

New Hybrid Capacitor Using Discharge Graphite-Fluoride/Li Primary Battery

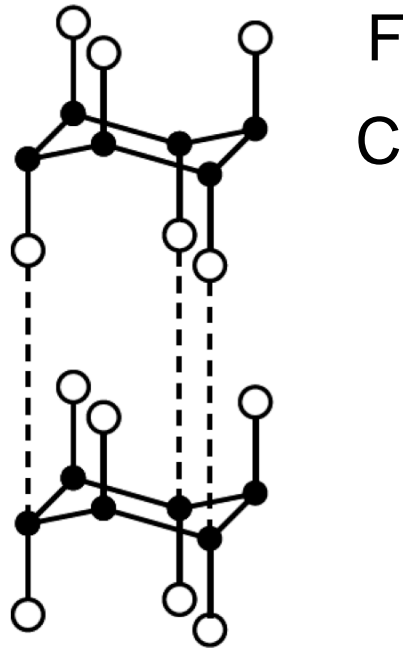
(II)

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Graphite Fluoride

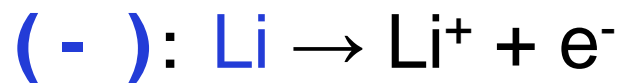


$(CF)_n$, Stage I

- **Graphite- Fluorine Intercalation Compound**
- **Lubricant**
- **Cathode Material (Li primary battery)**

Y. Sato, K. Itoh, R. Hagiwara, T. Fukunaga, and Y. Ito, *Carbon*, **42**, 2897 (2004).

Graphite Fluoride -Li Primary Battery



- High Voltage : ~3V
(high energy density)
- Wide Operation Temp. : -40~80°C
- Small Self-discharge (long life)

Watch, Utility meter, Float for fishing, etc.

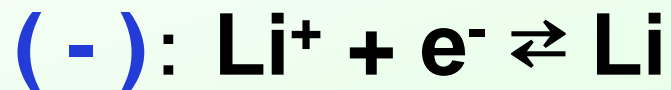
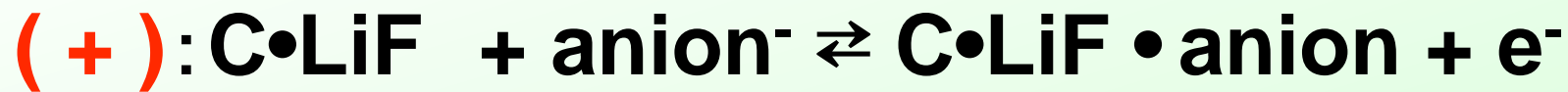
Points

Discharged product of positive electrode of GF-Li primary battery is **similar** to **the chemically defluorinated GF**, lamella-like carbon, **showing the high capacitance**).

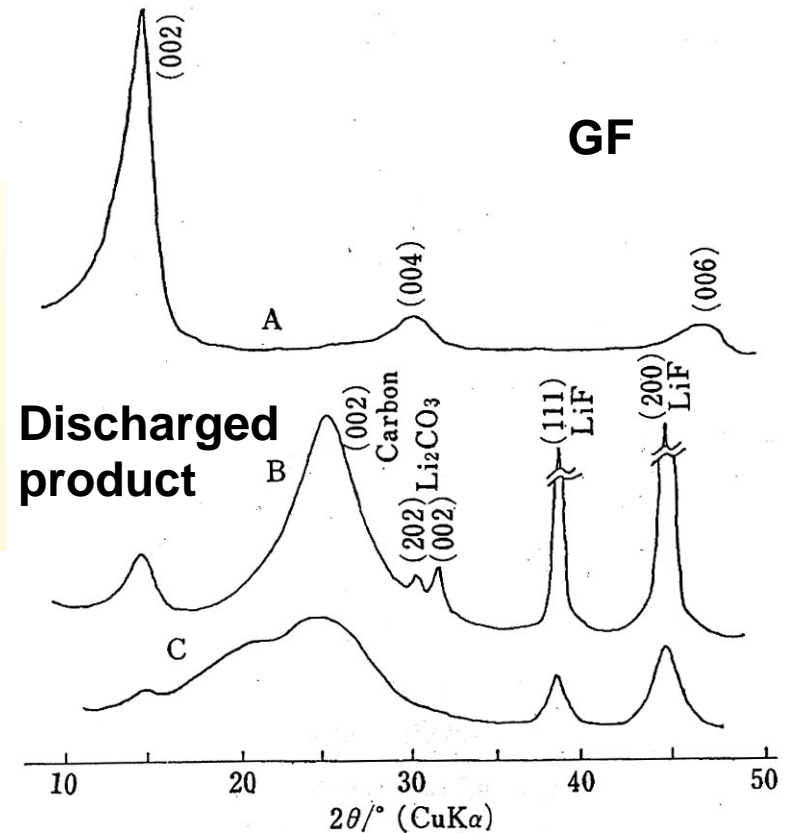
H.Touhara, et al., *Solid State Ionics*, **14**, 163 (1984). →

Idea

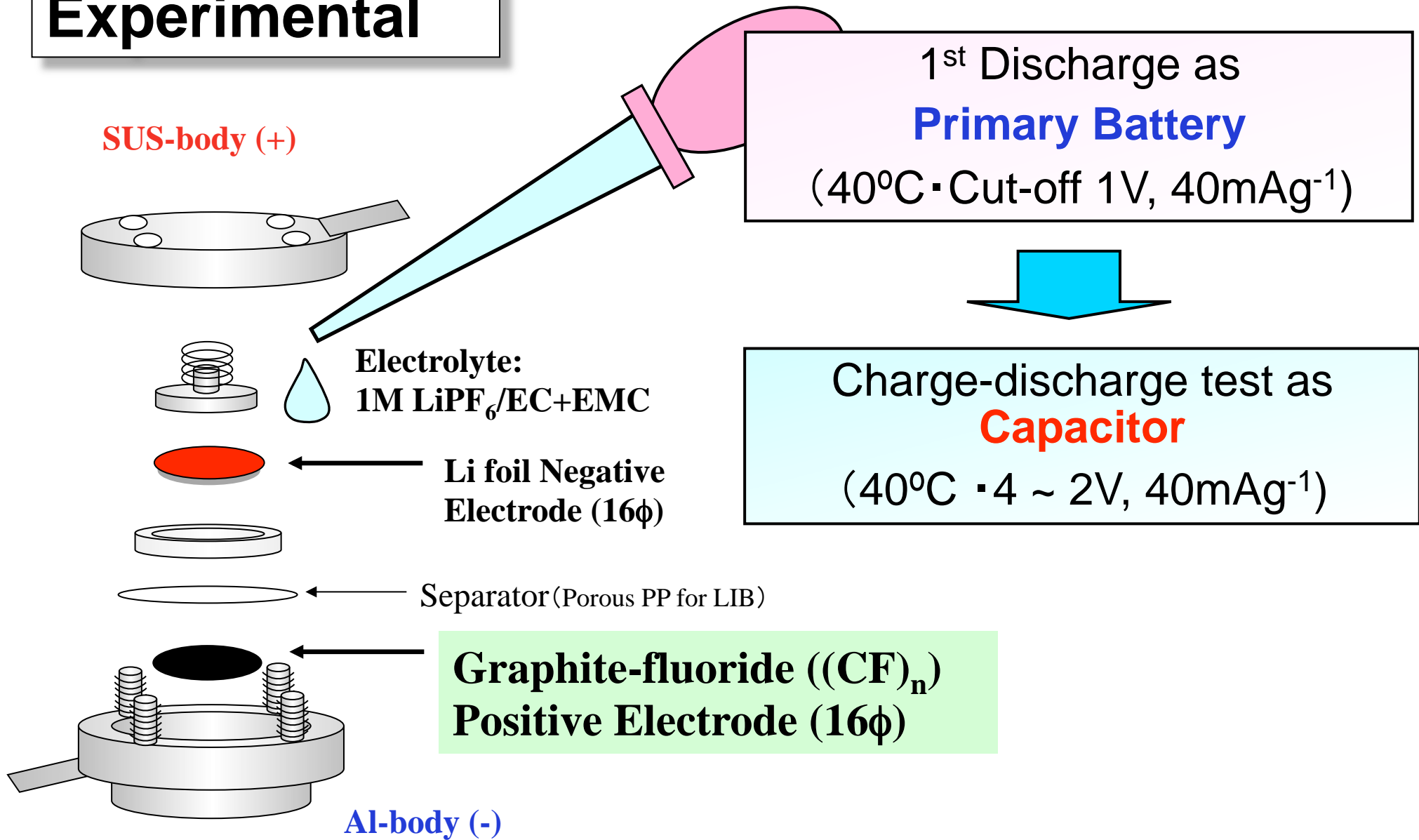
This point suggests that the following charge-discharge reaction as **capacitor** proceeds after discharging GF-Li primary battery.



In fact, the **discharged GF-Li primary battery** works as **hybrid electrochemical capacitors**.

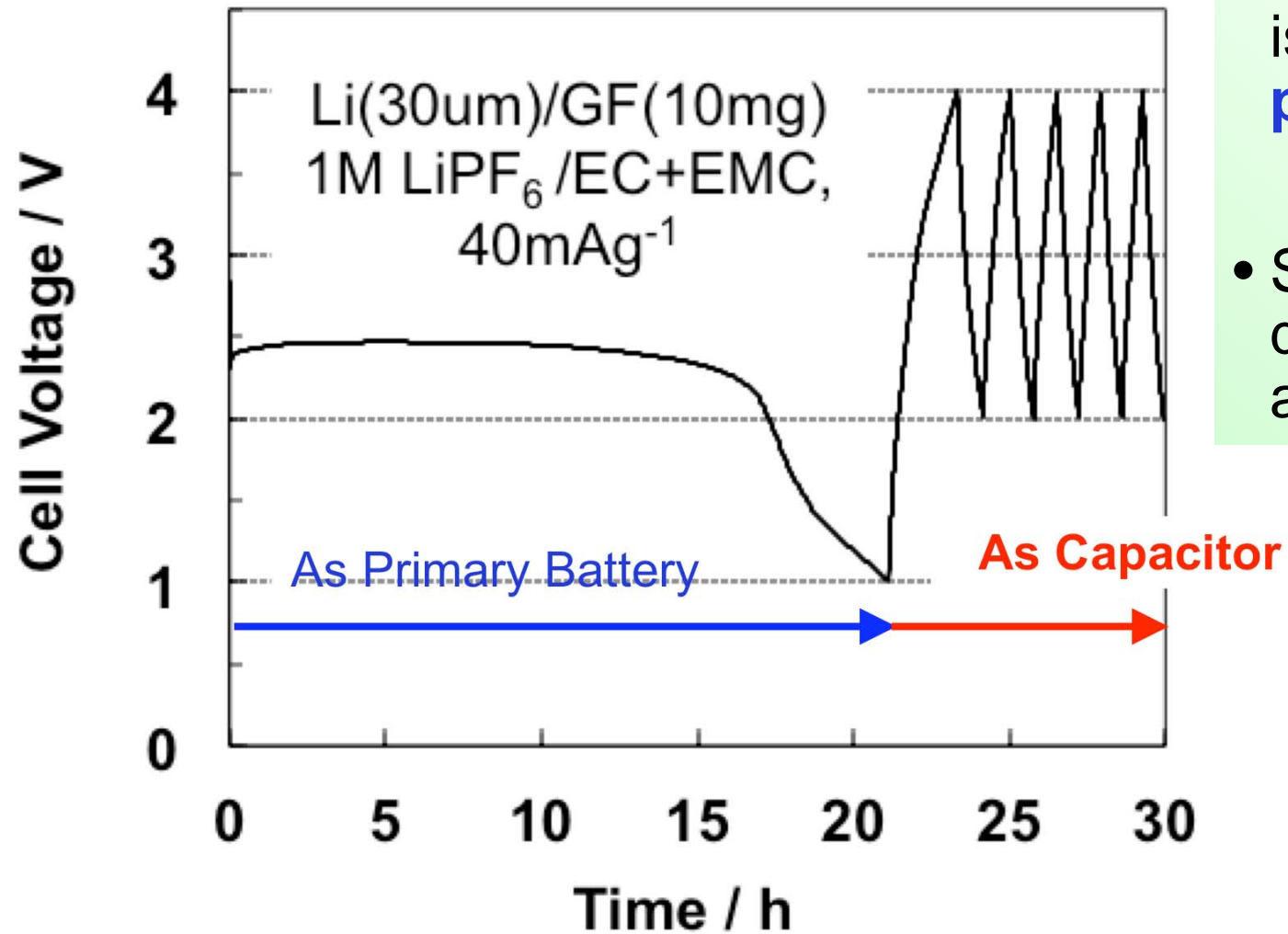


Experimental



Sealed Cell of (CF)_n-Li Primary Battery

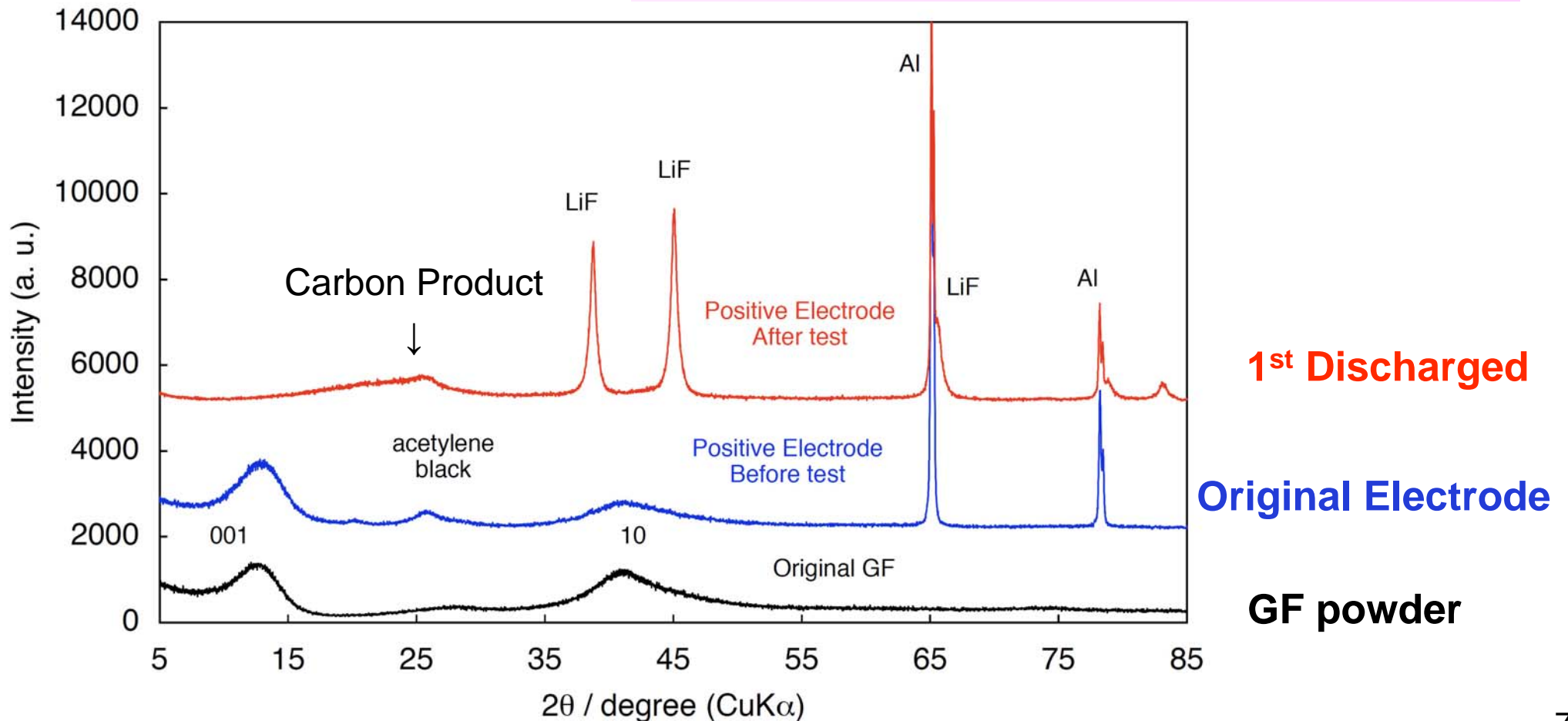
Result (Charge-discharge Curve)



- 1st discharge curve is typical for (CF)_n-Li **primary battery**.
- Subsequent charge-discharge curves are **capacitive!**

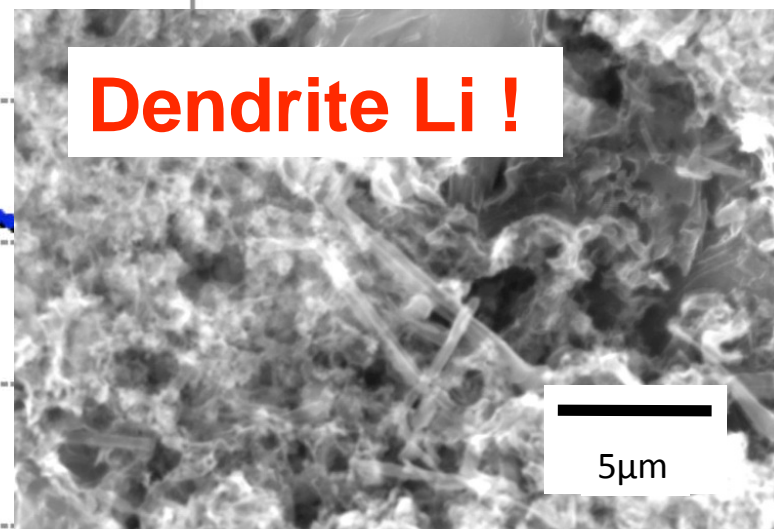
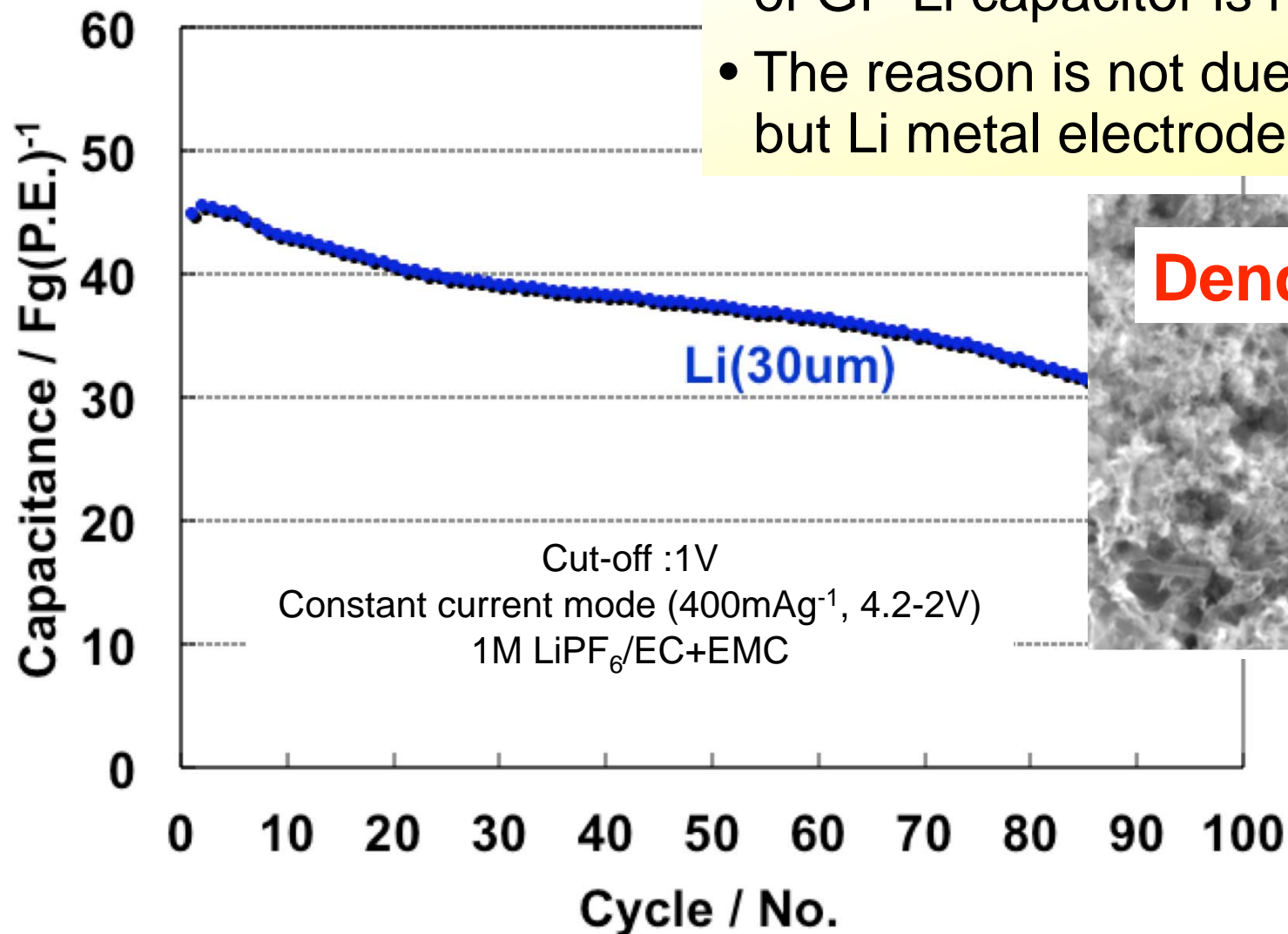
Result (XRD of GF positive electrode)

After 1st discharge, GF diffraction lines disappeared, and LiF lines and weak carbon halo appeared.

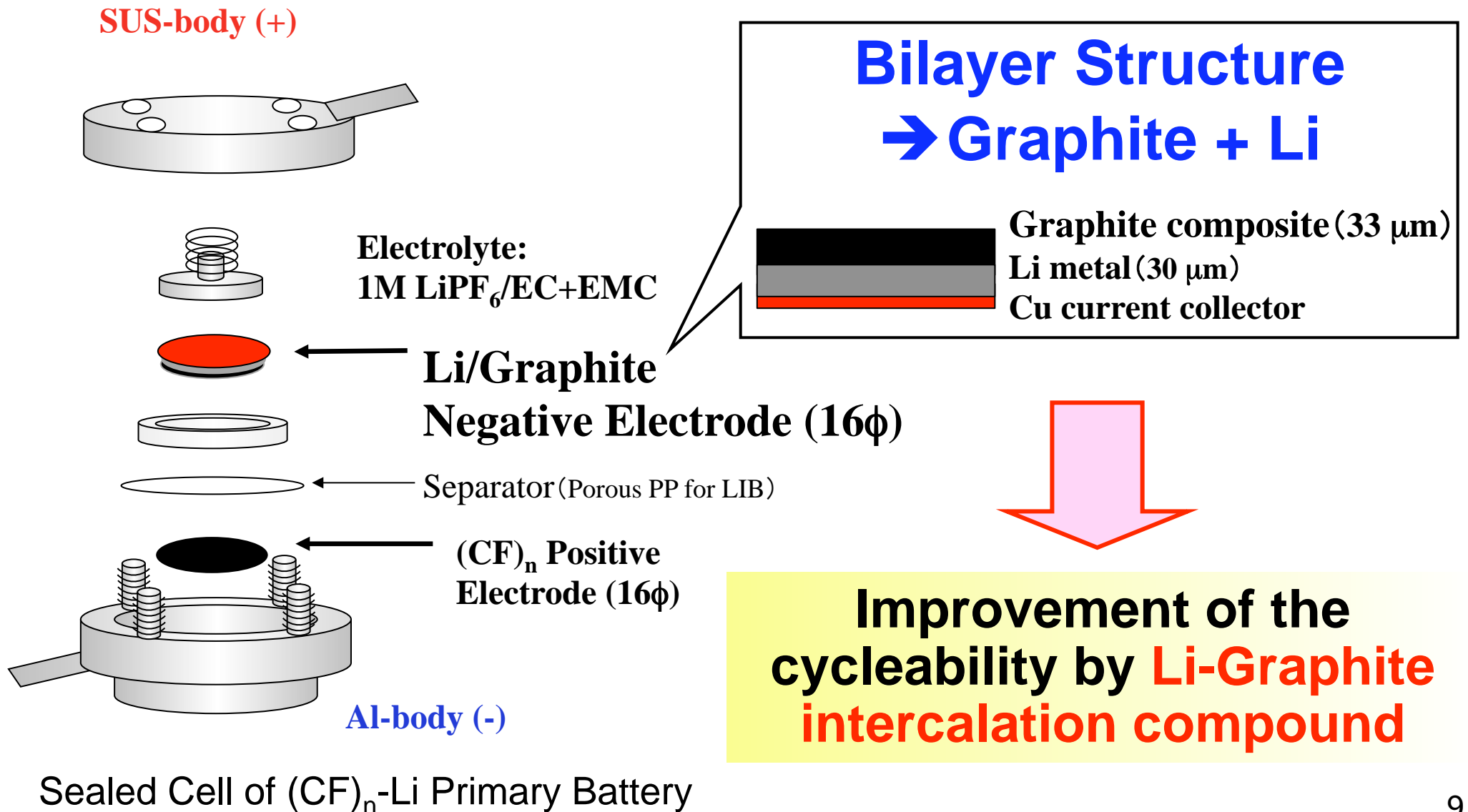


Result (Cycleability)

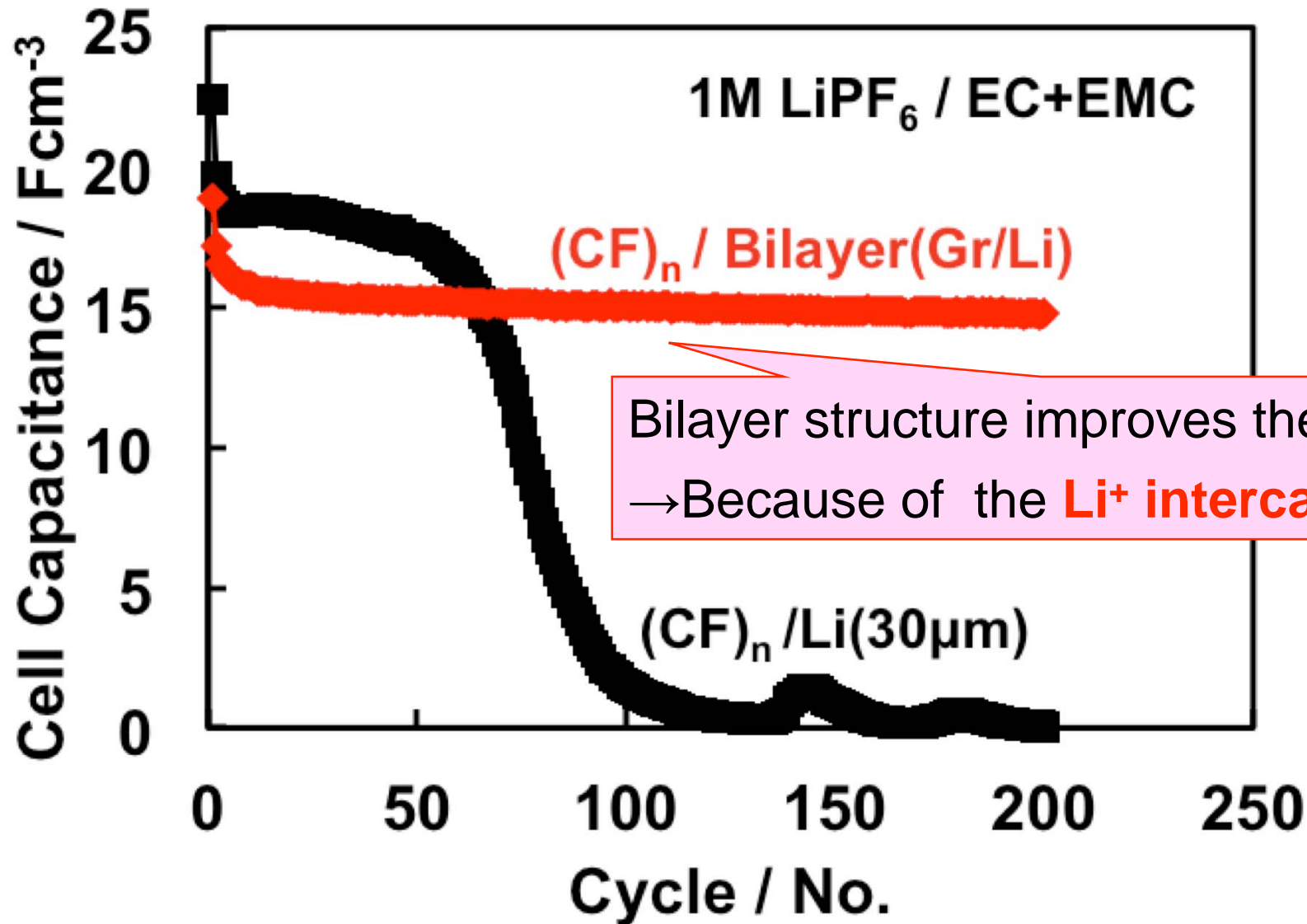
- Charge-discharge cycle performance of GF-Li capacitor is not good.
- The reason is not due to GF electrode but Li metal electrode.



Improvement of Cycle Performance



Effect of Bilayer Structure





Conclusion

1. **Discharged GF-Li primary battery** can be **charged** / discharged as capacitor.
2. This GF-Li capacitor consists of the carbon/LiF nano-composite (discharged product of primary battery) as positive electrode and Li metal negative electrode.
3. The cycle performance can be improved by using bilayer structure of Li & Graphite negative electrode.
4. The GF-Li capacitor shows higher energy density than EDLC and comparable one to LIC capacitor.