Li/$(CF)_n$ battery for low temperature and high power application

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Powering Life.™

Goal

- Develop a D-sized Li/$(CF)_n$ battery capable of high power that still retains its advantage of high capacity with 10 years of storage capability.
- Develop a D-sized Li/$(CF)_n$ battery capable of discharge at a low temperature of -30ºC.

Quallion Li / $(CF)_n$ Technology

	Current Li/$(CF)_n$ cells	Quallion Li/$(CF)_n$ cells
Material	Conventional CF_x	High surface area CF_x
Electrode	powder pressed electrodes	thin film coated electrodes
Internal Design	pellet wound	jellyroll
Electrolyte	conventional electrolyte	low viscosity electrolyte
Separator	non-woven	microporous thin film separator

- **Key elements that enable Quallion to build high power, low temperature capable Li / $(CF)_n$ cells.**

MATERIAL

Quallion CF_x

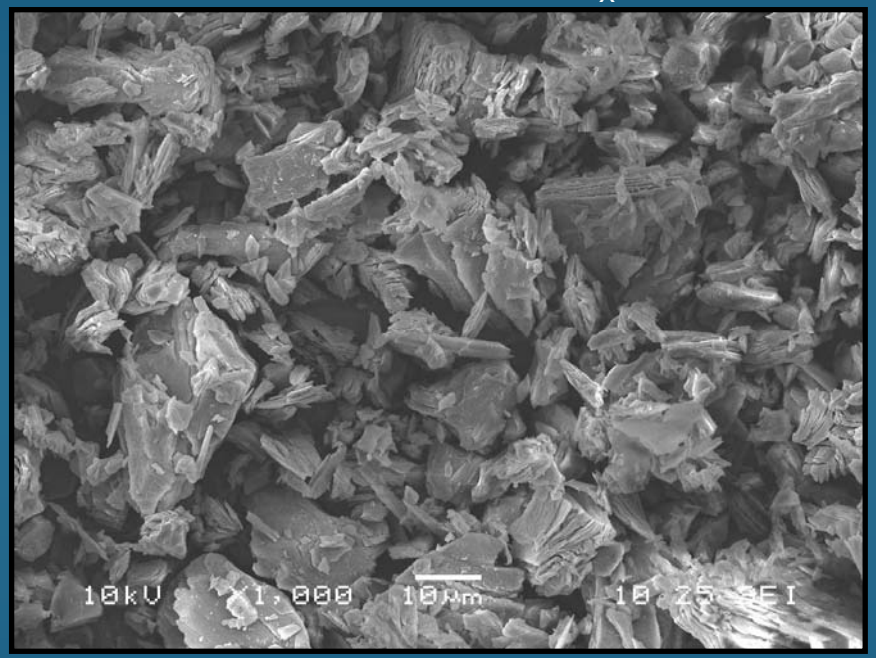
- Crystallinity of starting material
- Particle size
- Fluorination
- Bonding characteristics

➢All these factors affect the discharge characteristics of CF_x.

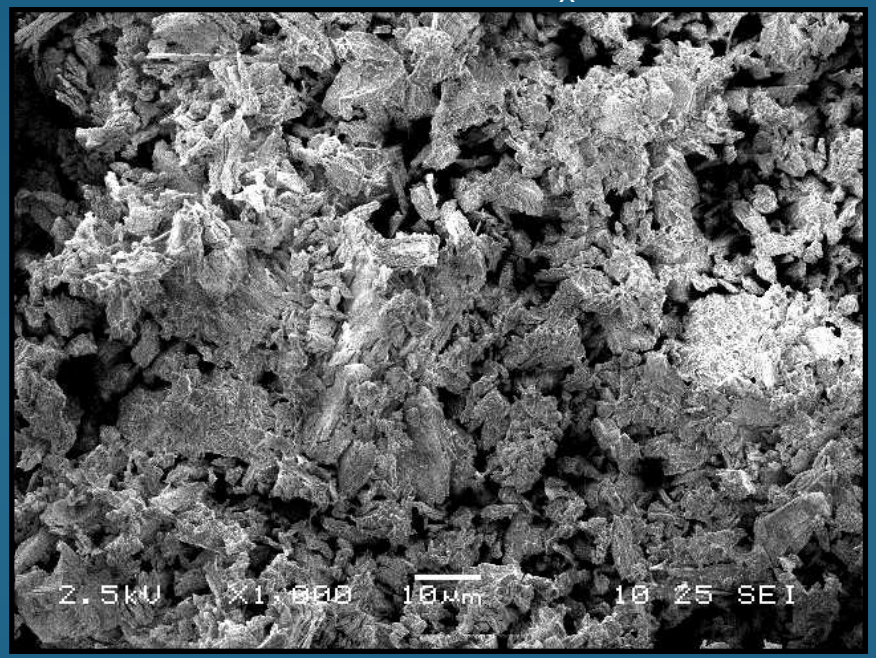
CF_x kind	Precursor	Synthesis temp
Conventional CF_x	Petroleum cokes	450°C
Quallion CF_x	Petroleum cokes, smaller precursors than conventional CF_x are used	450°C

MATERIAL
SEM Images

Conventional CF_x

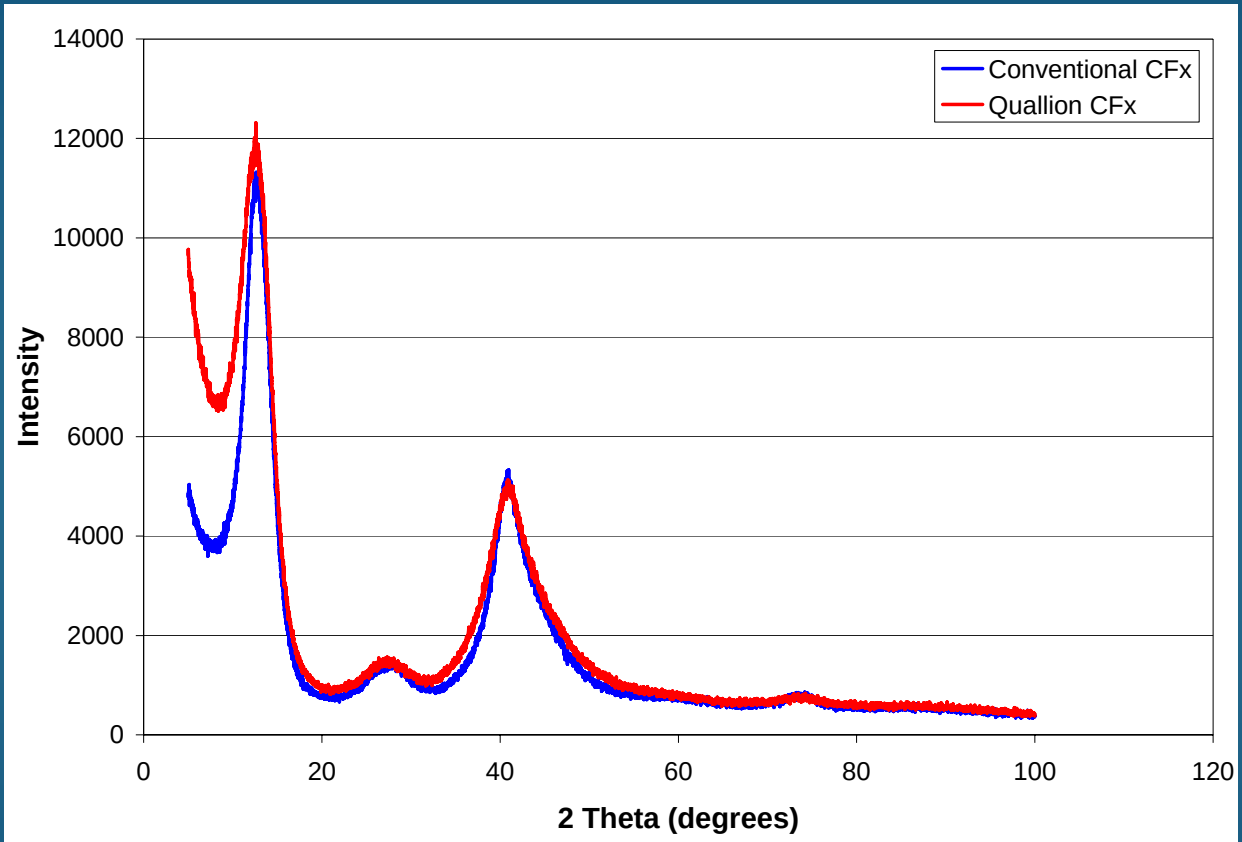


Quallion CF_x



- **Quallion CF_x has smaller particle sizes and higher surface area.**

MATERIAL
XRD Data



- **The crystallinity of Quallion's CF_x does not differ much from conventional CF_x.**

ELECTRODE

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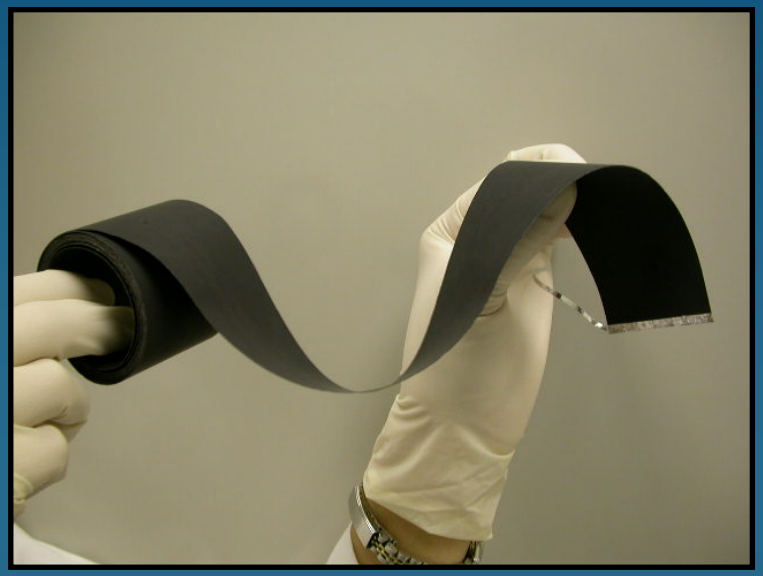
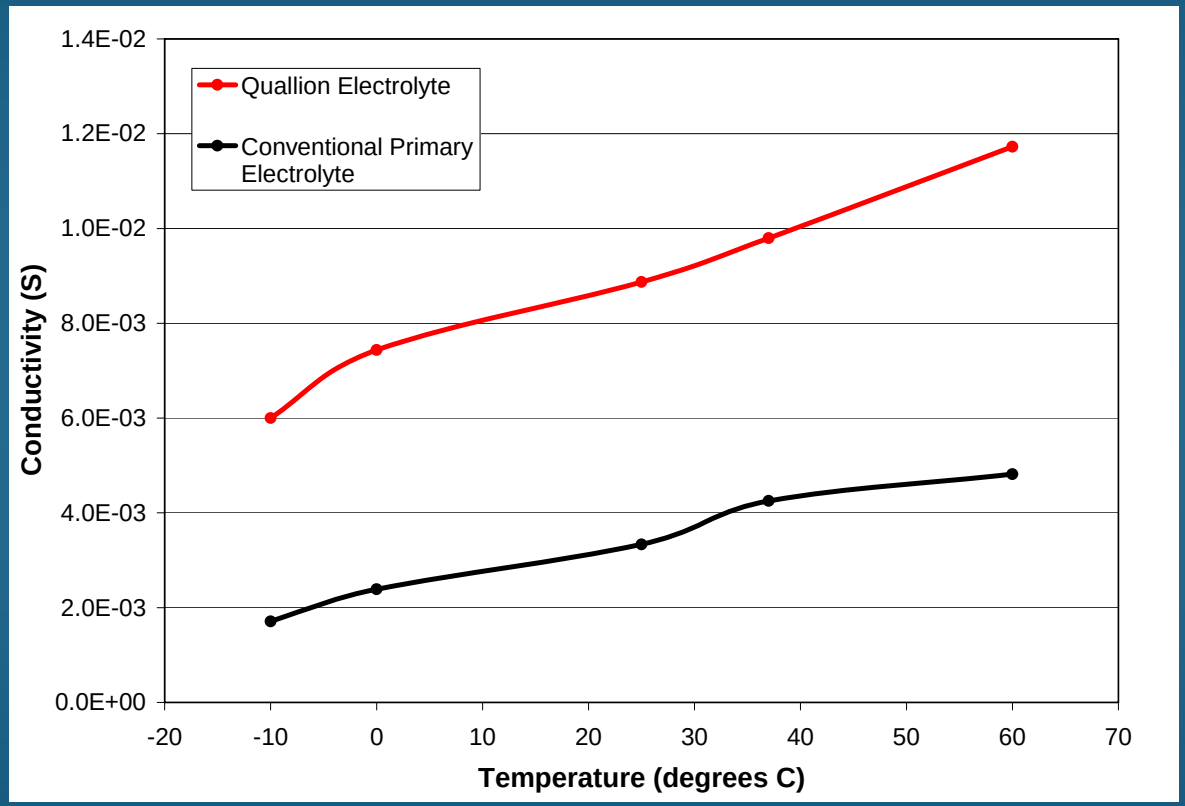
- Quallion utilizes a method of thin film coating to create flexible electrodes that can be easily wound into a jellyroll.



- The wound jellyroll design enables high power discharge of the cells.

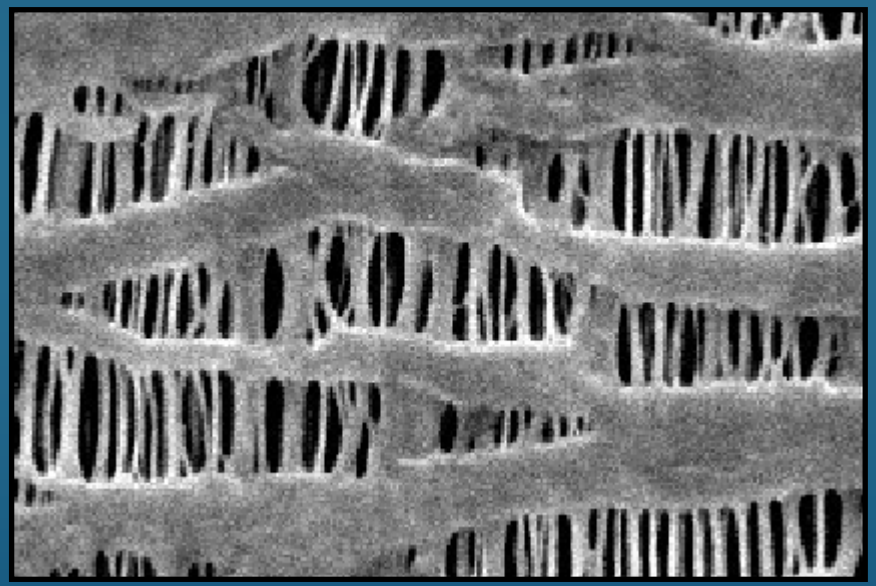
Low Viscosity Electrolyte



- **High conductivity throughout a broad range of operation temperatures.**

Separator

Microporous Polypropylene Membrane



SEM 20000x magnification

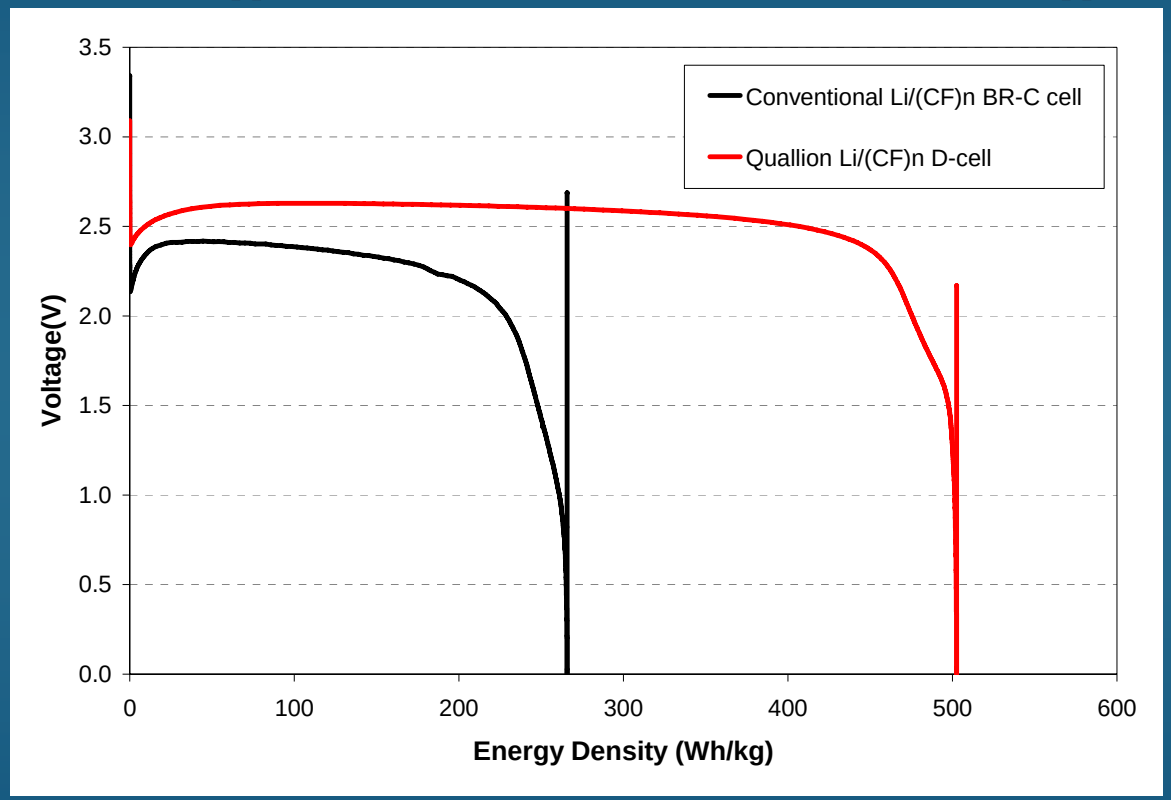
- Microporous polypropylene material
- Thin film (25 microns)
- High rate and low temperature capability

D-cell Comparison

- **Power and Temperature Tests**
  - **D-cell discharge at varying temperatures.**
  - **D-cell discharge at constant current and constant power.**

Capacity: 15 Ah
Diameter: 34 mm
Height: 60.5 mm

Discharge comparison between commercial CF_x cells and Quallion CF_x cells

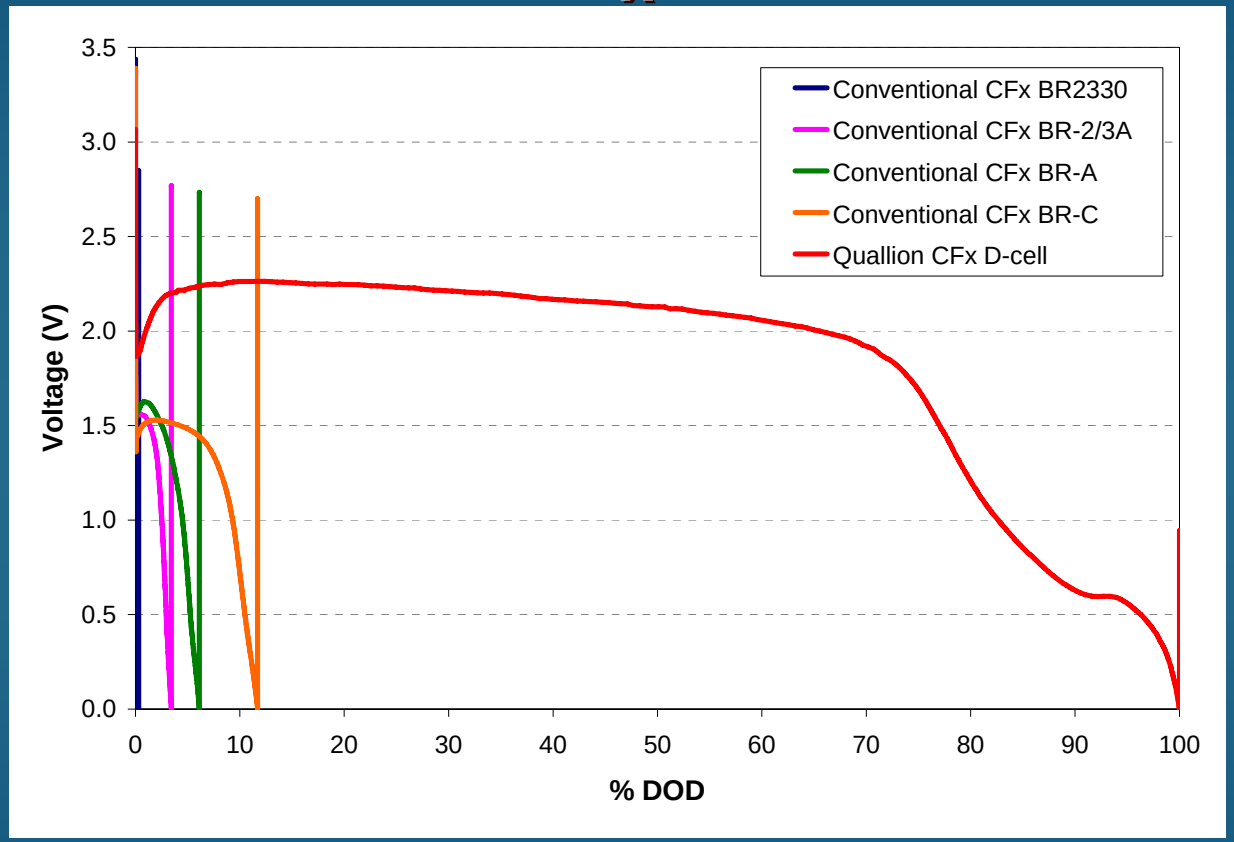


Conditions:

- 25°C
- C/7.5 Constant Current

- **The energy density of the Quallion $Li/(CF)_n$ D-cell is about double that of existing $Li/(CF)_n$ cells.**

Current CF_x Technology



Conditions:

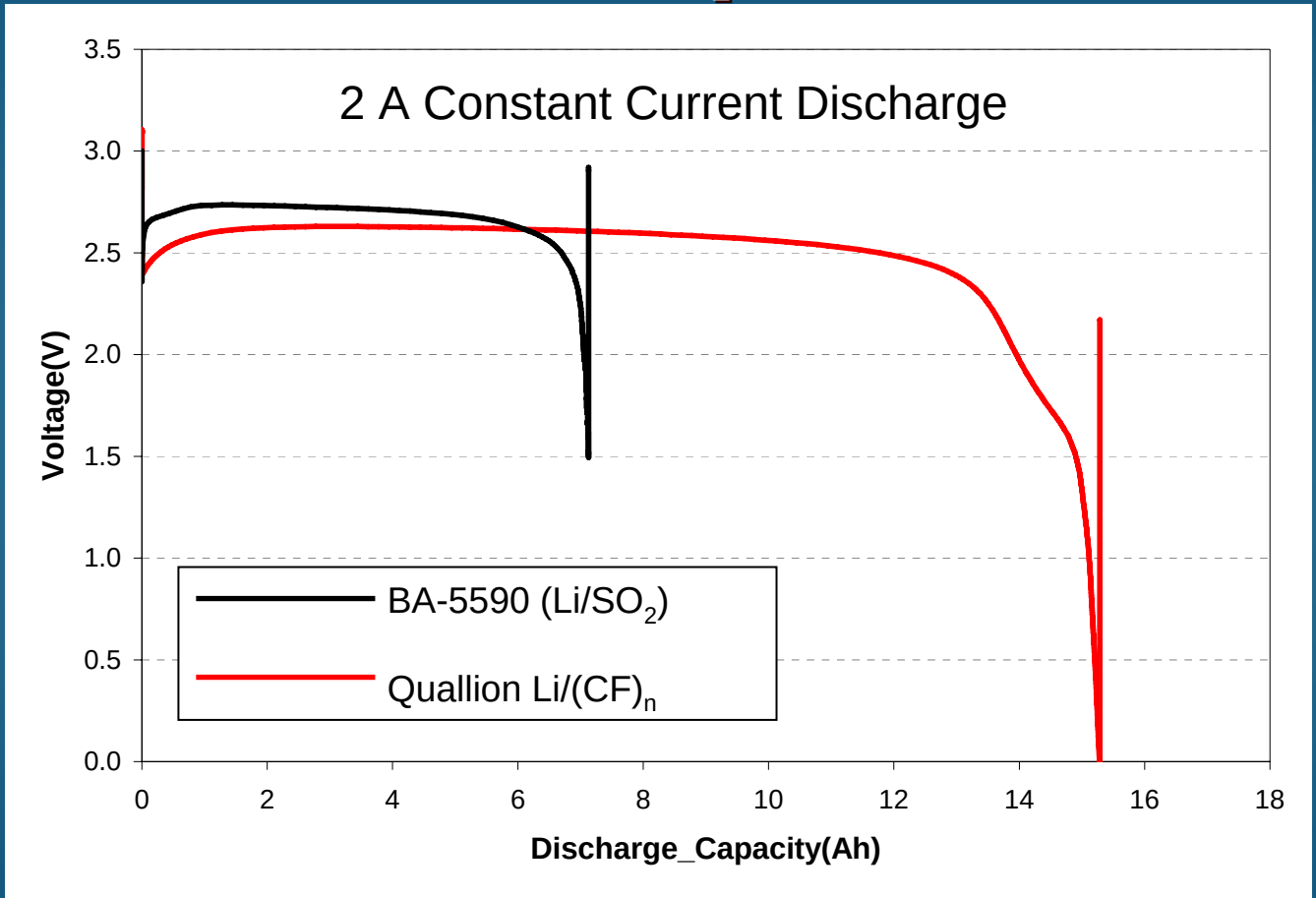
- **-30°C**
- **C/7.5 Constant Current**

- **Existing CF_x batteries are not able to operate efficiently above 2.0 V when discharged at high rates such as C/7.5 at -30°C.**
- **Quallion CF_x D-cell is operational above a 2.0 V cutoff for 65% of its capacity.**

Quallion Li/$(CF)_n$ Technology Comparison To The Current Military Battery (Li/SO_2) Technology

	D-cell Quallion Li/$(CF)_n$	BA-5590 Li/SO_2
Structure	cylindrical jellyroll	jellyroll
Case	aluminum	stainless steel
Cathode Composition	CF_x	SO_2
Anode Composition	Lithium	Lithium
Capacity (Ah)	15	7.5
Volumetric Energy Density (Wh/l)	680	350
Weight Energy Density (Wh/kg)	520	350

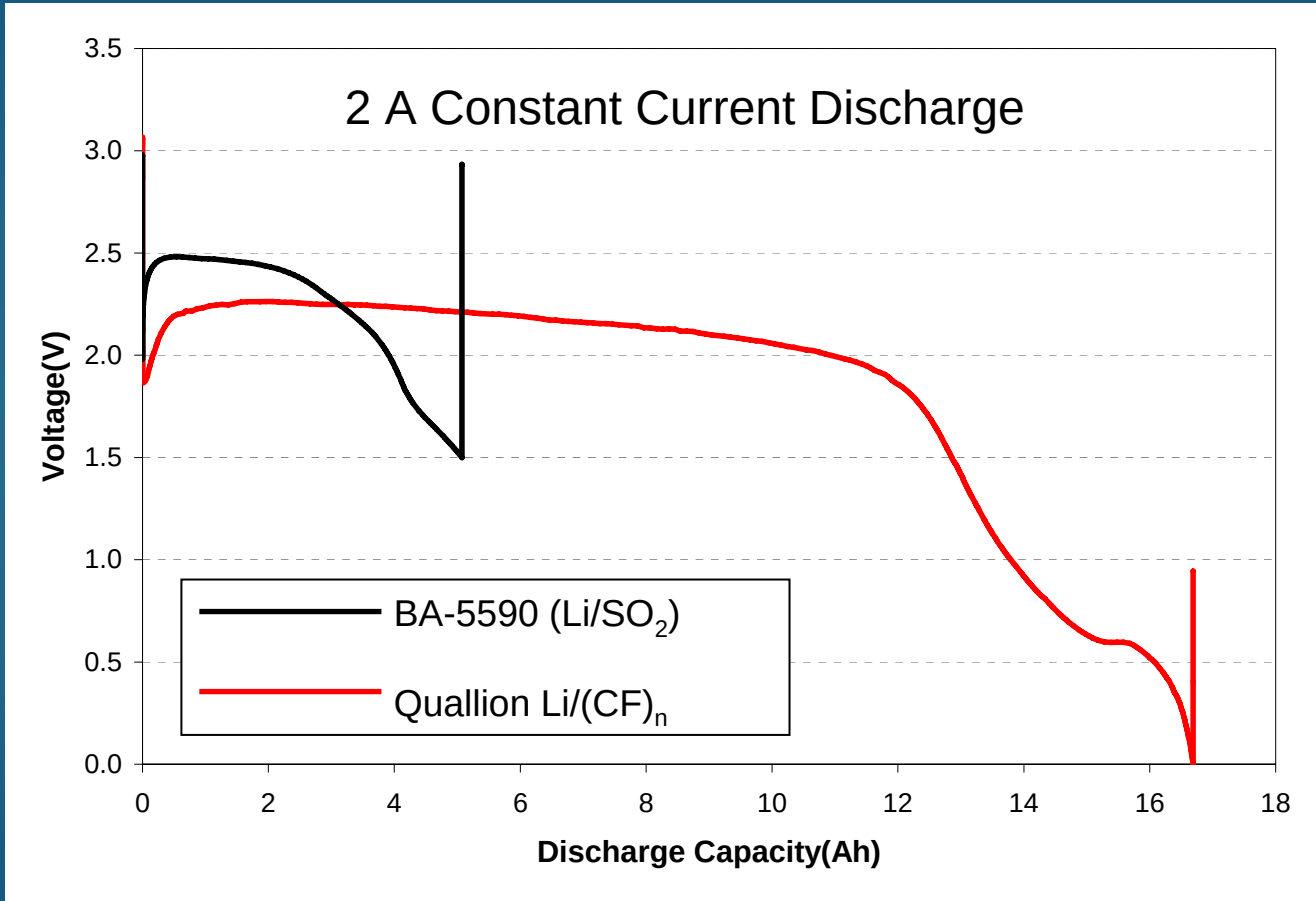
Room Temperature



- CF_x D-cell has more capacity (double) than the comparable sized SO_2 D-cell.

BA-5590 tests

-30ºC Discharge



- CF_x D-cell is capable of almost complete discharge at -30ºC.

Conclusion

- Quallion's New Li/$(CF)_n$ Battery Technology is able to double the energy density at high rate compared to conventional Li$(CF)_n$.
- Quallion's New Li/$(CF)_n$ Battery Technology doubles the capacity of the BA-X590/U Military Battery.
- Quallion's New Li/$(CF)_n$ Battery Technology is capable of discharge at -30ºC for over 65% DOD.
- New Li/CF_x technology is also applicable to cardiac applications, such as CHF devices.

Acknowledgements

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