Optimization of LiMnPO4 Using Solid State Processes

Charles F. Oladimeji, Pedro L. Moss, Mark H. Weatherspoon

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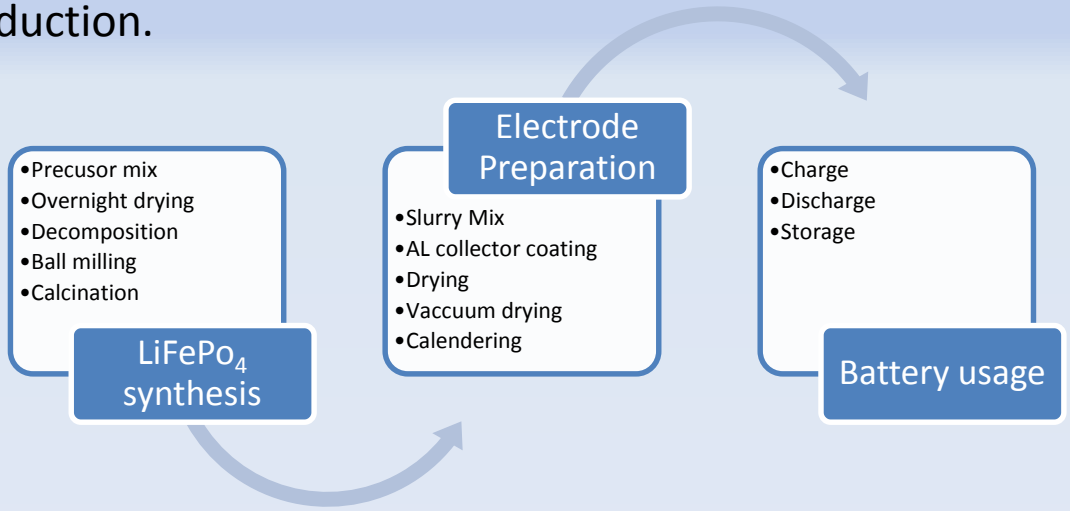
Introduction

$LiMnPO_4$ has an operating voltage of 4.1V and theoretical specific capacity of 170mAh/g. The downsides to the chemistry are the low electronic conductivity, large volumetric change, Jahn-Teller distortion etc.
Particle size reduction, coating, and doping have been reported as ways of improving the performance of the battery.

Solid state synthesis is a common synthesis method for preparing ceramics that have been adopted to making of battery materials. It involves heating the precursor at a very high temperature for reactions to occur.
The advantage of this method is its simplicity and ease of scalability for commercial production.



Experimental

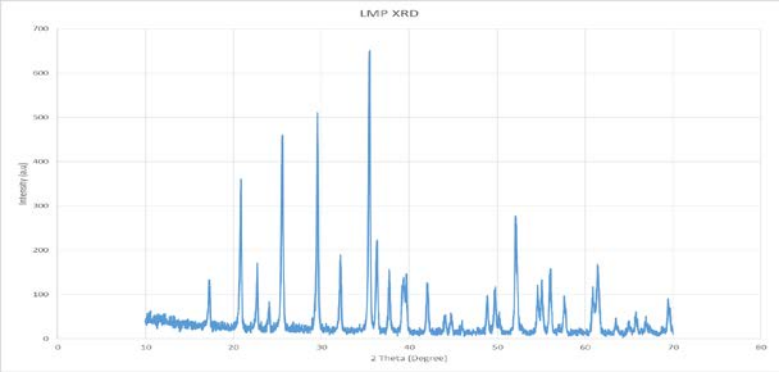
The carbon addition process during solid state synthesis varies in published literature. The objective of this experiment is to investigate the effects on performance.

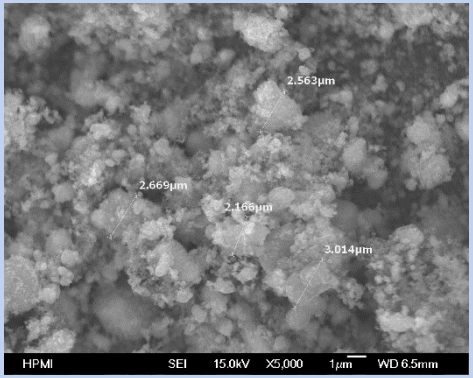
- $NH_4H_2PO_4$, Li_2CO_3, and $MnCO_3$ and $C_{12}H_{22}O_{11}$ were mixed by ball milling
- The mixture was decomposed at 350°C for 8hrs
- Ball milled again for 5 hours at 500 RPM
- Finally heated for 10 hours at 700°C for calcination
- Final product (LMP) mixed with carbon and PVDF

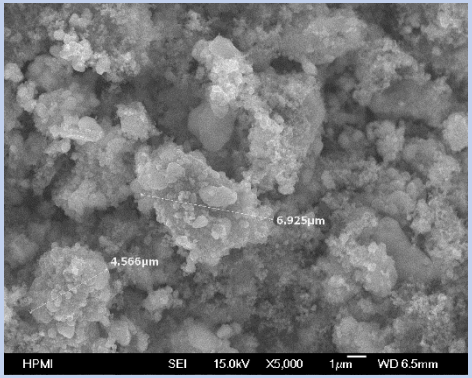
3 STEPS CARBON ADDITON
10 % sucrose during precursor mix
5% carbon black during high speed ball milling
5% carbon black final product mix

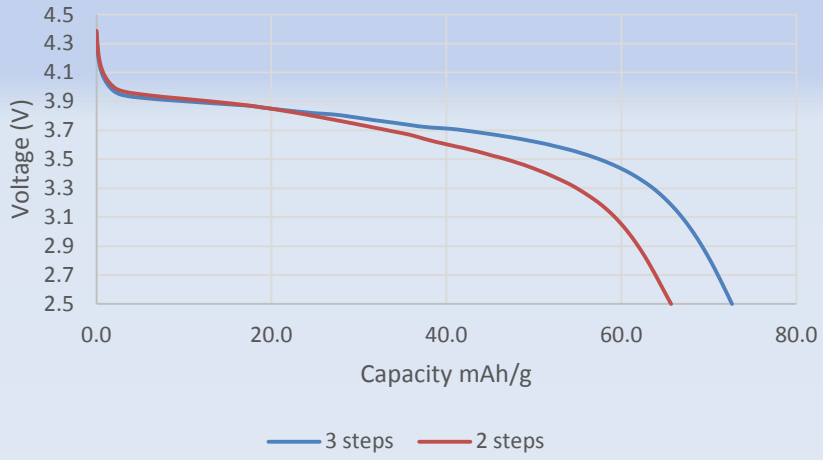
2 STEPS CARBON ADDITION
10 % sucrose during precursor mix
10% carbon black final product mix

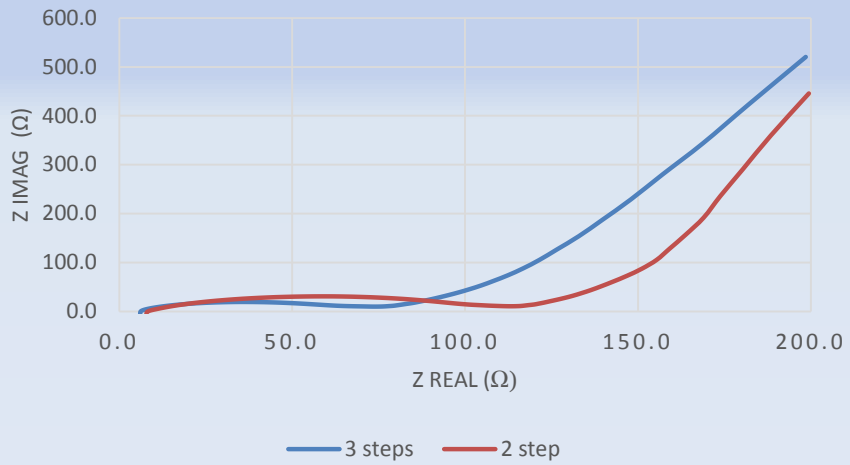
Results


LMP XRD
2 Theta (Degree)


2.563µm
2.669µm
2.166µm
3.014µm
HPMI SEI 15.0kV X5,000 1µm WD 6.5mm


6.925µm
4.566µm
HPMI SEI 15.0kV X5,000 1µm WD 6.5mm


1ST DISCHARGE
Voltage (V)
4.5
4.3
4.1
3.9
3.7
3.5
3.3
3.1
2.9
2.7
2.5
0.0
20.0
40.0
60.0
80.0
Capacity mAh/g
3 steps
2 steps


CARBON ADDDITION PROCESS
Z IMAG (Ω)
600.0
500.0
400.0
300.0
200.0
100.0
0.0
0.0
50.0
100.0
150.0
200.0
Z REAL (Ω)
3 steps
2 step

Conclusion

- More ball milling is need to reduce the particle size and agglomeration in the powder.
- The carbon addition process has a significant effect on the capacity and impedance of the battery.
- More attention should be paid to the carbon addition process.