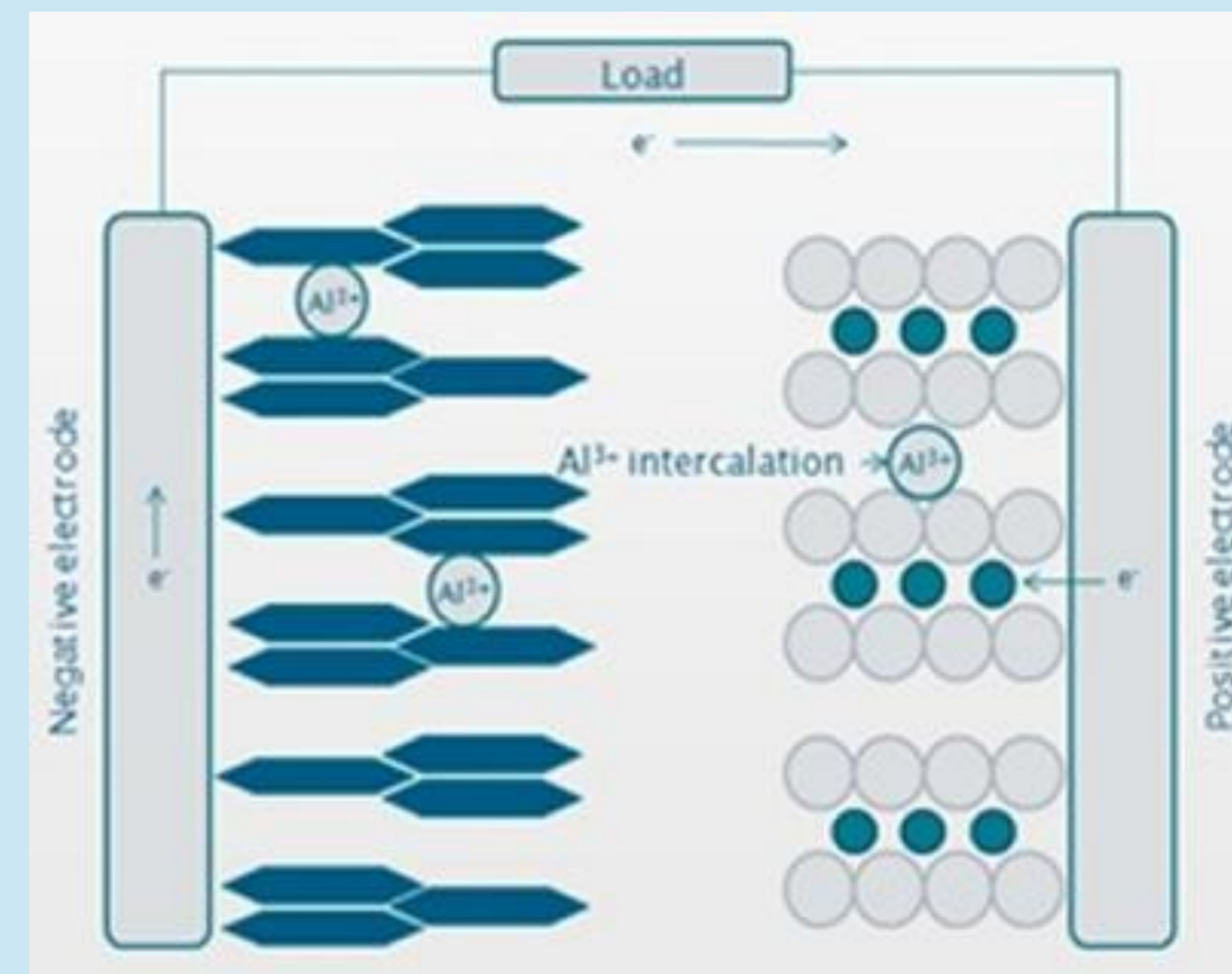


Figure 1: Al-ion battery schematic [1].

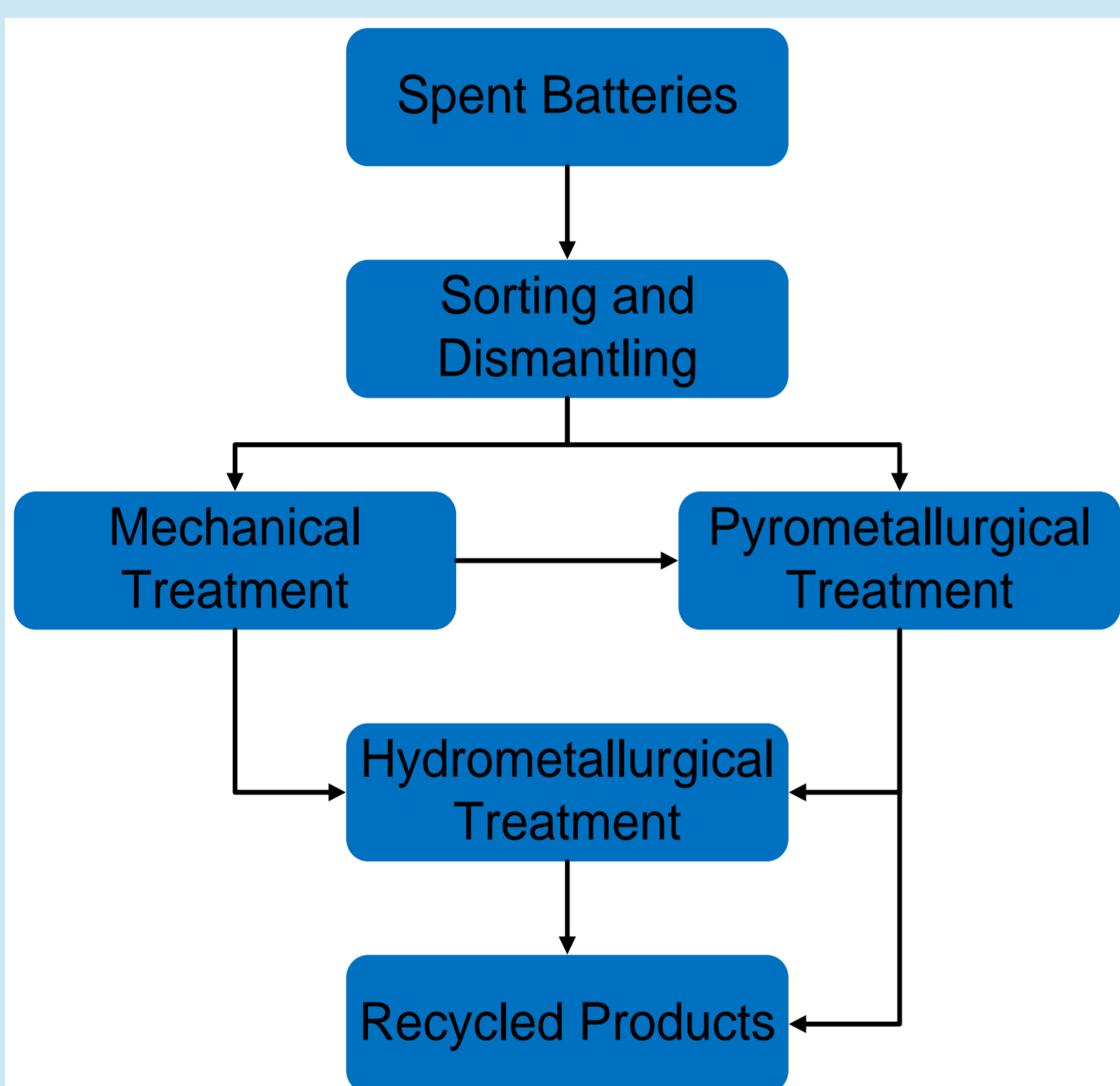


Figure 2: Battery recycling flowsheet.

Battery Recycling

- Although the Al-ion battery is in early development, the aspect of its recyclability can still be considered.
- From assessing the literature on battery recycling, processes can be devised for potential application to Al-ion battery recycling. In addition, issues that cause difficulty for recycling can be highlighted and avoided in Al-ion development.
- Recycling is a necessity to recover materials, reduce waste and save natural resources. However, the recycling process needs to be low energy, environmentally friendly and economic.
- The most successfully recycled battery is the lead-acid, this is because it has a standard shape, design and chemistry, a comprehensive collection network and strict environmental regulations. Additionally, lead has a high recyclability and value.

Life Cycle Analysis

- To develop a sustainable product, the environmental impact of each individual process throughout a product’s life cycle needs to be identified, analysed and evaluated.
- From assessing the literature of battery LCA, key processes in a battery’s life cycle can be highlighted. Thus, in Al-ion development these processes can be considered and developed to reduce their impact or find alternatives.
- For example, although batteries release no emissions at point of use, emissions are released through the electricity required to charge them and raw materials required to make them. Using LCA these processes are identified, analysed and evaluated. Efforts can then be made to reduce those environmental impacts through alternative routes.

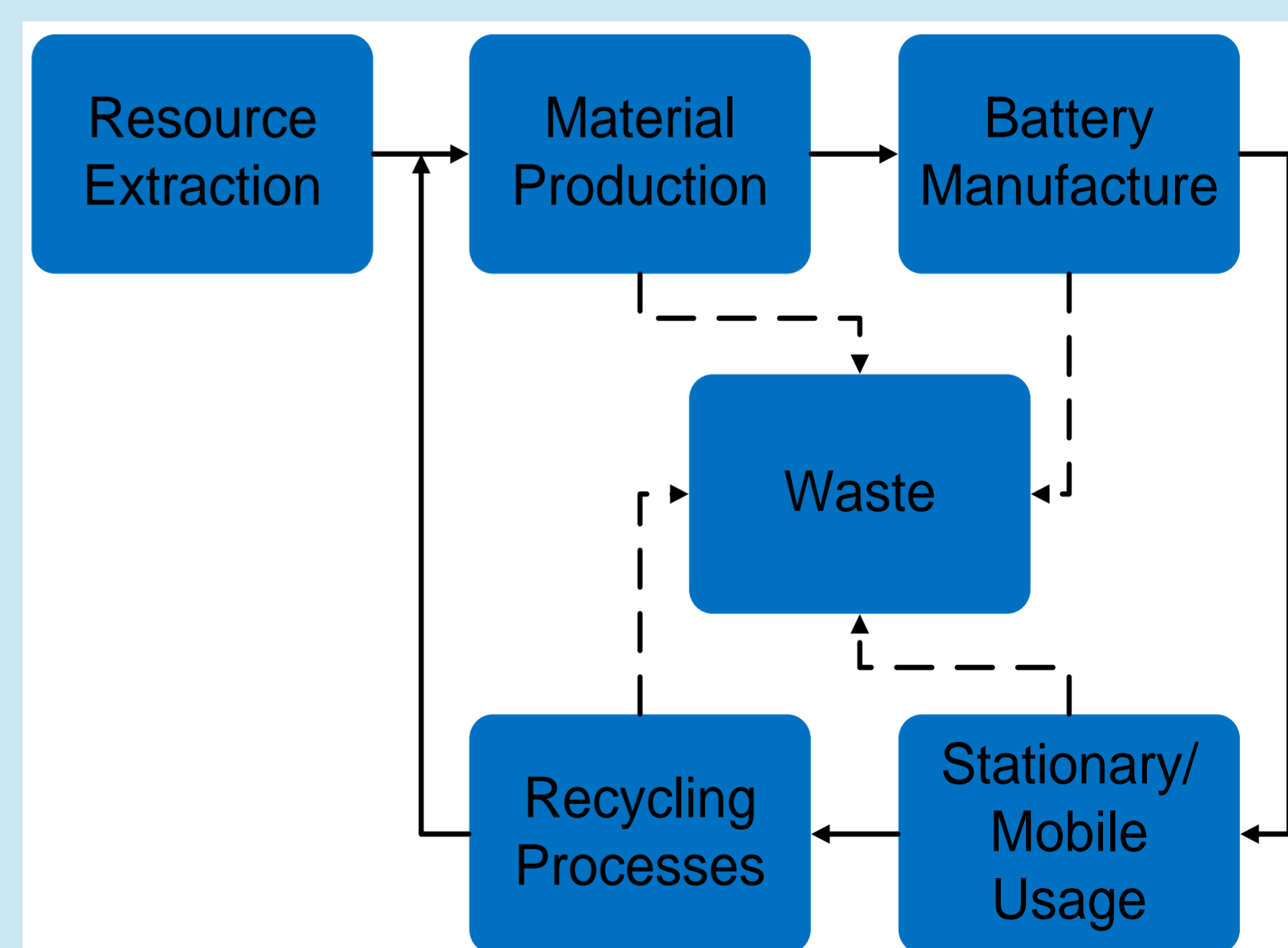


Figure 3: Battery life cycle.

Conclusion

- There are several different processes for recycling batteries.
- Three key areas are standardisation, recyclability and economics.
- Through recycling and LCA, the Al-ion battery can be designed and developed in a way to establish a sustainable product.

References

- [1] University of Southampton (2016); ALION, A Low-Cost Aluminium-Ion Battery. Available at: <http://www.southampton.ac.uk/engineering/research/projects/alion-a-low-cost-aluminium-ion-battery.page>

Future Work

- Experimentation of Al-ion battery components to assess their recyclability.
- Develop a preliminary Al-ion recycling process.
- Develop a LCA for Al-ion batteries.