Lithium Ion Batteries with Different Cathode Material

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Abstract

Lithium ion batteries are the most common batteries used in everyday life because of its low maintenance and self discharge ability makes it less than half of nickel-based systems. It has Nominal voltage of 3.6-4.3V which can directly power electronics. It uses cathode, anode and electrolyte as conductor. Currently cathode material used in the batteries are Lithium cobalt oxide. Cobalt is one the hazardous and costly element to mine. In this research we try to find replacement of cobalt with manganese oxide and copper doped manganese oxide.

Why replace cobalt with manganese?
- Easily available
- Can be found in several foods
- Relatively easy to process
- Cheaper in comparison to cobalt
- Environmentally friendly and safe
- High specific energy
- Slurry drying in oven at Higher C rate produces

Background

The layered manganese oxide LiMnO$_2$ is constructed from layers of manganese oxide octahedra
- High working current
- Suitable for discharging in low currents – pulses discharging possibility
- Long shelf life duration – capacity lost 5% a year
- Provides 25% capacity boost

Methodology

Active Material
- Carbon
- Black+PVDF+
- NMP+Cathode

Cell assembly
- 2 drops of electrolyte+cathode=3 drops+ separator+2 drops+2 drops of Lithium+2 stainless steel spacers+spring

Sealing with hydraulic press

Mix cathode slurry until it has a honey like consistency

Cell assembly
- 2 drops of electrolyte+cathode=3 drops+ separator+2 drops+2 drops of Lithium+2 stainless steel spacers+spring

Testing/cycling

Final assembly

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References

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Results

- Used to characterize batteries’ life time behavior
- Number of charge cycles reflect battery cathode stability
- Measures the number of charge and discharge cycles before it loses capacity
- Galvanostatic intermittent titration technique
- Charge-discharge pulse each 10 minutes long, followed by 10 minutes rest
- It tell us how fast Li$^+$ ions move in the CoO$_2$ material
- Diffusion constant can be calculated
- High Li$^+$ diffusion can lead to higher power density
- Transport properties of lithium can be obtained

Conclusion

- Making slurry with different doctor blade setting gave us the better visualization of discharge capacity vs cycle number
- More thick slurry gave us high discharge capacity but less cycle number
- NMP and PVDF mixing does not require vortexing it dilutes itself in 30-50 minutes
- Possible parameters for improving batteries have been eliminated (NMP concentration with 30% more, using 1/5 of active material to make areal loading 5 times less).