Analysis of effect of PC/DEC 1:1 LiPF6 1M + furanone 1.5wt% based electrolyte by LiBF4 addition

(PC/DEC 1:1 LiPF6 1M + furanone 1.5wt% 기반 전해액의 LiBF4첨가에 따른 영향성 분석)

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Introduction & Objective

❖Backgrounds.

: As the tremendous growth in electric battery industry, lithium-ion battery must be needed thermal stability for low and high temperature conditions and high efficiency conditions.

❖1st Previous Study.

: New PC/DEC electrolyte system improving the LIB low temperature performance.
Electrolyte : $PC/DEC + LiPF_6 + Furanone + FEC(Fluoroethylene\ Carbonates)$.

- Increase the thermal stability.
- Not good SEI(Solid Electrolyte Interface) layer.
- Severe capacity drop at rapid discharge rate.

❖ SEI layer can prevents the decompositions of the electrolyte components and plays a fundamental role in the cycle life and safety of LIBs.

❖2nd Previous Study.

Electrolyte : $EC/DEC + LiPF_6 + LiBF_4 + FEC$

- The absorbed BF_4 anion affected the SEI layer formation.
- The SEI layer has a great thermal stability, and that the thermal stability was far superior to the other systems.

❖Our Approach.

Electrolyte : $PC/DEC + LiPF_6 + LiBF_4 + Furanone.$
($with\ NMC$ − Graphite Electrode.)

- To solve the capacity drops at rapid discharge rate.
- To find more stable PC electrolyte System.

Experiment.

❖ Cathode : Graphite
❖ Anode : NCM
❖ Ref : PC:DEC 1:1 $LiPF_6$ 1M + Furanone 1.5wt%

❖Formation Test. (LiPF6 : LiBF4)

- 1st Charge & Discharge : 0.0V~4.5V and 4.5V ~ 3.0V.
- 2nd Charge & Discharge : 3.0V ~ 4.5V and 4.5V ~ 3.0V.
- 3rd Charge & Discharge : 3.0V ~ 4.5V and 4.5V ~ 3.0V.
- Check the capacity of battery & SEI layer formation peak from dQ/dV graph.

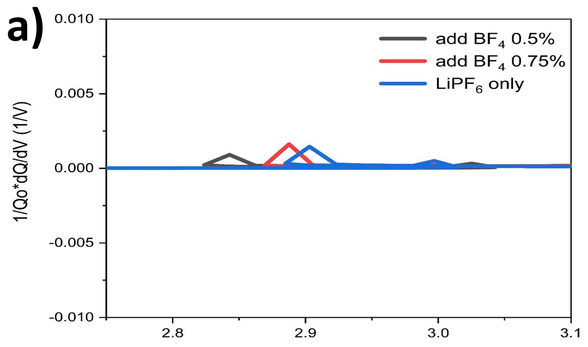
❖Rate Test.

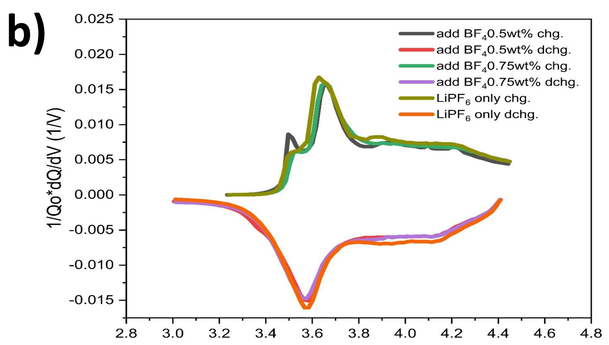
- 0.5C Charge & Discharge.
- 1C Charge & Discharge.
- 1C Charge & 2C Discharge.
- Check the high-rate performance of battery.

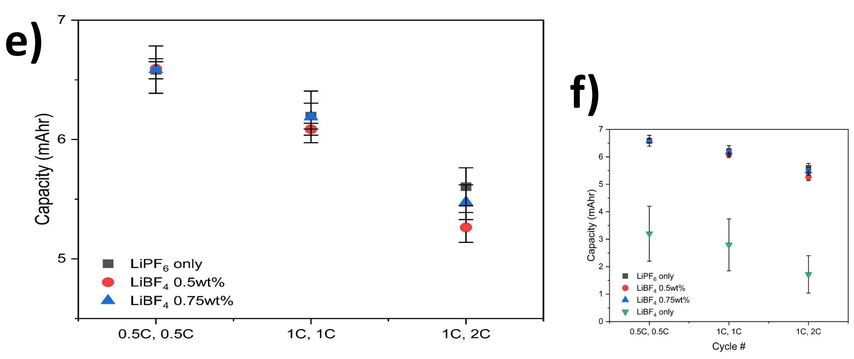
❖ EIS(Electrochemical Impedance Spectroscopy).

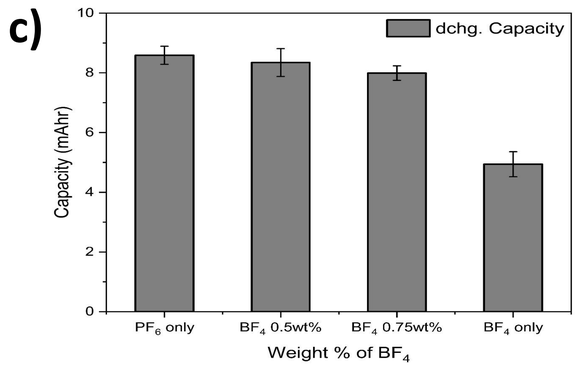
- Frequency : 2000kHz~20mHz
- Amplitude : 10mV
- Layer's performance prediction through Rct, and Rf.
- Check layer damage, etc.

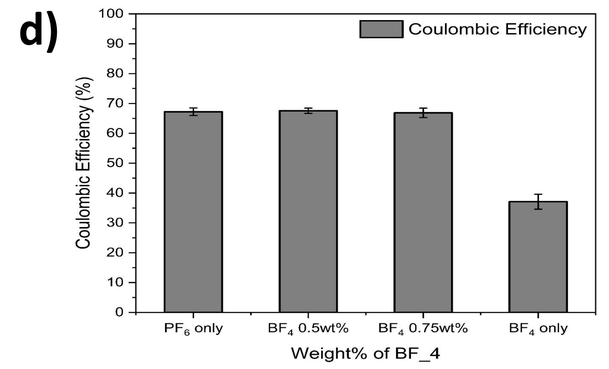
Results & Discussion.

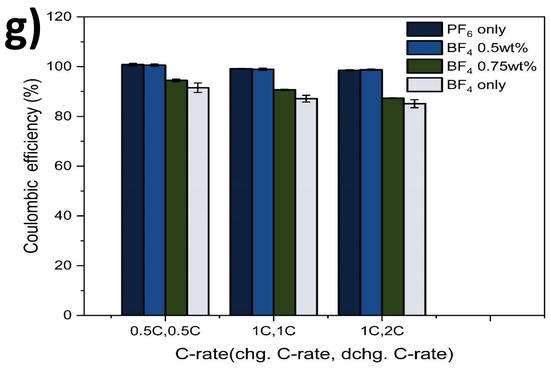






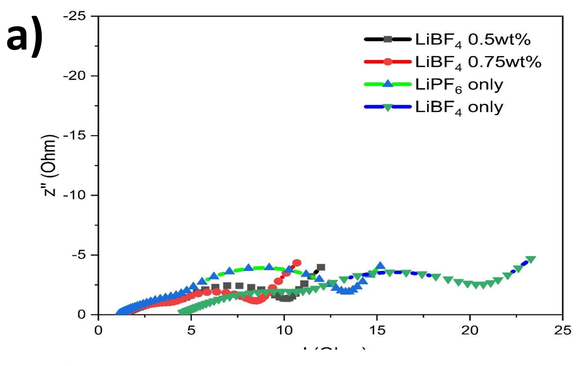


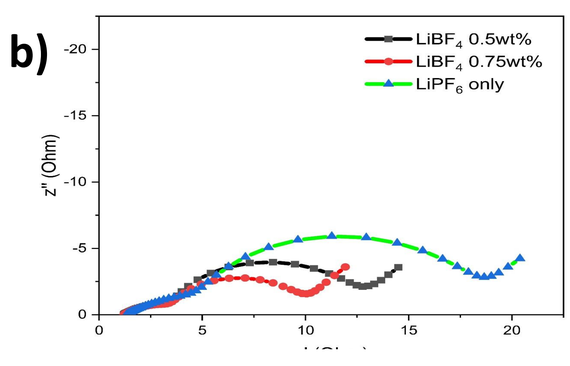


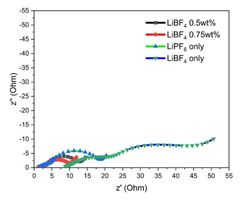


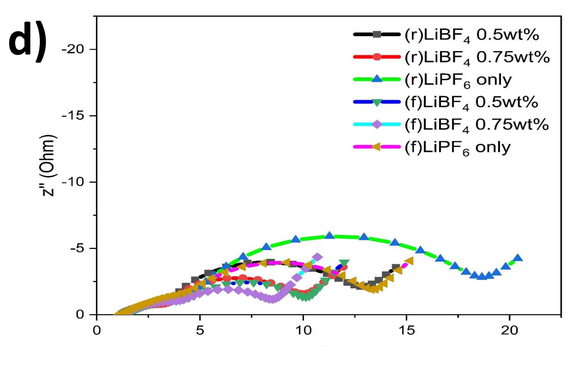
a) SEI formation peak of each composition b) dQ/dV graph of 2nd charge & discharge of each composition c) Initial discharge capacity of each composition d) Initial discharge efficiency of each composition e) Discharge capacity of each C-rate.(except $LiBF_4$ only composition) f) Discharge capacity of each C-rate g) Discharge efficiency of each C-rate

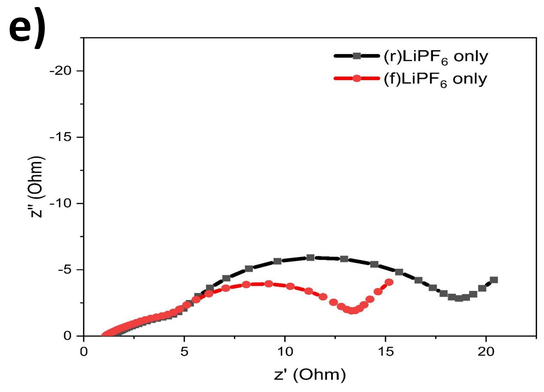
Electrochemicla Impedance Spectroscopy.

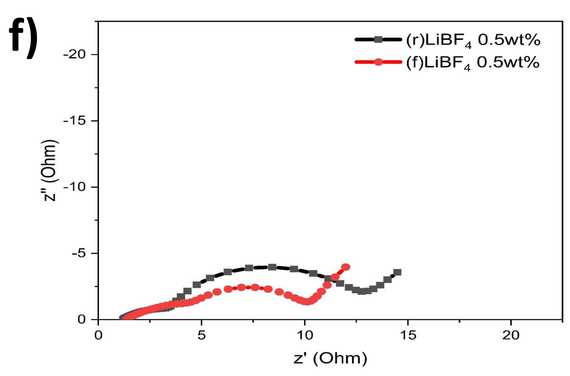


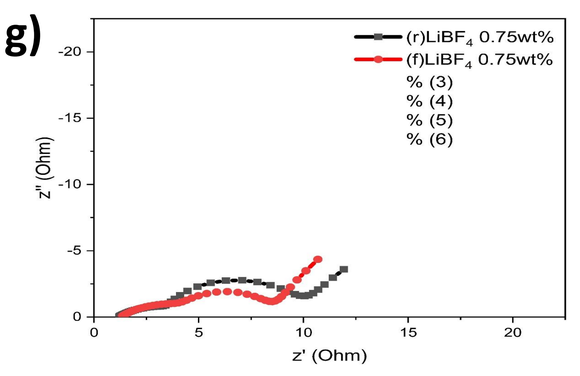












a) After formation, b, c) After rate test, d) Comparison of EIS results before and after rate test. e) EIS results of $LiBF_4$ 0.5wt%, composition after formation & rate test, f) EIS results of $LiBF_4$ 0.75wt% composition after formation & rate test , g) . EIS results of $LiPF_6$ only composition after formation & rate test,

Conclusion

- As a result of EIS analysis, it can be seen that the resistance of the SEI layer of 0.75wt% BF4 is reduced, which can be expected to increase the lifespan when a battery is fabricated with 0.75wt% BF4 as an electrolyte.
- The difference in rate performance did not widen significantly. Considering that the initial discharge capacity fell, it can be seen that adding BF4 showed better performance in the rate test.
- Therefore, if BF4 addition conditions are optimized, a battery with good high-rate performance can be developed without performance degradation at low temperature and high temperature.