Probing Gas Degradation Mechanisms in Sodium-Ion Batteries

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Why do we need sodium-ion batteries?

1. Abundant renewable energy sources, how to store them
2. Diversification from lithium-ion batteries, and their toxic, critical components
3. Cheaper, safer and more abundant compared to lithium-ion batteries

Why does the sodium-ion battery work?

Anode- Hard carbon from biomass precursors
Electrolyte- Sodium salt in organic solvent
Cathode- Layered polyanionic materials

Cell Discharge
Voltage
Specific Capacity mAhg⁻¹
Cell Charge

NaPF₆
Na⁺, PF₆⁻

Electrolyte degradation and gas evolution
Irreversible reaction of decomposition products
Solid electrolyte interface(SEI) formation

Loss of sodium inventory, no longer enough sodium ions to fill battery storage capacity
The ideal SEI should be stable, however in sodium ion batteries it can continuously form, causing more electrolyte decomposition and cell degradation

How can we slow down this process and make batteries last forever?

Our Approach: First fully understanding the degradation mechanisms in sodium ion batteries

Step 1. Benchmarking the ECMS cell against coin cell
- More studies on different electrolyte formulation in the ECMS to optimise electrolytes for slower SIB degradation
- Using surface sensitive techniques like (x-ray photoelectron spectroscopy) to investigate the surface of the electrode and determine SEI components

Step 2. Measuring gases evolved during cycling
- Electrolyte degradation and gas evolution has been seen to occur in sodium batteries at open circuit voltage, before charge or discharge
- Ethylene carbonate decomposition is a major contributor to gas evolution and SEI formation in sodium ion batteries

What have we found so far?

- Ethylene carbonate decomposition and gas evolution has been seen to occur in sodium batteries at open circuit voltage, before charge or discharge
- Ethylene carbonate decomposition is a major contributor to gas evolution and SEI formation in sodium ion batteries
- The presence of trace water in electrolyte increases the evolution of gases

Future Work

- More studies on different electrolyte formulation in the ECMS to optimise electrolytes for slower SIB degradation
- Using surface sensitive techniques like (x-ray photoelectron spectroscopy) to investigate the surface of the electrode and determine SEI components

Acknowledgement

I would like to thank the Damian Cummins scholarship for providing PhD funding, the European Research Council, the faraday institution degradation project and spectro-inlets, for their funding and support with the ECMS

Acknowledgement


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